

Engines

- Research
- Development
- Performance
- Durability
- Emissions
- Certification
- Fuels and Lubes Qualification

October 21st, 2014

Mr. Tom Parish
Managing Director
Rennsli Corp
P.O. Box 2150
Orem, UT 84059

Transmissions

- Dexron®/Mercon®
- Research
- Development

Re: Final Report for Intertek Proposal No. 51445 – Diesel Fuel Additive Testing

Tom,

This report summarizes the emissions and fuel consumption testing of Rennsli Diesel Fuel Additive versus a baseline ULSD fuel on both transient and steady state test cycles. Thank you for allowing Intertek to provide these testing services. If you have any questions, comments, or concerns please do not hesitate to give me a call at (210) 867-4648 or email me at Kira.Turner@intertek.com.

Vehicles

- Performance
- Durability
- Fuels/Lubes

Fuel Systems

- Live Fuel
- SHED
- Fuel Fill
- Slosh
- Pressure/Vacuum
- Soak

Best Regards,

Kira Turner
Project Engineer
Intertek Automotive Research

Introduction

Intertek provided Rennsli with test services for their diesel fuel additive. Testing took place from September 24th through October 8th of 2014. Services provided by Intertek included emissions, particulate matter (PM), and fuel economy testing. The test plan was comprised of both steady state and transient duty cycles, as well as a 50 hour period of endurance testing. Two fuels were compared during this testing: a baseline fuel of ultra-low sulfur diesel (ULSD), and a mixture of ULSD and the provided additive. The test engine used was a 2005 Caterpillar C15 with approximately 131.5 hours of run time at the start of testing. The engine was supplied by Intertek; engine details are listed below in Table 1.

Table 1: Engine Details

Manufacturer Engine Information		
Make	-	Caterpillar
Model	-	C15
Model Year	-	2005
Serial Number	-	BXS08383
Displacement	L	15
Max Rated Power	hp	475
Speed at Max Rated Power	rpm	1800
Low Idle	rpm	650
High Idle	rpm	2140
Intertek Measured Performance (40CFR1065 Torque Map)		
Ntest (Max Test Speed)	rpm	2084
Pmax (max Power)	hp	481
Tmax (Max Torque)	ft-lb	1859
Restrictions (set at rated power)		
Intake Air Pressure	kPag	-5.5
Exhaust Back Pressure	kPag	7.0
Intercooler Out Temperature	DegC	43
Intercooler Delta Pressure	kPag	8.0
Coolant and Oil Information		
Coolant	Cat ELC premix 50/50	
Oil	Chevron DELO 400 LE 15W-40	

Testing Details

The test engine was installed in Intertek's facility. A picture of the test cell and engine setup is included in Appendix A. Intertek provided all instrumentation, cooling systems including an intercooler, and all fuels and lubricants; Rennsli provided the fuel additive. There was no aftertreatment installed for the duration of the program. All testing was performed following regulations for a heavy duty, variable

speed, compression ignition, non-road engine as listed in 40 CFR 1039. This was agreed upon by Intertek and Rennsli due to how the additive is typically used in-situ. The test cycles run were the Non-Road Transient Cycle (NRTC) and Ramped Modal C1 (RMC C1), and were generated using a torque map which was run at the beginning of the program according to 40 CFR 1065.

The test plan was as follows:

- 1) Baseline fuel
 - a. Set restrictions at rated power: 1800rpm, 100% throttle
 - b. Run torque map: sweep engine from 615rpm to 2160rpm at 5 rpm/s
 - c. Four back to back NRTC cycles
 - d. Four back to back RMC C1 cycles
- 2) Fuel additive mixture
 - a. Connect engine to fuel tote with additive mixture
 - b. Purge engine and test cell of all fuel
 - c. Set restrictions at rated power
 - d. Four back to back NRTC cycles
 - e. Four back to back RMC C1 cycles
 - f. Run 99 looped RMC C1 cycles for a total of 50 hrs endurance
 - g. Four back to back NRTC cycles
 - h. Four back to back RMC C1 cycles
- 3) Baseline Fuel
 - a. Connect engine to tank with baseline fuel
 - b. Purge engine and test cell of all fuel
 - c. Four back to back NRTC cycles
 - d. Four back to back RMC C1 cycles

Restrictions were set prior to running each NRTC set. In order to allow all temperatures and pressures to stabilize, the engine was run for 10 minutes at rated power (1800rpm and 100% throttle) before fixing restrictions.

To provide for proper mixing, the fuel additive was first poured into an empty 350 gallon tote, after which the appropriate quantity of ULSD was added to achieve a 1:5000 ratio. Subsequently, and at the request of Rennsli, the additive was allowed to sit for at least 24 hours prior to running any emissions testing. When switching between fuels, the engine and test cell were purged of all residual fuel. To ensure this, a routine was completed which consisted of disconnecting the fuel supply at the engine and flowing 2 gallons of fuel into buckets in order to empty the test cell lines and day tank. The fuel was then reconnected and the engine was run for 5 minutes at rated power to make sure all residual fuel was removed from the engine.

The duty cycles were run looped together with 60 seconds of idle between each cycle to allow for switching of the PM filter media. However, this idle period was not included in the cycle emission

calculations. The first cycle of the set of four was provided as a preconditioning cycle and emissions were not monitored.

In addition to the emissions testing, Intertek provided a 50 hour endurance test which was completed between the two emissions tests on the additive fuel mixture. To complete this, 99 RMC C1 cycles were looped together, this time without the 60 seconds of idle between cycles. Since this test required more fuel than the tote could hold, the engine was shut down twice during the test to blend more fuel. During this portion of the testing, Intertek did not monitor emissions but did provide fuel flow measurement. A plot of Mode 5 of the RMC C1, which is the mode with the highest power rating, can be found in Figure A3 of Appendix A.

Emissions and Fuel Flow Measurement Details

Gaseous and particulate sampling was performed for all duty cycles (NRTC and RMC) using a full flow constant volume sampling system (CVS). The gaseous emissions constituents measured were CO, CO₂, THC, and NO_x, and were sampled continuously over the duty cycles. Concurrently, particulate emissions were sampled for all duty cycles. This was sampled using a secondary dilution system meeting the requirements specified in 40CFR1065. A batch sample was collected over the entire duty cycle on a filter-based sample media; the media used for all particulate testing were Whatman 47mm PTFE filters.

Intertek also provided fuel flow measurement using a Micromotion Elite Coriolis Flow Meter, and a diagram of the test cell fuel system is provided in Figure 1 of Appendix A.

Test Results

The 3 cycle averages for emissions, particulate, and fuel consumption are listed in the following tables. Tables 2 and 3 show the NRTC and RMC results respectively. Figures 1 and 2 show the percent differences of both, with all percent differences calculated with respect to the original baseline run. Detailed results from each cycle as well as the torque map are included in Appendix A.

Table 2: NRTC Cycle Average Results

NRTC: 3 Cycle Averages								
	Initial Run Baseline	Initial Run Additive	Second Run Additive	Repeat Baseline	Initial Run Baseline	Initial Run Additive	Second Run Additive	Repeat Baseline
	gm/kW-hr	gm/kW-hr	gm/kW-hr	gm/kW-hr	% diff	% diff	% diff	% diff
BSPM	0.226	0.234	0.235	0.230	0.0	3.5	4.0	1.8
BSTHC	0.371	0.396	0.365	0.369	0.0	6.7	-1.6	-0.5
BSCO	7.12	7.64	7.32	6.96	0.0	7.3	2.8	-2.2
BSCO ₂	851.7	854.3	857.2	856.3	0.0	0.3	0.6	0.5
BSNO_x	2.83	2.62	2.57	2.73	0.0	-7.4	-9.2	-3.5
BSFC	272.8	273.4	273.7	273.9	0.0	0.2	0.3	0.4

