TESTING OF A WHITE SANDS FUEL ADDITIVE USING THE TCEQ PROCEDURE FOR CERTIFICATION OF EMISSION REDUCTIONS FOR LOW EMISSION DIESEL FUELS

FINAL REPORT

SwRI Project No. 03.10664

Prepared for:

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Suite C
Scottsdale, AZ 85260

Prepared by:

E. Robert Fanick
Group Leader

January 2007

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ENGINE, EMISSIONS, AND VEHICLE RESEARCH DIVISION

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Results and discussion given in this report relate only to the test items described in this report.

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1.0 INTRODUCTION

The test results reported herein were generated by the Department of Engine and Emissions Research (DEER), Division of Engine, Emissions, and Vehicle Research at Southwest Research Institute® (SwRI®), for White Sands LLC. This study was run as SwRI Project 03.10664. The Principal Investigator and Project Leader for SwRI was Mr. E. Robert Fanick, Group Leader in DEER. SwRI technical personnel involved in engine operation, emissions sampling, and emissions analysis included Messrs. Ricky D. Frierson, Richard C. Mendez, and Johnny M. Cantu. Data reduction was performed by Ms. Sylvia G. Niño, Ms. Linda M. De Salme, and Ms. Amanda L. Korzekwa. The SwRI Project Manager for this work was Dr. Lawrence R. Smith, Manager of the Chemistry and Unregulated Emissions Section.

This report contains hot-start transient emission results obtained from a 1991 Detroit Diesel Corporation (DDC) Series 60 heavy-duty diesel engine using a reference fuel, Fuel R, and a candidate fuel, Fuel C, containing a fuel additive from White Sands LLC. This candidate fuel is called CB-LE. Fuel R met the specifications defined in the Texas Commission on Environmental Quality (TCEQ) Chapter 114 – Control of Air Pollution From Motor Vehicles, Subchapter H: Low Emission Fuels, Division 2: Low Emission Diesel. These fuels were tested following Alternative 4, as specified in the aforementioned TCEQ procedure.

2.0 EXPERIMENTAL SETUP

For testing, a 1991 DDC Series 60 (Serial No. 06R0038671) heavy-duty diesel engine was mounted in a transient-capable test cell. This engine had an inline, six-cylinder configuration rated for 365 hp at 1800 rpm. It was turbocharged and used a laboratory water-to-air heat exchanger for a charge air intercooler. Table 1 lists the engine specifications and features. The exhaust was routed to a full flow constant volume sampler (CVS) that utilized a positive displacement pump (PDP), as illustrated in Figure 1. Total flow in the tunnel was maintained at a nominal flow rate of about 2000 SCFM. Sample zone probes for total particulate (PM), heated oxides of nitrogen (NO_x), heated hydrocarbons (HC), carbon monoxide (CO), and carbon dioxide (CO_2) measurements were connected to the main tunnel. Probes for background gas measurement were connected downstream of the dilution air filter pack, but upstream of the mixing section. The dilution system was equipped with pressure and temperature sensors at various locations in order to obtain all necessary information required by the U.S. Code of Federal Regulation (40 CFR, Part 86, Subpart N).

TABLE 1. ENGINE SPECIFICATIONS AND FEATURES

Engine Parameter	Comment
Engine Serial Number	06R0038671
Make	Detroit Diesel
Model	Series 60, 6067GU60
Engine Displacement and Configuration	12.7 L, I-6
Emission Family	MDD12.7FZAK
Rated Power	365 bhp at 1800 rpm
Electronic Control Module	DDEC-II
Aspiration	Turbocharged

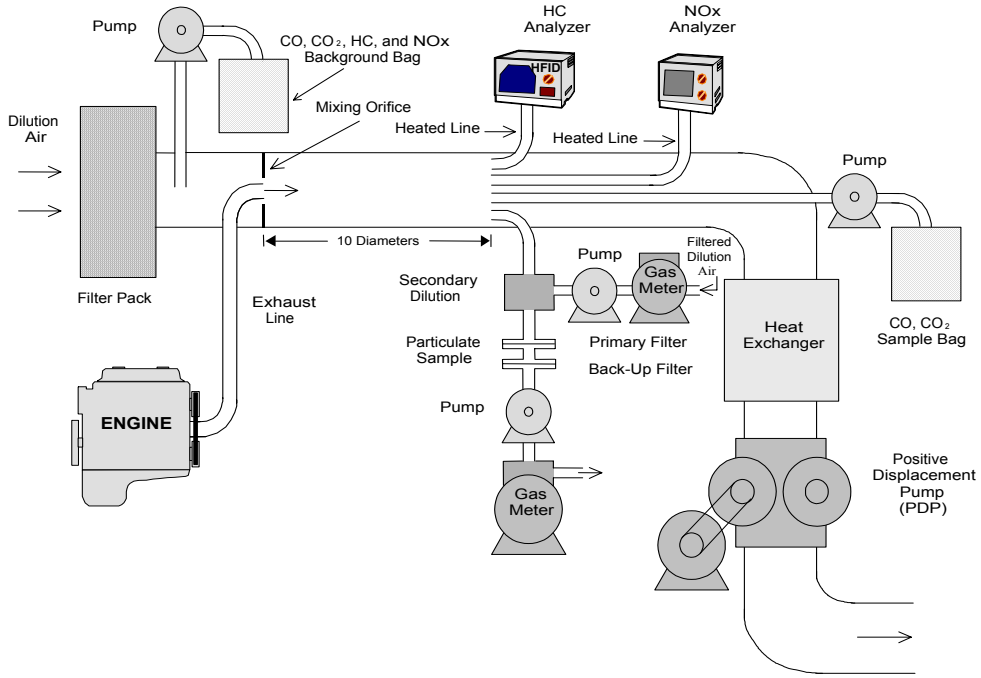

FIGURE 1. SAMPLING SYSTEM USED FOR TRANSIENT EMISSION MEASUREMENTS

3.0 DESCRIPTION OF FUELS TESTED

The ultra-low sulfur diesel (ULSD) reference fuel, Fuel R (SwRI Code EM-6144-F), met the compositional, chemical, and physical specifications described in TCEQ Chapter 114 – Control of Air Pollution From Motor Vehicles, Subchapter H: Low Emission Fuels, Division 2: Low Emission Diesel, §114.315. Approved Test Methods. This fuel was obtained from Halterman Products by White Sands LLC. The ULSD untreated diesel blend stock (SwRI Code EM-6067-F) was also obtained from Halterman Products by White Sands LLC. This fuel was treated with CB-LE additive; and the resulting fuel, Fuel C, was then identified as SwRI Code EM-6179-F.

To prepare Fuel C, 143.5 gals of the untreated diesel blend stock (EM-6067-F) were placed in a new 275 gallon tote provided by White Sands LLC for blending a single homogeneous batch of fuel. This blend stock was treated with CB-LE additive in the presence of a TCEQ observer, Clifford Tyree. To prepare a single batch of CB-LE additive, the individual components were weighed using a gravimetric balance accurate to 0.01 g. The smaller quantity component was added to the larger one, and the container was shaken thoroughly after the addition. This CB-LE additive was then added to the untreated diesel blend stock at a concentration of 8.416 g. per gallon and blended for one hour with a circulating pump. Fuel C (EM-6179-F) was transferred into individual 55 gallon drums. A "chain of custody" for the fuels and fuel components is included in Appendix A. Selected fuel properties for the reference fuel, the untreated diesel blend stock used to prepare the candidate fuel, and the candidate fuel are presented in Table 2.

Fuel C was analyzed for total nitrogen to determine the concentration of one of the additives, 2-ethylhexylnitrate. The average nitrogen concentration of Fuel C was 170 ppm by mass for three samples. The average nitrogen concentration for the untreated diesel blend stock (EM-6067-F) was 2.9 ppm by mass. By subtracting the untreated diesel blend stock nitrogen concentration from the Fuel C nitrogen concentration, the difference is the increase from the additive, or 167 ppm by mass. An analysis for other parts of the additive is pending and will be submitted in a separate report.

TABLE 2. FUEL ANALYSIS RESULTS

Fuel Code	Test Method	Reference Fuel Specifications	Reference Fuel EM-6144-F	Untreated Fuel Specifications	Untreated Fuel EM-6067-F			Treated Candidate Fuel EM-6179-F		
					1	2	3	1	2	3
Sulfur, ppm	D5453	15 max.	4	15 max.	10.1	9.9	9.5	11.5	11.4	11.3
Aromatics, vol %	D5186	10 max.	9.5	28-36	28.3	28.7	28.9	28.9	28.9	29.0
Polycyclic Aromatics, wt. %	D5186	1.4 max.	0.7	NA[a]	2.6	3.0	3.2	3.3	3.2	3.2
Nitrogen, ppm	D4629	10 max.	3.1	NA	2.7	2.9	3.1	172	171	168
Cetane Number	D613	48 min.	54.5	43-49	50.1[b]	50.4[b]	51.3[b]	56.4	56.9	56.5
API Gravity	D287	33-39	38.2	32-39	36.3	36.1	36.1	36.1	36.0	36.1
Flash Point, °F	D93	130 min.	164	NA	165	162	162	164	165	165
Viscosity @ 40°C, cSt	D445	2.0-4.1	2.397	NA	2.263	2.279	2.397	2.302	2.282	2.278
Ash, % mass	D482	0.01	<0.001	NA	<0.001	<0.001	<0.001	<0.001		
Cloud Point, °C	D2500	NA	-31	NA	-21	-20	-21	-19		
Copper Strip Corrosion	D130	No. 3	1B	NA	1B	1B	1B	1B		
Water & Sediment, vol %	D2709	0.05	0.01	NA	0.01	0.01	0.10	0.01		
Ramsbottom, wt %	D524	0.35	0.04	NA	0.1	0.1	0.1	0.12		
IBP, °F	D86	340-420	359	340-400	359	358	357	354	352	358
10%, °F		400-490	402	400-460	397[b]	395[b]	398[b]	395	394	398
50%, °F		470-560	487	470-540	482	481	482	483	479	483
90%, °F		550-610	567	560-630	589	587	586	588	587	587
EP, °F		580-660	608	610-690	635	635	633	632	630	633

[a]NA-Not applicable
[b]Parameter does not meet the untreated fuel specification

4.0 TEST PLAN AND TEST PROCEDURES

A test plan utilizing Alternative 4 of the TCEQ procedure for certification of emission reductions for alternative diesel fuels was submitted to TCEQ for approval and was subsequently approved by TCEQ for this work. Alternative 4 calls for the test sequence to include nine (9) hot-start tests with Fuel R to serve as the baseline, a conditioning period not to exceed 72 hours of engine operation with Fuel C, nine (9) hot-start tests with Fuel C to determine the effect of the additive, and a final set of six (6) hot-starts with Fuel R to determine if the engine emissions and fuel consumption rates returned to their original baseline levels. For this study, only 8 hours of durability were performed with Fuel C at the request of White Sands LLC and with the approval of TCEQ. The durability cycle utilized for operating the Detroit Diesel engine for 8 hours was a durability cycle used by Cummins for aging and engine deterioration factor determinations. This cycle was selected to represent normal engine operation. Table 3 describes the durability cycle used in this project. Prior to each set of three hot-start tests, a power validation and torque map were performed with the initial engine map used as the reference map for all subsequent testing. At the completion of testing, each individual test was considered for use in statistically comparing the two fuels. All transient emission tests were conducted according to the EPA Federal Test Procedure (FTP) specified in CFR 40, Part 86, Subpart N. The first run with Fuel R was used to generate the transient command cycle that was used for all subsequent emission tests.

TABLE 3. CUMMINS DURABILITY CYCLE FOR AGING AND ENGINE DETERIORATION FACTOR DETERMINATION

Cycle Description	Time, sec.
Idle	144
Peak Torque	36
Rated Power	360
High Idle	36
Rated Power	144
Transition to Peak Torque	36
Peak Torque	108
High Idle	36
Total	900

The test protocol was transformed into a specific test sequence as outlined in Table 4. Regulated emissions of HC, CO, CO_2, NO_x, and PM were measured along with CO_2. Procedures for the measurements of HC, CO, CO_2, NO_x, and PM are described in 40 CFR Subpart N, Part 86. The actual pattern for running Alternative 4 is shown in Table 5.

The EPA transient cycle is described by means of percent of maximum torque and percent of rated speed for each one-second interval over a test cycle of 1199 seconds duration. To generate a transient cycle, an engine's full power curve is obtained from an engine speed below curb idle speed to maximum no-load engine speed. Data from this "power curve" or engine map are used with the specified speed and load percentages to form a transient cycle. A graphic presentation of the speed and torque commands which constitute a transient cycle is given in Figure 2 for illustration purposes.

TABLE 4. PROCEDURE FOR ACCUMULATING REGULATED EMISSIONS DATA USING ALTERNATIVE 4 OF THE TCEQ PROTOCOL

Step	Description
1	Install engine. Perform emission instrument calibrations as required. Calibrate torquemeter and check signal conditioning systems. Validate CVS gaseous and particulate sampling systems using propane recovery techniques.
2	Check engine condition using Fuel R, and note fault codes if any. Bring engine oil level to "full" using the manufacturer's recommended oil.
3	Perform fuel change procedure to operate on Fuel R. Change filter, purge fuel supply, etc.
4	Warm up engine, and operate at rated speed and load, then check performance.
5	Conduct transient "full-throttle" torque map from low- to high-idle. Compute and store resulting transient command cycle. (Note: The initial transient command cycle with Fuel R was used for all subsequent emission tests in this test plan. Other torque-map information generated with either Fuels R or C during this test work was included for documentation purposes.)
6	Run two 20-minute practice or conditioning transient cycles without a 20-minute soak between cycles, and adjust dynamometer controls to meet statistical limits for transient cycle operation.
7	Soak the engine for 20-minutes. Run three hot-start transient tests with a 20-minute soak between each. For each individual hot-start test, determine THC, CO, NO_x, and PM.
8	Repeat Steps 4 through 7 two additional times.
9	Blend Fuel C according to written directions from White Sands LLC. Perform fuel change to Fuel C. Operate the engine for 8 hours using the Cummins durability cycle for aging and engine deterioration factor determination.
10	Repeat Steps 4 through 8.
11	Perform fuel change to Fuel R. Repeat Steps 4 through 7 two additional times.
12	Summarize data and prepare the final report.

In general, a transient test consists of a cold-start transient cycle and a hot-start transient cycle. The same engine command cycle is used in both cases. For the cold-start, the diesel engine is operated over a "prep" cycle, and then allowed to stand overnight in an ambient soak at a temperature between 68 and 86°F. The cold-start transient cycle begins when the engine is cranked for cold start-up. Upon completion of the cold-start transient cycle, the engine is stopped and allowed to stand for 20 minutes. After this hot-soak period, a hot-start cycle begins with engine cranking. In order to determine how well the engine followed the transient command cycle, engine performance is compared to engine command, and several statistics are computed. These computed statistics must be within tolerances specified in the CFR. In addition to the statistical parameters, the cycle work actually produced should be between 5 percent above and 15 percent below the work requested by the command cycle. The first five

TABLE 5. ACTUAL PATTERN OF RUNS USING ALTERNATIVE 4

Test Day	Hot Start Transient							
	Fuel	Test Number			Fuel	Test Number		
1	R	1	2	3	R	4	5	6
2	R	7	8	9				
Engine operation for 8 horus								
3	C	10	11	12	C	13	14	15
4	C	16	17	18	R	19	20	21
6	R	22	23	24				

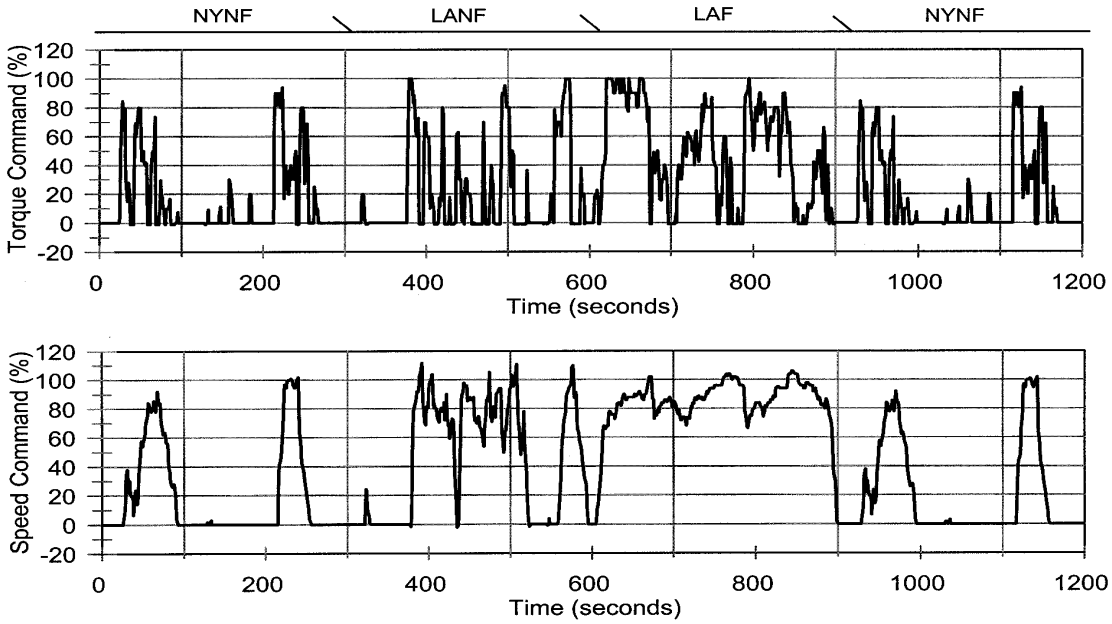

FIGURE 2. GRAPHIC REPRESENTATION OF TORQUE AND SPEED COMMANDS FOR THE TRANSIENT CYCLE FOR HEAVY-DUTY ENGINES

minutes of the cycle is designated as the New York Non-Freeway (NYNF) portion of the test and represents city operation with extensive idle time. The second five minutes is called the Los Angeles Non-Freeway (LANF) portion. This part of the test also represents city operation, but without the excessive idle time. The third five minute section of the test is called the Los Angeles Freeway (LAF) portion. This part is more representative of higher speed conditions

indicative of freeway operation. The final five minutes of the EPA transient cycle is a repeat of the NYNF portion. These four parts are combined to give the EPA transient cycle.

5.0 RESULTS

Results for the baseline transient torque map that was generated with Fuel R and used as the reference map for all subsequent transient runs are given in Table 6. Table 6 also contains the torque map data for Fuel C and data for the repeat maps with Fuel R. The results indicate that engine performance characteristics were consistent throughout the testing. Figure 3 shows a graphical representation of the torque map data for both fuels. More detailed data on the calibration, zero, and span information for the individual tests; the NO_x calibration curve performed on January 5, 2007; the detailed engine performance data (power validation and torque map data); and other required information according to 40 CFR 86-1344-94(c) is given in Appendix A.

TABLE 6. SUMMARY OF TRANSIENT TORQUE MAPS OBTAINED WITH THE 1991 DETROIT DIESEL SERIES 60 HEAVY-DUTY DIESEL TEST ENGINE

Engine Speed, rpm	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800
Initial Tests with Fuel R													
First Map, lb-ft[a]	618	664	779	911	1048	1203	1396	1328	1253	1206	1159	1109	1046
Second Map, lb-ft	618	674	791	908	1043	1200	1399	1334	1255	1203	1160	1108	1044
Third Map, lb-ft	632	682	802	915	1057	1203	1406	1344	1265	1213	1169	1118	1053
Fuel C													
First Map, lb-ft	621	677	804	908	1055	1202	1401	1342	1265	1211	1164	1120	1058
Second Map, lb-ft	632	689	808	915	1061	1211	1411	1348	1267	1216	1172	1121	1061
Third Map, lb-ft	637	691	809	928	1067	1216	1418	1353	1272	1222	1177	1127	1067
Final Tests with Fuel R													
First Map, lb-ft	628	674	796	910	1052	1198	1397	1335	1260	1209	1163	1112	1052
Second Map, lb-ft	628	681	801	911	1055	1209	1404	1349	1267	1212	1169	1119	1053

Idle speed: 600 rpm, rated speed: 1800 rpm.
[a] This map was used as reference for all subsequent transient cycles.

During steady-state performance checks, the 1991 DDC Series 60 engine had a maximum power of 360 hp at a rated speed of 1800 rpm with Fuel R for the initial baseline, and 362 hp and 364 hp for the two repeat tests with Fuel R; a maximum power of 366 hp for each of the three tests with Fuel C; and a maximum power of 366 hp and 368 hp for the final two baseline tests with Fuel R. Peak torque at 1200 rpm was 1412 lb-ft, 1415 lb-ft, and 1425 lb-ft on Fuel R for the initial baselines; 1420 lb-ft, 1424 lb-ft, and 1450 lb-ft on Fuel C; and 1420 lb-ft and 1428 lb-ft for the final baseline tests with Fuel R. No operational problems were observed.

Table 7 gives emission results for HC, non-methane hydrocarbons (NMHC), CO, NO_X, PM, and brake specific fuel consumption (BSFC) obtained for each of the tests. The average, standard deviation, and coefficient of variation for each set of nine hot-start transient tests are also included for each fuel. Detailed results are given in Appendix B. (Please note that while averages, standard deviations, and coefficient of variations were calculated for the six hot-start tests with Fuel R that followed the Fuel C testing, the data were not utilized in subsequent calculations as these tests were only conducted to determine if there were any residual effects from the additive.)