Figure 1: NRTC Percent Differences

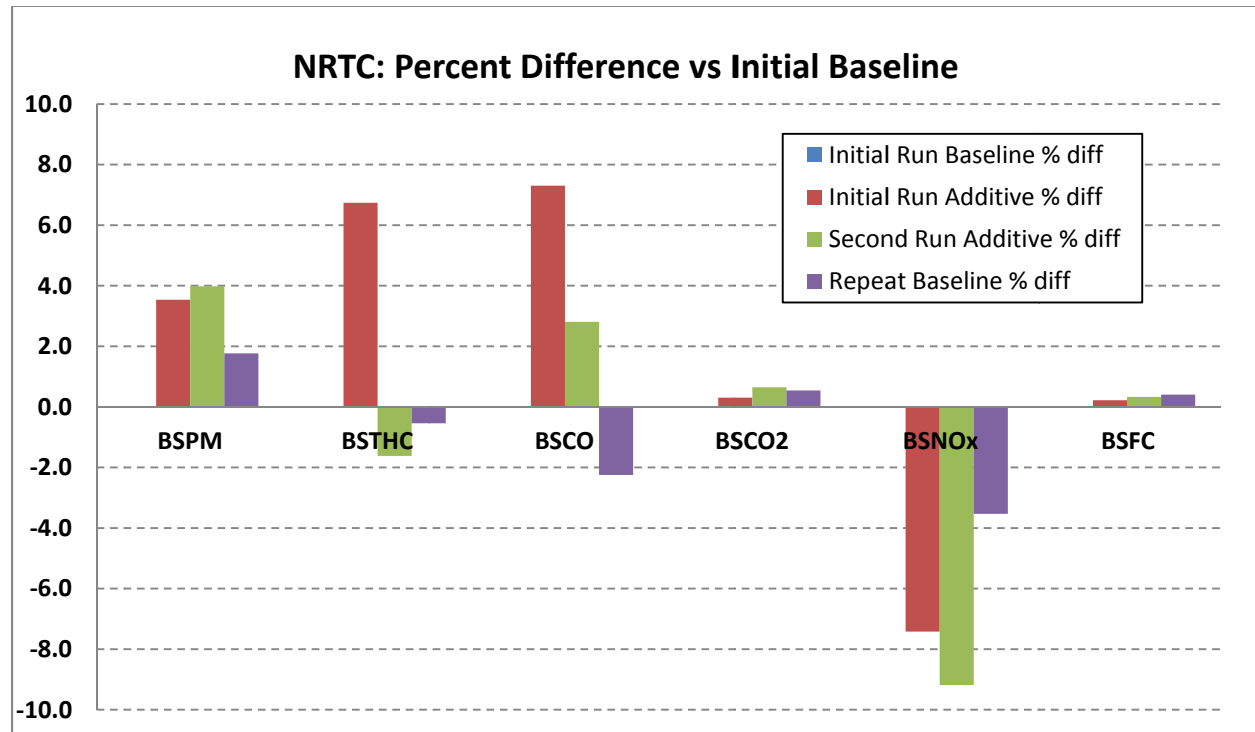
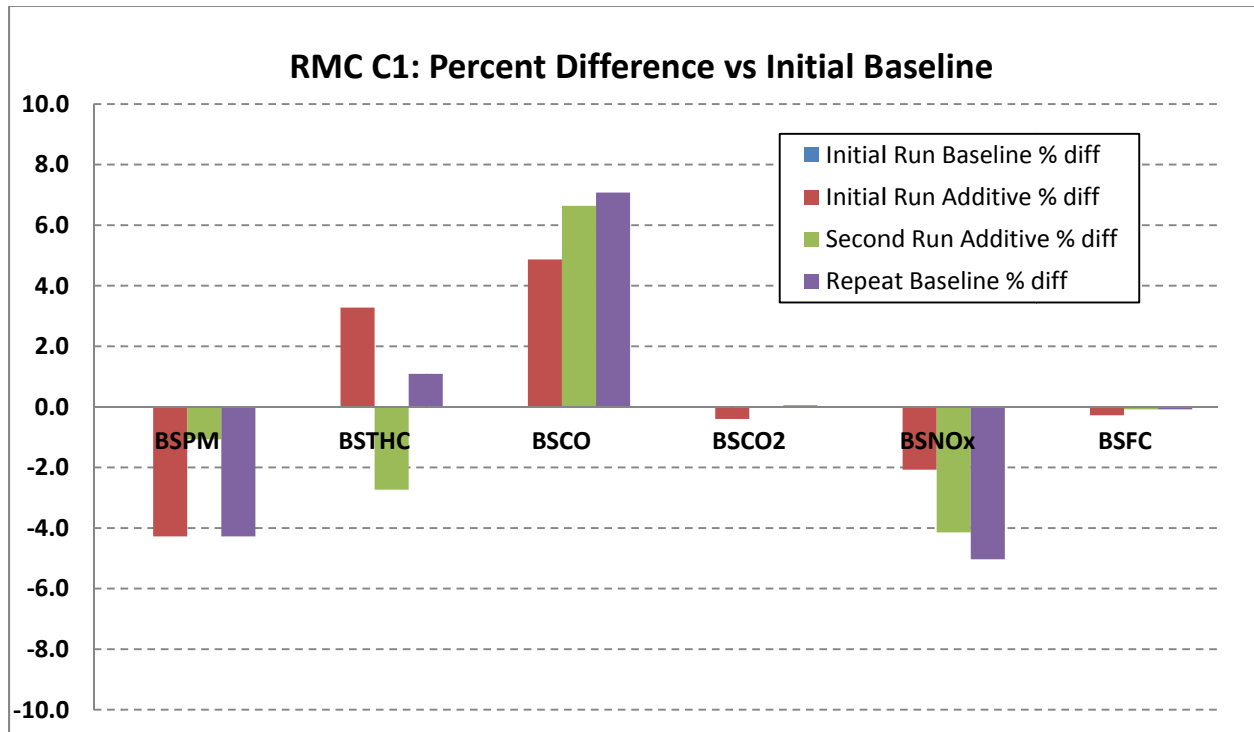


Table 3: RMC C1 Cycle Average Results

RMC C1: 3 Cycle Averages								
	Initial Run Baseline	Initial Run Additive	Second Run Additive	Repeat Baseline	Initial Run Baseline	Initial Run Additive	Second Run Additive	Repeat Baseline
	gm/kW-hr	gm/kW-hr	gm/kW-hr	gm/kW-hr	% diff	% diff	% diff	% diff
BSPM	0.187	0.179	0.185	0.179	0.0	-4.3	-1.1	-4.3
BSTHC	0.2	0.2	0.2	0.2	0.0	3.3	-2.7	1.1
BSCO	2.3	2.4	2.4	2.4	0.0	4.9	6.6	7.1
BSCO2	797.7	794.5	797.5	798.1	0.0	-0.4	0.0	0.1
BSNOx	3.4	3.3	3.2	3.2	0.0	-2.1	-4.1	-5.0
BSFC	253.0	252.3	252.8	252.8	0.0	-0.3	-0.1	-0.1

Figure 2: RMC C1 Percent Differences



Appendix A

Figure A1: Test Stand Setup.....	A1
Figure A2: Fuel Flow System	A1
Figure A3: Endurance BSFC Mode 5 Modal Averages	A2
Torque Map Results	A3
Initial Baseline Results	A4-A9
Initial Additive Results	A10-A15
Repeat Additive Results	A16-A21
Repeat Baseline Results	A22-A27



Figure A1: Test Stand Setup

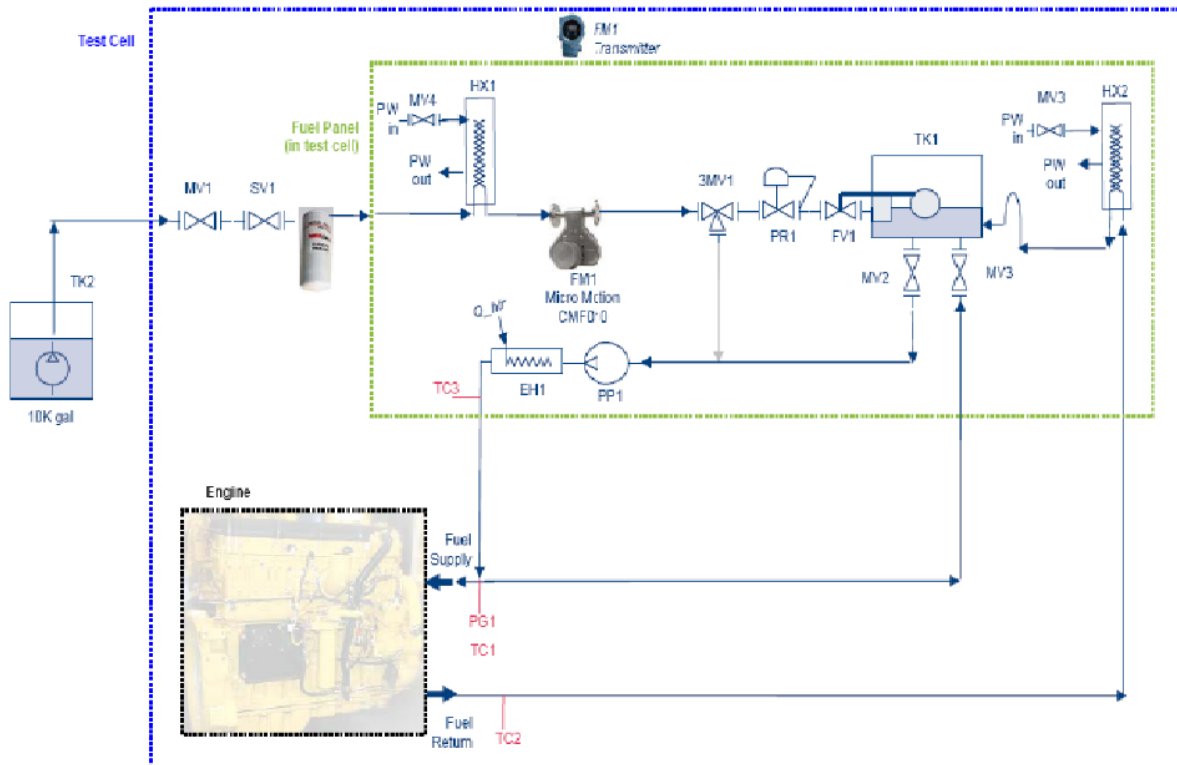


Figure A2: Fuel Flow System

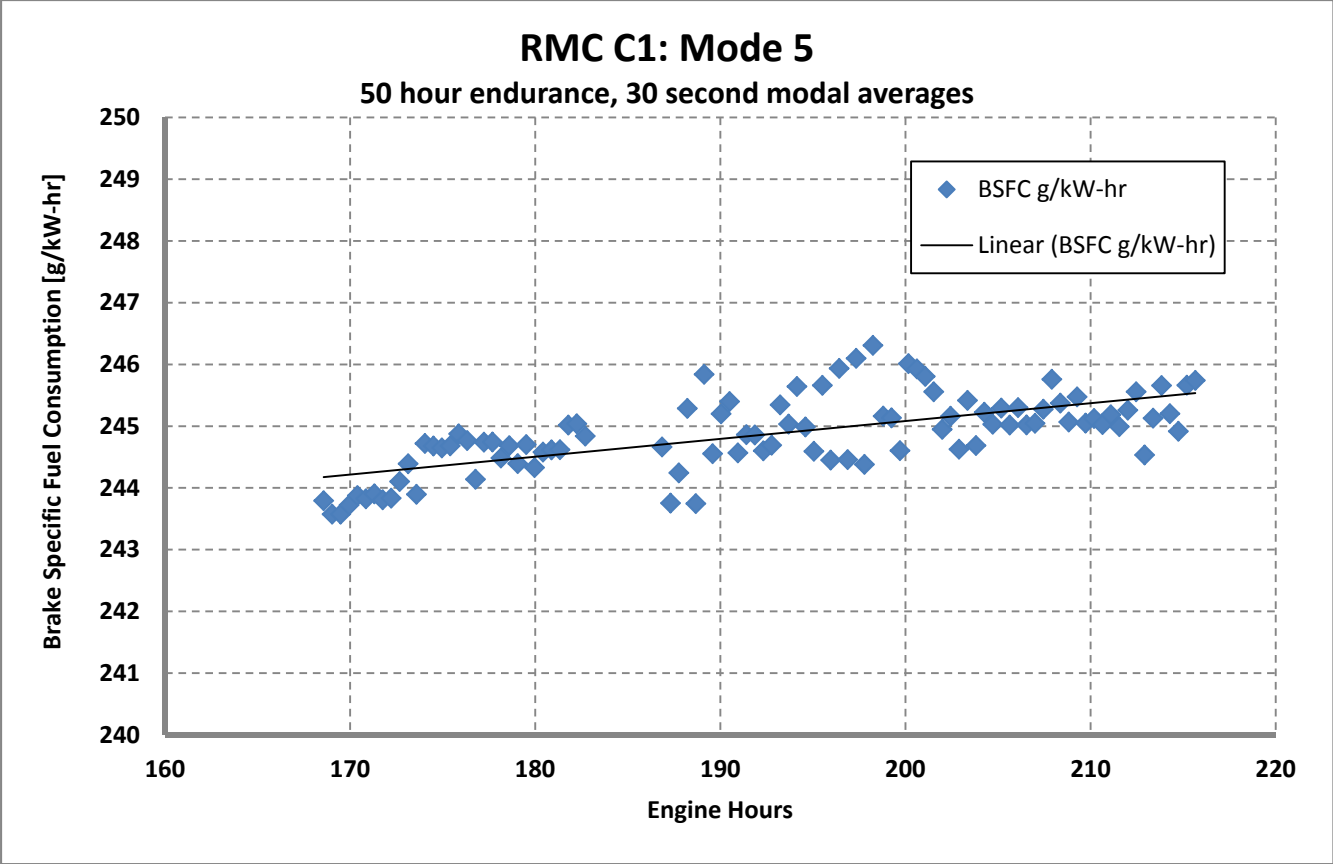


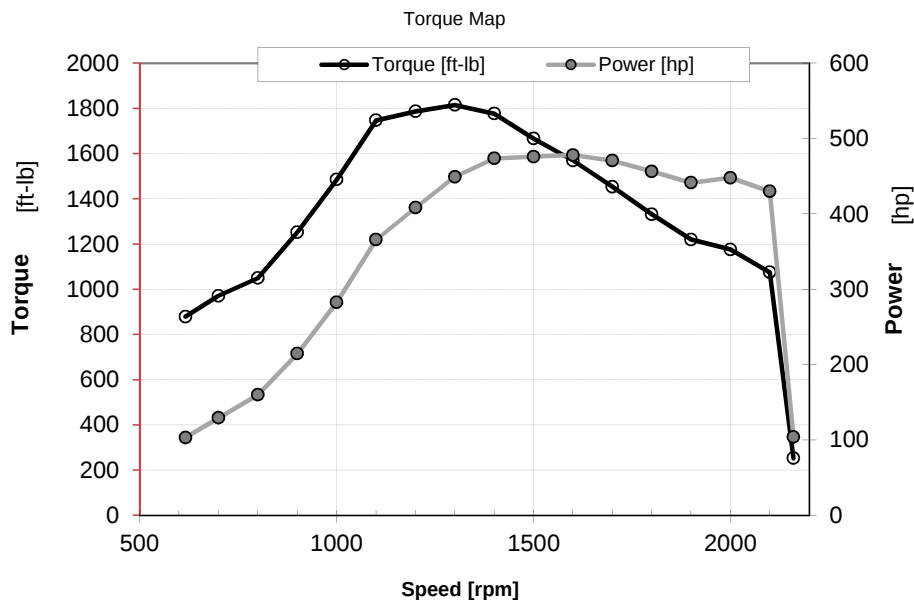
Figure A3: Endurance BSFC Mode 5 Modal Averages

Date	9/18/2014		
Time at Start	9:43:46 AM	Eng Hrs:	136.3
Cell	L10		
Engine Model:	C15		
Engine SN:	BSX08383		
Fuel / Fuel ID:	ULSD		
Notes:			
Filename:	TM_L10_781_51445_TM5_091814_0930_TMrept_DH092214.xlsm		
Barometer:	98.28 [kPaA]		
Map Duration:	294 [sec]		
Map Start Speed	616 [rpm]		
Map Stop Speed/Tq	2160 [rpm]	252.7 [ft-lbs]	
Measured Speed Ramp Rate	5.2 [rpm/s]		

Output 100rpm Torque Map

	Measured	Mfgr Specified	Recommend	Used
Nidle [rpm]	650	650	650	650
Nidle_hi [rpm]		2140	NA	NA
Pmax [hp]	481	475	NA	NA
N @ Pmax [rpm]	1548	1800	NA	NA
Ntest [rpm]	2084	0	2084	2084
Tmax [ft-lb]	1859	0	NA	NA
Nintermediate [rpm]	1302	0	1302	1302
Nrated [rpm]	1548	1800	1548	1548
NTE Speeds and 100% Torques				
Nlo [rpm]	944	0	944	944
Nhi [rpm]	2135	0	2135	2135
Nref [rpm]	2075	0	2075	2075
Nlo_gtr [rpm]	974		974	974
Npref [rpm]	1293		1293	1293
N_gtr100 [rpm]	1837		1837	1837
A [rpm]	1242	0	1242	1242
B [rpm]	1539	0	1539	1539
C [rpm]	1837	0	1837	1837
A100 [ft-lb]	1799	0	1799	1799
B100 [ft-lb]	1630	0	1630	1630
C100 [ft-lb]	1296	0	1296	1296

Speed [rpm]	Torque [ft-lb]	Power [hp]
616	879	103
700	971	129
800	1050	160
900	1253	215
1000	1486	283
1100	1747	366
1200	1787	408
1300	1815	449
1400	1778	474
1500	1667	476
1600	1570	478
1700	1454	471
1800	1332	456
1900	1220	441
2000	1177	448
2100	1075	430
2160	253	104



Date	9/24/2014	
Time / Eng Hrs at Start	5:20:48 PM	157.9 hrs
Cell	L10	
Engine Model:	Caterpillar C15	
Engine SN:	BSX08383	
Fuel:	#2 Diesel	H/C: α = 1.800
File Name:	820B_L10_C15_51445_NRTC_092414_Report_B7.xlsm	O/C: β = 0.000
Cycle Type	NRTC	Su/C: γ = 0.000
Notes:	Baseline Fuel	N/C: δ = 0.000



Intertek AR
5404 Bandera Road
San Antonio, TX 78238

Exhaust Flow Method: dil: ntot1

Calculations: 40CFR1065

PM Sample = CVS

Torque Map Filename:	TM_L10_781_51445_TM5_091814_0930_TMrept		
Ref Cycle Name:	781_L10_C15_NRTCx4_CMD_9_18_2014		
CMD Cycle Name:	781_NRTC_CMD_9_18_2014		
Idle Speed	650 [rpm]	CITT	0 ft-lb
Transmission Type:	Manual	Cycle Length	1237.9 [s]

Ref Cycle Work	59.59 hp-hr	44.43 kW-hr	
Cycle Work	58.08 hp-hr	43.31 kW-hr	-2.5%

Barometer (ave)	98.8 kPaA		
Intake Air Humidity (ave)	12.0 g/kg	Kh_cfr1065_ci	1.021
Dilution Air Humidity (ave)	8.0 g/kg		
Total Flow	82116 mol	Primary Filter	4591
Total PM Flow	9.7 mol	PM Filter Media	47MM-PTFE-WHATMAN
		Filter Weight Gain	1.137 mg

Drift Corrected Gaseous Emissions Results:

PM	9.601 [g]	0.165 [g/hp-hr]	0.222 [g/kW-hr]
CO	308.7 [g]	5.315 [g/hp-hr]	7.13 [g/kW-hr]
CO2	36885 [g]	635 [g/hp-hr]	852 [g/kW-hr]
THC	16.05 [g]	0.276 [g/hp-hr]	0.371 [g/kW-hr]
NMHC*	15.73 [g]	0.271 [g/hp-hr]	0.363 [g/kW-hr]
NOx	122.74 [g]	2.113 [g/hp-hr]	2.834 [g/kW-hr]
NMHC+NOx	138.5 [g]	2.384 [g/hp-hr]	3.197 [g/kW-hr]
Fuel CB	11.755 [kg]	0.446 [lb/hp-hr]	271 [g/kW-hr]
Fuel Measured	11.809 [kg]	0.448 [lb/hp-hr]	273 [g/kW-hr]

Statistical Criteria:	40CFR1065	Statistics Validation:	N_MTS	2084 rpm
Drop Points:	T_P PTS AT WOT	PASS	Tmax	1859 ft-lb
Time Delay =	0.5 [sec]		Pmax	481 hp
Cycle Statistics	Speed Limit	Torque Limit	Power Limit	
	Value	Value	Limit	Value
SEE	<5.0% of MTS 3.0	<10%Tmax 6.2	< 10%Pmax	6.3
R2	>0.970 0.978	>0.850 0.900	>0.910	0.938
M	0.950<M<1.030 0.982	0.830<a1<1.030 0.941	0.830<M<1.030	0.961
B	<10% of IDLE 5.6	<2.0%Tmax 1.3	<2.0%Pmax	0.9
# of Points	1238	1202		1202

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*NMHC Method: m_nmhc_0.98thc

Date	9/24/2014
Time / Eng Hrs at Start	5:42:26 PM 158.3 hrs
Cell	L10
Engine Model:	Caterpillar C15
Engine SN:	BSX08383
Fuel:	#2 Diesel
File Name:	820C_L10_C15_51445_NRTC_092414_Report_B7.xlsm
Cycle Type	NRTC
Notes:	Baseline Fuel



Intertek AR
5404 Bandera Road
San Antonio, TX 78238

Exhaust Flow Method: dil: ntot1

Calculations: 40CFR1065

PM Sample = CVS

Torque Map Filename:	TM_L10_781_51445_TM5_091814_0930_TMrept		
Ref Cycle Name:	781_L10_C15_NRTCx4_CMD_9_18_2014		
CMD Cycle Name:	781_NRTC_CMD_9_18_2014		
Idle Speed	650 [rpm]	CITT	0 ft-lb
Transmission Type:	Manual	Cycle Length	1237.9 [s]