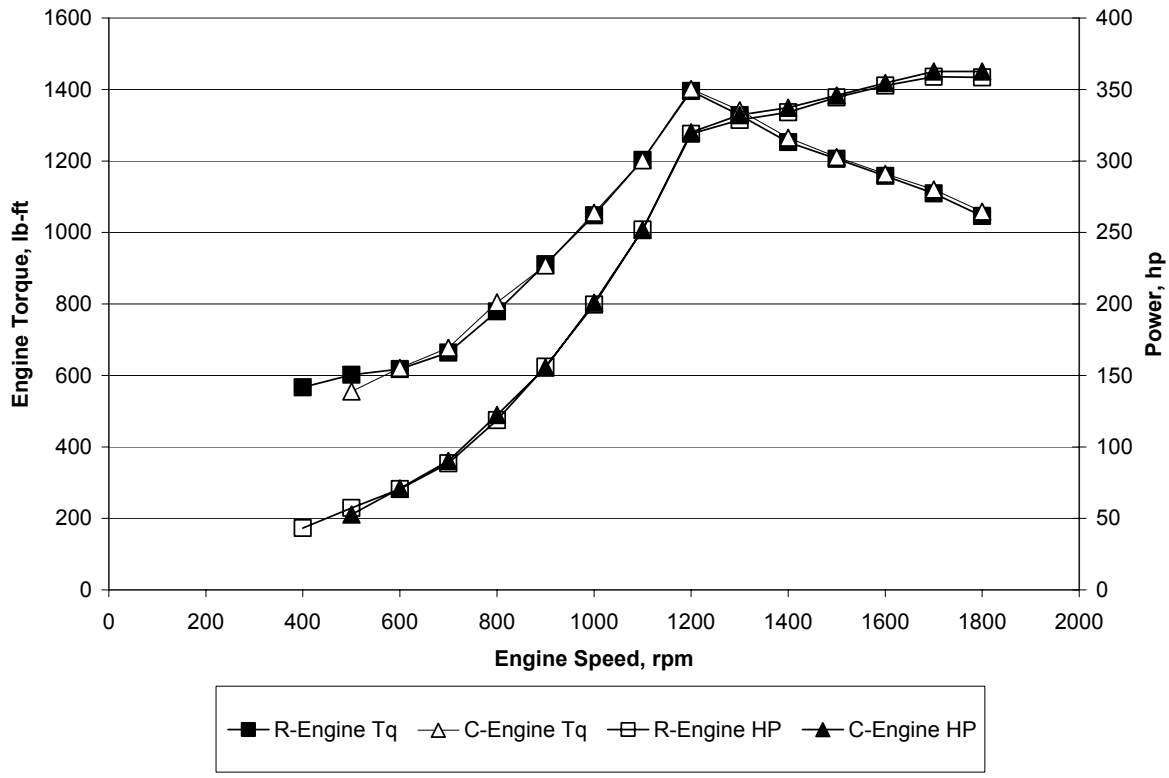

FIGURE 3. ENGINE PERORMANCE USING FUELS R AND C

Table 8 shows the statistical approach for comparing the emission results. With this approach, the average emissions from the nine individual tests with the candidate fuel, "Fuel C" (X_C), were compared to the average emission results for nine individual tests with the average reference fuel, "Fuel R" (X_R), by using the one-side t distribution as given in TCEQ Chapter 114, Control of Air Pollution From Motor Vehicles, Subchapter H: Low Emission Fuels, Division 2: Low Emission Diesel, §114.315, Approved Test Methods. The average term for the reference fuel for each emission was adjusted by the tolerance (1 percent of the average for NO_x and 2 percent of the average for HC, NMHC, CO, and PM) and by a value that included:

- Pooled standard deviation, S_p
- Square root of two divided by the number of tests, n, for both reference plus candidate (in this case, n = 18)
- One-sided upper percentage point of t distribution with a = 0.15 and 2n-2 degrees of freedom

The equation for this comparison is:

$$X_C < X_R + \delta - (S_p \times \sqrt{(2/n)} \times t(a, 2n\text{-}2))$$

TABLE 7. SUMMARY OF REGULATED EMISSIONS

Test Number	Test Date	Transient Emissions, g/hp-hr					BSFC, lb/hp-hr	Work, hp-hr
		HC	NMHC	CO	NO_x	PM		
R1	1/15/2007	0.066	0.065	2.948	4.739	0.232	0.381	23.77
R2	1/15/2007	0.084	0.082	2.944	4.700	0.231	0.380	23.98
R3	1/15/2007	0.083	0.081	2.906	4.925	0.230	0.383	23.86
R4	1/15/2007	0.094	0.092	2.970	4.610	0.228	0.376	24.01
R5	1/15/2007	0.085	0.083	3.009	4.708	0.233	0.380	23.94
R6	1/15/2007	0.086	0.084	2.945	4.684	0.236	0.375	24.02
R7	1/16/2007	0.088	0.086	2.909	4.578	0.222 (0.220)[a]	0.377	23.95
R8	1/16/2007	0.083	0.081	2.865	4.631	0.216 (0.212)[a]	0.378	23.92
R9	1/16/2007	0.095	0.093	2.892	4.658	0.222 (0.218)[a]	0.378	23.85
	Mean	0.085	0.083	2.932	4.691	0.228 (0.227)[a]	0.379	23.94
	Std. Dev	0.008	0.008	0.044	0.102	0.007 (0.008)[a]	0.002	0.09
	% COV	9.9%	9.9%	1.5%	2.2%	2.9% (3.6%)[a]	0.6%	0.4%
C10	1/18/2007	0.073	0.071	2.813	4.741	0.226	0.379	24.03
C11	1/18/2007	0.075	0.074	2.818	4.754	0.227	0.377	24.03
C12	1/18/2007	0.072	0.071	2.816	4.727	0.232	0.378	24.04
C13	1/18/2007	0.071	0.070	2.886	4.739	0.233	0.381	24.02
C14	1/18/2007	0.075	0.074	2.838	4.700	0.230	0.380	23.87
C15	1/18/2007	0.074	0.073	2.832	4.689	0.226	0.377	24.05
C16	1/18/2007	0.072	0.071	2.873	4.703	0.234	0.379	23.85
C17	1/18/2007	0.070	0.069	2.854	4.688	0.233	0.376	24.07
C18	1/18/2007	0.076	0.075	2.835	4.670	0.228	0.378	24.04
	Mean	0.073	0.072	2.841	4.712	0.230	0.378	24.00
	Std. Dev	0.002	0.002	0.026	0.029	0.003	0.002	0.08
	% COV	2.7%	2.8%	0.9%	0.1%	1.4%	1.4%	0.3%
R19	1/19/2007	0.076	0.074	2.977	4.557	0.231	0.382	23.84
R20	1/19/2007	0.073	0.072	2.965	4.562	0.235	0.381	23.79
R21	1/19/2007	0.075	0.074	2.951	4.517	0.234	0.378	24.02
R22	1/19/2007	0.070	0.069	3.059	4.552	0.229	0.380	24.04
R23	1/19/2007	0.076	0.074	3.003	4.523	0.233	0.377	24.03
R24	1/19/2007	0.064	0.063	3.030	4.551	0.228	0.379	24.03
	Mean	0.072	0.071	2.998	4.544	0.232	0.380	23.96
	Std. Dev	0.005	0.005	0.041	0.019	0.003	0.002	0.11
	% COV	6.5%	6.5%	1.4%	0.4%	1.2%	0.5%	0.5%

[a]Data in parenthesis were for filters that were reweighed at the request of White Sands LLC

Values presented in Table 8 were based on a spreadsheet calculation provided by TCEQ. If the average for the candidate fuel is less than the adjusted average for the reference fuel, then the candidate fuel is comparable or better than the reference fuel. It should be noted that the particulate filters taken during test numbers R7, R8, and R9 were reweighed at the request of White Sands LLC. These filters were weighed initially after conditioning for about 24 hours after collection, and the reweigh occurred prior to the 80 hour filter conditioning limit allowed by 40 CFR Part 86 Subpart N, §86.1339-90. Both sets of data have been included in Tables 7 and 8 for comparison.

TABLE 8. COMPARISON OF EMISSIONS USING TCEQ STATISTICAL CRITERIA

	HC	NMHC	CO	NO_x	PM
Number of Test Points, n [a]	18	18	18	18	18
R Average, X_R [b]	0.085	0.083	2.892	4.693	0.227 (0.228)[c]
C Average, X_c [b]	0.073	0.072	2.841	4.712	0.230
Pooled Std. Dev., Sp [b]	0.002	0.002	0.036	0.074	0.006 (0.005)[c]
Degrees of Freedom, df [d]	34	34	34	34	34
Student's t, t [e]	1.052	1.052	1.052	1.052	1.052
Tolerance Level [f]	0.002	0.002	0.059	0.047	0.005 (0.005)[c]
Adjusted R Average , Adj. X_R [g,b]	0.084	0.083	2.978	4.713	0.230 (0.231)[c]
Is X_c < Adj. X_R	Yes	Yes	Yes	Yes	No (Yes)[c]
Percent Reduction, r [h]	13.4	13.4	1.5	0.02	-0.4 (0.3)[c]

[a] For Alternative 4, n = number of tests (reference plus candidate)
[b] Units are in g/hp-hr
[c] Results for reweigh of filters for Tests R7, R8, and R9
[d] df = 2(n - 1)
[e] One-sided student's t for 2n - 2 degrees of freedom and significance level of 0.15.
[f] Tolerance level is 1 percent for NO_x and 2 percent for HC, NMHC, CO, and PM
[g] Adj. $X_R = X_R + \delta - (S_p \times \sqrt{(2/n)} \times t(a, 2n-2))$ where t(a,2n - 2) is 1.052
[h] Negative values indicate greater emissions

6.0 SUMMARY

This test program was conducted for White Sands LLC by the DEER at SwRI. The reference fuel (Fuel R) and the candidate fuel (Fuel C) were compared using hot-start transient tests run on a 1991, DDC Series 60 heavy-duty diesel engine following Alternative 4 using nine (9) hot-start tests with Fuel R, nine (9) hot-start tests with Fuel C, and six (6) hot-start tests as specified in the (TCEQ) Chapter 114 – Control of Air Pollution From Motor Vehicles, Subchapter H: Low Emission Fuels, Division 2: Low Emission Diesel and the test plan provided by Whites Sands LLC.

The average emission results for PM and NO_x using the candidate alternative diesel fuel were compared to the adjusted average emission results using the reference diesel fuel. The candidate fuel was found to decrease the NO_x emissions by 0.02 percent when compared to the reference fuel. The PM emissions were decreased by 0.3 percent if the second filter weights were included and increased by 0.4 percent if only the initial weights were used. If the average of the two sets of filter weights were utilized, then the average PM emissions were increased by 0.0001 g/bhp-hr. Average HC, NMHC, and CO emissions were lower with the candidate fuel than with the reference fuel (13, 13, and 1.5 percent lower, respectively). Additional interpretation of the data has been left to White Sands LLC.

APPENDIX A TEST INFORMATION

Fuel Sample Chain of Custody
Calibration, Zero, and Span Information for Hydrocarbons
Calibration, Zero, and Span Information for Oxides of Nitrogen
Calibration, Zero, and Span Information for Carbon Monoxide
Calibration, Zero, and Span Information for Carbon Dioxide
NO_x Calibration Curve (1/5/07)
Power Validation and Torque Map Data for a 1991 Detroit Diesel Series 60
Detailed Test Information with Reference Fuel and with CB-LE from White Sands LLC

APPENDIX 1: "CHAIN OF CUSTODY" FORM FOR CANDIDATE SAMPLES TESTING

1.1 Candidate Fuel Dosing

A. Total quantity of candidate fuel [EM-6067-F] measured: 143.51 gals (e.g. 150.0 gals)

B. Total quantity of CB-LE additive blended into candidate fuel: 1207.78 grams (e.g. 1262.4g)

Measurements by: (SwRI) [signature] sign E ROBERT FANCK print 1/15/07 date

TCEQ Observer: C D Tyree sign C D Tyree print Jan 15, 2007 date

1.2 Obtaining Fuel Samples

C. Quantity of reference fuel [#EM-6144-F] sampled: 1 gals (e.g. 1.0 gals)
Sample number assigned: EM-6144-F

D. Quantity of untreated candidate fuel [EM-6067-F] sampled: 3 gals (e.g. 1.0 gals)
Sample numbers assigned: EM-6067-F

E. Quantity of treated candidate fuel [EM-6067-F+CB-LE] sampled: 3 gals (e.g. 1.0 gals)
Sample numbers assigned: EM-6179-F

SAMPLES TAKEN 1/15/07 SENT FOR ANALYSIS 1/17/07

Sampled by: (SwRI) [signature] sign E. ROBERT FANCK print 1/17/07 date

TCEQ Observer: C D Tyree sign C. Tyree print Jan 17, 07 date

1.3 Accepting Fuel Samples For Analysis

F. Samples accepted for analysis:

Sample Number EM-6144F Susan Gehring sign (SwRI Division 8) Susan Gehring print 1·15·07 date

Sample Number EM-6067F Susan Gehring sign (SwRI Division 8) Susan Gehring print 1·15·07 date

Sample Number EM-6179-F Susan Gehring sign (SwRI Division 8) Susan Gehring print 1·17·07 date

TCEQ Observer: C D Tyree sign C Tyree print Jan 17, 2007 date

1.4 Analytical Results

Will be reported separately on signed analysis sheets

TABLE A-2. CALIBRATION, ZERO, AND SPAN INFORMATION FOR HYDROCARBONS

Test Number	Cal. Gas, conc.	Pre-Test, meter div.			Post-Test, meter div.		Drift, %FS	
		Zero	Span	Zero	Zero	Span	Zero	Span
R1	91.48	-0.14	91.60	-0.14	0.50	92.38	0.64	0.86
R2	91.48	0.06	91.61	0.07	0.03	91.51	-0.03	-0.11
R3	91.48	0.08	91.60	0.03	-0.18	91.12	-0.26	-0.52
R4	91.48	0.10	91.50	-0.09	-0.26	91.31	-0.36	-0.20
R5	91.48	-0.10	91.66	-0.07	0.12	91.84	0.23	0.20
R6	91.48	0.02	91.38	0.02	0.21	91.60	0.20	0.24
R7	91.48	0.04	91.47	0.02	0.31	91.75	0.27	0.31
R8	91.48	0.03	91.50	0.05	0.39	91.73	0.37	0.25
R9	91.48	-0.10	91.36	-0.03	-0.13	91.09	-0.03	-0.30
C10	91.48	0.15	91.53	0.04	0.21	91.86	0.06	0.36
C11	91.48	0.06	91.67	-0.00	0.25	91.64	0.13	-0.03
C12	91.48	0.04	91.64	0.18	0.35	91.65	0.31	0.01
C13	91.48	0.26	91.33	0.25	0.35	91.33	0.10	-0.00
C14	91.48	0.15	91.30	0.14	0.51	91.51	0.37	0.24
C15	91.48	0.21	91.48	0.18	0.37	91.49	0.16	0.01
C16	91.48	0.14	91.35	-0.03	0.19	91.30	0.05	-0.05
C17	91.48	0.26	91.46	0.27	0.80	91.93	0.54	0.51
C18	91.48	-0.10	91.26	-0.05	0.12	91.28	0.22	0.02
R19	91.48	0.02	91.69	0.04	0.21	91.77	0.18	0.09
R20	91.48	-0.03	91.73	-0.04	0.11	91.89	0.15	0.17
R21	91.48	0.12	91.34	0.16	0.62	91.55	0.50	0.22
R22	91.48	0.11	91.51	0.08	0.29	91.34	0.18	-0.18
R23	91.48	0.14	91.12	0.08	0.40	91.59	0.26	0.51
R24	91.48	0.24	91.47	0.13	0.48	91.38	0.25	-0.10

TABLE A-3. CALIBRATION, ZERO, AND SPAN INFORMATION FOR OXIDES OF NITROGEN

Test Number	Cal. Gas, conc.	Pre-Test, meter div.			Post-Test, meter div.		Drift, %FS	
		Zero	Span	Zero	Zero	Span	Zero	Span
R1	272.49	-0.04	272.15	0.09	0.01	272.24	0.04	0.03
R2	272.49	0.08	272.57	0.18	-0.04	272.40	-0.12	-0.06
R3	272.49	-0.05	272.24	0.08	0.04	272.46	-0.09	0.08
R4	272.49	-0.05	272.61	0.14	-0.08	272.19	-0.03	-0.15
R5	272.49	-0.04	272.55	-0.05	-0.03	272.62	0.01	0.03
R6	272.49	-0.08	272.69	0.00	0.03	272.31	0.11	-0.14
R7	272.49	-0.07	272.47	-0.04	-0.12	271.48	-0.05	-0.36
R8	272.49	0.05	272.34	0.15	-0.04	272.73	-0.08	0.14
R9	272.49	-0.03	272.20	0.12	0.00	272.11	0.04	-0.03
C10	272.49	0.17	272.31	0.35	0.01	271.03	-0.16	-0.47
C11	272.49	0.02	272.81	0.06	0.17	272.89	0.15	0.03
C12	272.49	0.04	273.03	0.39	-0.00	272.64	-0.05	-0.14
C13	272.49	0.23	272.41	0.31	0.16	272.13	-0.07	-0.10
C14	272.49	0.19	272.40	0.40	0.11	272.21	-0.08	-0.07
C15	272.49	0.29	272.30	0.29	0.20	272.22	-0.08	-0.03
C16	272.49	0.20	272.49	0.43	0.23	271.31	0.02	-0.44
C17	272.49	0.17	272.61	0.19	0.15	271.82	-0.02	-0.29
C18	272.49	0.12	272.32	0.22	0.17	272.52	0.05	0.07
R19	272.49	0.05	272.26	0.13	-0.01	271.94	-0.07	-0.12
R20	272.49	0.11	272.39	0.14	0.02	271.95	-0.09	-0.16
R21	272.49	0.16	272.31	0.09	0.17	272.31	0.02	0.00
R22	272.49	-0.05	272.31	0.08	0.17	272.85	0.22	0.20
R23	272.49	0.27	272.50	0.35	0.24	271.33	-0.03	-0.43
R24	272.49	0.29	272.58	0.30	0.15	272.32	-0.13	-0.10

TABLE A-4. CALIBRATION, ZERO, AND SPAN INFORMATION FOR CARBON MONOXIDE

Test Number	Cal. Gas, conc.	Pre-Test, meter div.			Post-Test, meter div.	
		Zero	Span	Zero	Zero	Span
R1	95.96	0.0	95.5	0.0	0.0	95.5
R2	95.96	0.0	95.5	0.0	0.0	95.3
R3	95.96	0.0	95.5	0.0	0.0	95.4
R4	95.96	0.0	95.5	0.0	0.0	95.5
R5	95.96	0.0	95.5	0.0	0.1	95.3
R6	95.96	0.0	95.5	0.0	0.0	95.4
R7	95.96	0.0	95.5	0.0	0.0	95.6
R8	95.96	0.0	95.5	0.0	0.0	95.5
R9	95.96	0.0	95.5	0.0	0.0	95.4
C10	95.96	0.0	95.5	0.0	0.1	95.3
C11	95.96	0.0	95.5	0.0	0.1	95.4
C12	95.96	0.0	95.5	0.0	0.1	95.5
C13	95.96	0.0	95.5	0.0	0.2	95.6
C14	95.96	0.0	95.5	0.0	0.0	95.6
C15	95.96	0.0	95.5	0.0	0.0	95.4
C16	95.96	0.0	95.5	0.0	0.1	95.4
C17	95.96	0.0	95.5	0.0	0.0	95.5
C18	95.96	0.0	95.5	0.0	0.0	95.5
R19	91.22	0.0	91.2	0.0	0.0	91.1
R20	91.22	0.0	91.2	0.0	0.1	91.1
R21	91.22	0.0	91.2	0.0	0.0	91.1
R22	91.22	0.0	91.2	0.0	0.0	91.1
R23	91.22	0.0	91.2	0.1	0.0	91.1
R24	91.22	0.0	91.2	0.1	0.1	91.1

TABLE A-5. CALIBRATION, ZERO, AND SPAN INFORMATION FOR CARBON DIOXIDE

Test Number	Cal. Gas, conc.	Pre-Test, meter div.			Post-Test, meter div.	
		Zero	Span	Zero	Zero	Span
R1	9009.22	0.0	90.2	0.0	0.1	90.1
R2	9009.22	0.0	90.2	0.0	0.1	90.1
R3	9009.22	0.0	90.2	0.0	0.0	90.2
R4	9009.22	0.0	90.2	0.0	0.0	90.3
R5	9009.22	0.0	90.2	0.0	0.0	90.3
R6	9009.22	0.0	90.2	0.0	0.0	90.2
R7	9009.22	0.0	90.2	0.0	0.0	90.3
R8	9009.22	0.0	90.2	0.0	0.0	90.1
R9	9009.22	0.0	90.1	0.0	0.1	90.2
C10	9009.22	0.0	90.2	0.0	0.0	90.3
C11	9009.22	0.0	90.2	0.0	0.0	90.4
C12	9009.22	0.0	90.2	0.0	0.0	90.3
C13	9009.22	0.0	90.2	0.0	0.0	90.2
C14	9009.22	0.0	90.2	0.0	0.0	90.2
C15	9009.22	0.0	90.2	0.0	0.0	90.1
C16	9009.22	0.0	90.2	0.0	0.0	90.1
C17	9009.22	0.0	90.2	0.0	0.1	90.0
C18	9009.22	0.0	90.2	0.0	0.1	90.3
R19	9009.22	0.0	90.2	0.0	0.1	90.3
R20	9009.22	0.0	90.2	0.0	0.0	90.1
R21	9009.22	0.0	90.2	0.0	0.0	90.3
R22	9009.22	0.0	90.2	0.0	0.0	90.3
R23	9009.22	0.0	90.2	0.0	0.1	90.3
R24	9009.22	0.0	90.2	0.0	0.1	90.3

TABLE A-6. NO_X CALIBRATION CURVE (1/5/07)

Concentration	Actual	Meter	% Point	% Full Scale
273.330	273.195	90.481	-0.049	-0.045
245.997	246.170	81.470	0.071	0.058
218.395	218.395	72.215	-0.123	-0.090
191.331	190.794	63.022	-0.281	-0.179
163.998	163.529	53.946	-0.286	-0.156
136.665	136.287	44.883	-0.276	-0.126
109.332	109.383	35.937	0.047	0.017
81.999	82.222	26.910	0.272	0.074
54.666	55.016	17.873	0.640	0.117
27.333	27.636	8.784	1.109	0.101
27.240	27.332	8.683	0.336	0.031
24.516	24.605	7.778	0.363	0.030
21.792	21.806	6.849	0.062	0.005
19.068	19.061	5.938	-0.035	-0.002
16.344	16.335	5.033	-0.057	-0.003
13.620	13.621	4.133	0.009	0.000
10.896	10.927	3.239	0.285	0.010
5.448	5.524	1.447	1.398	0.025
2.724	2.803	0.544	2.908	0.026
0.000	0.065	-0.364	--	0.022

3-10664-001
Project Number

PV-R1
Test or ID Number

POWER VALIDATION
HEAVY-DUTY DIESEL ENGINE

Cell No.: 4	Date: 01/15/2007	Start Time: 8:37	Finish Time: 8:56
Engine S/N or ID: S60 38671		[X] As-Received	[ ] Modified
Operator: RDF	Project Leader: Robert Fanick		Fuel Code: EM-6144-F
Low Idle rpm (no load): 600	Low Idle rpm @ 0	lb-ft CITT: 600	High Idle rpm (governed): 1,925
Notes:			

Parameters	Rated Power	Peak Torque
Torque (lb-ft)	1,051	1,412
Speed (rpm)	1,800	1,200
Power (bhp)	360.0	323.0
Fuel Flow (lb/hr)	11.5	105.8
Water Out (°F)	186.0	187
Water In (°F)	178	177
Oil (°F)	200	210
Inlet Air (°F)	80.0	79
Fuel (°F)	102	99
Exhaust (°F)	832	1,000
Intercooler In (°F)	285	276
Intercooler Out (°F)	111	100
IC Coolant Supply (°F)		
Inlet Air Dewpoint (°F)	51.1	52.3
Chiller Water (°F)	57.0	57.0
Barometer ("Hg)	29.45	29.45
Inlet Air Restriction ("H2O)	-16.0	-7.75
Exhaust Restriction ("Hg)	2.5	1.38
Boost Pres. Before IC ("Hg)	38.00	34.90
Boost Pres. After IC ("Hg)	34.3	33.1
Intercooler ÐP ("H2O)	50.3	
Oil Pressure (psig)	55.0	47.0
Fuel Pressure (psig)	9.8	11.0
Engine Water Pres. (psig)		
Hour Meter (hours)	1,279.4	1,279.4

3-10664-001
Project Number

MAP R-1
Test Number

POWER MAP
HEAVY-DUTY DIESEL ENGINE

Date: 01/05/2007 Time: 8:37	Engine Model: S60		
Cell No.: 4	Serial No. or ID: 38671		
Operator: RDF	Hour Meter: 1,279.1	Dura. Hours:	0.00
Project Leader: Robert Fanick	Fuel Code: EM-6144-F	Baro., "Hg:	29.45

MAP PRECONDITIONING

Parameter	Rated Speed	RatedTorque
Power (bhp)	360.00	323.00
Torque (lb-ft)	1,051.00	1,412.00
Speed (rpm)	1,800.00	1,200.00
Fuel Flow (lb/hr)	115.30	105.80
Inlet Air Restriction ("H2O)	-16.00	-7.75
Exhaust Restriction ("Hg)	2.50	1.38
Intake Air (°F)	80.00	79.00
Intake Air Dewpoint (°F)	51.10	52.30
ÐP Across Intercooler ("H2O)	50.30	24.50
Temperature After Intercooler (°F)	111.00	100.00

Map @ [X] 8 rpm/sec sweep [ ] Other: Idle Speed, rpm Low: 600 High: 1,925

RESULTS

Speed, rpm	Torque lb-ft	Speed, rpm	Torque lb-ft	Speed, rpm	Torque lb-ft	Speed, rpm	Torque lb-ft
100		1100	1,203	2100		3100	
200		1200	1,396	2200		3200	
300		1300	1,328	2300		3300	
400	567	1400	1,253	2400		3400	
500	602	1500	1,206	2500		3500	
600	618	1600	1,159	2600		3600	
700	664	1700	1,109	2700		3700	
800	779	1800	1,046	2800		3800	
900	911	1900		2900		3900	
1000	1,048	2000		3000		4000	

Speed Ramp Rate 8.3 rpm/sec RATED SPEED, rpm: Manufacturer 1,800 Measured 1,704

Calculated Maximum Speed = 1.13*[Highest RATED SPEED - Curb Idle Speed] + Curb Idle Speed = 1,956 rpm