Ref Cycle Work	59.59 hp-hr	44.43 kW-hr	
Cycle Work	58.09 hp-hr	43.32 kW-hr	-2.5%

Barometer (ave)	98.8 kPaA		
Intake Air Humidity (ave)	12.0 g/kg	Kh_cfr1065_ci	1.020
Dilution Air Humidity (ave)	8.2 g/kg		
Total Flow	82084 mol	Primary Filter	4592
Total PM Flow	9.7 mol	PM Filter Media	47MM-PTFE-WHATMAN
		Filter Weight Gain	1.158 mg

Drift Corrected Gaseous Emissions Results:

PM	9.768 [g]	0.168 [g/hp-hr]	0.225 [g/kW-hr]
CO	317.6 [g]	5.467 [g/hp-hr]	7.33 [g/kW-hr]
CO2	36923 [g]	636 [g/hp-hr]	852 [g/kW-hr]
THC	16.54 [g]	0.285 [g/hp-hr]	0.382 [g/kW-hr]
NMHC*	16.21 [g]	0.279 [g/hp-hr]	0.374 [g/kW-hr]
NOx	121.17 [g]	2.086 [g/hp-hr]	2.797 [g/kW-hr]
NMHC+NOx	137.4 [g]	2.365 [g/hp-hr]	3.171 [g/kW-hr]
Fuel CB	11.772 [kg]	0.447 [lb/hp-hr]	272 [g/kW-hr]
Fuel Measured	11.825 [kg]	0.449 [lb/hp-hr]	273 [g/kW-hr]

Statistical Criteria:		40CFR1065	Statistics Validation:		N_MTS	2084 rpm
Drop Points:		T_P PTS AT WOT	PASS		Tmax	1859 ft-lb
Time Delay =		0.5 [sec]			Pmax	481 hp
Cycle Statistics	Speed Limit	Value	Torque Limit	Value	Power Limit	Value
SEE	<5.0% of MTS	3.2	<10%Tmax	6.4	< 10%Pmax	6.4
R2	>0.970	0.975	>0.850	0.893	>0.910	0.935
M	0.950<M<1.030	0.980	0.830<a1<1.030	0.927	0.830<M<1.030	0.953
B	<10% of IDLE	6.0	<2.0%Tmax	1.7	<2.0%Pmax	1.2
# of Points		1238		1202		1202

Last Saved: 10/16/2014 9:03

*NMHC Method: m_nmhc_0.98thc

Date	9/24/2014	 Intertek AR 5404 Bandera Road San Antonio, TX 78238
Time / Eng Hrs at Start	6:04:04 PM 158.6 hrs	
Cell	L10	
Engine Model:	Caterpillar C15	
Engine SN:	BSX08383	
Fuel:	#2 Diesel	Exhaust Flow Method: dil: ntot1
File Name:	820D_L10_C15_51445_NRTC_092414_Report_B7.xlsm	Calculations: 40CFR1065
Cycle Type	NRTC	PM Sample = CVS
Notes:	Baseline Fuel	H/C: α = 1.800
		O/C: β = 0.000
		Su/C: γ = 0.000
		N/C: δ = 0.000

Torque Map Filename:	TM_L10_781_51445_TM5_091814_0930_TMrept		
Ref Cycle Name:	781_L10_C15_NRTCx4_CMD_9_18_2014		
CMD Cycle Name:	781_NRTC_CMD_9_18_2014		
Idle Speed	650 [rpm]	CITT	0 ft-lb
Transmission Type:	Manual	Cycle Length	1237.9 [s]

Ref Cycle Work	59.59 hp-hr	44.43 kW-hr	
Cycle Work	58.05 hp-hr	43.29 kW-hr	-2.6%

Barometer (ave)	98.8 kPaA		
Intake Air Humidity (ave)	12.0 g/kg	Kh_cfr1065_ci	1.020
Dilution Air Humidity (ave)	8.3 g/kg		
Total Flow	82075 mol	Primary Filter	4617
Total PM Flow	9.7 mol	PM Filter Media	47MM-PTFE-WHATMAN
		Filter Weight Gain	1.181 mg

Drift Corrected Gaseous Emissions Results:

PM	9.960 [g]	0.172 [g/hp-hr]	0.230 [g/kW-hr]
CO	299.1 [g]	5.153 [g/hp-hr]	6.91 [g/kW-hr]
CO2	36841 [g]	635 [g/hp-hr]	851 [g/kW-hr]
THC	15.67 [g]	0.270 [g/hp-hr]	0.362 [g/kW-hr]
NMHC*	15.36 [g]	0.265 [g/hp-hr]	0.355 [g/kW-hr]
NOx	123.56 [g]	2.128 [g/hp-hr]	2.854 [g/kW-hr]
NMHC+NOx	138.9 [g]	2.393 [g/hp-hr]	3.209 [g/kW-hr]
Fuel CB	11.736 [kg]	0.446 [lb/hp-hr]	271 [g/kW-hr]
Fuel Measured	11.801 [kg]	0.448 [lb/hp-hr]	273 [g/kW-hr]

Statistical Criteria:		40CFR1065	Statistics Validation:		N_MTS	2084 rpm
Drop Points:		T_P PTS AT WOT	PASS		Tmax	1859 ft-lb
Time Delay =		0.5 [sec]			Pmax	481 hp
Cycle Statistics	Speed Limit	Value	Torque Limit	Value	Power Limit	Value
SEE	<5.0% of MTS	3.1	<10%Tmax	6.5	< 10%Pmax	6.5
R2	>0.970	0.976	>0.850	0.890	>0.910	0.934
M	0.950<M<1.030	0.981	0.830<a1<1.030	0.925	0.830<M<1.030	0.953
B	<10% of IDLE	5.7	<2.0%Tmax	1.7	<2.0%Pmax	1.2
# of Points		1238		1199		1199

Last Saved: 10/17/2014 9:54

*NMHC Method: m_nmhc_0.98thc

Date	9/25/2014	 Intertek AR 5404 Bandera Road San Antonio, TX 78238
Time / Eng Hrs at Start	1:29:49 PM 160.3 hrs	
Cell	L10	
Engine Model:	Caterpillar C15	
Engine SN:	BSX08383	
Fuel:	#2 Diesel	Exhaust Flow Method: dil: ntot1
File Name:	822B_L10_C15_51445_RMC_C1_092514_Report_B7.xlsm	Calculations: 40CFR1065
Cycle Type	RMC C1	PM Sample = CVS
Notes:	Baseline Fuel	H/C: α = 1.800
		O/C: β = 0.000
		Su/C: γ = 0.000
		N/C: δ = 0.000

Torque Map Filename:	TM_L10_781_51445_TM5_091814_0930_TMrept		
Ref Cycle Name:	781_L10_C15_RMC_C1x4_CMD_9_18_2014		
CMD Cycle Name:	781__RMC-C1_CMD_9_18_2014		
Idle Speed	650 [rpm]	CITT	0 ft-lb
Transmission Type:	Manual	Cycle Length	1799.9 [s]

Ref Cycle Work	125.85 hp-hr	93.85 kW-hr	
Cycle Work	124.50 hp-hr	92.84 kW-hr	-1.1%

Barometer (ave)	99.0 kPaA		
Intake Air Humidity (ave)	12.0 g/kg	Kh_cfr1065_ci	1.020
Dilution Air Humidity (ave)	10.5 g/kg		
Total Flow	119295 mol	Primary Filter	4618
Total PM Flow	9.1 mol	PM Filter Media	47MM-PTFE-WHATMAN
		Filter Weight Gain	1.291 mg

Drift Corrected Gaseous Emissions Results:

PM	17.003 [g]	0.137 [g/hp-hr]	0.183 [g/kW-hr]
CO	208.9 [g]	1.678 [g/hp-hr]	2.25 [g/kW-hr]
CO2	74111 [g]	595 [g/hp-hr]	798 [g/kW-hr]
THC	16.97 [g]	0.136 [g/hp-hr]	0.183 [g/kW-hr]
NMHC*	16.63 [g]	0.134 [g/hp-hr]	0.179 [g/kW-hr]
NOx	313.86 [g]	2.521 [g/hp-hr]	3.381 [g/kW-hr]
NMHC+NOx	330.5 [g]	2.655 [g/hp-hr]	3.560 [g/kW-hr]
Fuel CB	23.401 [kg]	0.414 [lb/hp-hr]	252 [g/kW-hr]
Fuel Measured	23.488 [kg]	0.416 [lb/hp-hr]	253 [g/kW-hr]

Statistical Criteria:		40CFR1065	Statistics Validation:		N_MTS	2084 rpm
Drop Points:		T_P PTS AT WOT	PASS		Tmax	1859 ft-lb
Time Delay =		0.5 [sec]			Pmax	481 hp
Cycle Statistics	Speed Limit	Value	Torque Limit	Value	Power Limit	Value
SEE	<5.0% of MTS	0.2	<10%Tmax	1.3	< 10%Pmax	1.4
R2	>0.970	1.000	>0.850	0.998	>0.910	0.998
M	0.950<M<1.030	1.000	0.830<a1<1.030	0.979	0.830<M<1.030	0.975
B	<10% of IDLE	0.1	<2.0%Tmax	0.4	<2.0%Pmax	0.7
# of Points		1800		1800		1800

Last Saved: 10/17/2014 10:14

*NMHC Method: m_nmhc_0.98thc

Date	9/25/2014	 Intertek AR 5404 Bandera Road San Antonio, TX 78238
Time / Eng Hrs at Start	2:00:49 PM	
Cell	L10	
Engine Model:	Caterpillar C15	
Engine SN:	BSX08383	
Fuel:	#2 Diesel	Exhaust Flow Method: dil: ntot1
File Name:	822C_L10_C15_51445_RMC_C1_092514_Report_B7.xlsm	Calculations: 40CFR1065
Cycle Type	RMC C1	PM Sample = CVS
Notes:	Baseline Fuel	H/C: α = 1.800
		O/C: β = 0.000
		Su/C: γ = 0.000
		N/C: δ = 0.000

Torque Map Filename:	TM_L10_781_51445_TM5_091814_0930_TMrept		
Ref Cycle Name:	781_L10_C15_RMC_C1x4_CMD_9_18_2014		
CMD Cycle Name:	781_RMC-C1_CMD_9_18_2014		
Idle Speed	650 [rpm]	CITT	0 ft-lb
Transmission Type:	Manual	Cycle Length	1799.9 [s]

Ref Cycle Work	125.85 hp-hr	93.85 kW-hr	
Cycle Work	124.41 hp-hr	92.77 kW-hr	-1.1%

Barometer (ave)	98.9 kPaA		
Intake Air Humidity (ave)	12.0 g/kg	Kh_cfr1065_ci	1.020
Dilution Air Humidity (ave)	10.5 g/kg		
Total Flow	119244 mol	Primary Filter	4619
Total PM Flow	9.1 mol	PM Filter Media	47MM-PTFE-WHATMAN
		Filter Weight Gain	1.337 mg

Drift Corrected Gaseous Emissions Results:

PM	17.590 [g]	0.141 [g/hp-hr]	0.190 [g/kW-hr]
CO	209.9 [g]	1.687 [g/hp-hr]	2.26 [g/kW-hr]
CO2	74008 [g]	595 [g/hp-hr]	798 [g/kW-hr]
THC	17.31 [g]	0.139 [g/hp-hr]	0.187 [g/kW-hr]
NMHC*	16.96 [g]	0.136 [g/hp-hr]	0.183 [g/kW-hr]
NOx	313.75 [g]	2.522 [g/hp-hr]	3.382 [g/kW-hr]
NMHC+NOx	330.7 [g]	2.658 [g/hp-hr]	3.565 [g/kW-hr]
Fuel CB	23.369 [kg]	0.414 [lb/hp-hr]	252 [g/kW-hr]
Fuel Measured	23.475 [kg]	0.416 [lb/hp-hr]	253 [g/kW-hr]

Statistical Criteria:		40CFR1065	Statistics Validation:		N_MTS	2084 rpm
Drop Points:		T_P PTS AT WOT	PASS		Tmax	1859 ft-lb
Time Delay =		0.5 [sec]			Pmax	481 hp
Cycle Statistics	Speed Limit	Value	Torque Limit	Value	Power Limit	Value
SEE	<5.0% of MTS	0.2	<10%Tmax	1.4	< 10%Pmax	1.4
R2	>0.970	1.000	>0.850	0.998	>0.910	0.998
M	0.950<M<1.030	1.000	0.830<a1<1.030	0.978	0.830<M<1.030	0.974
B	<10% of IDLE	0.1	<2.0%Tmax	0.5	<2.0%Pmax	0.8
# of Points		1800		1800		1800

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*NMHC Method: m_nmhc_0.98thc

Date	9/25/2014	 Intertek AR 5404 Bandera Road San Antonio, TX 78238
Time / Eng Hrs at Start	2:31:49 PM 161.3 hrs	
Cell	L10	
Engine Model:	Caterpillar C15	
Engine SN:	BSX08383	
Fuel:	#2 Diesel	Exhaust Flow Method: dil: ntot1
File Name:	822D_L10_C15_51445_RMC_C1_092514_Report_B7.xlsm	Calculations: 40CFR1065
Cycle Type	RMC C1	PM Sample = CVS
Notes:	Baseline Fuel	H/C: α = 1.800
		O/C: β = 0.000
		Su/C: γ = 0.000
		N/C: δ = 0.000

Torque Map Filename:	TM_L10_781_51445_TM5_091814_0930_TMrept		
Ref Cycle Name:	781_L10_C15_RMC_C1x4_CMD_9_18_2014		
CMD Cycle Name:	781__RMC-C1_CMD_9_18_2014		
Idle Speed	650 [rpm]	CITT	0 ft-lb
Transmission Type:	Manual	Cycle Length	1799.9 [s]

Ref Cycle Work	125.85 hp-hr	93.85 kW-hr	
Cycle Work	124.40 hp-hr	92.76 kW-hr	-1.2%

Barometer (ave)	98.9 kPaA		
Intake Air Humidity (ave)	12.0 g/kg	Kh_cfr1065_ci	1.020
Dilution Air Humidity (ave)	10.6 g/kg		
Total Flow	119225 mol	Primary Filter	4620
Total PM Flow	9.1 mol	PM Filter Media	47MM-PTFE-WHATMAN
		Filter Weight Gain	1.337 mg

Drift Corrected Gaseous Emissions Results:

PM	17.595 [g]	0.141 [g/hp-hr]	0.190 [g/kW-hr]
CO	209.4 [g]	1.683 [g/hp-hr]	2.26 [g/kW-hr]
CO2	73954 [g]	595 [g/hp-hr]	797 [g/kW-hr]
THC	16.68 [g]	0.134 [g/hp-hr]	0.180 [g/kW-hr]
NMHC*	16.35 [g]	0.131 [g/hp-hr]	0.176 [g/kW-hr]
NOx	312.51 [g]	2.512 [g/hp-hr]	3.369 [g/kW-hr]
NMHC+NOx	328.9 [g]	2.644 [g/hp-hr]	3.545 [g/kW-hr]
Fuel CB	23.352 [kg]	0.414 [lb/hp-hr]	252 [g/kW-hr]
Fuel Measured	23.472 [kg]	0.416 [lb/hp-hr]	253 [g/kW-hr]

Statistical Criteria:		40CFR1065	Statistics Validation:		N_MTS	2084 rpm
Drop Points:		T_P PTS AT WOT	PASS		Tmax	1859 ft-lb
Time Delay =		0.5 [sec]			Pmax	481 hp
Cycle Statistics	Speed Limit	Value	Torque Limit	Value	Power Limit	Value
SEE	<5.0% of MTS	0.2	<10%Tmax	1.4	< 10%Pmax	1.4
R2	>0.970	1.000	>0.850	0.998	>0.910	0.998
M	0.950<M<1.030	1.000	0.830<a1<1.030	0.978	0.830<M<1.030	0.974
B	<10% of IDLE	0.1	<2.0%Tmax	0.5	<2.0%Pmax	0.8
# of Points		1800		1800		1800

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*NMHC Method: m_nmhc_0.98thc

Date	9/26/2014	 Intertek AR 5404 Bandera Road San Antonio, TX 78238	
Time / Eng Hrs at Start	11:19:28 AM 162.8 hrs		
Cell	L10		
Engine Model:	Caterpillar C15		
Engine SN:	BSX08383		
Fuel:	#2 Diesel	Exhaust Flow Method: dil: ntot1	
File Name:	824B_L10_C15_51445_NRTC_092614_Report_B7.xlsm	Calculations: 40CFR1065	
Cycle Type	NRTC	PM Sample = CVS	
Notes:	Fuel Additive Mixture; PM flow failed proportionality check	H/C: α = 1.800	
		O/C: β = 0.000	
		Su/C: γ = 0.000	
		N/C: δ = 0.000	
Torque Map Filename:	TM_L10_781_51445_TM5_091814_0930_TMrept		
Ref Cycle Name:	781_L10_C15_NRTCx4_CMD_9_18_2014		
CMD Cycle Name:	781_NRTC_CMD_9_18_2014		
Idle Speed	650 [rpm]	CITT	0 ft-lb
Transmission Type:	Manual	Cycle Length	1237.8 [s]
Ref Cycle Work	59.59 hp-hr	44.43 kW-hr	
Cycle Work	58.04 hp-hr	43.28 kW-hr	-2.6%
Barometer (ave)	99.0 kPaA		
Intake Air Humidity (ave)	12.0 g/kg	Kh_cfr1065_ci	1.020
Dilution Air Humidity (ave)	11.0 g/kg		
Total Flow	82170 mol	Primary Filter	4621
Total PM Flow	9.4 mol	PM Filter Media	47MM-PTFE-WHATMAN
		Filter Weight Gain	1.120 mg

Drift Corrected Gaseous Emissions Results:

PM	9.7631302 [g]	0.1682023 [g/hp-hr]	0.225563 [g/kW-hr]
CO	324.5 [g]	5.590 [g/hp-hr]	7.50 [g/kW-hr]
CO2	36999 [g]	637 [g/hp-hr]	855 [g/kW-hr]
THC	16.79 [g]	0.289 [g/hp-hr]	0.388 [g/kW-hr]
NMHC*	16.45 [g]	0.283 [g/hp-hr]	0.380 [g/kW-hr]
NOx	113.69 [g]	1.959 [g/hp-hr]	2.627 [g/kW-hr]
NMHC+NOx	130.1 [g]	2.242 [g/hp-hr]	3.007 [g/kW-hr]
Fuel CB	11.800 [kg]	0.448 [lb/hp-hr]	273 [g/kW-hr]
Fuel Measured	11.832 [kg]	0.449 [lb/hp-hr]	273 [g/kW-hr]

Statistical Criteria:	40CFR1065	Statistics Validation:	N_MTS	2084 rpm
Drop Points:	T_P PTS AT WOT	PASS	Tmax	1859 ft-lb
Time Delay =	0.5 [sec]		Pmax	481 hp
Cycle Statistics	Speed Limit Value	Torque Limit Value	Power Limit Value	
SEE	<5.0% of MTS 3.1	<10%Tmax 6.3	< 10%Pmax 6.2	
R2	>0.970 0.976	>0.850 0.898	>0.910 0.938	
M	0.950<M<1.030 0.982	0.830<a1<1.030 0.936	0.830<M<1.030 0.959	
B	<10% of IDLE 5.5	<2.0%Tmax 1.4	<2.0%Pmax 1.0	
# of Points	1238	1201	1201	

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*NMHC Method: m_nmhc_0.98thc

Date	9/26/2014
Time / Eng Hrs at Start	11:41:06 AM 163.2 hrs
Cell	L10
Engine Model:	Caterpillar C15
Engine SN:	BSX08383
Fuel:	#2 Diesel
File Name:	824C_L10_C15_51445_NRTC_092614_Report_B7.xlsm
Cycle Type	NRTC
Notes:	Fuel Additive Mixture



Intertek AR
5404 Bandera Road
San Antonio, TX 78238

Exhaust Flow Method: dil: ntot1

Calculations: 40CFR1065

PM Sample = CVS

Torque Map Filename:	TM_L10_781_51445_TM5_091814_0930_TMrept		
Ref Cycle Name:	781_L10_C15_NRTCx4_CMD_9_18_2014		
CMD Cycle Name:	781_NRTC_CMD_9_18_2014		
Idle Speed	650 [rpm]	CITT	0 ft-lb
Transmission Type:	Manual	Cycle Length	1237.9 [s]