TRANSIENT CYCLE INPUTS

CITT: 0 lb-ft

Idle Speed: 600 rpm Rated Speed 1,800 rpm Max. Power 360.4 hp Max. Torque 1,417 lb-ft

DIESEL ENGINE SET-UP DATA

Required Information as per CFR 86-1344-94 (c) CERTD1.DER Rev. 8-95

1. Engine Manufacturer: **Detroit Diesel**
2. Engine system combination: **heavy-duty diesel engine**
3. Engine Model: **Series 60** Engine Displacement (in^3): **775**
4. Engine identification number: **06R0038671**
5. Applicable engine model year: **1991**
6. Engine fuel type: **TxLED ULSD Reference Fuel**
7. Recommended lubricating oil type: **DETROIT DIESEL POWER GUARD 15W-40**
8. Exhaust pipe configuration, pipe sizes, etc: **see item 17 below**
9. Curb or low idle speed (RPM): **600**
10. Dynamometer idle speed. (Automatic transmission engines only.) **NA**
11. Engine parameter specifications (such as injection timing or injector height setting, operating temperature, etc): **NA**
12. Engine performance data:
    - Manufacturer's advertised maximum power (BHP) **365**
    - Manufacturer's rated engine speed (RPM) **1800**
    - Manufacturer's measured fuel rate at maximum power (lb_m/hr) **11**
    - Manufacturer's maximum governed engine speed (RPM) **19**
13. Recommended start-up procedure: **NA**
14. Maximum safe engine operating speed (RPM): **NA**
15. Number of hours of operation accumulated on engine (prior to installation): **NA**
16. Manufacturer's recommended inlet depression (in. H_2O): **-16**

    Typical in-use inlet depression (in. H_2O): **-1**
17. Exhaust system:
    - Header pipe inside diameter (inches) **4**
    - Tailpipe inside diameter (inches) **5**
    - Minimum distance in-use between the exhaust manifold and the exit of the chassis exhaust system: _____
    - Other: _____

Diesel Engine Pre-Test Data

Required Information as per CFR 86-1244-94 (d)

CERTD2.DER Rev. 8-95

1. Engine-system combination: **heavy-duty diesel fueled engine**
2. Engine identification number: **06R0038671**
3. Instrument operator(s): **Richard Mendez**
4. Engine operator(s): **Ricky D. Frierson**
5. Number of hours of operation accumulated on the engine prior to beginning the test sequence:

   125
6. Identification and specification of test fuel: **TxLED Low Sulfur Diesel Fuel**

   SwRI Fuel Code: EM-6144-F
7. Emission Analyzers and Equipment:

Emission Analyzers	Serial No.	Verification Date	Operator
HC continuous	1000456	1/4/07	J. Cantu
CO bag	56314704	12/20/07	R. Guerra
CO2 bag	D000JOYT	1/9/07	R. Guerra
NO_x continuous	1000448	1/5/07	J. Cantu
NO_x converter	1000448	1/3/07	J. Cantu
Equipment			
CVS	12	1/12/07	J. Cantu
Torquemeter	324	1/12/07	R. Frierson

DIESEL ENGINE TEST DATA

Required Information as per CFR 86-1344-94 (e) CERTD3.DER Rev. 8-95

1. Date and time of day: **1/15/2007 10:06 am, 10:48 am, 11:28 am**
2. Test number: R1, R2, R3
3. Engine intake air or test cell temperature (°F): **78, 79, 77**
4. Barometric pressure (in. Hg): **29.50, 29.51, 29.51**
5. Engine intake or test cell humidity (% RH): **51, 49, 62** CVS dilution air humidity (%RH): **41, 41, 45**
6. Maximum torque verses speed curve as determined in 86.1332, with minimum and maximum engine speeds, and a description of the mapping technique used: **see attached**
7. Measured maximum horsepower engine speed (RPM): **1800** Maximum torque speed (RPM): **1200**
8. Measured maximum horsepower (BHP): 360.4 Maximum measured torque (ft-lb): 1417
9. Measured high idle engine speed (RPM): **1925**
10. Measured fuel consumption rate (lb_m/hr) at maximum power: **115.3** and at peak torque: 105.8
11. Cold-soak time interval and cool down procedures: **overnight soak**
12. Temperature set point of the heated continuous analysis system components (°F): 375
13. Test cycle validation statistics as specified in 86.1341 for each test phase (cold and hot): **see attached**
14. Total CVS flow rate and dilution factor for each test phase (cold and hot):
    CVS Flow Rate (scfm): **2215.25, 2212.85, 2212.66** Dilution Factor: **22.19, 22.04, 21.93**
15. Dilute exhaust mixture temperature at gas meter (°F): **72, 72, 72**
    Secondary dilution air temperature at gas meter (°F): **74, 76, 76**
16. Maximum temperature at 90mm particulate filter sample zone (°F): **117, 118, 119**
17. Dilute exhaust sample concentrations (background corrected):
    HC (ppmC) **2.13, 2.73. 2.71** CO (ppmC) **47.42, 47.81, 46.97**
    CO_2 (%) **0.5538, 0.5579, 0.5602** NO_X (ppm) **46.53, 46.65, 46.85**
19. Diesel fuel composition: **see attached**
21. The stabilized pre-test weight and post-test weight of each particulate sample and back-up filter:
    Pre-Test Primary (mg) **474.221, 463.578, 484.161**
    Post-test Primary (mg) **478.304, 467.661, 488.177**
    Pre-test Backup (mg) **weighed as pair** Post-test Backup (mg) **weighed as pair**
22. Brake specific emissions (g/BHP-hr) for HC, CO, NO_X for each test phase (cold and hot):
    HC **0.066, 0.084, 0.083** CO **2.948, 2.944, 2.906**
    NO_X **4.739, 4.700, 4.925** Part. **0.232, 0.231, 0.230**
23. The weighted (cold and hot) brake specific emissions (g/BHP-hr) for the total test:
    HC **NA** CO **NA** NO_X **NA** Part. **NA**
24. The carbon balance brake specific fuel consumption (lb/BHP-hr) for the total test: **NA**
25. The number of hours of operation accumulated on the engine after completing the test sequence: **NA**

3-10664-001
Project Number

R-PV2
Test or ID Number

POWER VALIDATION
HEAVY-DUTY DIESEL ENGINE

Cell No.: 4	Date: 01/15/2007	Start Time: 11:58	Finish Time: 12:06
Engine S/N or ID: S60 38671		[X] As-Received	[ ] Modified
Operator: RDF	Project Leader: Robert Fanick		Fuel Code: EM-6144
Low Idle rpm (no load): 600	Low Idle rpm @ 0	lb-ft CITT: 0	High Idle rpm (governed): 1,800
Notes:			

Parameters	Rated Power	Peak Torque
Torque (lb-ft)	1,059	1,415
Speed (rpm)	1,800	1,200
Power (bhp)	362.0	324.0
Fuel Flow (lb/hr)	116.3	105.9
Water Out (°F)	182.0	182
Water In (°F)	179	175
Oil (°F)	208	217
Inlet Air (°F)	79.0	80
Fuel (°F)	97	98
Exhaust (°F)	820	998
Intercooler In (°F)	282	276
Intercooler Out (°F)	113	105
IC Coolant Supply (°F)		
Inlet Air Dewpoint (°F)	63.3	65.5
Chiller Water (°F)	57.0	57.0
Barometer ("Hg)	29.50	
Inlet Air Restriction ("H2O)	-16.1	-7.60
Exhaust Restriction ("Hg)	2.5	1.36
Boost Pres. Before IC ("Hg)	38.00	35.00
Boost Pres. After IC ("Hg)	34.4	33.1
Intercooler ÐP ("H2O)	49.6	25.8
Oil Pressure (psig)	53.0	46.0
Fuel Pressure (psig)	9.0	10.1
Engine Water Pres. (psig)		
Hour Meter (hours)	1,281.4	1,281.5

3-10664-001
Project Number

R-PM2
Test Number

POWER MAP
HEAVY-DUTY DIESEL ENGINE

Date: 01/15/2007 Time: 11:58	Engine Model: DDS60		
Cell No.: 4	Serial No. or ID: 38671		
Operator: RDF	Hour Meter: 1,281.3	Dura. Hours:	0.00
Project Leader: Robert Fanick	Fuel Code: 6144	Baro., "Hg:	29.50

MAP PRECONDITIONING

Parameter	Rated Speed	RatedTorque
Power (bhp)	362.00	324.00
Torque (lb-ft)	1,059.00	1,415.00
Speed (rpm)	1,800.00	1,200.00
Fuel Flow (lb/hr)	116.30	105.90
Inlet Air Restriction ("H2O)	-16.10	-7.60
Exhaust Restriction ("Hg)	2.50	1.36
Intake Air (°F)	79.00	80.00
Intake Air Dewpoint (°F)	63.30	65.50
ÐP Across Intercooler ("H2O)	49.60	25.80
Temperature After Intercooler (°F)	113.00	105.00

Map @ [X] 8 rpm/sec sweep [ ] Other: Idle Speed, rpm Low: 600 High: 1,925

RESULTS

Speed, rpm	Torque lb-ft	Speed, rpm	Torque lb-ft	Speed, rpm	Torque lb-ft	Speed, rpm	Torque lb-ft
100		1100	1,200	2100		3100	
200		1200	1,399	2200		3200	
300		1300	1,334	2300		3300	
400	565	1400	1,255	2400		3400	
500	584	1500	1,203	2500		3500	
600	618	1600	1,160	2600		3600	
700	674	1700	1,108	2700		3700	
800	791	1800	1,044	2800		3800	
900	908	1900		2900		3900	
1000	1,043	2000		3000		4000	

Speed Ramp Rate 8.2 rpm/sec RATED SPEED, rpm: Manufacturer 1,800 Measured 1,701

Calculated Maximum Speed = 1.13*[Highest RATED SPEED - Curb Idle Speed] + Curb Idle Speed = 1,956 rpm

TRANSIENT CYCLE INPUTS

CITT: 0 lb-ft

Idle Speed: 600 rpm Rated Speed 1,800 rpm Max. Power 360.2 hp Max. Torque 1,417 lb-ft

DIESEL ENGINE SET-UP DATA

Required Information as per CFR 86-1344-94 (c)

CERTD1.DER Rev. 8-95

1. Engine Manufacturer: **Detroit Diesel**
2. Engine system combination: **heavy-duty diesel engine**
3. Engine Model: **Series 60** Engine Displacement (in^3): **775**
4. Engine identification number: **06R0038671**
5. Applicable engine model year: **1991**
6. Engine fuel type: **TxLED ULSD Reference Fuel**
7. Recommended lubricating oil type: **DETROIT DIESEL POWER GUARD 15W-40**
8. Exhaust pipe configuration, pipe sizes, etc: **see item 17 below**
9. Curb or low idle speed (RPM): **600**
10. Dynamometer idle speed. (Automatic transmission engines only.) **NA**
11. Engine parameter specifications (such as injection timing or injector height setting, operating temperature, etc): **NA**
12. Engine performance data:
    - Manufacturer's advertised maximum power (BHP) **365**
    - Manufacturer's rated engine speed (RPM) **1800**
    - Manufacturer's measured fuel rate at maximum power (lb_m/hr) **11**
    - Manufacturer's maximum governed engine speed (RPM) **19**
13. Recommended start-up procedure: **NA**
14. Maximum safe engine operating speed (RPM): **NA**
15. Number of hours of operation accumulated on engine (prior to installation): **NA**
16. Manufacturer's recommended inlet depression (in. H_2O): **-16**

    Typical in-use inlet depression (in. H_2O): **-1**
17. Exhaust system:
    - Header pipe inside diameter (inches) **4**
    - Tailpipe inside diameter (inches) **5**
    - Minimum distance in-use between the exhaust manifold and the exit of the chassis exhaust system: _____
    - Other: _____

Diesel Engine Pre-Test Data

Required Information as per CFR 86-1244-94 (d) CERTD2.DER Rev. 8-95

1. Engine-system combination **heavy-duty diesel fueled engine**
2. Engine identification number: **06R0038671**
3. Instrument operator(s): **Richard C. Mendez**
4. Engine operator(s): **Ricky D. Frierson**
5. Number of hours of operation accumulated on the engine prior to beginning the test sequence:

   0
6. Identification and specification of test fuel: **TxLED Low Sulfur Diesel Fuel**

   SwRI Fuel Code: EM-6144-F
7. Emission Analyzers and Equipment:

Emission Analyzers	Serial No.	Verification Date	Operator
HC continuous	1000456	1/4/07	J. Cantu
CO bag	56314704	12/20/07	R. Guerra
CO2 bag	D000JOYT	1/9/07	R. Guerra
NO_x continuous	1000448	1/5/07	J. Cantu
NO_x converter	1000448	1/3/07	J. Cantu
Equipment			
CVS	12	1/12/07	J. Cantu
Torquemeter	324	1/12/07	R. Frierson

DIESEL ENGINE TEST DATA

Required Information as per CFR 86-1344-94 (e) CERTD3.DER Rev. 8-95

1. Date and time of day: 1/15/07 **1: 58 pm, 2:38 pm, 3:08 pm**
2. Test number: **R4, R5, R6**
3. Engine intake air or test cell temperature (°F): **78, 79, 80**
4. Barometric pressure (in. Hg): **29.49, 29.48, 29.48**
5. Engine intake or test cell humidity (% RH): **45, 48, 47** CVS dilution air humidity (%RH): **38, 39, 39**
6. Maximum torque verses speed curve as determined in 86.1332, with minimum and maximum engine speeds, and a description of the mapping technique used: **see attached**
7. Measured maximum horsepower engine speed (RPM): **1800** Maximum torque speed (RPM): **1200**
8. Measured maximum horsepower (BHP): **360.2** Maximum measured torque (ft-lb): **1417.4**
9. Measured high idle engine speed (RPM): **---**
10. Measured fuel consumption rate (lb_m/hr) at maximum power: **116.3** and at peak torque: **105.9**
11. Cold-soak time interval and cool down procedures: **overnight soak**
12. Temperature set point of the heated continuous analysis system components (°F): 375
13. Test cycle validation statistics as specified in 86.1341 for each test phase (cold and hot): **see attached**
14. Total CVS flow rate and dilution factor for each test phase (cold and hot):
    CVS Flow Rate (scfm): **2214.50, 2207.13, 2207.14** Dilution Factor: **22.15, 22.11, 22.27**
15. Dilute exhaust mixture temperature at gas meter (°F): **70, 70, 70**
    Secondary dilution air temperature at gas meter (°F): **74, 75, 75**
16. Maximum temperature at 90mm particulate filter sample zone (°F): **117, 117, 114**
17. Dilute exhaust sample concentrations (background corrected):
    HC (ppmC) **3.09, 2.77, 2.83** CO (ppmC) **48.25, 48.92, 48.05**
    CO_2 (%) **0.5558, 0.5586, 0.5535** NO_X (ppm) **46.80, 46.93, 46.77**
19. Diesel fuel composition: **see attached**
21. The stabilized pre-test weight and post-test weight of each particulate sample and back-up filter:
    Pre-Test Primary (mg) **473.464, 488.493, 482.996**
    Post-test Primary (mg) **477.527, 492.576, 487.123**
    Pre-test Backup (mg) **weighed as pair** Post-test Backup (mg) **weighed as pair**
22. Brake specific emissions (g/BHP-hr) for HC, CO, NO_X for each test phase (cold and hot):
    HC **0.094, 0.085, 0.086** CO **2.970, 3.009, 2.945**
    NO_X **4.610, 4.708, 4.684** Part **0.228, 0.233, 0.236**
23. The weighted (cold and hot) brake specific emissions (g/BHP-hr) for the total test:
    HC NA CO NA NO_X NA Part. NA
24. The carbon balance brake specific fuel consumption (lb/BHP-hr) for the total test: **NA**
25. The number of hours of operation accumulated on the engine after completing the test sequence: **NA**

3-10664-001
Project Number

PV-R3
Test or ID Number

POWER VALIDATION
HEAVY-DUTY DIESEL ENGINE

Cell No.: 4	Date: 01/16/2007	Start Time: 9.32	Finish Time: 10.01
Engine S/N or ID: S60 38671		[X] As-Received	[ ] Modified
Operator: RDF	Project Leader: Robert Fanick		Fuel Code: 6144
Low Idle rpm (no load): 600	Low Idle rpm @ 0	lb-ft CITT: 0	High Idle rpm (governed): 1,925
Notes:			

Parameters	Rated Power	Peak Torque
Torque (lb-ft)	1,064	1,425
Speed (rpm)	1,800	1,200
Power (bhp)	364.0	325.0
Fuel Flow (lb/hr)	115.2	106.4
Water Out (°F)	183.0	185
Water In (°F)	176	171
Oil (°F)	212	218
Inlet Air (°F)	79.0	79
Fuel (°F)	96	97
Exhaust (°F)	810	990
Intercooler In (°F)	277	274
Intercooler Out (°F)	100	96
IC Coolant Supply (°F)		
Inlet Air Dewpoint (°F)	64.3	65.1
Chiller Water (°F)	59.0	59.0
Barometer ("Hg)	29.72	29.72
Inlet Air Restriction ("H2O)	-16.0	-7.70
Exhaust Restriction ("Hg)	2.4	1.40
Boost Pres. Before IC ("Hg)	37.70	35.00
Boost Pres. After IC ("Hg)	34.0	33.2
Intercooler ÐP ("H2O)	50.0	25.2
Oil Pressure (psig)	53.0	46.0
Fuel Pressure (psig)	9.2	10.5
Engine Water Pres. (psig)		
Hour Meter (hours)	1,283.7	1,283.7

3-10664-001
Project Number

R-Map3
Test Number

POWER MAP
HEAVY-DUTY DIESEL ENGINE

Date: 01/16/2007 Time: 9.32	Engine Model: S60		
Cell No.: 4	Serial No. or ID: 38671		
Operator: RDF	Hour Meter: 1,283.3	Dura. Hours:	0.00
Project Leader: Robert Fanick	Fuel Code: 6144	Baro., "Hg:	29.72

MAP PRECONDITIONING

Parameter	Rated Speed	RatedTorque
Power (bhp)	364.00	325.00
Torque (lb-ft)	1,064.00	1,425.00
Speed (rpm)	1,800.00	1,200.00
Fuel Flow (lb/hr)	115.20	106.40
Inlet Air Restriction ("H2O)	-16.00	-7.70
Exhaust Restriction ("Hg)	2.40	1.40
Intake Air (°F)	79.00	79.00
Intake Air Dewpoint (°F)	64.30	65.10
ÐP Across Intercooler ("H2O)	50.30	25.20
Temperature After Intercooler (°F)	100.00	96.00

Map @ [X] 8 rpm/sec sweep [ ] Other: Idle Speed, rpm Low: 600 High: 1,925

RESULTS

Speed, rpm	Torque lb-ft	Speed, rpm	Torque lb-ft	Speed, rpm	Torque lb-ft	Speed, rpm	Torque lb-ft
100		1100	1,203	2100		3100	
200		1200	1,406	2200		3200	
300		1300	1,344	2300		3300	
400	574	1400	1,265	2400		3400	
500	607	1500	1,213	2500		3500	
600	632	1600	1,169	2600		3600	
700	682	1700	1,118	2700		3700	
800	802	1800	1,053	2800		3800	
900	915	1900		2900		3900	
1000	1,057	2000		3000		4000	

Speed Ramp Rate 8.4 rpm/sec RATED SPEED, rpm: Manufacturer 1,800 Measured 1,701

Calculated Maximum Speed = 1.13*[Highest RATED SPEED - Curb Idle Speed] + Curb Idle Speed = 1,956 rpm

TRANSIENT CYCLE INPUTS

CITT: 0 lb-ft

Idle Speed: 600 rpm Rated Speed 1,800 rpm Max. Power 362.9 hp Max. Torque 1,426 lb-ft

DIESEL ENGINE SET-UP DATA

Required Information as per CFR 86-1344-94 (c)

CERTD1.DER Rev. 8-95

1. Engine Manufacturer: **Detroit Diesel**
2. Engine system combination: **heavy-duty diesel engine**
3. Engine Model: **Series 60** Engine Displacement (in^3): **775**
4. Engine identification number: **06R0038671**
5. Applicable engine model year: **1991**
6. Engine fuel type: **TxLED ULSD Reference Fuel**
7. Recommended lubricating oil type: **DETROIT DIESEL POWER GUARD 15W-40**
8. Exhaust pipe configuration, pipe sizes, etc: **see item 17 below**
9. Curb or low idle speed (RPM): **600**
10. Dynamometer idle speed. (Automatic transmission engines only.) **NA**
11. Engine parameter specifications (such as injection timing or injector height setting, operating temperature, etc): **NA**
12. Engine performance data:
    - Manufacturer's advertised maximum power (BHP) **365**
    - Manufacturer's rated engine speed (RPM) **1800**
    - Manufacturer's measured fuel rate at maximum power (lb_m/hr) **11**
    - Manufacturer's maximum governed engine speed (RPM) **19**
13. Recommended start-up procedure: **NA**
14. Maximum safe engine operating speed (RPM): **NA**
15. Number of hours of operation accumulated on engine (prior to installation): **NA**
16. Manufacturer's recommended inlet depression (in. H_2O): **-16**

    Typical in-use inlet depression (in. H_2O): **-1**
17. Exhaust system:
    - Header pipe inside diameter (inches) **4**
    - Tailpipe inside diameter (inches) **5**
    - Minimum distance in-use between the exhaust manifold and the exit of the chassis exhaust system: _____
    - Other: _____

Diesel Engine Pre-Test Data
Required Information as per CFR 86-1244-94 (d)

CERTD2.DER Rev. 8-95

1. Engine-system combination **heavy-duty diesel fueled engine**
2. Engine identification number: **06R0038671**
3. Instrument operator(s): **Richard C. Mendez**
4. Engine operator(s): **Ricky D. Frierson**
5. Number of hours of operation accumulated on the engine prior to beginning the test sequence:

   0
6. Identification and specification of test fuel: **TxLED Low Sulfur Diesel Fuel**

   SwRI Fuel Code: EM-6144-F
7. Emission Analyzers and Equipment:

Emission Analyzers	Serial No.	Verification Date	Operator
HC continuous	1000456	1/4/07	J. Cantu
CO bag	56314704	12/20/07	R. Guerra
CO2 bag	D000JOYT	1/9/07	R. Guerra
NO_x continuous	1000448	1/5/07	J. Cantu
NO_x converter	1000448	1/3/07	J. Cantu
Equipment			
CVS	12	1/12/07	J. Cantu
Torquemeter	324	1/12/07	R. Frierson

DIESEL ENGINE TEST DATA

Required Information as per CFR 86-1344-94 (e) CERTD3.DER Rev. 8-95

1. Date and time of day: **1/16/07 11:10 am, 11:50 am, 12:30 pm**
2. Test number: **R7, R8, R9**
3. Engine intake air or test cell temperature (°F): **78, 78, 78**
4. Barometric pressure (in. Hg): **29.74, 29.75, 29.71**
5. Engine intake or test cell humidity (% RH): **52, 52, 52** CVS dilution air humidity (%RH): **47, 42, 45**
6. Maximum torque verses speed curve as determined in 86.1332, with minimum and maximum engine speeds, and a description of the mapping technique used: **see attached**
7. Measured maximum horsepower engine speed (RPM): **1800** Maximum torque speed (RPM): **1200**
8. Measured maximum horsepower (BHP): **362.9** Maximum measured torque (ft-lb): **1426.1**
9. Measured high idle engine speed (RPM): **---**
10. Measured fuel consumption rate (lb_m/hr) at maximum power: **115.2** and at peak torque: **106.4**
11. Cold-soak time interval and cool down procedures: **overnight soak**
12. Temperature set point of the heated continuous analysis system components (°F): **375**
13. Test cycle validation statistics as specified in 86.1341 for each test phase (cold and hot): **see attached**
14. Total CVS flow rate and dilution factor for each test phase (cold and hot):
    CVS Flow Rate (scfm): **2233.88, 2234.76, 2228.28** Dilution Factor: **22.54, 22.35, 22.43**
15. Dilute exhaust mixture temperature at gas meter (°F): **72, 72, 72**
    Secondary dilution air temperature at gas meter (°F): **73, 73, 74**
16. Maximum temperature at 90mm particulate filter sample zone (°F): **118, 118, 119**
17. Dilute exhaust sample concentrations (background corrected):
    HC (ppmC) **2.86, 2.70, 3.07** CO (ppmC) **46.75, 46.23, 46.38**
    CO_2 (%) **0.5474, 0.5515, 0.5476** NO_X (ppm) **44.72, 45.55, 45.44**
19. Diesel fuel composition: **see attached**
21. The stabilized pre-test weight and post-test weight of each particulate sample and back-up filter:
    Pre-Test Primary (mg) **488.714, 477.564, 468.357**
    Post-test Primary (mg) **492.678 (492.713), 481.451 (481.528), 472.312 (472.380)** *
    Pre-test Backup (mg) **weighed as pair** Post-test Backup (mg) **weighed as pair**
22. Brake specific emissions (g/BHP-hr) for HC, CO, NO_X for each test phase (cold and hot):
    HC **0.088, 0.083, 0.095** CO **2.909, 02.865, 2.892**
    NO_X **4.578, 4.631, 4.658** Part. **0.222, 0.216, 0.222**
23. The weighted (cold and hot) brake specific emissions (g/BHP-hr) for the total test:
    HC **NA** CO **NA** NO_X **NA** Part. **NA**
24. The carbon balance brake specific fuel consumption (lb/BHP-hr) for the total test: **NA**
25. The number of hours of operation accumulated on the engine after completing the test sequence: **NA**