Ref Cycle Work	59.59 hp-hr	44.43 kW-hr	
Cycle Work	58.06 hp-hr	43.29 kW-hr	-2.6%

Barometer (ave)	99.0 kPaA		
Intake Air Humidity (ave)	12.0 g/kg	Kh_cfr1065_ci	1.020
Dilution Air Humidity (ave)	11.0 g/kg		
Total Flow	82165 mol	Primary Filter	4622
Total PM Flow	9.7 mol	PM Filter Media	47MM-PTFE-WHATMAN
		Filter Weight Gain	1.193 mg

Drift Corrected Gaseous Emissions Results:

PM	10.066 [g]	0.173 [g/hp-hr]	0.233 [g/kW-hr]
CO	334.7 [g]	5.765 [g/hp-hr]	7.73 [g/kW-hr]
CO2	36978 [g]	637 [g/hp-hr]	854 [g/kW-hr]
THC	17.28 [g]	0.298 [g/hp-hr]	0.399 [g/kW-hr]
NMHC*	16.94 [g]	0.292 [g/hp-hr]	0.391 [g/kW-hr]
NOx	112.98 [g]	1.946 [g/hp-hr]	2.610 [g/kW-hr]
NMHC+NOx	129.9 [g]	2.238 [g/hp-hr]	3.001 [g/kW-hr]
Fuel CB	11.798 [kg]	0.448 [lb/hp-hr]	273 [g/kW-hr]
Fuel Measured	11.835 [kg]	0.449 [lb/hp-hr]	273 [g/kW-hr]

Statistical Criteria:	40CFR1065	Statistics Validation:	N_MTS	2084 rpm
Drop Points:	T_P PTS AT WOT	PASS	Tmax	1859 ft-lb
Time Delay =	0.6 [sec]		Pmax	481 hp
Cycle Statistics	Speed Limit	Torque Limit	Power Limit	
	Value	Value	Limit	Value
SEE	<5.0% of MTS3.3	<10%Tmax6.5	< 10%Pmax	6.4
R2	>0.9700.973	>0.8500.890	>0.910	0.935
M	0.950<M<1.0300.980	0.830<a1<1.0300.933	0.830<M<1.030	0.957
B	<10% of IDLE6.2	<2.0%Tmax1.6	<2.0%Pmax	1.2
# of Points	1238	1201		1201

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*NMHC Method: m_nmhc_0.98thc

Date	9/26/2014
Time / Eng Hrs at Start	12:02:44 PM 163.5 hrs
Cell	L10
Engine Model:	Caterpillar C15
Engine SN:	BSX08383
Fuel:	#2 Diesel
File Name:	824D_L10_C15_51445_NRTC_092614_Report_B7.xlsm
Cycle Type	NRTC
Notes:	Fuel Additive Mixture



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Exhaust Flow Method: dil: ntot1

Calculations: 40CFR1065

PM Sample = CVS

Torque Map Filename:	TM_L10_781_51445_TM5_091814_0930_TMrept		
Ref Cycle Name:	781_L10_C15_NRTCx4_CMD_9_18_2014		
CMD Cycle Name:	781_NRTC_CMD_9_18_2014		
Idle Speed	650 [rpm]	CITT	0 ft-lb
Transmission Type:	Manual	Cycle Length	1238.0 [s]

Ref Cycle Work	59.59 hp-hr	44.43 kW-hr	
Cycle Work	58.05 hp-hr	43.29 kW-hr	-2.6%

Barometer (ave)	98.9 kPaA		
Intake Air Humidity (ave)	12.0 g/kg	Kh_cfr1065_ci	1.021
Dilution Air Humidity (ave)	11.4 g/kg		
Total Flow	82159 mol	Primary Filter	4623
Total PM Flow	9.7 mol	PM Filter Media	47MM-PTFE-WHATMAN
		Filter Weight Gain	1.205 mg

Drift Corrected Gaseous Emissions Results:

PM	10.163 [g]	0.175 [g/hp-hr]	0.235 [g/kW-hr]
CO	333.3 [g]	5.742 [g/hp-hr]	7.70 [g/kW-hr]
CO2	36966 [g]	637 [g/hp-hr]	854 [g/kW-hr]
THC	17.32 [g]	0.298 [g/hp-hr]	0.400 [g/kW-hr]
NMHC*	16.97 [g]	0.292 [g/hp-hr]	0.392 [g/kW-hr]
NOx	113.00 [g]	1.947 [g/hp-hr]	2.610 [g/kW-hr]
NMHC+NOx	130.0 [g]	2.239 [g/hp-hr]	3.002 [g/kW-hr]
Fuel CB	11.794 [kg]	0.448 [lb/hp-hr]	272 [g/kW-hr]
Fuel Measured	11.832 [kg]	0.449 [lb/hp-hr]	273 [g/kW-hr]

Statistical Criteria:		40CFR1065	Statistics Validation:		N_MTS	2084 rpm
Drop Points:		T_P PTS AT WOT	PASS		Tmax	1859 ft-lb
Time Delay =		0.6 [sec]			Pmax	481 hp
Cycle Statistics	Speed Limit	Value	Torque Limit	Value	Power Limit	Value
SEE	<5.0% of MTS	3.0	<10%Tmax	6.5	< 10%Pmax	6.5
R2	>0.970	0.978	>0.850	0.890	>0.910	0.932
M	0.950<M<1.030	0.983	0.830<a1<1.030	0.931	0.830<M<1.030	0.953
B	<10% of IDLE	5.5	<2.0%Tmax	1.6	<2.0%Pmax	1.2
# of Points		1238		1201		1201

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*NMHC Method: m_nmhc_0.98thc

Date	9/26/2014	 Intertek AR 5404 Bandera Road San Antonio, TX 78238
Time / Eng Hrs at Start	1:11:37 PM 164.4 hrs	
Cell	L10	
Engine Model:	Caterpillar C15	
Engine SN:	BSX08383	
Fuel:	#2 Diesel	Exhaust Flow Method: dil: ntot1
File Name:	825B_L10_C15_51445_RMC_C1_092614_Report.xlsm	Calculations: 40CFR1065
Cycle Type	RMC C1	PM Sample = CVS
Notes:	Fuel Additive Mixture	H/C: α = 1.800
		O/C: β = 0.000
		Su/C: γ = 0.000
		N/C: δ = 0.000

Torque Map Filename:	TM_L10_781_51445_TM5_091814_0930_TMrept		
Ref Cycle Name:	781_L10_C15_RMC_C1x4_CMD_9_18_2014		
CMD Cycle Name:	781_RMC-C1_CMD_9_18_2014		
Idle Speed	650 [rpm]	CITT	0 ft-lb
Transmission Type:	Manual	Cycle Length	1799.9 [s]

Ref Cycle Work	125.85 hp-hr	93.85 kW-hr	
Cycle Work	124.61 hp-hr	92.92 kW-hr	-1.0%

Barometer (ave)	98.8 kPaA		
Intake Air Humidity (ave)	12.0 g/kg	Kh_cfr1065_ci	1.020
Dilution Air Humidity (ave)	11.1 g/kg		
Total Flow	119226 mol	Primary Filter	4624
Total PM Flow	9.0 mol	PM Filter Media	47MM-PTFE-WHATMAN
		Filter Weight Gain	1.255 mg

Drift Corrected Gaseous Emissions Results:

PM	16.704 [g]	0.134 [g/hp-hr]	0.180 [g/kW-hr]
CO	221.2 [g]	1.775 [g/hp-hr]	2.38 [g/kW-hr]
CO2	73847 [g]	593 [g/hp-hr]	795 [g/kW-hr]
THC	17.50 [g]	0.140 [g/hp-hr]	0.188 [g/kW-hr]
NMHC*	17.15 [g]	0.138 [g/hp-hr]	0.185 [g/kW-hr]
NOx	307.47 [g]	2.467 [g/hp-hr]	3.309 [g/kW-hr]
NMHC+NOx	324.6 [g]	2.605 [g/hp-hr]	3.494 [g/kW-hr]
Fuel CB	23.325 [kg]	0.413 [lb/hp-hr]	251 [g/kW-hr]
Fuel Measured	23.429 [kg]	0.415 [lb/hp-hr]	252 [g/kW-hr]

Statistical Criteria:		40CFR1065	Statistics Validation:		N_MTS	2084 rpm
Drop Points:		T_P PTS AT WOT	PASS		Tmax	1859 ft-lb
Time Delay =		0.5 [sec]			Pmax	481 hp
Cycle Statistics	Speed Limit	Value	Torque Limit	Value	Power Limit	Value
SEE	<5.0% of MTS	0.2	<10%Tmax	1.3	< 10%Pmax	1.3
R2	>0.970	1.000	>0.850	0.998	>0.910	0.998
M	0.950<M<1.030	1.000	0.830<a1<1.030	0.981	0.830<M<1.030	0.978
B	<10% of IDLE	0.1	<2.0%Tmax	0.4	<2.0%Pmax	0.7
# of Points		1800		1798		1798

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*NMHC Method: m_nmhc_0.98thc

Date	9/26/2014	 Intertek AR 5404 Bandera Road San Antonio, TX 78238
Time / Eng Hrs at Start	1:42:37 PM 164.9 hrs	
Cell	L10	
Engine Model:	Caterpillar C15	
Engine SN:	BSX08383	
Fuel:	#2 Diesel	Exhaust Flow Method: dil: ntot1
File Name:	825C_L10_C15_51445_RMC_C1_092614_Report.xlsm	Calculations: 40CFR1065
Cycle Type	RMC C1	PM Sample = CVS
Notes:	Fuel Additive Mixture	H/C: α = 1.800
		O/C: β = 0.000
		Su/C: γ = 0.000
		N/C: δ = 0.000

Torque Map Filename:	TM_L10_781_51445_TM5_091814_0930_TMrept		
Ref Cycle Name:	781_L10_C15_RMC_C1x4_CMD_9_18_2014		
CMD Cycle Name:	781_RMC-C1_CMD_9_18_2014		
Idle Speed	650 [rpm]	CITT	0 ft-lb
Transmission Type:	Manual	Cycle Length	1799.8 [s]