***Note: Reweigh filter weigh gains shown in parenthesis.**

3-10664-001
Project Number

C-PV1
Test or ID Number

POWER VALIDATION
HEAVY-DUTY DIESEL ENGINE

Cell No.: 4	Date: 01/18/2007	Start Time: 09:05	Finish Time: 09:23
Engine S/N or ID: s60 38671		[X] As-Received	[ ] Modified
Operator: rdf	Project Leader: Robert Fanick		Fuel Code: 6179
Low Idle rpm (no load): 600	Low Idle rpm @ 0	lb-ft CITT: 0	High Idle rpm (governed): 1,925
Notes:			

Parameters	Rated Power	Peak Torque
Torque (lb-ft)	1,067	1,420
Speed (rpm)	1,800	1,200
Power (bhp)	366.0	324.0
Fuel Flow (lb/hr)	117.7	108.6
Water Out (°F)	186.0	185
Water In (°F)	174	178
Oil (°F)	194	204
Inlet Air (°F)	79.0	79
Fuel (°F)	102	103
Exhaust (°F)	840	1,010
Intercooler In (°F)	283	276
Intercooler Out (°F)	116	110
IC Coolant Supply (°F)		
Inlet Air Dewpoint (°F)	57.0	56.9
Chiller Water (°F)	58.0	58.0
Barometer ("Hg)	29.49	
Inlet Air Restriction ("H2O)	-16.2	-7.50
Exhaust Restriction ("Hg)	2.5	1.40
Boost Pres. Before IC ("Hg)	38.60	35.50
Boost Pres. After IC ("Hg)	34.9	33.6
Intercooler ÐP ("H2O)	50.3	25.8
Oil Pressure (psig)	56.0	48.0
Fuel Pressure (psig)	9.0	10.8
Engine Water Pres. (psig)		
Hour Meter (hours)	1,293.9	1,293.9

3-10664-001
Project Number

C-PM1
Test Number

POWER MAP
HEAVY-DUTY DIESEL ENGINE

Date: 01/18/2007 Time: 09:05	Engine Model: DDS60		
Cell No.: 4	Serial No. or ID: 38671		
Operator: RDF	Hour Meter: 1,293.6	Dura. Hours:	0.00
Project Leader: Robert Fanick	Fuel Code: 6179	Baro., "Hg:	29.48

MAP PRECONDITIONING

Parameter	Rated Speed	RatedTorque
Power (bhp)	366.00	324.00
Torque (lb-ft)	1,067.00	1,420.00
Speed (rpm)	1,800.00	1,200.00
Fuel Flow (lb/hr)	117.70	108.60
Inlet Air Restriction ("H2O)	-16.20	-7.50
Exhaust Restriction ("Hg)	2.50	1.40
Intake Air (°F)	79.00	79.00
Intake Air Dewpoint (°F)	57.00	56.90
ÐP Across Intercooler ("H2O)	50.30	25.80
Temperature After Intercooler (°F)	116.00	110.00

Map @ [X] 8 rpm/sec sweep [ ] Other: Idle Speed, rpm Low: 600 High: 1,925

RESULTS

Speed, rpm	Torque lb-ft	Speed, rpm	Torque lb-ft	Speed, rpm	Torque lb-ft	Speed, rpm	Torque lb-ft
100		1100	1,202	2100		3100	
200		1200	1,401	2200		3200	
300		1300	1,342	2300		3300	
400		1400	1,265	2400		3400	
500	555	1500	1,211	2500		3500	
600	621	1600	1,164	2600		3600	
700	677	1700	1,120	2700		3700	
800	804	1800	1,058	2800		3800	
900	908	1900		2900		3900	
1000	1,055	2000		3000		4000	

Speed Ramp Rate 8.0 rpm/sec RATED SPEED, rpm: Manufacturer 1,800 Measured 1,713

Calculated Maximum Speed = 1.13*[Highest RATED SPEED - Curb Idle Speed] + Curb Idle Speed = 1,956 rpm

TRANSIENT CYCLE INPUTS

CITT: 0 lb-ft

Idle Speed: 600 rpm Rated Speed 1,800 rpm Max. Power 364.7 hp Max. Torque 1,422 lb-ft

DIESEL ENGINE SET-UP DATA

Required Information as per CFR 86-1344-94 (c)

CERTD1.DER Rev. 8-95

1. Engine Manufacturer: **Detroit Diesel**
2. Engine system combination: **heavy-duty diesel engine**
3. Engine Model: **Series 60** Engine Displacement (in^3): **775**
4. Engine identification number: **06R0038671**
5. Applicable engine model year: **1991**
6. Engine fuel type: **CB-LE Candidate Fuel**
7. Recommended lubricating oil type: **DETROIT DIESEL POWER GUARD 15W-40**
8. Exhaust pipe configuration, pipe sizes, etc: **see item 17 below**
9. Curb or low idle speed (RPM): **600**
10. Dynamometer idle speed. (Automatic transmission engines only.) **NA**
11. Engine parameter specifications (such as injection timing or injector height setting, operating temperature, etc): **NA**
12. Engine performance data:
    - Manufacturer's advertised maximum power (BHP) **365**
    - Manufacturer's rated engine speed (RPM) **1800**
    - Manufacturer's measured fuel rate at maximum power (lb_m/hr) **11**
    - Manufacturer's maximum governed engine speed (RPM) **19**
13. Recommended start-up procedure: **NA**
14. Maximum safe engine operating speed (RPM): **NA**
15. Number of hours of operation accumulated on engine (prior to installation): **NA**
16. Manufacturer's recommended inlet depression (in. H_2O): **-16**

    Typical in-use inlet depression (in. H_2O): **-1**
17. Exhaust system:
    - Header pipe inside diameter (inches) **4**
    - Tailpipe inside diameter (inches) **5**
    - Minimum distance in-use between the exhaust manifold and the exit of the chassis exhaust system: _____
    - Other: _____

Diesel Engine Pre-Test Data

Required Information as per CFR 86-1244-94 (d)

CERTD2.DER Rev. 8-95

1. Engine-system combination **heavy-duty diesel fueled engine**
2. Engine identification number: **06R0038671**
3. Instrument operator(s): **Johnny M. Cantu**
4. Engine operator(s): **Ricky D. Frierson**
5. Number of hours of operation accumulated on the engine prior to beginning the test sequence:

   8
6. Identification and specification of test fuel: **CB-LE Candidate Fuel**

   SwRI Fuel Code: EM-6179-F
7. Emission Analyzers and Equipment:

Emission Analyzers	Serial No.	Verification Date	Operator
HC continuous	1000456	1/4/07	J. Cantu
CO bag	56314704	12/20/07	R. Guerra
CO2 bag	D000JOYT	1/9/07	R. Guerra
NO_x continuous	1000448	1/5/07	J. Cantu
NO_x converter	1000448	1/3/07	J. Cantu
Equipment			
CVS	12	1/12/07	J. Cantu
Torquemeter	324	1/12/07	R. Frierson

DIESEL ENGINE TEST DATA

Required Information as per CFR 86-1344-94 (e) CERTD3.DER Rev. 8-95

1. Date and time of day: **1/18/07 10:34 am, 11:14 am, 11:54 am**
2. Test number: **C10, C11, C12**
3. Engine intake air or test cell temperature (°F): **78, 77, 78**
4. Barometric pressure (in. Hg): **29.48, 29.48, 29.47**
5. Engine intake or test cell humidity (% RH): **43, 45, 44** CVS dilution air humidity (%RH): **43, 49, 49**
6. Maximum torque verses speed curve as determined in 86.1332, with minimum and maximum engine speeds, and a description of the mapping technique used: **see attached**
7. Measured maximum horsepower engine speed (RPM): **1800** Maximum torque speed (RPM): **1200**
8. Measured maximum horsepower (BHP): **364.7** Maximum measured torque (ft-lb): **1421.5**
9. Measured high idle engine speed (RPM): **---**
10. Measured fuel consumption rate (lb_m/hr) at maximum power: **124.91** and at peak torque: **106.06**
11. Cold-soak time interval and cool down procedures: **overnight soak**
12. Temperature set point of the heated continuous analysis system components (°F): **375**
13. Test cycle validation statistics as specified in 86.1341 for each test phase (cold and hot): **see attached**
14. Total CVS flow rate and dilution factor for each test phase (cold and hot):
    CVS Flow Rate (scfm): **2213.56, 2203.68, 2203.18** Dilution Factor: **22.47, 22.50, 22.47**
15. Dilute exhaust mixture temperature at gas meter (°F): **73, 74, 73**
    Secondary dilution air temperature at gas meter (°F): **76, 76, 76**
16. Maximum temperature at 90mm particulate filter sample zone (°F): **118, 119, 119**
17. Dilute exhaust sample concentrations (background corrected):
    HC (ppmC) **2.44, 2.49, 2.40** CO (ppmC) **45.77, 46.04, 46.05**
    CO_2 (%) **0.5653, 0.5643, 0.5662** NO_X (ppm) **48.40, 48.77, 48.39**
19. Diesel fuel composition: **see attached**
21. The stabilized pre-test weight and post-test weight of each particulate sample and back-up filter:
    Pre-Test Primary (mg) **476.639, 475.072, 480.540**
    Post-test Primary (mg) **480.628, 479.140, 484.690**
    Pre-test Backup (mg) **weighed as pair** Post-test Backup (mg) **weighed as pair**
22. Brake specific emissions (g/BHP-hr) for HC, CO, NO_X for each test phase (cold and hot):
    HC **0.073, 0.075, 0.072** CO **2.813, 2.818, 2.816**
    NO_X **4.741, 4.754, 4.727** Part. **0.226, 0.227, 0.232**
23. The weighted (cold and hot) brake specific emissions (g/BHP-hr) for the total test:
    HC **NA** CO **NA** NO_X **NA** Part. **NA**
24. The carbon balance brake specific fuel consumption (lb/BHP-hr) for the total test: **NA**
25. The number of hours of operation accumulated on the engine after completing the test sequence: **NA**

3-10664-001
Project Number

C-PV-2
Test or ID Number

POWER VALIDATION
HEAVY-DUTY DIESEL ENGINE

Cell No.: 4	Date: 01/18/2007	Start Time: 12:37	Finish Time: 12:44
Engine S/N or ID: S60 38671		[X] As-Received	[ ] Modified
Operator: RDF	Project Leader: Robert Fanick		Fuel Code: EM-6179-F
Low Idle rpm (no load): 600	Low Idle rpm @ 0	lb-ft CITT: 0	High Idle rpm (governed): 1,925
Notes:			

Parameters	Rated Power	Peak Torque
Torque (lb-ft)	1,069	1,424
Speed (rpm)	1,800	1,200
Power (bhp)	366.0	327.0
Fuel Flow (lb/hr)	116.7	107.6
Water Out (°F)	178.0	178
Water In (°F)	175	182
Oil (°F)	205	214
Inlet Air (°F)	79.0	79
Fuel (°F)	98	98
Exhaust (°F)	829	1,020
Intercooler In (°F)	283	277
Intercooler Out (°F)	120	113
IC Coolant Supply (°F)		
Inlet Air Dewpoint (°F)	53.1	54.1
Chiller Water (°F)	56.0	56.0
Barometer ("Hg)	29.44	29.44
Inlet Air Restriction ("H2O)	-15.9	-7.40
Exhaust Restriction ("Hg)	2.4	1.35
Boost Pres. Before IC ("Hg)	38.50	35.20
Boost Pres. After IC ("Hg)	34.8	33.4
Intercooler ÐP ("H2O)	50.3	
Oil Pressure (psig)	54.0	47.0
Fuel Pressure (psig)	10.0	10.8
Engine Water Pres. (psig)		
Hour Meter (hours)	1,295.9	1,295.9

3-10664-001
Project Number

C-MAP-2
Test Number

POWER MAP
HEAVY-DUTY DIESEL ENGINE

Date: 01/18/2007 Time: 12:37	Engine Model: S60		
Cell No.: 4	Serial No. or ID: 38671		
Operator: RDF	Hour Meter: 1,295.8	Dura. Hours:	0.00
Project Leader: Robert Fanick	Fuel Code: EM-6179-f	Baro., "Hg:	29.44

MAP PRECONDITIONING

Parameter	Rated Speed	RatedTorque
Power (bhp)	366.00	327.00
Torque (lb-ft)	1,069.00	1,424.00
Speed (rpm)	1,800.00	1,200.00
Fuel Flow (lb/hr)	116.70	107.60
Inlet Air Restriction ("H2O)	-15.90	-7.40
Exhaust Restriction ("Hg)	2.40	1.35
Intake Air (°F)	79.00	79.00
Intake Air Dewpoint (°F)	53.10	54.10
ÐP Across Intercooler ("H2O)	50.30	24.50
Temperature After Intercooler (°F)	120.00	113.00

Map @ [X] 8 rpm/sec sweep [ ] Other: Idle Speed, rpm Low: 600 High: 1,925

RESULTS

Speed, rpm	Torque lb-ft	Speed, rpm	Torque lb-ft	Speed, rpm	Torque lb-ft	Speed, rpm	Torque lb-ft
100		1100	1,211	2100		3100	
200		1200	1,411	2200		3200	
300		1300	1,348	2300		3300	
400	573	1400	1,267	2400		3400	
500	590	1500	1,216	2500		3500	
600	632	1600	1,172	2600		3600	
700	689	1700	1,121	2700		3700	
800	808	1800	1,061	2800		3800	
900	915	1900		2900		3900	
1000	1,061	2000		3000		4000	

Speed Ramp Rate 8.2 rpm/sec RATED SPEED, rpm: Manufacturer 1,800 Measured 1,716

Calculated Maximum Speed = 1.13*[Highest RATED SPEED - Curb Idle Speed] + Curb Idle Speed = 1,956 rpm

TRANSIENT CYCLE INPUTS

CITT: 0 lb-ft

Idle Speed: 600 rpm Rated Speed 1,800 rpm Max. Power 365.6 hp Max. Torque 1,429 lb-ft

DIESEL ENGINE SET-UP DATA

Required Information as per CFR 86-1344-94 (c)

CERTD1.DER Rev. 8-95

1. Engine Manufacturer: **Detroit Diesel**
2. Engine system combination: **heavy-duty diesel engine**
3. Engine Model: **Series 60** Engine Displacement (in^3): **775**
4. Engine identification number: **06R0038671**
5. Applicable engine model year: **1991**
6. Engine fuel type: **CB-LE Candidate Fuel**
7. Recommended lubricating oil type: **DETROIT DIESEL POWER GUARD 15W-40**
8. Exhaust pipe configuration, pipe sizes, etc: **see item 17 below**
9. Curb or low idle speed (RPM): **600**
10. Dynamometer idle speed. (Automatic transmission engines only.) **NA**
11. Engine parameter specifications (such as injection timing or injector height setting, operating temperature, etc): **NA**
12. Engine performance data:
    - Manufacturer's advertised maximum power (BHP) **365**
    - Manufacturer's rated engine speed (RPM) **1800**
    - Manufacturer's measured fuel rate at maximum power (lb_m/hr) **11**
    - Manufacturer's maximum governed engine speed (RPM) **19**
13. Recommended start-up procedure: **NA**
14. Maximum safe engine operating speed (RPM): **NA**
15. Number of hours of operation accumulated on engine (prior to installation): **NA**
16. Manufacturer's recommended inlet depression (in. H_2O): **-16**

    Typical in-use inlet depression (in. H_2O): **-1**
17. Exhaust system:
    - Header pipe inside diameter (inches) **4**
    - Tailpipe inside diameter (inches) **5**
    - Minimum distance in-use between the exhaust manifold and the exit of the chassis exhaust system: _____
    - Other: _____

Diesel Engine Pre-Test Data

Required Information as per CFR 86-1244-94 (d) CERTD2.DER Rev. 8-95

1. Engine-system combination **heavy-duty diesel fueled engine**
2. Engine identification number: **06R0038671**
3. Instrument operator(s): **Johnny M. Cantu**
4. Engine operator(s): **Ricky D. Frierson**
5. Number of hours of operation accumulated on the engine prior to beginning the test sequence:

   0
6. Identification and specification of test fuel: **CB-LE Candidate Fuel**

   SwRI Fuel Code: EM-6179-F
7. Emission Analyzers and Equipment:

Emission Analyzers	Serial No.	Verification Date	Operator
HC continuous	1000456	1/4/07	J. Cantu
CO bag	56314704	12/20/07	R. Guerra
CO2 bag	D000JOYT	1/9/07	R. Guerra
NO_x continuous	1000448	1/5/07	J. Cantu
NO_x converter	1000448	1/3/07	J. Cantu
Equipment			
CVS	12	1/12/07	J. Cantu
Torquemeter	324	1/12/07	R. Frierson

DIESEL ENGINE TEST DATA

Required Information as per CFR 86-1344-94 (e)

CERTD3.DER Rev. 8-95

1. Date and time of day: **1/18/07 1:51 pm, 2:38 pm, 3:17 pm**
2. Test number: **C13, C14, C15**
3. Engine intake air or test cell temperature (°F): **79, 77, 77**
4. Barometric pressure (in. Hg): **29.41, 29.41, 29.40**
5. Engine intake or test cell humidity (% RH): 45, 44, 45 CVS dilution air humidity (%RH): 47, 47, 47
6. Maximum torque verses speed curve as determined in 86.1332, with minimum and maximum engine speeds, and a description of the mapping technique used: **see attached**
7. Measured maximum horsepower engine speed (RPM): 1800 Maximum torque speed (RPM): **1200**
8. Measured maximum horsepower (BHP): **365.6** Maximum measured torque (ft-lb): 1429.4
9. Measured high idle engine speed (RPM): ---
10. Measured fuel consumption rate (lb_m/hr) at maximum power: 116.7 and at peak torque: 107.6
11. Cold-soak time interval and cool down procedures: **overnight soak**
12. Temperature set point of the heated continuous analysis system components (°F): **375**
13. Test cycle validation statistics as specified in 86.1341 for each test phase (cold and hot): **see attached**
14. Total CVS flow rate and dilution factor for each test phase (cold and hot):
    CVS Flow Rate (scfm): **2208.11, 2208.10, 2200.91** Dilution Factor: **22.32, 22.43, 22.50**
15. Dilute exhaust mixture temperature at gas meter (°F): **74, 74, 75**
    Secondary dilution air temperature at gas meter (°F): **77, 77, 77**
16. Maximum temperature at 90mm particulate filter sample zone (°F): **120, 119, 120**
17. Dilute exhaust sample concentrations (background corrected):
    HC (ppmC) **2.36, 2.47, 2.45** CO (ppmC) **47.06, 45.98, 46.37**
    CO_2 (%) **0.5694, 0.5645, 0.5652** NO_X (ppm) **48.00, 47.88, 48.18**
19. Diesel fuel composition: **see attached**
21. The stabilized pre-test weight and post-test weight of each particulate sample and back-up filter:
    Pre-Test Primary (mg) **473.404, 476.646, 478.013**
    Post-test Primary (mg) **477.480, 480.636, 482.012**
    Pre-test Backup (mg) **weighed as pair** Post-test Backup (mg) **weighed as pair**
22. Brake specific emissions (g/BHP-hr) for HC, CO, NO_X for each test phase (cold and hot):
    HC **0.071, 0.075, 0.074** CO **2.886, 2.838, 2.832**
    NO_X **4.739, 4.700, 4.689** Part. **0.233, 0.230, 0.226**
23. The weighted (cold and hot) brake specific emissions (g/BHP-hr) for the total test:
    HC NA CO NA NO_X NA Part. NA
24. The carbon balance brake specific fuel consumption (lb/BHP-hr) for the total test: NA
25. The number of hours of operation accumulated on the engine after completing the test sequence: **NA**

3-10664-001
Project Number

C-PV3
Test or ID Number

POWER VALIDATION
HEAVY-DUTY DIESEL ENGINE

Cell No.: 4	Date: 01/18/2007	Start Time: 15:46	Finish Time: 15:55
Engine S/N or ID: S60 38671		[X] As-Received	[ ] Modified
Operator: RDF	Project Leader: Robert Fanick		Fuel Code: EM-6179
Low Idle rpm (no load): 600	Low Idle rpm @ 0	lb-ft CITT: 0	High Idle rpm (governed): 1,925
Notes:			

Parameters	Rated Power	Peak Torque
Torque (lb-ft)	1,075	1,450
Speed (rpm)	1,800	1,200
Power (bhp)	369.0	333.0
Fuel Flow (lb/hr)	119.2	109.8
Water Out (°F)	177.0	176
Water In (°F)	180	179
Oil (°F)	211	219
Inlet Air (°F)	80.0	79
Fuel (°F)	91	95
Exhaust (°F)	829	1,013
Intercooler In (°F)	285	281
Intercooler Out (°F)	114	105
IC Coolant Supply (°F)		
Inlet Air Dewpoint (°F)	53.0	53.5
Chiller Water (°F)	55.0	55.0
Barometer ("Hg)	29.41	
Inlet Air Restriction ("H2O)	-16.0	-7.80
Exhaust Restriction ("Hg)	2.5	1.40
Boost Pres. Before IC ("Hg)	38.70	36.30
Boost Pres. After IC ("Hg)	34.9	34.2
Intercooler ÐP ("H2O)	51.7	
Oil Pressure (psig)	53.0	46.0
Fuel Pressure (psig)	9.2	10.5
Engine Water Pres. (psig)		
Hour Meter (hours)	1,297.8	1,297.9

3-10664-001
Project Number

C-PM3
Test Number

POWER MAP
HEAVY-DUTY DIESEL ENGINE

Date: 01/18/2007 Time: 15:46	Engine Model: DDS60		
Cell No.: 4	Serial No. or ID: 38671		
Operator: RDF	Hour Meter: 1,297.7	Dura. Hours:	0.00
Project Leader: Robert Fanick	Fuel Code: EM-6179	Baro., "Hg:	29.41

MAP PRECONDITIONING

Parameter	Rated Speed	RatedTorque
Power (bhp)	369.00	333.00
Torque (lb-ft)	1,075.00	1,450.00
Speed (rpm)	1,800.00	1,200.00
Fuel Flow (lb/hr)	119.20	109.80
Inlet Air Restriction ("H2O)	-16.00	-7.80
Exhaust Restriction ("Hg)	2.50	1.40
Intake Air (°F)	80.00	79.00
Intake Air Dewpoint (°F)	53.00	53.50
ÐP Across Intercooler ("H2O)	51.70	28.60
Temperature After Intercooler (°F)	114.00	105.00

Map @ [X] 8 rpm/sec sweep [ ] Other: Idle Speed, rpm Low: 600 High: 1,925

RESULTS

Speed, rpm	Torque lb-ft	Speed, rpm	Torque lb-ft	Speed, rpm	Torque lb-ft	Speed, rpm	Torque lb-ft
100		1100	1,216	2100		3100	
200		1200	1,418	2200		3200	
300		1300	1,353	2300		3300	
400	574	1400	1,272	2400		3400	
500	592	1500	1,222	2500		3500	
600	637	1600	1,177	2600		3600	
700	691	1700	1,127	2700		3700	
800	809	1800	1,067	2800		3800	
900	928	1900		2900		3900	
1000	1,067	2000		3000		4000	

Speed Ramp Rate 8.2 rpm/sec RATED SPEED, rpm: Manufacturer 1,800 Measured 1,712

Calculated Maximum Speed = 1.13*[Highest RATED SPEED - Curb Idle Speed] + Curb Idle Speed = 1,956 rpm

TRANSIENT CYCLE INPUTS

CITT: 0 lb-ft

Idle Speed: 600 rpm Rated Speed 1,800 rpm Max. Power 366.9 hp Max. Torque 1,432 lb-ft

DIESEL ENGINE SET-UP DATA

Required Information as per CFR 86-1344-94 (c)

CERTD1.DER Rev. 8-95

1. Engine Manufacturer: **Detroit Diesel**
2. Engine system combination: **heavy-duty diesel engine**
3. Engine Model: **Series 60** Engine Displacement (in^3): **775**
4. Engine identification number: **06R0038671**
5. Applicable engine model year: **1991**
6. Engine fuel type: **CB-LE Candidate Fuel**
7. Recommended lubricating oil type: **DETROIT DIESEL POWER GUARD 15W-40**
8. Exhaust pipe configuration, pipe sizes, etc: **see item 17 below**
9. Curb or low idle speed (RPM): **600**
10. Dynamometer idle speed. (Automatic transmission engines only.) **NA**
11. Engine parameter specifications (such as injection timing or injector height setting, operating temperature, etc): **NA**
12. Engine performance data:
    - Manufacturer's advertised maximum power (BHP) **365**
    - Manufacturer's rated engine speed (RPM) **1800**
    - Manufacturer's measured fuel rate at maximum power (lb_m/hr) **11**
    - Manufacturer's maximum governed engine speed (RPM) **19**
13. Recommended start-up procedure: **NA**
14. Maximum safe engine operating speed (RPM): **NA**
15. Number of hours of operation accumulated on engine (prior to installation): **NA**
16. Manufacturer's recommended inlet depression (in. H_2O): **-16**

    Typical in-use inlet depression (in. H_2O): **-1**
17. Exhaust system:
    - Header pipe inside diameter (inches) **4**
    - Tailpipe inside diameter (inches) **5**
    - Minimum distance in-use between the exhaust manifold and the exit of the chassis exhaust system: _____
    - Other: _____

Diesel Engine Pre-Test Data

Required Information as per CFR 86-1244-94 (d)

CERTD2.DER Rev. 8-95

1. Engine-system combination **heavy-duty diesel fueled engine**
2. Engine identification number: **06R0038671**
3. Instrument operator(s): **Johnny M. Cantu**
4. Engine operator(s): **Ricky D. Frierson**
5. Number of hours of operation accumulated on the engine prior to beginning the test sequence:

   0
6. Identification and specification of test fuel: **CB-LE Candidate Fuel**

   SwRI Fuel Code: EM-6179-F
7. Emission Analyzers and Equipment:

Emission Analyzers	Serial No.	Verification Date	Operator
HC continuous	1000456	1/4/07	J. Cantu
CO bag	56314704	12/20/07	R. Guerra
CO2 bag	D000JOYT	1/9/07	R. Guerra
NO_x continuous	1000448	1/5/07	J. Cantu
NO_x converter	1000448	1/3/07	J. Cantu
Equipment			
CVS	12	1/12/07	J. Cantu
Torquemeter	324	1/12/07	R. Frierson

DIESEL ENGINE TEST DATA

Required Information as per CFR 86-1344-94 (e)

CERTD3.DER Rev. 8-95

1. Date and time of day: **1/18/07 5:01 pm, 5:48 pm, 6:29 pm**
2. Test number: **C16, C17, C18**
3. Engine intake air or test cell temperature (°F): **76, 78, 78**
4. Barometric pressure (in. Hg): **29.41, 29.41, 29.43**
5. Engine intake or test cell humidity (% RH): 48, 44, 43 CVS dilution air humidity (%RH): 44, 47, 51
6. Maximum torque verses speed curve as determined in 86.1332, with minimum and maximum engine speeds, and a description of the mapping technique used: **see attached**
7. Measured maximum horsepower engine speed (RPM): 1800 Maximum torque speed (RPM): **1200**
8. Measured maximum horsepower (BHP): **366.9** Maximum measured torque (ft-lb): 1431.5
9. Measured high idle engine speed (RPM): **---**
10. Measured fuel consumption rate (lb_m/hr) at maximum power: 119.2 and at peak torque: 109.8
11. Cold-soak time interval and cool down procedures: **overnight soak**
12. Temperature set point of the heated continuous analysis system components (°F): **375**
13. Test cycle validation statistics as specified in 86.1341 for each test phase (cold and hot): **see attached**
14. Total CVS flow rate and dilution factor for each test phase (cold and hot):
    CVS Flow Rate (scfm): **2208.26, 2205.00, 2199.71** Dilution Factor: **22.62, 22.50, 22.43**
15. Dilute exhaust mixture temperature at gas meter (°F): **74, 74, 74**
    Secondary dilution air temperature at gas meter (°F): **77, 77, 77**
16. Maximum temperature at 90mm particulate filter sample zone (°F): **119, 119, 119**
17. Dilute exhaust sample concentrations (background corrected):
    HC (ppmC) **2.38, 2.34, 2.54** CO (ppmC) **46.53, 46.69, 46.43**
    CO_2 (%) **0.5621, 0.5633, 0.5672** NO_X (ppm) **47.56, 47.98, 48.15**
19. Diesel fuel composition: **see attached**
21. The stabilized pre-test weight and post-test weight of each particulate sample and back-up filter:
    Pre-Test Primary (mg) **478.456, 476.362, 472.933**
    Post-test Primary (mg) **482.626, 480.519, 477.049**
    Pre-test Backup (mg) **weighed as pair** Post-test Backup (mg) **weighed as pair**
22. Brake specific emissions (g/BHP-hr) for HC, CO, NO_X for each test phase (cold and hot):
    HC **0.072, 0.070, 0.076** CO **2.873, 2.854, 2.835**
    NO_X **4.703, 4.688, 4.670** Part. **0.234, 0.233, 0.228**
23. The weighted (cold and hot) brake specific emissions (g/BHP-hr) for the total test:
    HC NA CO NA NO_X NA Part. NA
24. The carbon balance brake specific fuel consumption (lb/BHP-hr) for the total test: NA
25. The number of hours of operation accumulated on the engine after completing the test sequence: **NA**

3-10664-001
Project Number

PV-1 R
Test or ID Number

POWER VALIDATION
HEAVY-DUTY DIESEL ENGINE

Cell No.: 4	Date: 01/19/2007	Start Time: 8:30	Finish Time: 8:53
Engine S/N or ID: S60		[X] As-Received	[ ] Modified
Operator: RDF	Project Leader: Robert Fanick		Fuel Code: EM-6144-F
Low Idle rpm (no load): 600	Low Idle rpm @ 0	lb-ft CITT: 0	High Idle rpm (governed): 1,925
Notes:			

Parameters	Rated Power	Peak Torque
Torque (lb-ft)	1,059	1,420
Speed (rpm)	1,800	1,200
Power (bhp)	366.0	329.0
Fuel Flow (lb/hr)	121.4	106.4
Water Out (°F)	183.0	183
Water In (°F)	176	179
Oil (°F)	207	216
Inlet Air (°F)	80.0	79
Fuel (°F)	96	96
Exhaust (°F)	820	1,001
Intercooler In (°F)	275	275
Intercooler Out (°F)	116	107
IC Coolant Supply (°F)		
Inlet Air Dewpoint (°F)	52.0	52.5
Chiller Water (°F)	56.0	56.0
Barometer ("Hg)	29.52	29.52
Inlet Air Restriction ("H2O)	-16.0	-7.40
Exhaust Restriction ("Hg)	2.5	1.35
Boost Pres. Before IC ("Hg)	38.00	34.90
Boost Pres. After IC ("Hg)	34.3	33.2
Intercooler ÐP ("H2O)	50.0	23.0
Oil Pressure (psig)	54.0	47.0
Fuel Pressure (psig)	9.5	11.0
Engine Water Pres. (psig)		
Hour Meter (hours)	1,300.0	1,300.1

3-10664-001
Project Number

R MAP 1
Test Number

POWER MAP
HEAVY-DUTY DIESEL ENGINE

Date: 01/19/2007 Time: 8:30	Engine Model: S60		
Cell No.: 4	Serial No. or ID: 38671		
Operator: RDF	Hour Meter: 1,299.7	Dura. Hours:	0.00
Project Leader: Robert Fanick	Fuel Code: EM-6144-F	Baro., "Hg:	29.52

MAP PRECONDITIONING

Parameter	Rated Speed	RatedTorque
Power (bhp)	366.00	329.00
Torque (lb-ft)	1,059.00	1,420.00
Speed (rpm)	1,800.00	1,200.00
Fuel Flow (lb/hr)	121.40	106.40
Inlet Air Restriction ("H2O)	-16.00	-7.40
Exhaust Restriction ("Hg)	2.50	1.35
Intake Air (°F)	80.00	79.00
Intake Air Dewpoint (°F)	52.00	52.50
ÐP Across Intercooler ("H2O)	50.00	23.00
Temperature After Intercooler (°F)	116.00	107.00

Map @ [X] 8 rpm/sec sweep [ ] Other: Idle Speed, rpm Low: 600 High: 1,925

RESULTS

Speed, rpm	Torque lb-ft	Speed, rpm	Torque lb-ft	Speed, rpm	Torque lb-ft	Speed, rpm	Torque lb-ft
100		1100	1,198	2100		3100	
200		1200	1,397	2200		3200	
300		1300	1,335	2300		3300	
400	576	1400	1,260	2400		3400	
500	605	1500	1,209	2500		3500	
600	628	1600	1,163	2600		3600	
700	674	1700	1,112	2700		3700	
800	796	1800	1,052	2800		3800	
900	910	1900		2900		3900	
1000	1,052	2000		3000		4000	

Speed Ramp Rate 8.3 rpm/sec RATED SPEED, rpm: Manufacturer 1,800 Measured 1,717

Calculated Maximum Speed = 1.13*[Highest RATED SPEED - Curb Idle Speed] + Curb Idle Speed = 1,956 rpm

TRANSIENT CYCLE INPUTS

CITT: 0 lb-ft

Idle Speed: 600 rpm Rated Speed 1,800 rpm Max. Power 362.2 hp Max. Torque 1,419 lb-ft

DIESEL ENGINE SET-UP DATA

Required Information as per CFR 86-1344-94 (c)

CERTD1.DER Rev. 8-95

1. Engine Manufacturer: **Detroit Diesel**
2. Engine system combination: **heavy-duty diesel engine**
3. Engine Model: **Series 60** Engine Displacement (in^3): **775**
4. Engine identification number: **06R0038671**
5. Applicable engine model year: **1991**
6. Engine fuel type: **TxLED ULSD Reference Fuel**
7. Recommended lubricating oil type: **DETROIT DIESEL POWER GUARD 15W-40**
8. Exhaust pipe configuration, pipe sizes, etc: **see item 17 below**
9. Curb or low idle speed (RPM): **600**
10. Dynamometer idle speed. (Automatic transmission engines only.) **NA**
11. Engine parameter specifications (such as injection timing or injector height setting, operating temperature, etc): **NA**
12. Engine performance data:
    - Manufacturer's advertised maximum power (BHP) **365**
    - Manufacturer's rated engine speed (RPM) **1800**
    - Manufacturer's measured fuel rate at maximum power (lb_m/hr) **11**
    - Manufacturer's maximum governed engine speed (RPM) **19**
13. Recommended start-up procedure: **NA**
14. Maximum safe engine operating speed (RPM): **NA**
15. Number of hours of operation accumulated on engine (prior to installation): **NA**
16. Manufacturer's recommended inlet depression (in. H_2O): **-16**

    Typical in-use inlet depression (in. H_2O): **-1**
17. Exhaust system:
    - Header pipe inside diameter (inches) **4**
    - Tailpipe inside diameter (inches) **5**
    - Minimum distance in-use between the exhaust manifold and the exit of the chassis exhaust system: _____
    - Other: _____

Diesel Engine Pre-Test Data

Required Information as per CFR 86-1244-94 (d) CERTD2.DER Rev. 8-95

1. Engine-system combination **heavy-duty diesel fueled engine**
2. Engine identification number: **06R0038671**
3. Instrument operator(s): **Johnny M. Cantu**
4. Engine operator(s): **Ricky D. Frierson**
5. Number of hours of operation accumulated on the engine prior to beginning the test sequence:

   0
6. Identification and specification of test fuel: **TxLED Low Sulfur Diesel Fuel**

   SwRI Fuel Code: EM-6144-F
7. Emission Analyzers and Equipment:

Emission Analyzers	Serial No.	Verification Date	Operator
HC continuous	1000456	1/4/07	J. Cantu
CO bag	56314704	12/20/07	R. Guerra
CO2 bag	D000JOYT	1/9/07	R. Guerra
NO_x continuous	1000448	1/5/07	J. Cantu
NO_x converter	1000448	1/3/07	J. Cantu
Equipment			
CVS	12	1/12/07	J. Cantu
Torquemeter	324	1/12/07	R. Frierson

DIESEL ENGINE TEST DATA

Required Information as per CFR 86-1344-94 (e) CERTD3.DER Rev. 8-95

1. Date and time of day: **1/19/07 10:02 am, 10:42 am, 11:22 am**
2. Test number: **R19, R20. R21**
3. Engine intake air or test cell temperature (°F): **79, 77, 78**
4. Barometric pressure (in. Hg): **29.53, 29.52, 29.51**
5. Engine intake or test cell humidity (% RH): 43, 46, 45 CVS dilution air humidity (%RH): 43, 46, 43
6. Maximum torque verses speed curve as determined in 86.1332, with minimum and maximum engine speeds, and a description of the mapping technique used: **see attached**
7. Measured maximum horsepower engine speed (RPM): 1800 Maximum torque speed (RPM): **1200**
8. Measured maximum horsepower (BHP): **362.2** Maximum measured torque (ft-lb): 1419.3
9. Measured high idle engine speed (RPM): **---**
10. Measured fuel consumption rate (lb_m/hr) at maximum power: 121.4 and at peak torque: 106.4
11. Cold-soak time interval and cool down procedures: **overnight soak**
12. Temperature set point of the heated continuous analysis system components (°F): **375**
13. Test cycle validation statistics as specified in 86.1341 for each test phase (cold and hot): **see attached**
14. Total CVS flow rate and dilution factor for each test phase (cold and hot):
    CVS Flow Rate (scfm): **2215.71, 2210.08, 2209.27** Dilution Factor: **22.00, 22.08, 22.07**
15. Dilute exhaust mixture temperature at gas meter (°F): **74, 72, 74**
    Secondary dilution air temperature at gas meter (°F): **79, 77, 78**
16. Maximum temperature at 90mm particulate filter sample zone (°F): **119, 120, 119**
17. Dilute exhaust sample concentrations (background corrected):
    HC (ppmC) **2.45, 2.38, 2.45** CO (ppmC) **48.00, 47.84, 48.08**
    CO_2 (%) **0.5571, 0.5561, 0.5569** NO_X (ppm) **46.01, 46.00, 45.99**
19. Diesel fuel composition: **see attached**
21. The stabilized pre-test weight and post-test weight of each particulate sample and back-up filter:
    Pre-Test Primary (mg) **479.110, 483.534, 471.788**
    Post-test Primary (mg) **483.236, 487.632, 475.759**
    Pre-test Backup (mg) **weighed as pair** Post-test Backup (mg) **weighed as pair**
22. Brake specific emissions (g/BHP-hr) for HC, CO, NO_X for each test phase (cold and hot):
    HC **0.076, 0.073, 0.075** CO **2.997, 2.965, 2.951**
    NO_X **4.557, 4.562, 4.517** Part. **0.231, 0.235, 0.234**
23. The weighted (cold and hot) brake specific emissions (g/BHP-hr) for the total test:
    HC NA CO NA NO_X NA Part. NA
24. The carbon balance brake specific fuel consumption (lb/BHP-hr) for the total test: NA
25. The number of hours of operation accumulated on the engine after completing the test sequence: **NA**

3-10664-001
Project Number

R-PV-2
Test or ID Number

POWER VALIDATION
HEAVY-DUTY DIESEL ENGINE

Cell No.: 4	Date: 01/19/2007	Start Time: 12:06	Finish Time: 12:14
Engine S/N or ID: S60 38671		[X] As-Received	[ ] Modified
Operator: RDF	Project Leader: Robert Fanick		Fuel Code: EM-6144
Low Idle rpm (no load): 600	Low Idle rpm @ 0	lb-ft CITT: 0	High Idle rpm (governed): 1,925
Notes:			

Parameters	Rated Power	Peak Torque
Torque (lb-ft)	1,067	1,438
Speed (rpm)	1,800	1,200
Power (bhp)	368.0	333.0
Fuel Flow (lb/hr)	119.6	105.3
Water Out (°F)	178.0	176
Water In (°F)	175	178
Oil (°F)	207	216
Inlet Air (°F)	79.0	79
Fuel (°F)	95	95
Exhaust (°F)	827	1,009
Intercooler In (°F)	283	279
Intercooler Out (°F)	117	108
IC Coolant Supply (°F)		
Inlet Air Dewpoint (°F)	53.0	53.9
Chiller Water (°F)	56.0	57.0
Barometer ("Hg)	29.48	
Inlet Air Restriction ("H2O)	-16.0	-7.70
Exhaust Restriction ("Hg)	2.5	1.40
Boost Pres. Before IC ("Hg)	38.10	35.90
Boost Pres. After IC ("Hg)	34.4	33.9
Intercooler ÐP ("H2O)	50.3	27.0
Oil Pressure (psig)	53.0	47.0
Fuel Pressure (psig)	9.8	10.8
Engine Water Pres. (psig)		
Hour Meter (hours)	1,302.0	1,302.0

3-10664-001
Project Number

R-PM-2
Test Number

POWER MAP
HEAVY-DUTY DIESEL ENGINE

Date: 01/19/2007 Time: 12:06	Engine Model: DDS60		
Cell No.: 4	Serial No. or ID: 38671		
Operator: RDF	Hour Meter: 1,301.9	Dura. Hours:	0.00
Project Leader: Robert Fanick	Fuel Code: EM-6144	Baro., "Hg:	29.48

MAP PRECONDITIONING

Parameter	Rated Speed	RatedTorque
Power (bhp)	368.00	333.00
Torque (lb-ft)	1,067.00	1,438.00
Speed (rpm)	1,800.00	1,200.00
Fuel Flow (lb/hr)	119.60	105.30
Inlet Air Restriction ("H2O)	-16.00	-7.70
Exhaust Restriction ("Hg)	2.50	1.40
Intake Air (°F)	79.00	79.00
Intake Air Dewpoint (°F)	53.00	53.90
ÐP Across Intercooler ("H2O)	50.30	27.00
Temperature After Intercooler (°F)	117.00	108.00

Map @ [X] 8 rpm/sec sweep [ ] Other: Idle Speed, rpm Low: 600 High: 1,925

RESULTS

Speed, rpm	Torque lb-ft	Speed, rpm	Torque lb-ft	Speed, rpm	Torque lb-ft	Speed, rpm	Torque lb-ft
100		1100	1,209	2100		3100	
200		1200	1,404	2200		3200	
300		1300	1,349	2300		3300	
400	568	1400	1,267	2400		3400	
500	582	1500	1,212	2500		3500	
600	628	1600	1,169	2600		3600	
700	681	1700	1,119	2700		3700	
800	801	1800	1,053	2800		3800	
900	911	1900		2900		3900	
1000	1,055	2000		3000		4000	

Speed Ramp Rate 8.2 rpm/sec RATED SPEED, rpm: Manufacturer 1,800 Measured 1,708

Calculated Maximum Speed = 1.13*[Highest RATED SPEED - Curb Idle Speed] + Curb Idle Speed = 1,956 rpm

TRANSIENT CYCLE INPUTS

CITT: 0 lb-ft

Idle Speed: 600 rpm Rated Speed 1,800 rpm Max. Power 364.2 hp Max. Torque 1,424 lb-ft

DIESEL ENGINE SET-UP DATA

Required Information as per CFR 86-1344-94 (c) CERTD1.DER Rev. 8-95

1. Engine Manufacturer: **Detroit Diesel**
2. Engine system combination: **heavy-duty diesel engine**
3. Engine Model: **Series 60** Engine Displacement (in^3): **775**
4. Engine identification number: **06R0038671**
5. Applicable engine model year: **1991**
6. Engine fuel type: **TxLED ULSD Reference Fuel**
7. Recommended lubricating oil type: **DETROIT DIESEL POWER GUARD 15W-40**
8. Exhaust pipe configuration, pipe sizes, etc: **see item 17 below**
9. Curb or low idle speed (RPM): **600**
10. Dynamometer idle speed. (Automatic transmission engines only.) **NA**
11. Engine parameter specifications (such as injection timing or injector height setting, operating temperature, etc): **NA**
12. Engine performance data:
    - Manufacturer's advertised maximum power (BHP) **365**
    - Manufacturer's rated engine speed (RPM) **1800**
    - Manufacturer's measured fuel rate at maximum power (lb_m/hr) **11**
    - Manufacturer's maximum governed engine speed (RPM) **19**
13. Recommended start-up procedure: **NA**
14. Maximum safe engine operating speed (RPM): **NA**
15. Number of hours of operation accumulated on engine (prior to installation): **NA**
16. Manufacturer's recommended inlet depression (in. H_2O): **-16**

    Typical in-use inlet depression (in. H_2O): **-1**
17. Exhaust system:
    - Header pipe inside diameter (inches) **4**
    - Tailpipe inside diameter (inches) **5**
    - Minimum distance in-use between the exhaust manifold and the exit of the chassis exhaust system: _____
    - Other: _____

Diesel Engine Pre-Test Data

Required Information as per CFR 86-1244-94 (d)

CERTD2.DER Rev. 8-95

1. Engine-system combination **heavy-duty diesel fueled engine**
2. Engine identification number: **06R0038671**
3. Instrument operator(s): **Johnny M. Cantu**
4. Engine operator(s): **Ricky D. Frierson**
5. Number of hours of operation accumulated on the engine prior to beginning the test sequence:

   0
6. Identification and specification of test fuel: **TxLED Low Sulfur Diesel Fuel**

   SwRI Fuel Code: EM-6144-F
7. Emission Analyzers and Equipment:

Emission Analyzers	Serial No.	Verification Date	Operator
HC continuous	1000456	1/4/07	J. Cantu
CO bag	56314704	12/20/07	R. Guerra
CO2 bag	D000JOYT	1/9/07	R. Guerra
NO_x continuous	1000448	1/5/07	J. Cantu
NO_x converter	1000448	1/3/07	J. Cantu
Equipment			
CVS	12	1/12/07	J. Cantu
Torquemeter	324	1/12/07	R. Frierson

DIESEL ENGINE TEST DATA

Required Information as per CFR 86-1344-94 (e)