Ref Cycle Work	125.85 hp-hr	93.85 kW-hr	
Cycle Work	124.51 hp-hr	92.85 kW-hr	-1.1%

Barometer (ave)	98.8 kPaA		
Intake Air Humidity (ave)	12.0 g/kg	Kh_cfr1065_ci	1.020
Dilution Air Humidity (ave)	10.9 g/kg		
Total Flow	119181 mol	Primary Filter	4625
Total PM Flow	9.1 mol	PM Filter Media	47MM-PTFE-WHATMAN
		Filter Weight Gain	1.312 mg

Drift Corrected Gaseous Emissions Results:

PM	17.248 [g]	0.139 [g/hp-hr]	0.186 [g/kW-hr]
CO	219.4 [g]	1.762 [g/hp-hr]	2.36 [g/kW-hr]
CO2	73795 [g]	593 [g/hp-hr]	795 [g/kW-hr]
THC	17.54 [g]	0.141 [g/hp-hr]	0.189 [g/kW-hr]
NMHC*	17.19 [g]	0.138 [g/hp-hr]	0.185 [g/kW-hr]
NOx	308.74 [g]	2.480 [g/hp-hr]	3.325 [g/kW-hr]
NMHC+NOx	325.9 [g]	2.618 [g/hp-hr]	3.510 [g/kW-hr]
Fuel CB	23.307 [kg]	0.413 [lb/hp-hr]	251 [g/kW-hr]
Fuel Measured	23.423 [kg]	0.415 [lb/hp-hr]	252 [g/kW-hr]

Statistical Criteria:	40CFR1065	Statistics Validation:	N_MTS	2084 rpm
Drop Points:	T_P PTS AT WOT	PASS	Tmax	1859 ft-lb
Time Delay =	0.5 [sec]		Pmax	481 hp
Cycle Statistics	Speed Limit	Torque Limit	Power Limit	
	Value	Value	Limit	Value
SEE	<5.0% of MTS 0.3	<10%Tmax 1.3	< 10%Pmax	1.4
R2	>0.970 1.000	>0.850 0.998	>0.910	0.998
M	0.950<M<1.030 1.000	0.830<a1<1.030 0.981	0.830<M<1.030	0.976
B	<10% of IDLE 0.0	<2.0%Tmax 0.4	<2.0%Pmax	0.7
# of Points	1800	1798		1798

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*NMHC Method: m_nmhc_0.98thc

Date	9/26/2014	
Time / Eng Hrs at Start	4:40:27 PM	166.4 hrs
Cell	L10	
Engine Model:	Caterpillar C15	
Engine SN:	BSX08383	
Fuel:	#2 Diesel	H/C: α = 1.800
File Name:	860C_L10_C15_51445_RMC_C1_092614_Report.xlsm	O/C: β = 0.000
Cycle Type	RMC C1	Su/C: γ = 0.000
Notes:	Fuel Additive Mixture	N/C: δ = 0.000



Intertek AR
5404 Bandera Road
San Antonio, TX 78238

Exhaust Flow Method: dil: ntot1

Calculations: 40CFR1065

PM Sample = CVS

Torque Map Filename:	TM_L10_781_51445_TM5_091814_0930_TMrept		
Ref Cycle Name:	781_L10_C15_RMC_C1x4_CMD_9_18_2014		
CMD Cycle Name:	781_RMC-C1_CMD_9_18_2014		
Idle Speed	650 [rpm]	CITT	0 ft-lb
Transmission Type:	Manual	Cycle Length	1799.9 [s]

Ref Cycle Work	125.85 hp-hr	93.85 kW-hr	
Cycle Work	124.61 hp-hr	92.92 kW-hr	-1.0%

Barometer (ave)	98.6 kPaA		
Intake Air Humidity (ave)	12.0 g/kg	Kh_cfr1065_ci	1.020
Dilution Air Humidity (ave)	10.8 g/kg		
Total Flow	119227 mol	Primary Filter	4627
Total PM Flow	9.1 mol	PM Filter Media	47MM-PTFE-WHATMAN
		Filter Weight Gain	1.210 mg

Drift Corrected Gaseous Emissions Results:

PM	15.904 [g]	0.128 [g/hp-hr]	0.171 [g/kW-hr]
CO	220.2 [g]	1.767 [g/hp-hr]	2.37 [g/kW-hr]
CO2	73784 [g]	592 [g/hp-hr]	794 [g/kW-hr]
THC	17.69 [g]	0.142 [g/hp-hr]	0.190 [g/kW-hr]
NMHC*	17.33 [g]	0.139 [g/hp-hr]	0.187 [g/kW-hr]
NOx	306.52 [g]	2.460 [g/hp-hr]	3.299 [g/kW-hr]
NMHC+NOx	323.8 [g]	2.599 [g/hp-hr]	3.485 [g/kW-hr]
Fuel CB	23.305 [kg]	0.412 [lb/hp-hr]	251 [g/kW-hr]
Fuel Measured	23.457 [kg]	0.415 [lb/hp-hr]	252 [g/kW-hr]

Statistical Criteria:		40CFR1065	Statistics Validation:		N_MTS	2084 rpm
Drop Points:		T_P PTS AT WOT	PASS		Tmax	1859 ft-lb
Time Delay =		0.5 [sec]			Pmax	481 hp
Cycle Statistics	Speed Limit	Value	Torque Limit	Value	Power Limit	Value
SEE	<5.0% of MTS	0.2	<10%Tmax	1.3	< 10%Pmax	1.4
R2	>0.970	1.000	>0.850	0.998	>0.910	0.998
M	0.950<M<1.030	1.000	0.830<a1<1.030	0.981	0.830<M<1.030	0.977
B	<10% of IDLE	0.0	<2.0%Tmax	0.4	<2.0%Pmax	0.7
# of Points		1800		1800		1800

Last Saved: 9/30/2014 10:02

*NMHC Method: m_nmhc_0.98thc

Date	10/6/2014	
Time / Eng Hrs at Start	11:21:19 AM	216.8 hrs
Cell	L10	
Engine Model:	Caterpillar C15	
Engine SN:	BSX08383	
Fuel:	#2 Diesel	H/C: α = 1.800
File Name:	847B_L10_C15_51445_NRTC_100614_Report.xlsm	O/C: β = 0.000
Cycle Type	NRTC	Su/C: γ = 0.000
Notes:	Fuel Additive Mixture	N/C: δ = 0.000



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Exhaust Flow Method: dil: ntot1

Calculations: 40CFR1065

PM Sample = CVS

Torque Map Filename:	TM_L10_781_51445_TM5_091814_0930_TMrept		
Ref Cycle Name:	781_L10_C15_NRTCx4_CMD_9_18_2014		
CMD Cycle Name:	781_NRTC_CMD_9_18_2014		
Idle Speed	650 [rpm]	CITT	0 ft-lb
Transmission Type:	Manual	Cycle Length	1237.9 [s]

Ref Cycle Work	59.59 hp-hr	44.43 kW-hr	
Cycle Work	58.08 hp-hr	43.31 kW-hr	-2.5%

Barometer (ave)	98.3 kPaA		
Intake Air Humidity (ave)	12.0 g/kg	Kh_cfr1065_ci	1.021
Dilution Air Humidity (ave)	13.9 g/kg		
Total Flow	82720 mol	Primary Filter	4629
Total PM Flow	9.7 mol	PM Filter Media	47MM-PTFE-WHATMAN
		Filter Weight Gain	1.177 mg

Drift Corrected Gaseous Emissions Results:

PM	10.000 [g]	0.172 [g/hp-hr]	0.231 [g/kW-hr]
CO	315.1 [g]	5.425 [g/hp-hr]	7.28 [g/kW-hr]
CO2	37124 [g]	639 [g/hp-hr]	857 [g/kW-hr]
THC	15.01 [g]	0.258 [g/hp-hr]	0.346 [g/kW-hr]
NMHC*	14.71 [g]	0.253 [g/hp-hr]	0.340 [g/kW-hr]
NOx	110.83 [g]	1.908 [g/hp-hr]	2.559 [g/kW-hr]
NMHC+NOx	125.5 [g]	2.161 [g/hp-hr]	2.898 [g/kW-hr]
Fuel CB	11.833 [kg]	0.449 [lb/hp-hr]	273 [g/kW-hr]
Fuel Measured	11.864 [kg]	0.450 [lb/hp-hr]	274 [g/kW-hr]

Statistical Criteria:	40CFR1065	Statistics Validation:	N_MTS	2084 rpm
Drop Points:	T_P PTS AT WOT	PASS	Tmax	1859 ft-lb
Time Delay =	0.5 [sec]		Pmax	481 hp

Cycle Statistics	Speed Limit	Value	Torque Limit	Value	Power Limit	Value
SEE	<5.0% of MTS	3.0	<10%Tmax	6.2	< 10%Pmax	6.2
R2	>0.970	0.977	>0.850	0.901	>0.910	0.940
M	0.950<M<1.030	0.982	0.830<a1<1.030	0.947	0.830<M<1.030	0.966
B	<10% of IDLE	5.6	<2.0%Tmax	1.2	<2.0%Pmax	0.8
# of Points		1238		1200		1200

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*NMHC Method: m_nmhc_0.98thc

Date	10/6/2014	 Intertek AR 5404 Bandera Road San Antonio, TX 78238
Time / Eng Hrs at Start	11:42:57 AM 217.2 hrs	
Cell	L10	
Engine Model:	Caterpillar C15	
Engine SN:	BSX08383	
Fuel:	#2 Diesel	Exhaust Flow Method: dil: ntot1
File Name:	847C_L10_C15_51445_NRTC_100614_Report.xlsm	Calculations: 40CFR1065
Cycle Type	NRTC	PM Sample = CVS
Notes:	Fuel Additive Mixture	H/C: α = 1.800
		O/C: β = 0.000
		Su/C: γ = 0.000
		N/C: δ = 0.000