CERTD3.DER Rev. 8-95

1. Date and time of day: 1/19/07 1:22 pm, 2:08 pm, 2:46 pm
2. Test number: R22, R23, R24
3. Engine intake air or test cell temperature (°F): 77, 78, 79
4. Barometric pressure (in. Hg): 29.44, 29.42, 29.40
5. Engine intake or test cell humidity (% RH): 46, 44, 43 CVS dilution air humidity (%RH): 46, 49, 49
6. Maximum torque verses speed curve as determined in 86.1332, with minimum and maximum engine speeds, and a description of the mapping technique used: see attached
7. Measured maximum horsepower engine speed (RPM): 1800 Maximum torque speed (RPM): 1200
8. Measured maximum horsepower (BHP): 364.2 Maximum measured torque (ft-lb): 1423.9
9. Measured high idle engine speed (RPM): ---
10. Measured fuel consumption rate (lb_m/hr) at maximum power: 119.6 and at peak torque: 105.3
11. Cold-soak time interval and cool down procedures: overnight soak
12. Temperature set point of the heated continuous analysis system components (°F): 375
13. Test cycle validation statistics as specified in 86.1341 for each test phase (cold and hot): see attached
14. Total CVS flow rate and dilution factor for each test phase (cold and hot):
    CVS Flow Rate (scfm): 2210.38, 2205.74, 2204.12 Dilution Factor: 21.95, 22.07, 21.96
15. Dilute exhaust mixture temperature at gas meter (°F): 74, 74, 74
    Secondary dilution air temperature at gas meter (°F): 78, 78, 78
16. Maximum temperature at 90mm particulate filter sample zone (°F): 120, 118, 119
17. Dilute exhaust sample concentrations (background corrected):
    HC (ppmC) 2.28, 2.50, 2.09 CO (ppmC) 49.83, 49.04, 49.52
    CO_2 (%) 0.5591, 0.5561, 0.5599 NO_X (ppm) 46.38, 46.16, 46.53
19. Diesel fuel composition: see attached
21. The stabilized pre-test weight and post-test weight of each particulate sample and back-up filter:
    Pre-Test Primary (mg) 482.371, 480.138, 479.021
    Post-test Primary (mg) 486.389, 484.163, 483.032
    Pre-test Backup (mg) weighed as pair Post-test Backup (mg) weighed as pair
22. Brake specific emissions (g/BHP-hr) for HC, CO, NO_X for each test phase (cold and hot):
    HC 0.070, 0.076, 064 CO 3.059, 3.003, 3.030
    NO_X 4.552, 4.523, 4.551 Part. 0.229, 0.233, 0.228
23. The weighted (cold and hot) brake specific emissions (g/BHP-hr) for the total test:
    HC NA CO NA NO_X NA Part. NA
24. The carbon balance brake specific fuel consumption (lb/BHP-hr) for the total test: NA
25. The number of hours of operation accumulated on the engine after completing the test sequence: NA

APPENDIX B

Transient Regulated Emissions Data for the 1991 Detroit Diesel Series 60

Test No.	Page No.
R1	B-1
R2	B-2
R3	B-3
R4	B-4
R5	B-5
R6	B-6
R7	B-7
R7 (Reweigh)	B-8
R8	B-9
R8 (Reweigh)	B-10
R9	B-11
R9 (Reweigh)	B-12
C10	B-13
C11	B-14
C12	B-15
C13	B-16
C14	B-17
C15	B-18
C16	B-19
C17	B-20
C18	B-21
R19	B-22
R20	B-23
R21	B-24
R22	B-25
R23	B-26
R24	B-27

Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.:	R1		DIESEL 2D, EM-6144-F
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/15/2007	Time: 10:08	HCR: 1.892	FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT:	4.12-R	H= 0.137 C= 0.863 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.50	in Hg	99.9 kPa
Engine Inlet Air			
Temperature:	78.0	°F	25.6 °C
Dew Point:	58.3	°F	14.6 °C
Abs. Humidity:	74.0	gr/lb	10.6 g/kg
Rel. Humidity:	51	%	
Dilution Air:			
Temperature:	71.0	°F	21.7 °C
Abs. Humidity	47.2	gr/lb	6.7 g/kg
Rel. Humidity:	41	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		5.57	ppm	
HC Bckgrd	n/a		3.60	ppm	
CO Sample	50.0	2	48.82	ppm	(Dry)
CO Bckgrd	0.2	2	0.19	ppm	
NOx Sample	n/a		47.43	ppm	(Dry)
NOx Bckgrd	0.5	1	0.13	ppm	
CO2 Sample	61.1	1	0.5968	ppm	(Wet)
CO2 Bckgrd	4.7	1	0.0450	ppm	

Corrected Concentrations

HC	2.13	ppm
CO	47.42	ppm
NOx	46.53	ppm
CO2	0.5538	ppm

Mass Emissions

HC		1.566	grams	
CO		70.082	grams	
NOx		112.651	grams	
Particulate		5.516	grams	
CO2		12.861	kg	
Fuel	9.05 lb		4.10 kg	

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,213.6	62.69
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.48	0.04
Gas Meter 2:	3.12	0.09
Sample Rate:	1.64	0.05
Total Flow Rate:	2,215.25	62.74

Particulate Data

Filter Number:	8570.0-176 (pair)	
Weight Gain:	4.083	mg
Sample Multiplier:	1.351	

Correction Factors

NOx Humidity CF:	0.997
Dry-to-Wet CF, Sample:	0.984
Dry-to-Wet CF, Bckgrd:	0.989
Dilution Factor:	22.19

Test Cycle Data

Sample Time:	1,214.00	sec		
Work:	23.77	hp-hr	17.73	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	44,821.8	scf	1,269.38	scm

Brake-Specific Emission Results

BSHC (Cell)	0.066	g/hp-hr	0.088	g/kW-hr
CO	2.948	g/hp-hr	3.954	g/kW-hr
NOx (Cell)	4.739	g/hp-hr	6.355	g/kW-hr
Particulate	0.232	g/hp-hr	0.311	g/kW-hr
CO2	541.1	g/hp-hr	725.58	g/kW-hr
BSFC	0.381	lb/hp-hr	0.232	kg/kW-hr

Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.:	R2		DIESEL 2D, EM-6144-F
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/15/2007	Time: 10:48	HCR: 1.892	FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT:	4.12-R	H= 0.137 C= 0.863 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.51	in Hg	99.9 kPa
Engine Inlet Air			
Temperature:	79.0	°F	26.1 °C
Dew Point:	58.1	°F	14.5 °C
Abs. Humidity:	73.4	gr/lb	10.5 g/kg
Rel. Humidity:	49	%	
Dilution Air:			
Temperature:	71.0	°F	21.7 °C
Abs. Humidity	47.2	gr/lb	6.7 g/kg
Rel. Humidity:	41	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		7.03	ppm	
HC Bckgrd	n/a		4.50	ppm	
CO Sample	50.3	2	49.12	ppm	(Dry)
CO Bckgrd	0.1	2	0.09	ppm	
NOx Sample	n/a		47.51	ppm	(Dry)
NOx Bckgrd	0.3	1	0.08	ppm	
CO2 Sample	61.5	1	0.6009	ppm	(Wet)
CO2 Bckgrd	4.7	1	0.0450	ppm	

Corrected Concentrations

HC	2.73	ppm
CO	47.81	ppm
NOx	46.65	ppm
CO2	0.5579	ppm

Mass Emissions

HC		2.006	grams	
CO		70.595	grams	
NOx		112.704	grams	
Particulate		5.528	grams	
CO2		12.947	kg	
Fuel	9.11 lb		4.13 kg	

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,211.2	62.62
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.48	0.04
Gas Meter 2:	3.11	0.09
Sample Rate:	1.63	0.05
Total Flow Rate:	2,212.85	62.67

Particulate Data

Filter Number:	8571.0-177 (pair)	
Weight Gain:	4.083	mg
Sample Multiplier:	1.354	

Correction Factors

NOx Humidity CF:	0.996
Dry-to-Wet CF, Sample:	0.984
Dry-to-Wet CF, Bckgrd:	0.989
Dilution Factor:	22.04

Test Cycle Data

Sample Time:	1,214.40	sec		
Work:	23.98	hp-hr	17.88	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	44,788.2	scf	1,268.43	scm

Brake-Specific Emission Results

BSHC (Cell)	0.084	g/hp-hr	0.112	g/kW-hr
CO	2.944	g/hp-hr	3.948	g/kW-hr
NOx (Cell)	4.700	g/hp-hr	6.303	g/kW-hr
Particulate	0.231	g/hp-hr	0.309	g/kW-hr
CO2	539.9	g/hp-hr	724.02	g/kW-hr
BSFC	0.380	lb/hp-hr	0.231	kg/kW-hr

Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.: R3		DIESEL 2D, EM-6144-F	
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/15/2007	Time: 11:28	HCR: 1.892	FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT:	4.12-R	H= 0.137 C= 0.863 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.51	in Hg	99.9 kPa
Engine Inlet Air			
Temperature:	77.0	°F	25.0 °C
Dew Point:	63.0	°F	17.2 °C
Abs. Humidity:	87.7	gr/lb	12.5 g/kg
Rel. Humidity:	62	%	
Dilution Air:			
Temperature:	71.0	°F	21.7 °C
Abs. Humidity	51.4	gr/lb	7.3 g/kg
Rel. Humidity:	45	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		5.95	ppm	
HC Bckgrd	n/a		3.40	ppm	
CO Sample	49.6	2	48.42	ppm	(Dry)
CO Bckgrd	0.2	2	0.19	ppm	
NOx Sample	n/a		47.76	ppm	(Dry)
NOx Bckgrd	0.3	1	0.08	ppm	
CO2 Sample	61.8	1	0.6040	ppm	(Wet)
CO2 Bckgrd	4.8	1	0.0459	ppm	

Corrected Concentrations

HC	2.71	ppm
CO	46.97	ppm
NOx	46.85	ppm
CO2	0.5602	ppm

Mass Emissions

HC		1.984	grams	
CO		69.348	grams	
NOx		117.500	grams	
Particulate		5.498	grams	
CO2		12.997	kg	
Fuel	9.14 lb		4.15	kg

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,211.0	62.62
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.48	0.04
Gas Meter 2:	3.09	0.09
Sample Rate:	1.62	0.05
Total Flow Rate:	2,212.66	62.66

Particulate Data

Filter Number:	8572.0-178 (pair)	
Weight Gain:	4.016	mg
Sample Multiplier:	1.369	

Correction Factors

NOx Humidity CF:	1.034
Dry-to-Wet CF, Sample:	0.983
Dry-to-Wet CF, Bckgrd:	0.988
Dilution Factor:	21.93

Test Cycle Data

Sample Time:	1,214.30	sec		
Work:	23.86	hp-hr	17.79	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	44,780.6	scf	1,268.21	scm

Brake-Specific Emission Results

BSHC (Cell)	0.083	g/hp-hr	0.112	g/kW-hr
CO	2.906	g/hp-hr	3.898	g/kW-hr
NOx (Cell)	4.925	g/hp-hr	6.604	g/kW-hr
Particulate	0.230	g/hp-hr	0.309	g/kW-hr
CO2	544.7	g/hp-hr	730.48	g/kW-hr
BSFC	0.383	lb/hp-hr	0.233	kg/kW-hr

Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.: R4		DIESEL 2D, EM-6144-F	
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/15/2007	Time: 13:58	HCR: 1.892	FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT:	4.12-R	H= 0.137 C= 0.863 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.49	in Hg	99.9 kPa
Engine Inlet Air			
Temperature:	78.0	°F	25.6 °C
Dew Point:	54.7	°F	12.6 °C
Abs. Humidity:	64.8	gr/lb	9.3 g/kg
Rel. Humidity:	45	%	
Dilution Air:			
Temperature:	67.0	°F	19.4 °C
Abs. Humidity	37.7	gr/lb	5.4 g/kg
Rel. Humidity:	38	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		5.57	ppm	
HC Bckgrd	n/a		2.60	ppm	
CO Sample	50.7	2	49.52	ppm	(Dry)
CO Bckgrd	0.1	2	0.09	ppm	
NOx Sample	n/a		47.60	ppm	(Dry)
NOx Bckgrd	0.5	1	0.13	ppm	
CO2 Sample	61.2	1	0.5978	ppm	(Wet)
CO2 Bckgrd	4.6	1	0.0440	ppm	

Corrected Concentrations

HC	3.09	ppm
CO	48.25	ppm
NOx	46.80	ppm
CO2	0.5558	ppm

Mass Emissions

HC		2.267	grams	
CO		71.315	grams	
NOx		110.685	grams	
Particulate		5.477	grams	
CO2		12.908	kg	
Fuel	9.08 lb		4.12 kg	

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,212.9	62.67
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.47	0.04
Gas Meter 2:	3.11	0.09
Sample Rate:	1.64	0.05
Total Flow Rate:	2,214.50	62.72

Particulate Data

Filter Number:	8573.0-179 (pair)	
Weight Gain:	4.063	mg
Sample Multiplier:	1.348	

Correction Factors

NOx Humidity CF:	0.974
Dry-to-Wet CF, Sample:	0.986
Dry-to-Wet CF, Bckgrd:	0.991
Dilution Factor:	22.15

Test Cycle Data

Sample Time:	1,214.50	sec		
Work:	24.01	hp-hr	17.90	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	44,825.1	scf	1,269.47	scm

Brake-Specific Emission Results

BSHC (Cell)	0.094	g/hp-hr	0.127	g/kW-hr
CO	2.970	g/hp-hr	3.983	g/kW-hr
NOx (Cell)	4.610	g/hp-hr	6.182	g/kW-hr
Particulate	0.228	g/hp-hr	0.306	g/kW-hr
CO2	537.6	g/hp-hr	720.92	g/kW-hr
BSFC	0.378	lb/hp-hr	0.230	kg/kW-hr

Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.:	R5		DIESEL 2D, EM-6144-F
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/15/2007	Time: 14:38	HCR: 1.892	FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT:	4.12-R	H= 0.137 C= 0.863 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.48	in Hg	99.8 kPa
Engine Inlet Air			
Temperature:	79.0	°F	26.1 °C
Dew Point:	57.6	°F	14.2 °C
Abs. Humidity:	72.2	gr/lb	10.3 g/kg
Rel. Humidity:	48	%	
Dilution Air:			
Temperature:	68.0	°F	20.0 °C
Abs. Humidity	40.0	gr/lb	5.7 g/kg
Rel. Humidity:	39	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		5.83	ppm	
HC Bckgrd	n/a		3.20	ppm	
CO Sample	51.5	2	50.31	ppm	(Dry)
CO Bckgrd	0.2	2	0.19	ppm	
NOx Sample	n/a		47.73	ppm	(Dry)
NOx Bckgrd	0.4	1	0.10	ppm	
CO2 Sample	61.3	1	0.5988	ppm	(Wet)
CO2 Bckgrd	4.4	1	0.0421	ppm	

Corrected Concentrations

HC	2.77	ppm
CO	48.92	ppm
NOx	46.93	ppm
CO2	0.5586	ppm

Mass Emissions

HC		2.030	grams	
CO		72.039	grams	
NOx		112.700	grams	
Particulate		5.567	grams	
CO2		12.928	kg	
Fuel	9.10 lb		4.13 kg	

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,205.5	62.46
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.48	0.04
Gas Meter 2:	3.10	0.09
Sample Rate:	1.62	0.05
Total Flow Rate:	2,207.13	62.51

Particulate Data

Filter Number:	8574.0 (pair)	
Weight Gain:	4.083	mg
Sample Multiplier:	1.363	

Correction Factors

NOx Humidity CF:	0.993
Dry-to-Wet CF, Sample:	0.985
Dry-to-Wet CF, Bckgrd:	0.991
Dilution Factor:	22.11

Test Cycle Data

Sample Time:	1,214.30	sec		
Work:	23.94	hp-hr	17.85	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	44,668.6	scf	1,265.04	scm

Brake-Specific Emission Results

BSHC (Cell)	0.085	g/hp-hr	0.114	g/kW-hr
CO	3.009	g/hp-hr	4.035	g/kW-hr
NOx (Cell)	4.708	g/hp-hr	6.313	g/kW-hr
Particulate	0.233	g/hp-hr	0.312	g/kW-hr
CO2	540.0	g/hp-hr	724.15	g/kW-hr
BSFC	0.380	lb/hp-hr	0.231	kg/kW-hr

Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.: R6		DIESEL 2D, EM-6144-F	
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/15/2007	Time: 15:18	HCR: 1.892	FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT: 4.12-R		H= 0.137 C= 0.863 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.48	in Hg	99.8 kPa
Engine Inlet Air			
Temperature:	80.0	°F	26.7 °C
Dew Point:	57.9	°F	14.4 °C
Abs. Humidity:	72.9	gr/lb	10.4 g/kg
Rel. Humidity:	47	%	
Dilution Air:			
Temperature:	68.0	°F	20.0 °C
Abs. Humidity	40.0	gr/lb	5.7 g/kg
Rel. Humidity:	39	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		5.60	ppm	
HC Bckgrd	n/a		2.90	ppm	
CO Sample	50.6	2	49.42	ppm	(Dry)
CO Bckgrd	0.2	2	0.19	ppm	
NOx Sample	n/a		47.59	ppm	(Dry)
NOx Bckgrd	0.5	1	0.13	ppm	
CO2 Sample	60.9	1	0.5947	ppm	(Wet)
CO2 Bckgrd	4.5	1	0.0431	ppm	

Corrected Concentrations

HC	2.83	ppm
CO	48.05	ppm
NOx	46.77	ppm
CO2	0.5535	ppm

Mass Emissions

HC		2.070	grams	
CO		70.749	grams	
NOx		112.509	grams	
Particulate		5.659	grams	
CO2		12.807	kg	
Fuel	9.01 lb		4.09 kg	

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,205.5	62.46
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.47	0.04
Gas Meter 2:	3.08	0.09
Sample Rate:	1.61	0.05
Total Flow Rate:	2,207.14	62.51

Particulate Data

Filter Number:	8579.0 (pair)	
Weight Gain:	4.127	mg
Sample Multiplier:	1.371	

Correction Factors

NOx Humidity CF:	0.995
Dry-to-Wet CF, Sample:	0.985
Dry-to-Wet CF, Bckgrd:	0.991
Dilution Factor:	22.27

Test Cycle Data

Sample Time:	1,214.00	sec		
Work:	24.02	hp-hr	17.91	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	44,657.9	scf	1,264.74	scm

Brake-Specific Emission Results

BSHC (Cell)	0.086	g/hp-hr	0.116	g/kW-hr
CO	2.945	g/hp-hr	3.950	g/kW-hr
NOx (Cell)	4.684	g/hp-hr	6.281	g/kW-hr
Particulate	0.236	g/hp-hr	0.316	g/kW-hr
CO2	533.2	g/hp-hr	715.02	g/kW-hr
BSFC	0.375	lb/hp-hr	0.228	kg/kW-hr

Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.:	R7	DIESEL 2D, EM-6144-F	
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/16/2007	Time: 11:10	HCR: 1.892	FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT:	4.12-R	H= 0.137 C= 0.863 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.74	in Hg	100.7 kPa
Engine Inlet Air			
Temperature:	78.0	°F	25.6 °C
Dew Point:	59.1	°F	15.1 °C
Abs. Humidity:	75.5	gr/lb	10.8 g/kg
Rel. Humidity:	52	%	
Dilution Air:			
Temperature:	69.0	°F	20.6 °C
Abs. Humidity	50.0	gr/lb	7.1 g/kg
Rel. Humidity:	47	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		5.92	ppm	
HC Bckgrd	n/a		3.20	ppm	
CO Sample	49.3	2	48.12	ppm	(Dry)
CO Bckgrd	0.1	2	0.09	ppm	
NOx Sample	n/a		45.57	ppm	(Dry)
NOx Bckgrd	0.3	1	0.08	ppm	
CO2 Sample	60.2	1	0.5876	ppm	(Wet)
CO2 Bckgrd	4.4	1	0.0421	ppm	

Corrected Concentrations

HC	2.86	ppm
CO	46.75	ppm
NOx	44.72	ppm
CO2	0.5474	ppm

Mass Emissions

HC		2.119	grams	
CO		69.673	grams	
NOx		109.634	grams	
Particulate		5.310	grams	
CO2		12.818	kg	
Fuel	9.02 lb		4.09 kg	

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,232.2	63.22
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.49	0.04
Gas Meter 2:	3.17	0.09
Sample Rate:	1.68	0.05
Total Flow Rate:	2,233.88	63.26

Particulate Data

Filter Number:	8580.0-182 (pair)	
Weight Gain:	3.999	mg
Sample Multiplier:	1.328	

Correction Factors

NOx Humidity CF:	1.001
Dry-to-Wet CF, Sample:	0.983
Dry-to-Wet CF, Bckgrd:	0.989
Dilution Factor:	22.54

Test Cycle Data

Sample Time:	1,214.00	sec		
Work:	23.95	hp-hr	17.86	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	45,198.9	scf	1,280.06	scm

Brake-Specific Emission Results

BSHC (Cell)	0.088	g/hp-hr	0.119	g/kW-hr
CO	2.909	g/hp-hr	3.901	g/kW-hr
NOx (Cell)	4.578	g/hp-hr	6.139	g/kW-hr
Particulate	0.222	g/hp-hr	0.297	g/kW-hr
CO2	535.2	g/hp-hr	717.71	g/kW-hr
BSFC	0.377	lb/hp-hr	0.229	kg/kW-hr

Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.: R7		DIESEL 2D, EM-6144-F	
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/16/2007	Time: 11:10	HCR: 1.892	FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT:	4.12-R	H= 0.137 C= 0.863 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.74	in Hg	100.7 kPa
Engine Inlet Air			
Temperature:	78.0	°F	25.6 °C
Dew Point:	59.1	°F	15.1 °C
Abs. Humidity:	75.5	gr/lb	10.8 g/kg
Rel. Humidity:	52	%	
Dilution Air:			
Temperature:	69.0	°F	20.6 °C
Abs. Humidity	50.0	gr/lb	7.1 g/kg
Rel. Humidity:	47	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		5.92	ppm	
HC Bckgrd	n/a		3.20	ppm	
CO Sample	49.3	2	48.12	ppm	(Dry)
CO Bckgrd	0.1	2	0.09	ppm	
NOx Sample	n/a		45.57	ppm	(Dry)
NOx Bckgrd	0.3	1	0.08	ppm	
CO2 Sample	60.2	1	0.5876	ppm	(Wet)
CO2 Bckgrd	4.4	1	0.0421	ppm	

Corrected Concentrations

HC	2.86	ppm
CO	46.75	ppm
NOx	44.72	ppm
CO2	0.5474	ppm

Mass Emissions

HC		2.119	grams	
CO		69.673	grams	
NOx		109.634	grams	
Particulate		5.263	grams	
CO2		12.818	kg	
Fuel	9.02 lb		4.09	kg

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,232.2	63.22
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.49	0.04
Gas Meter 2:	3.17	0.09
Sample Rate:	1.68	0.05
Total Flow Rate:	2,233.88	63.26

Particulate Data

Filter Number:	8580.0-182 (pair)	
Weight Gain:	3.964	mg
Sample Multiplier:	1.328	

Correction Factors

NOx Humidity CF:	1.001
Dry-to-Wet CF, Sample:	0.983
Dry-to-Wet CF, Bckgrd:	0.989
Dilution Factor:	22.54

Test Cycle Data

Sample Time:	1,214.00	sec		
Work:	23.95	hp-hr	17.86	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	45,198.9	scf	1,280.06	scm

Brake-Specific Emission Results

BSHC (Cell)	0.088	g/hp-hr	0.119	g/kW-hr
CO	2.909	g/hp-hr	3.901	g/kW-hr
NOx (Cell)	4.578	g/hp-hr	6.139	g/kW-hr
Particulate	0.220	g/hp-hr	0.295	g/kW-hr
CO2	535.2	g/hp-hr	717.71	g/kW-hr
BSFC	0.377	lb/hp-hr	0.229	kg/kW-hr

Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.:	R8		DIESEL 2D, EM-6144-F
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/16/2007	Time: 11:50	HCR: 1.892	FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT:	4.12-R	H= 0.137 C= 0.863 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.75	in Hg	100.7 kPa
Engine Inlet Air			
Temperature:	78.0	°F	25.6 °C
Dew Point:	58.7	°F	14.8 °C
Abs. Humidity:	74.4	gr/lb	10.6 g/kg
Rel. Humidity:	52	%	
Dilution Air:			
Temperature:	72.0	°F	22.2 °C
Abs. Humidity	49.2	gr/lb	7.0 g/kg
Rel. Humidity:	42	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		6.04	ppm	
HC Bckgrd	n/a		3.50	ppm	
CO Sample	48.6	2	47.42	ppm	(Dry)
CO Bckgrd	n/a	2	0.00	ppm	
NOx Sample	n/a		46.41	ppm	(Dry)
NOx Bckgrd	0.3	1	0.08	ppm	
CO2 Sample	60.7	1	0.5927	ppm	(Wet)
CO2 Bckgrd	4.5	1	0.0431	ppm	

Corrected Concentrations

HC	2.70	ppm
CO	46.23	ppm
NOx	45.55	ppm
CO2	0.5515	ppm

Mass Emissions

HC		1.998	grams	
CO		68.934	grams	
NOx		111.410	grams	
Particulate		5.196	grams	
CO2		12.923	kg	
Fuel	9.09 lb		4.12 kg	

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,233.1	63.24
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.49	0.04
Gas Meter 2:	3.19	0.09
Sample Rate:	1.70	0.05
Total Flow Rate:	2,234.76	63.29

Particulate Data

Filter Number:	8581.0-183 (pair)	
Weight Gain:	3.964	mg
Sample Multiplier:	1.311	

Correction Factors

NOx Humidity CF:	0.998
Dry-to-Wet CF, Sample:	0.983
Dry-to-Wet CF, Bckgrd:	0.989
Dilution Factor:	22.35

Test Cycle Data

Sample Time:	1,214.20	sec		
Work:	24.06	hp-hr	17.94	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	45,224.0	scf	1,280.77	scm

Brake-Specific Emission Results

BSHC (Cell)	0.083	g/hp-hr	0.111	g/kW-hr
CO	2.865	g/hp-hr	3.842	g/kW-hr
NOx (Cell)	4.631	g/hp-hr	6.210	g/kW-hr
Particulate	0.216	g/hp-hr	0.290	g/kW-hr
CO2	537.1	g/hp-hr	720.26	g/kW-hr
BSFC	0.378	lb/hp-hr	0.230	kg/kW-hr

Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.: R8		DIESEL 2D, EM-6144-F	
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/16/2007	Time: 11:50	HCR: 1.892	FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT:	4.12-R	H= 0.137 C= 0.863 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.75	in Hg	100.7 kPa
Engine Inlet Air			
Temperature:	78.0	°F	25.6 °C
Dew Point:	58.7	°F	14.8 °C
Abs. Humidity:	74.4	gr/lb	10.6 g/kg
Rel. Humidity:	52	%	
Dilution Air:			
Temperature:	72.0	°F	22.2 °C
Abs. Humidity	49.2	gr/lb	7.0 g/kg
Rel. Humidity:	42	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		6.04	ppm	
HC Bckgrd	n/a		3.50	ppm	
CO Sample	48.6	2	47.42	ppm	(Dry)
CO Bckgrd	n/a	2	0.00	ppm	
NOx Sample	n/a		46.41	ppm	(Dry)
NOx Bckgrd	0.3	1	0.08	ppm	
CO2 Sample	60.7	1	0.5927	ppm	(Wet)
CO2 Bckgrd	4.5	1	0.0431	ppm	

Corrected Concentrations

HC	2.70	ppm
CO	46.23	ppm
NOx	45.55	ppm
CO2	0.5515	ppm

Mass Emissions

HC	1.998	grams		
CO	68.934	grams		
NOx	111.410	grams		
Particulate	5.095	grams		
CO2	12.923	kg		
Fuel	9.09	lb	4.12	kg

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,233.1	63.24
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.49	0.04
Gas Meter 2:	3.19	0.09
Sample Rate:	1.70	0.05
Total Flow Rate:	2,234.76	63.29

Particulate Data

Filter Number:	8581.0-183 (pair)	
Weight Gain:	3.887	mg
Sample Multiplier:	1.311	

Correction Factors

NOx Humidity CF:	0.998
Dry-to-Wet CF, Sample:	0.983
Dry-to-Wet CF, Bckgrd:	0.989
Dilution Factor:	22.35

Test Cycle Data

Sample Time:	1,214.20	sec		
Work:	24.06	hp-hr	17.94	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	45,224.0	scf	1,280.77	scm

Brake-Specific Emission Results

BSHC (Cell)	0.083	g/hp-hr	0.111	g/kW-hr
CO	2.865	g/hp-hr	3.842	g/kW-hr
NOx (Cell)	4.631	g/hp-hr	6.210	g/kW-hr
Particulate	0.212	g/hp-hr	0.284	g/kW-hr
CO2	537.1	g/hp-hr	720.26	g/kW-hr
BSFC	0.378	lb/hp-hr	0.230	kg/kW-hr

Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.: R9		DIESEL 2D, EM-6144-F	
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/16/2007	Time: 12:30	HCR: 1.892	FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT:	4.12-R	H= 0.137 C= 0.863 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.71	in Hg	100.6 kPa
Engine Inlet Air			
Temperature:	78.0	°F	25.6 °C
Dew Point:	59.0	°F	15.0 °C
Abs. Humidity:	75.3	gr/lb	10.8 g/kg
Rel. Humidity:	52	%	
Dilution Air:			
Temperature:	71.0	°F	21.7 °C
Abs. Humidity	50.9	gr/lb	7.3 g/kg
Rel. Humidity:	45	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		5.84	ppm	
HC Bckgrd	n/a		2.90	ppm	
CO Sample	48.8	2	47.62	ppm	(Dry)
CO Bckgrd	n/a	2	0.00	ppm	
NOx Sample	n/a		46.31	ppm	(Dry)
NOx Bckgrd	0.3	1	0.08	ppm	
CO2 Sample	60.5	1	0.5906	ppm	(Wet)
CO2 Bckgrd	4.7	1	0.0450	ppm	

Corrected Concentrations

HC	3.07	ppm
CO	46.38	ppm
NOx	45.44	ppm
CO2	0.5476	ppm

Mass Emissions

HC		2.268	grams	
CO		68.972	grams	
NOx		111.089	grams	
Particulate		5.288	grams	
CO2		12.796	kg	
Fuel	9.00 lb		4.08	kg

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,226.6	63.06
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.49	0.04
Gas Meter 2:	3.18	0.09
Sample Rate:	1.70	0.05
Total Flow Rate:	2,228.28	63.11

Particulate Data

Filter Number:	8760.0, (pair)	
Weight Gain:	4.023	mg
Sample Multiplier:	1.314	

Correction Factors

NOx Humidity CF:	1.001
Dry-to-Wet CF, Sample:	0.983
Dry-to-Wet CF, Bckgrd:	0.988
Dilution Factor:	22.43

Test Cycle Data

Sample Time:	1,214.40	sec		
Work:	23.85	hp-hr	17.78	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	45,100.4	scf	1,277.27	scm

Brake-Specific Emission Results

BSHC (Cell)	0.095	g/hp-hr	0.128	g/kW-hr
CO	2.892	g/hp-hr	3.878	g/kW-hr
NOx (Cell)	4.658	g/hp-hr	6.246	g/kW-hr
Particulate	0.222	g/hp-hr	0.297	g/kW-hr
CO2	536.5	g/hp-hr	719.47	g/kW-hr
BSFC	0.378	lb/hp-hr	0.230	kg/kW-hr

Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.: R9		DIESEL 2D, EM-6144-F	
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/16/2007	Time: 12:30	HCR: 1.892	FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT:	4.12-R	H= 0.137 C= 0.863 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.71	in Hg	100.6 kPa
Engine Inlet Air			
Temperature:	78.0	°F	25.6 °C
Dew Point:	59.0	°F	15.0 °C
Abs. Humidity:	75.3	gr/lb	10.8 g/kg
Rel. Humidity:	52	%	
Dilution Air:			
Temperature:	71.0	°F	21.7 °C
Abs. Humidity	50.9	gr/lb	7.3 g/kg
Rel. Humidity:	45	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		5.84	ppm	
HC Bckgrd	n/a		2.90	ppm	
CO Sample	48.8	2	47.62	ppm	(Dry)
CO Bckgrd	n/a	2	0.00	ppm	
NOx Sample	n/a		46.31	ppm	(Dry)
NOx Bckgrd	0.3	1	0.08	ppm	
CO2 Sample	60.5	1	0.5906	ppm	(Wet)
CO2 Bckgrd	4.7	1	0.0450	ppm	

Corrected Concentrations

HC	3.07	ppm
CO	46.38	ppm
NOx	45.44	ppm
CO2	0.5476	ppm

Mass Emissions

HC		2.268	grams	
CO		68.972	grams	
NOx		111.089	grams	
Particulate		5.199	grams	
CO2		12.796	kg	
Fuel	9.00 lb		4.08	kg

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,226.6	63.06
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.49	0.04
Gas Meter 2:	3.18	0.09
Sample Rate:	1.70	0.05
Total Flow Rate:	2,228.28	63.11

Particulate Data

Filter Number:	8760.0, (pair)	
Weight Gain:	3.955	mg
Sample Multiplier:	1.314	

Correction Factors

NOx Humidity CF:	1.001
Dry-to-Wet CF, Sample:	0.983
Dry-to-Wet CF, Bckgrd:	0.988
Dilution Factor:	22.43

Test Cycle Data

Sample Time:	1,214.40	sec		
Work:	23.85	hp-hr	17.78	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	45,100.4	scf	1,277.27	scm

Brake-Specific Emission Results

BSHC (Cell)	0.095	g/hp-hr	0.128	g/kW-hr
CO	2.892	g/hp-hr	3.878	g/kW-hr
NOx (Cell)	4.658	g/hp-hr	6.246	g/kW-hr
Particulate	0.218	g/hp-hr	0.292	g/kW-hr
CO2	536.5	g/hp-hr	719.47	g/kW-hr
BSFC	0.378	lb/hp-hr	0.230	kg/kW-hr

Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.: C10		DIESEL 2D, EM-6-F	
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/18/2007	Time: 10:34	HCR: 1.718	FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT:	4.12-R	H= 0.126 C= 0.874 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.48	in Hg	99.8 kPa
Engine Inlet Air			
Temperature:	78.0	°F	25.6 °C
Dew Point:	54.0	°F	12.2 °C
Abs. Humidity:	63.2	gr/lb	9.0 g/kg
Rel. Humidity:	43	%	
Dilution Air:			
Temperature:	73.0	°F	22.8 °C
Abs. Humidity	52.5	gr/lb	7.5 g/kg
Rel. Humidity:	43	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		5.78	ppm	
HC Bckgrd	3.5	2	3.50	ppm	
CO Sample	48.3	2	47.13	ppm	(Dry)
CO Bckgrd	0.2	2	0.19	ppm	
NOx Sample	n/a		49.39	ppm	(Dry)
NOx Bckgrd	0.6	1	0.15	ppm	
CO2 Sample	62.4	1	0.6101	ppm	(Wet)
CO2 Bckgrd	4.9	1	0.0469	ppm	

Corrected Concentrations

HC	2.44	ppm
CO	45.77	ppm
NOx	48.40	ppm
CO2	0.5653	ppm

Mass Emissions

HC		1.765	grams	
CO		67.596	grams	
NOx		113.931	grams	
Particulate		5.439	grams	
CO2		13.120	kg	
Fuel	9.11 lb		4.13 kg	

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,211.9	62.64
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.47	0.04
Gas Meter 2:	3.09	0.09
Sample Rate:	1.62	0.05
Total Flow Rate:	2,213.56	62.69

Particulate Data

Filter Number:	8761.0-185, (pair)	
Weight Gain:	3.989	mg
Sample Multiplier:	1.363	

Correction Factors

NOx Humidity CF:	0.970
Dry-to-Wet CF, Sample:	0.983
Dry-to-Wet CF, Bckgrd:	0.988
Dilution Factor:	22.47

Test Cycle Data

Sample Time:	1,214.30	sec		
Work:	24.03	hp-hr	17.92	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	44,798.7	scf	1,268.73	scm

Brake-Specific Emission Results

BSHC (Cell)	0.073	g/hp-hr	0.098	g/kW-hr
CO	2.813	g/hp-hr	3.772	g/kW-hr
NOx (Cell)	4.741	g/hp-hr	6.358	g/kW-hr
Particulate	0.226	g/hp-hr	0.304	g/kW-hr
CO2	546.0	g/hp-hr	732.20	g/kW-hr
BSFC	0.379	lb/hp-hr	0.231	kg/kW-hr

Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.: C11		DIESEL 2D, EM-6-F	
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/18/2007	Time: 11:14	HCR: 1.718	FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT: 4.12-R		H= 0.126 C= 0.874 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.48	in Hg	99.8 kPa
Engine Inlet Air			
Temperature:	77.0	°F	25.0 °C
Dew Point:	53.9	°F	12.2 °C
Abs. Humidity:	63.0	gr/lb	9.0 g/kg
Rel. Humidity:	45	%	
Dilution Air:			
Temperature:	72.0	°F	22.2 °C
Abs. Humidity	58.6	gr/lb	8.4 g/kg
Rel. Humidity:	49	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		5.74	ppm	
HC Bckgrd	n/a		3.40	ppm	
CO Sample	48.6	2	47.42	ppm	(Dry)
CO Bckgrd	0.1	2	0.09	ppm	
NOx Sample	n/a		49.84	ppm	(Dry)
NOx Bckgrd	0.6	1	0.15	ppm	
CO2 Sample	62.3	1	0.6091	ppm	(Wet)
CO2 Bckgrd	4.9	1	0.0469	ppm	

Corrected Concentrations

HC	2.49	ppm
CO	46.04	ppm
NOx	48.77	ppm
CO2	0.5643	ppm

Mass Emissions

HC	1.797	grams		
CO	67.709	grams		
NOx	114.242	grams		
Particulate	5.446	grams		
CO2	13.040	kg		
Fuel	9.06	lb	4.11	kg

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,202.0	62.36
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.47	0.04
Gas Meter 2:	3.12	0.09
Sample Rate:	1.65	0.05
Total Flow Rate:	2,203.68	62.41

Particulate Data

Filter Number:	8774.0-186 (pair)	
Weight Gain:	4.068	mg
Sample Multiplier:	1.339	

Correction Factors

NOx Humidity CF:	0.970
Dry-to-Wet CF, Sample:	0.981
Dry-to-Wet CF, Bckgrd:	0.987
Dilution Factor:	22.50

Test Cycle Data

Sample Time:	1,214.40	sec		
Work:	24.03	hp-hr	17.92	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	44,602.4	scf	1,263.17	scm

Brake-Specific Emission Results

BSHC (Cell)	0.075	g/hp-hr	0.100	g/kW-hr
CO	2.818	g/hp-hr	3.779	g/kW-hr
NOx (Cell)	4.754	g/hp-hr	6.375	g/kW-hr
Particulate	0.227	g/hp-hr	0.304	g/kW-hr
CO2	542.6	g/hp-hr	727.70	g/kW-hr
BSFC	0.377	lb/hp-hr	0.229	kg/kW-hr

Analyzed: 01/18/2007 13:38

Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.: C12		DIESEL 2D, EM-6-F	
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/18/2007	Time: 11:54	HCR: 1.718	FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT: 4.12-R		H= 0.126 C= 0.874 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.47	in Hg	99.8 kPa
Engine Inlet Air			
Temperature:	78.0	°F	25.6 °C
Dew Point:	54.4	°F	12.4 °C
Abs. Humidity:	64.2	gr/lb	9.2 g/kg
Rel. Humidity:	44	%	
Dilution Air:			
Temperature:	72.0	°F	22.2 °C
Abs. Humidity	58.7	gr/lb	8.4 g/kg
Rel. Humidity:	49	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		5.65	ppm	
HC Bckgrd	n/a		3.40	ppm	
CO Sample	48.7	2	47.52	ppm	(Dry)
CO Bckgrd	0.2	2	0.19	ppm	
NOx Sample	n/a		49.74	ppm	(Dry)
NOx Bckgrd	1.8	1	0.45	ppm	
CO2 Sample	62.4	1	0.6101	ppm	(Wet)
CO2 Bckgrd	4.8	1	0.0459	ppm	

Corrected Concentrations

HC	2.40	ppm
CO	46.05	ppm
NOx	48.39	ppm
CO2	0.5662	ppm

Mass Emissions

HC	1.732	grams		
CO	67.691	grams		
NOx	113.648	grams		
Particulate	5.578	grams		
CO2	13.081	kg		
Fuel	9.08 lb		4.12 kg	

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,201.5	62.35
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.47	0.04
Gas Meter 2:	3.11	0.09
Sample Rate:	1.64	0.05
Total Flow Rate:	2,203.18	62.40

Particulate Data

Filter Number:	8775.0-187 (pair)	
Weight Gain:	4.150	mg
Sample Multiplier:	1.344	

Correction Factors

NOx Humidity CF:	0.973
Dry-to-Wet CF, Sample:	0.981
Dry-to-Wet CF, Bckgrd:	0.987
Dilution Factor:	22.47

Test Cycle Data

Sample Time:	1,214.30	sec		
Work:	24.04	hp-hr	17.93	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	44,588.6	scf	1,262.78	scm

Brake-Specific Emission Results

BSHC (Cell)	0.072	g/hp-hr	0.097	g/kW-hr
CO	2.816	g/hp-hr	3.776	g/kW-hr
NOx (Cell)	4.727	g/hp-hr	6.340	g/kW-hr
Particulate	0.232	g/hp-hr	0.311	g/kW-hr
CO2	544.1	g/hp-hr	729.70	g/kW-hr
BSFC	0.378	lb/hp-hr	0.230	kg/kW-hr

Analyzed: 01/18/2007 16:41

Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.: C13		DIESEL 2D, EM-6-F	
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/18/2007	Time: 13:54	HCR: 1.718	FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT:	4.12-R	H= 0.126 C= 0.874 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.41	in Hg	99.6 kPa
Engine Inlet Air			
Temperature:	79.0	°F	26.1 °C
Dew Point:	55.6	°F	13.1 °C
Abs. Humidity:	67.2	gr/lb	9.6 g/kg
Rel. Humidity:	45	%	
Dilution Air:			
Temperature:	74.0	°F	23.3 °C
Abs. Humidity	60.0	gr/lb	8.6 g/kg
Rel. Humidity:	47	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		5.70	ppm	
HC Bckgrd	n/a		3.50	ppm	
CO Sample	49.8	2	48.62	ppm	(Dry)
CO Bckgrd	0.3	2	0.28	ppm	
NOx Sample	n/a		49.10	ppm	(Dry)
NOx Bckgrd	0.7	1	0.18	ppm	
CO2 Sample	62.8	1	0.6142	ppm	(Wet)
CO2 Bckgrd	4.9	1	0.0469	ppm	

Corrected Concentrations

HC	2.36	ppm
CO	47.06	ppm
NOx	48.00	ppm
CO2	0.5694	ppm

Mass Emissions

HC	1.703	grams		
CO	69.324	grams		
NOx	113.842	grams		
Particulate	5.607	grams		
CO2	13.180	kg		
Fuel	9.15	lb	4.15	kg

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,206.5	62.49
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.47	0.04
Gas Meter 2:	3.08	0.09
Sample Rate:	1.61	0.05
Total Flow Rate:	2,208.11	62.54

Particulate Data

Filter Number:	8776.0 (pair)	
Weight Gain:	4.076	mg
Sample Multiplier:	1.376	

Correction Factors

NOx Humidity CF:	0.980
Dry-to-Wet CF, Sample:	0.981
Dry-to-Wet CF, Bckgrd:	0.986
Dilution Factor:	22.32

Test Cycle Data

Sample Time:	1,214.00	sec		
Work:	24.02	hp-hr	17.91	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	44,677.5	scf	1,265.29	scm

Brake-Specific Emission Results

BSHC (Cell)	0.071	g/hp-hr	0.095	g/kW-hr
CO	2.886	g/hp-hr	3.870	g/kW-hr
NOx (Cell)	4.739	g/hp-hr	6.356	g/kW-hr
Particulate	0.233	g/hp-hr	0.313	g/kW-hr
CO2	548.7	g/hp-hr	735.84	g/kW-hr
BSFC	0.381	lb/hp-hr	0.232	kg/kW-hr

Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.:	C14	DIESEL 2D, EM-6-F	
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/18/2007	Time: 14:34	HCR: 1.718	FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT:	4.12-R	H= 0.126 C= 0.874 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.41	in Hg	99.6 kPa
Engine Inlet Air			
Temperature:	77.0	°F	25.0 °C
Dew Point:	53.6	°F	12.0 °C
Abs. Humidity:	62.4	gr/lb	8.9 g/kg
Rel. Humidity:	44	%	
Dilution Air:			
Temperature:	74.0	°F	23.3 °C
Abs. Humidity	60.0	gr/lb	8.6 g/kg
Rel. Humidity:	47	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		5.91	ppm	
HC Bckgrd	n/a		3.60	ppm	
CO Sample	48.6	2	47.42	ppm	(Dry)
CO Bckgrd	0.2	2	0.19	ppm	
NOx Sample	n/a		49.12	ppm	(Dry)
NOx Bckgrd	1.3	1	0.33	ppm	
CO2 Sample	62.5	1	0.6111	ppm	(Wet)
CO2 Bckgrd	5.1	1	0.0488	ppm	

Corrected Concentrations

HC	2.47	ppm
CO	45.98	ppm
NOx	47.88	ppm
CO2	0.5645	ppm

Mass Emissions

HC	1.785	grams		
CO	67.737	grams		
NOx	112.189	grams		
Particulate	5.494	grams		
CO2	13.067	kg		
Fuel	9.08	lb	4.12	kg

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,206.5	62.49
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.47	0.04
Gas Meter 2:	3.07	0.09
Sample Rate:	1.60	0.05
Total Flow Rate:	2,208.10	62.53

Particulate Data

Filter Number:	8777.0-189 (pair)	
Weight Gain:	3.990	mg
Sample Multiplier:	1.377	

Correction Factors

NOx Humidity CF:	0.968
Dry-to-Wet CF, Sample:	0.981
Dry-to-Wet CF, Bckgrd:	0.986
Dilution Factor:	22.43

Test Cycle Data

Sample Time:	1,214.10	sec		
Work:	23.87	hp-hr	17.80	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	44,681.0	scf	1,265.39	scm

Brake-Specific Emission Results

BSHC (Cell)	0.075	g/hp-hr	0.100	g/kW-hr
CO	2.838	g/hp-hr	3.805	g/kW-hr
NOx (Cell)	4.700	g/hp-hr	6.303	g/kW-hr
Particulate	0.230	g/hp-hr	0.309	g/kW-hr
CO2	547.4	g/hp-hr	734.12	g/kW-hr
BSFC	0.380	lb/hp-hr	0.231	kg/kW-hr

Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.: C15		DIESEL 2D, EM-6-F	
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/18/2007	Time: 15:14	HCR: 1.718	FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT:	4.12-R	H= 0.126 C= 0.874 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.40	in Hg	99.5 kPa
Engine Inlet Air			
Temperature:	77.0	°F	25.0 °C
Dew Point:	53.9	°F	12.2 °C
Abs. Humidity:	63.1	gr/lb	9.0 g/kg
Rel. Humidity:	45	%	
Dilution Air:			
Temperature:	74.0	°F	23.3 °C
Abs. Humidity	60.0	gr/lb	8.6 g/kg
Rel. Humidity:	47	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		5.99	ppm	
HC Bckgrd	n/a		3.70	ppm	
CO Sample	48.9	2	47.72	ppm	(Dry)
CO Bckgrd	0.1	2	0.09	ppm	
NOx Sample	n/a		49.28	ppm	(Dry)
NOx Bckgrd	0.7	1	0.18	ppm	
CO2 Sample	62.3	1	0.6091	ppm	(Wet)
CO2 Bckgrd	4.8	1	0.0459	ppm	

Corrected Concentrations

HC	2.45	ppm
CO	46.37	ppm
NOx	48.18	ppm
CO2	0.5652	ppm

Mass Emissions

HC	1.769	grams		
CO	68.103	grams		
NOx	112.759	grams		
Particulate	5.429	grams		
CO2	13.045	kg		
Fuel	9.06	lb	4.11	kg

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,199.3	62.29
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.47	0.04
Gas Meter 2:	3.09	0.09
Sample Rate:	1.62	0.05
Total Flow Rate:	2,200.91	62.33

Particulate Data

Filter Number:	8778.0 (pair)	
Weight Gain:	3.999	mg
Sample Multiplier:	1.358	

Correction Factors

NOx Humidity CF:	0.970
Dry-to-Wet CF, Sample:	0.981
Dry-to-Wet CF, Bckgrd:	0.986
Dilution Factor:	22.50

Test Cycle Data

Sample Time:	1,214.40	sec		
Work:	24.05	hp-hr	17.93	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	44,546.4	scf	1,261.58	scm

Brake-Specific Emission Results

BSHC (Cell)	0.074	g/hp-hr	0.099	g/kW-hr
CO	2.832	g/hp-hr	3.797	g/kW-hr
NOx (Cell)	4.689	g/hp-hr	6.287	g/kW-hr
Particulate	0.226	g/hp-hr	0.303	g/kW-hr
CO2	542.4	g/hp-hr	727.41	g/kW-hr
BSFC	0.377	lb/hp-hr	0.229	kg/kW-hr

Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.:	C16	DIESEL 2D, EM-6-F	
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/18/2007	Time: 17:04	HCR: 1.718	FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT:	4.12-R	H= 0.126 C= 0.874 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.41	in Hg	99.6 kPa
Engine Inlet Air			
Temperature:	76.0	°F	24.4 °C
Dew Point:	54.7	°F	12.6 °C
Abs. Humidity:	65.0	gr/lb	9.3 g/kg
Rel. Humidity:	48	%	
Dilution Air:			
Temperature:	74.0	°F	23.3 °C
Abs. Humidity	55.5	gr/lb	7.9 g/kg
Rel. Humidity:	44	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		6.01	ppm	
HC Bckgrd	n/a		3.80	ppm	
CO Sample	49.1	2	47.92	ppm	(Dry)
CO Bckgrd	0.2	2	0.19	ppm	
NOx Sample	n/a		48.57	ppm	(Dry)
NOx Bckgrd	0.6	1	0.15	ppm	
CO2 Sample	62.0	1	0.6060	ppm	(Wet)
CO2 Bckgrd	4.8	1	0.0459	ppm	

Corrected Concentrations

HC	2.38	ppm
CO	46.53	ppm
NOx	47.56	ppm
CO2	0.5621	ppm

Mass Emissions

HC	1.718	grams		
CO	68.529	grams		
NOx	112.162	grams		
Particulate	5.581	grams		
CO2	13.011	kg		
Fuel	9.04	lb	4.10	kg

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,206.6	62.49
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.47	0.04
Gas Meter 2:	3.12	0.09
Sample Rate:	1.65	0.05
Total Flow Rate:	2,208.26	62.54

Particulate Data

Filter Number:	8779.0-191 (pair)	
Weight Gain:	4.160	mg
Sample Multiplier:	1.342	

Correction Factors

NOx Humidity CF:	0.975
Dry-to-Wet CF, Sample:	0.982
Dry-to-Wet CF, Bckgrd:	0.987
Dilution Factor:	22.62

Test Cycle Data

Sample Time:	1,213.80	sec		
Work:	23.85	hp-hr	17.78	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	44,673.2	scf	1,265.17	scm

Brake-Specific Emission Results

BSHC (Cell)	0.072	g/hp-hr	0.097	g/kW-hr
CO	2.873	g/hp-hr	3.853	g/kW-hr
NOx (Cell)	4.703	g/hp-hr	6.307	g/kW-hr
Particulate	0.234	g/hp-hr	0.314	g/kW-hr
CO2	545.5	g/hp-hr	731.55	g/kW-hr
BSFC	0.379	lb/hp-hr	0.230	kg/kW-hr

Analyzed: 01/19/2007 14:41

Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.:	C17	DIESEL 2D, EM-6-F	
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/18/2007	Time: 17:44	HCR: 1.718	FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT:	4.12-R	H= 0.126 C= 0.874 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.41	in Hg	99.6 kPa
Engine Inlet Air			
Temperature:	78.0	°F	25.6 °C
Dew Point:	54.4	°F	12.4 °C
Abs. Humidity:	64.3	gr/lb	9.2 g/kg
Rel. Humidity:	44	%	
Dilution Air:			
Temperature:	74.0	°F	23.3 °C
Abs. Humidity	60.0	gr/lb	8.6 g/kg
Rel. Humidity:	47	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		6.64	ppm	
HC Bckgrd	n/a		4.50	ppm	
CO Sample	49.5	2	48.32	ppm	(Dry)
CO Bckgrd	0.4	2	0.37	ppm	
NOx Sample	n/a		49.10	ppm	(Dry)
NOx Bckgrd	0.8	1	0.20	ppm	
CO2 Sample	62.3	1	0.6091	ppm	(Wet)
CO2 Bckgrd	5.0	1	0.0479	ppm	

Corrected Concentrations

HC	2.34	ppm
CO	46.69	ppm
NOx	47.98	ppm
CO2	0.5633	ppm

Mass Emissions

HC		1.689	grams	
CO		68.695	grams	
NOx		112.831	grams	
Particulate		5.617	grams	
CO2		13.024	kg	
Fuel	9.05 lb		4.10 kg	

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,203.4	62.40
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.47	0.04
Gas Meter 2:	3.10	0.09
Sample Rate:	1.63	0.05
Total Flow Rate:	2,205.00	62.45

Particulate Data

Filter Number:	8847.0-192, (pair)	
Weight Gain:	4.155	mg
Sample Multiplier:	1.352	

Correction Factors

NOx Humidity CF:	0.973
Dry-to-Wet CF, Sample:	0.981
Dry-to-Wet CF, Bckgrd:	0.986
Dilution Factor:	22.50

Test Cycle Data

Sample Time:	1,214.30	sec		
Work:	24.07	hp-hr	17.95	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	44,625.4	scf	1,263.82	scm

Brake-Specific Emission Results

BSHC (Cell)	0.070	g/hp-hr	0.094	g/kW-hr
CO	2.854	g/hp-hr	3.827	g/kW-hr
NOx (Cell)	4.688	g/hp-hr	6.286	g/kW-hr
Particulate	0.233	g/hp-hr	0.313	g/kW-hr
CO2	541.1	g/hp-hr	725.63	g/kW-hr
BSFC	0.376	lb/hp-hr	0.229	kg/kW-hr

Analyzed: 01/19/2007 14:44

Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.:	C18	DIESEL 2D, EM-6-F	
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/18/2007	Time: 18:24	HCR: 1.718	FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT:	4.12-R	H= 0.126 C= 0.874 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.43	in Hg	99.6 kPa
Engine Inlet Air			
Temperature:	78.0	°F	25.6 °C
Dew Point:	53.4	°F	11.9 °C
Abs. Humidity:	61.9	gr/lb	8.8 g/kg
Rel. Humidity:	43	%	
Dilution Air:			
Temperature:	74.0	°F	23.3 °C
Abs. Humidity	64.6	gr/lb	9.2 g/kg
Rel. Humidity:	51	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		6.17	ppm	
HC Bckgrd	n/a		3.80	ppm	
CO Sample	49.2	2	48.02	ppm	(Dry)
CO Bckgrd	0.3	2	0.28	ppm	
NOx Sample	n/a		49.30	ppm	(Dry)
NOx Bckgrd	0.7	1	0.18	ppm	
CO2 Sample	62.5	1	0.6111	ppm	(Wet)
CO2 Bckgrd	4.8	1	0.0459	ppm	

Corrected Concentrations

HC	2.54	ppm
CO	46.43	ppm
NOx	48.15	ppm
CO2	0.5672	ppm

Mass Emissions

HC	1.829	grams		
CO	68.149	grams		
NOx	112.277	grams		
Particulate	5.474	grams		
CO2	13.085	kg		
Fuel	9.09	lb	4.12	kg

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,198.1	62.25
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.47	0.04
Gas Meter 2:	3.12	0.09
Sample Rate:	1.65	0.05
Total Flow Rate:	2,199.71	62.30

Particulate Data

Filter Number:	8848.0-193 (pair)	
Weight Gain:	4.102	mg
Sample Multiplier:	1.334	

Correction Factors

NOx Humidity CF:	0.967
Dry-to-Wet CF, Sample:	0.980
Dry-to-Wet CF, Bckgrd:	0.985
Dilution Factor:	22.43

Test Cycle Data

Sample Time:	1,214.40	sec		
Work:	24.04	hp-hr	17.93	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	44,522.2	scf	1,260.89	scm

Brake-Specific Emission Results

BSHC (Cell)	0.076	g/hp-hr	0.102	g/kW-hr
CO	2.835	g/hp-hr	3.802	g/kW-hr
NOx (Cell)	4.670	g/hp-hr	6.263	g/kW-hr
Particulate	0.228	g/hp-hr	0.305	g/kW-hr
CO2	544.3	g/hp-hr	729.90	g/kW-hr
BSFC	0.378	lb/hp-hr	0.230	kg/kW-hr

Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.:	R19	DIESEL 2D, EM-6144-F	
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/19/2007	Time: 10:02	HCR: 1.892	FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT:	4.12-R	H= 0.137 C= 0.863 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.53	in Hg	100.0 kPa
Engine Inlet Air			
Temperature:	79.0	°F	26.1 °C
Dew Point:	54.4	°F	12.4 °C
Abs. Humidity:	64.0	gr/lb	9.1 g/kg
Rel. Humidity:	43	%	
Dilution Air:			
Temperature:	74.0	°F	23.3 °C
Abs. Humidity	55.2	gr/lb	7.9 g/kg
Rel. Humidity:	43	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		6.08	ppm	
HC Bckgrd	n/a		3.80	ppm	
CO Sample	51.0	2	49.81	ppm	(Dry)
CO Bckgrd	0.6	2	0.56	ppm	
NOx Sample	n/a		47.01	ppm	(Dry)
NOx Bckgrd	0.6	1	0.15	ppm	
CO2 Sample	61.6	1	0.6019	ppm	(Wet)
CO2 Bckgrd	4.9	1	0.0469	ppm	

Corrected Concentrations

HC	2.45	ppm
CO	48.00	ppm
NOx	46.01	ppm
CO2	0.5571	ppm

Mass Emissions

HC		1.802	grams	
CO		70.960	grams	
NOx		108.635	grams	
Particulate		5.505	grams	
CO2		12.943	kg	
Fuel	9.11 lb		4.13	kg

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,214.1	62.70
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.48	0.04
Gas Meter 2:	3.08	0.09
Sample Rate:	1.60	0.05
Total Flow Rate:	2,215.71	62.75

Particulate Data

Filter Number:	8849.0-194 (pair)	
Weight Gain:	3.971	mg
Sample Multiplier:	1.386	

Correction Factors

NOx Humidity CF:	0.972
Dry-to-Wet CF, Sample:	0.982
Dry-to-Wet CF, Bckgrd:	0.987
Dilution Factor:	22.00

Test Cycle Data

Sample Time:	1,214.20	sec		
Work:	23.84	hp-hr	17.78	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	44,838.6	scf	1,269.86	scm

Brake-Specific Emission Results

BSHC (Cell)	0.076	g/hp-hr	0.101	g/kW-hr
CO	2.977	g/hp-hr	3.992	g/kW-hr
NOx (Cell)	4.557	g/hp-hr	6.111	g/kW-hr
Particulate	0.231	g/hp-hr	0.310	g/kW-hr
CO2	542.9	g/hp-hr	728.04	g/kW-hr
BSFC	0.382	lb/hp-hr	0.232	kg/kW-hr

Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.: R20		DIESEL 2D, EM-6144-F	
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/19/2007	Time: 10:42	HCR: 1.892	FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT:	4.12-R	H= 0.137 C= 0.863 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.52	in Hg	100.0 kPa
Engine Inlet Air			
Temperature:	77.0	°F	25.0 °C
Dew Point:	54.7	°F	12.6 °C
Abs. Humidity:	64.8	gr/lb	9.3 g/kg
Rel. Humidity:	46	%	
Dilution Air:			
Temperature:	72.0	°F	22.2 °C
Abs. Humidity	54.1	gr/lb	7.7 g/kg
Rel. Humidity:	46	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		6.01	ppm	
HC Bckgrd	n/a		3.80	ppm	
CO Sample	50.4	2	49.22	ppm	(Dry)
CO Bckgrd	0.1	2	0.09	ppm	
NOx Sample	n/a		47.02	ppm	(Dry)
NOx Bckgrd	0.7	1	0.18	ppm	
CO2 Sample	61.4	1	0.5999	ppm	(Wet)
CO2 Bckgrd	4.8	1	0.0459	ppm	

Corrected Concentrations

HC	2.38	ppm
CO	47.84	ppm
NOx	46.00	ppm
CO2	0.5561	ppm

Mass Emissions

HC		1.745	grams	
CO		70.532	grams	
NOx		108.536	grams	
Particulate		5.582	grams	
CO2		12.884	kg	
Fuel	9.07 lb		4.11 kg	

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,208.4	62.54
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.48	0.04
Gas Meter 2:	3.12	0.09
Sample Rate:	1.63	0.05
Total Flow Rate:	2,210.08	62.59

Particulate Data

Filter Number:	8674.0-195 (pair)	
Weight Gain:	4.126	mg
Sample Multiplier:	1.353	

Correction Factors

NOx Humidity CF:	0.974
Dry-to-Wet CF, Sample:	0.982
Dry-to-Wet CF, Bckgrd:	0.988
Dilution Factor:	22.08

Test Cycle Data

Sample Time:	1,214.10	sec		
Work:	23.79	hp-hr	17.74	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	44,721.0	scf	1,266.52	scm

Brake-Specific Emission Results

BSHC (Cell)	0.073	g/hp-hr	0.098	g/kW-hr
CO	2.965	g/hp-hr	3.976	g/kW-hr
NOx (Cell)	4.562	g/hp-hr	6.118	g/kW-hr
Particulate	0.235	g/hp-hr	0.315	g/kW-hr
CO2	541.6	g/hp-hr	726.28	g/kW-hr
BSFC	0.381	lb/hp-hr	0.232	kg/kW-hr

Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.: R21		DIESEL 2D, EM-6144-F	
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/19/2007	Time: 11:22	HCR: 1.892	FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT: 4.12-R		H= 0.137 C= 0.863 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.51	in Hg	99.9 kPa
Engine Inlet Air			
Temperature:	78.0	°F	25.6 °C
Dew Point:	54.7	°F	12.6 °C
Abs. Humidity:	64.8	gr/lb	9.3 g/kg
Rel. Humidity:	45	%	
Dilution Air:			
Temperature:	73.0	°F	22.8 °C
Abs. Humidity	52.4	gr/lb	7.5 g/kg
Rel. Humidity:	43	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		6.27	ppm	
HC Bckgrd	n/a		4.00	ppm	
CO Sample	50.6	2	49.42	ppm	(Dry)
CO Bckgrd	0.1	2	0.09	ppm	
NOx Sample	n/a		46.94	ppm	(Dry)
NOx Bckgrd	0.5	1	0.13	ppm	
CO2 Sample	61.4	1	0.5999	ppm	(Wet)
CO2 Bckgrd	4.7	1	0.0450	ppm	

Corrected Concentrations

HC	2.45	ppm
CO	48.08	ppm
NOx	45.99	ppm
CO2	0.5569	ppm

Mass Emissions

HC		1.795	grams	
CO		70.871	grams	
NOx		108.488	grams	
Particulate		5.610	grams	
CO2		12.902	kg	
Fuel	9.08 lb		4.12 kg	

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,207.7	62.52
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.48	0.04
Gas Meter 2:	3.09	0.09
Sample Rate:	1.61	0.05
Total Flow Rate:	2,209.27	62.57

Particulate Data

Filter Number:	8675.0-196 (pair)	
Weight Gain:	4.098	mg
Sample Multiplier:	1.369	

Correction Factors

NOx Humidity CF:	0.974
Dry-to-Wet CF, Sample:	0.982
Dry-to-Wet CF, Bckgrd:	0.988
Dilution Factor:	22.07

Test Cycle Data

Sample Time:	1,214.30	sec		
Work:	24.02	hp-hr	17.91	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	44,711.9	scf	1,266.27	scm

Brake-Specific Emission Results

BSHC (Cell)	0.075	g/hp-hr	0.100	g/kW-hr
CO	2.951	g/hp-hr	3.957	g/kW-hr
NOx (Cell)	4.517	g/hp-hr	6.057	g/kW-hr
Particulate	0.234	g/hp-hr	0.313	g/kW-hr
CO2	537.1	g/hp-hr	720.29	g/kW-hr
BSFC	0.378	lb/hp-hr	0.230	kg/kW-hr

Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.:	R22		DIESEL 2D, EM-6144-F
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/19/2007	Time: 13:24	HCR:	1.892 FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT:	4.12-R	H= 0.137 C= 0.863 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.44	in Hg	99.7 kPa
Engine Inlet Air			
Temperature:	77.0	°F	25.0 °C
Dew Point:	54.5	°F	12.5 °C
Abs. Humidity:	64.5	gr/lb	9.2 g/kg
Rel. Humidity:	46	%	
Dilution Air:			
Temperature:	73.0	°F	22.8 °C
Abs. Humidity	57.1	gr/lb	8.2 g/kg
Rel. Humidity:	46	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		6.10	ppm	
HC Bckgrd	n/a		4.00	ppm	
CO Sample	54.4	2	53.20	ppm	(Dry)
CO Bckgrd	2.2	2	2.07	ppm	
NOx Sample	n/a		47.36	ppm	(Dry)
NOx Bckgrd	0.4	1	0.10	ppm	
CO2 Sample	61.7	1	0.6029	ppm	(Wet)
CO2 Bckgrd	4.8	1	0.0459	ppm	

Corrected Concentrations

HC	2.28	ppm
CO	49.83	ppm
NOx	46.38	ppm
CO2	0.5591	ppm

Mass Emissions

HC	1.673	grams		
CO	73.535	grams		
NOx	109.430	grams		
Particulate	5.508	grams		
CO2	12.964	kg		
Fuel	9.13	lb	4.14	kg

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,208.8	62.55
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.46	0.04
Gas Meter 2:	3.08	0.09
Sample Rate:	1.61	0.05
Total Flow Rate:	2,210.38	62.60

Particulate Data

Filter Number:	8676.0-197 (pair)	
Weight Gain:	4.018	mg
Sample Multiplier:	1.371	

Correction Factors

NOx Humidity CF:	0.973
Dry-to-Wet CF, Sample:	0.981
Dry-to-Wet CF, Bckgrd:	0.987
Dilution Factor:	21.95

Test Cycle Data

Sample Time:	1,214.90	sec		
Work:	24.04	hp-hr	17.93	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	44,756.5	scf	1,267.53	scm

Brake-Specific Emission Results

BSHC (Cell)	0.070	g/hp-hr	0.093	g/kW-hr
CO	3.059	g/hp-hr	4.102	g/kW-hr
NOx (Cell)	4.552	g/hp-hr	6.104	g/kW-hr
Particulate	0.229	g/hp-hr	0.307	g/kW-hr
CO2	539.3	g/hp-hr	723.19	g/kW-hr
BSFC	0.380	lb/hp-hr	0.231	kg/kW-hr

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Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.:	R23	DIESEL 2D, EM-6144-F	
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/19/2007	Time: 14:04	HCR: 1.892	FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT:	4.12-R	H= 0.137 C= 0.863 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.42	in Hg	99.6 kPa
Engine Inlet Air			
Temperature:	78.0	°F	25.6 °C
Dew Point:	54.6	°F	12.6 °C
Abs. Humidity:	64.7	gr/lb	9.2 g/kg
Rel. Humidity:	44	%	
Dilution Air:			
Temperature:	71.0	°F	21.7 °C
Abs. Humidity	56.0	gr/lb	8.0 g/kg
Rel. Humidity:	49	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		6.03	ppm	
HC Bckgrd	n/a		3.70	ppm	
CO Sample	51.7	2	50.51	ppm	(Dry)
CO Bckgrd	0.1	2	0.09	ppm	
NOx Sample	n/a		47.10	ppm	(Dry)
NOx Bckgrd	0.3	1	0.08	ppm	
CO2 Sample	61.4	1	0.5999	ppm	(Wet)
CO2 Bckgrd	4.8	1	0.0459	ppm	

Corrected Concentrations

HC	2.50	ppm
CO	49.04	ppm
NOx	46.16	ppm
CO2	0.5561	ppm

Mass Emissions

HC	1.826	grams		
CO	72.168	grams		
NOx	108.681	grams		
Particulate	5.601	grams		
CO2	12.859	kg		
Fuel	9.05	lb	4.10	kg

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,204.2	62.42
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.47	0.04
Gas Meter 2:	3.05	0.09
Sample Rate:	1.59	0.04
Total Flow Rate:	2,205.74	62.47

Particulate Data

Filter Number:	8866.0-198 (pair)	
Weight Gain:	4.025	mg
Sample Multiplier:	1.391	

Correction Factors

NOx Humidity CF:	0.974
Dry-to-Wet CF, Sample:	0.982
Dry-to-Wet CF, Bckgrd:	0.987
Dilution Factor:	22.07

Test Cycle Data

Sample Time:	1,214.10	sec		
Work:	24.03	hp-hr	17.92	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	44,633.2	scf	1,264.04	scm

Brake-Specific Emission Results

BSHC (Cell)	0.076	g/hp-hr	0.102	g/kW-hr
CO	3.003	g/hp-hr	4.027	g/kW-hr
NOx (Cell)	4.523	g/hp-hr	6.065	g/kW-hr
Particulate	0.233	g/hp-hr	0.313	g/kW-hr
CO2	535.1	g/hp-hr	717.61	g/kW-hr
BSFC	0.377	lb/hp-hr	0.229	kg/kW-hr

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Southwest Research Institute - Department of Emissions Research
EPA Hot Transient Emission Test Results
Project No. 3-10664-001

Engine Model:	1991 Detroit Diesel S60	Test No.:	R24	DIESEL 2D, EM-6144-F	
Engine Desc.:	12.7 L (775 CID) 6	Date: 01/19/2007	Time: 14:44	HCR: 1.892	FID Resp: 1.00
Engine Cycle:	Diesel	Program HDT:	4.12-R	H= 0.137 C= 0.863 O= 0.000 X= 0.000	
Engine S/N:	06R0038671	Cell: 4	Bag Cart: 1		

Ambient/Test Cell Conditions

Barometer:	29.40	in Hg	99.5 kPa
Engine Inlet Air			
Temperature:	79.0	°F	26.1 °C
Dew Point:	54.4	°F	12.4 °C
Abs. Humidity:	64.3	gr/lb	9.2 g/kg
Rel. Humidity:	43	%	
Dilution Air:			
Temperature:	72.0	°F	22.2 °C
Abs. Humidity	58.8	gr/lb	8.4 g/kg
Rel. Humidity:	49	%	

Measured Gaseous Data

	Meter	Range	Concentration		
HC Sample	n/a		6.10	ppm	
HC Bckgrd	n/a		4.20	ppm	
CO Sample	52.3	2	51.11	ppm	(Dry)
CO Bckgrd	0.2	2	0.19	ppm	
NOx Sample	n/a		47.53	ppm	(Dry)
NOx Bckgrd	0.4	1	0.10	ppm	
CO2 Sample	61.7	1	0.6029	ppm	(Wet)
CO2 Bckgrd	4.7	1	0.0450	ppm	

Corrected Concentrations

HC	2.09	ppm
CO	49.52	ppm
NOx	46.53	ppm
CO2	0.5599	ppm

Mass Emissions

HC	1.528	grams		
CO	72.820	grams		
NOx	109.364	grams		
Particulate	5.488	grams		
CO2	12.940	kg		
Fuel	9.11	lb	4.13	kg

Sample Flows

	scfm	scmm
Blower 1 Rate:	2,202.5	62.38
Blower 2 Rate:	0.0	0.00
90 mm System:		
Gas Meter 1:	1.46	0.04
Gas Meter 2:	3.07	0.09
Sample Rate:	1.61	0.05
Total Flow Rate:	2,204.12	62.42

Particulate Data

Filter Number:	8867.0 (pair)	
Weight Gain:	4.011	mg
Sample Multiplier:	1.368	

Correction Factors

NOx Humidity CF:	0.973
Dry-to-Wet CF, Sample:	0.981
Dry-to-Wet CF, Bckgrd:	0.987
Dilution Factor:	21.96

Test Cycle Data

Sample Time:	1,214.20	sec		
Work:	24.03	hp-hr	17.92	kW-hr
Reference Work:	23.92	hp-hr	17.84	kW-hr
Total Volume (Vmix):	44,604.0	scf	1,263.21	scm

Brake-Specific Emission Results

BSHC (Cell)	0.064	g/hp-hr	0.085	g/kW-hr
CO	3.030	g/hp-hr	4.064	g/kW-hr
NOx (Cell)	4.551	g/hp-hr	6.103	g/kW-hr
Particulate	0.228	g/hp-hr	0.306	g/kW-hr
CO2	538.5	g/hp-hr	722.13	g/kW-hr
BSFC	0.379	lb/hp-hr	0.231	kg/kW-hr

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