Torque Map Filename:	TM_L10_781_51445_TM5_091814_0930_TMrept		
Ref Cycle Name:	781_L10_C15_NRTCx4_CMD_9_18_2014		
CMD Cycle Name:	781_NRTC_CMD_9_18_2014		
Idle Speed	650 [rpm]	CITT	0 ft-lb
Transmission Type:	Manual	Cycle Length	1237.9 [s]

Ref Cycle Work	59.59 hp-hr	44.43 kW-hr	
Cycle Work	58.10 hp-hr	43.33 kW-hr	-2.5%

Barometer (ave)	98.3 kPaA		
Intake Air Humidity (ave)	12.0 g/kg	Kh_cfr1065_ci	1.020
Dilution Air Humidity (ave)	13.4 g/kg		
Total Flow	82657 mol	Primary Filter	4630
Total PM Flow	9.7 mol	PM Filter Media	47MM-PTFE-WHATMAN
		Filter Weight Gain	1.199 mg

Drift Corrected Gaseous Emissions Results:

PM	10.178 [g]	0.175 [g/hp-hr]	0.235 [g/kW-hr]
CO	319.9 [g]	5.506 [g/hp-hr]	7.38 [g/kW-hr]
CO2	37122 [g]	639 [g/hp-hr]	857 [g/kW-hr]
THC	16.15 [g]	0.278 [g/hp-hr]	0.373 [g/kW-hr]
NMHC*	15.83 [g]	0.272 [g/hp-hr]	0.365 [g/kW-hr]
NOx	110.94 [g]	1.909 [g/hp-hr]	2.560 [g/kW-hr]
NMHC+NOx	126.8 [g]	2.182 [g/hp-hr]	2.926 [g/kW-hr]
Fuel CB	11.835 [kg]	0.449 [lb/hp-hr]	273 [g/kW-hr]
Fuel Measured	11.853 [kg]	0.450 [lb/hp-hr]	274 [g/kW-hr]

Statistical Criteria:	40CFR1065	Statistics Validation:	N_MTS	2084 rpm
Drop Points:	T_P PTS AT WOT	PASS	Tmax	1859 ft-lb
Time Delay =	0.5 [sec]		Pmax	481 hp
Cycle Statistics	Speed Limit	Torque Limit	Power Limit	
	Value	Value	Limit	Value
SEE	<5.0% of MTS 2.9	<10%Tmax 6.1	< 10%Pmax	6.2
R2	>0.970 0.979	>0.850 0.905	>0.910	0.941
M	0.950<M<1.030 0.984	0.830<a1<1.030 0.954	0.830<M<1.030	0.968
B	<10% of IDLE 5.1	<2.0%Tmax 1.0	<2.0%Pmax	0.7
# of Points	1238	1199		1199

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*NMHC Method: m_nmhc_0.98thc

Date	10/6/2014	 Intertek AR 5404 Bandera Road San Antonio, TX 78238
Time / Eng Hrs at Start	12:04:35 PM 217.6 hrs	
Cell	L10	
Engine Model:	Caterpillar C15	
Engine SN:	BSX08383	
Fuel:	#2 Diesel	Exhaust Flow Method: dil: ntot1
File Name:	847D_L10_C15_51445_NRTC_100614_Report.xlsm	Calculations: 40CFR1065
Cycle Type	NRTC	PM Sample = CVS
Notes:	Fuel Additive Mixture	H/C: α = 1.800
		O/C: β = 0.000
		Su/C: γ = 0.000
		N/C: δ = 0.000

Torque Map Filename:	TM_L10_781_51445_TM5_091814_0930_TMrept		
Ref Cycle Name:	781_L10_C15_NRTCx4_CMD_9_18_2014		
CMD Cycle Name:	781_NRTC_CMD_9_18_2014		
Idle Speed	650 [rpm]	CITT	0 ft-lb
Transmission Type:	Manual	Cycle Length	1237.9 [s]

Ref Cycle Work	59.59 hp-hr	44.43 kW-hr	
Cycle Work	58.04 hp-hr	43.28 kW-hr	-2.6%

Barometer (ave)	98.3 kPaA		
Intake Air Humidity (ave)	12.0 g/kg	Kh_cfr1065_ci	1.020
Dilution Air Humidity (ave)	12.7 g/kg		
Total Flow	82663 mol	Primary Filter	4631
Total PM Flow	9.7 mol	PM Filter Media	47MM-PTFE-WHATMAN
		Filter Weight Gain	1.220 mg

Drift Corrected Gaseous Emissions Results:

PM	10.353 [g]	0.178 [g/hp-hr]	0.239 [g/kW-hr]
CO	316.5 [g]	5.453 [g/hp-hr]	7.31 [g/kW-hr]
CO2	37125 [g]	640 [g/hp-hr]	858 [g/kW-hr]
THC	16.24 [g]	0.280 [g/hp-hr]	0.375 [g/kW-hr]
NMHC*	15.92 [g]	0.274 [g/hp-hr]	0.368 [g/kW-hr]
NOx	111.93 [g]	1.928 [g/hp-hr]	2.586 [g/kW-hr]
NMHC+NOx	127.8 [g]	2.203 [g/hp-hr]	2.954 [g/kW-hr]
Fuel CB	11.835 [kg]	0.450 [lb/hp-hr]	273 [g/kW-hr]
Fuel Measured	11.842 [kg]	0.450 [lb/hp-hr]	274 [g/kW-hr]

Statistical Criteria:		40CFR1065	Statistics Validation:		N_MTS	2084 rpm
Drop Points:		T_P PTS AT WOT	PASS		Tmax	1859 ft-lb
Time Delay =		0.5 [sec]			Pmax	481 hp
Cycle Statistics	Speed Limit	Value	Torque Limit	Value	Power Limit	Value
SEE	<5.0% of MTS	3.3	<10%Tmax	6.5	< 10%Pmax	6.4
R2	>0.970	0.973	>0.850	0.890	>0.910	0.935
M	0.950<M<1.030	0.979	0.830<a1<1.030	0.927	0.830<M<1.030	0.954
B	<10% of IDLE	6.3	<2.0%Tmax	1.7	<2.0%Pmax	1.2
# of Points		1238		1202		1202

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*NMHC Method: m_nmhc_0.98thc

Date	10/6/2014	 Intertek AR 5404 Bandera Road San Antonio, TX 78238
Time / Eng Hrs at Start	1:27:35 PM 218.4 hrs	
Cell	L10	
Engine Model:	Caterpillar C15	
Engine SN:	BSX08383	
Fuel:	#2 Diesel	Exhaust Flow Method: dil: ntot1
File Name:	848B_L10_C15_51445_RMC_C1_100614_Report.xlsm	Calculations: 40CFR1065
Cycle Type	RMC C1	PM Sample = CVS
Notes:	Fuel Additive Mixture	H/C: α = 1.800
		O/C: β = 0.000
		Su/C: γ = 0.000
		N/C: δ = 0.000

Torque Map Filename:	TM_L10_781_51445_TM5_091814_0930_TMrept		
Ref Cycle Name:	781_L10_C15_RMC_C1x4_CMD_9_18_2014		
CMD Cycle Name:	781_RMC-C1_CMD_9_18_2014		
Idle Speed	650 [rpm]	CITT	0 ft-lb
Transmission Type:	Manual	Cycle Length	1800.0 [s]

Ref Cycle Work	125.85 hp-hr	93.85 kW-hr	
Cycle Work	124.06 hp-hr	92.51 kW-hr	-1.4%

Barometer (ave)	98.2 kPaA		
Intake Air Humidity (ave)	12.0 g/kg	Kh_cfr1065_ci	1.020
Dilution Air Humidity (ave)	12.2 g/kg		
Total Flow	119874 mol	Primary Filter	4632
Total PM Flow	9.1 mol	PM Filter Media	47MM-PTFE-WHATMAN
		Filter Weight Gain	1.262 mg

Drift Corrected Gaseous Emissions Results:

PM	16.679 [g]	0.134 [g/hp-hr]	0.180 [g/kW-hr]
CO	220.7 [g]	1.779 [g/hp-hr]	2.39 [g/kW-hr]
CO2	73852 [g]	595 [g/hp-hr]	798 [g/kW-hr]
THC	16.15 [g]	0.130 [g/hp-hr]	0.175 [g/kW-hr]
NMHC*	15.82 [g]	0.128 [g/hp-hr]	0.171 [g/kW-hr]
NOx	299.39 [g]	2.413 [g/hp-hr]	3.236 [g/kW-hr]
NMHC+NOx	315.2 [g]	2.541 [g/hp-hr]	3.407 [g/kW-hr]
Fuel CB	23.325 [kg]	0.414 [lb/hp-hr]	252 [g/kW-hr]
Fuel Measured	23.401 [kg]	0.416 [lb/hp-hr]	253 [g/kW-hr]

Statistical Criteria:	40CFR1065	Statistics Validation:	N_MTS	2084 rpm
Drop Points:	T_P PTS AT WOT	PASS	Tmax	1859 ft-lb
Time Delay =	0.5 [sec]		Pmax	481 hp
Cycle Statistics	Speed Limit	Torque Limit	Power Limit	
	Value	Value	Value	
SEE	<5.0% of MTS 0.3	<10%Tmax 1.4	< 10%Pmax 1.5	
R2	>0.970 1.000	>0.850 0.998	>0.910 0.998	
M	0.950<M<1.030 1.000	0.830<a1<1.030 0.974	0.830<M<1.030 0.968	
B	<10% of IDLE 0.1	<2.0%Tmax 0.5	<2.0%Pmax 0.9	
# of Points	1800	1800	1800	

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*NMHC Method: m_nmhc_0.98thc

Date	10/6/2014
Time / Eng Hrs at Start	1:58:35 PM 218.9 hrs
Cell	L10
Engine Model:	Caterpillar C15
Engine SN:	BSX08383
Fuel:	#2 Diesel
File Name:	848C_L10_C15_51445_RMC_C1_100614_Report.xlsm
Cycle Type	RMC C1
Notes:	Fuel Additive Mixture



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Exhaust Flow Method: dil: ntot1

Calculations: 40CFR1065

PM Sample = CVS

Torque Map Filename:	TM_L10_781_51445_TM5_091814_0930_TMrept		
Ref Cycle Name:	781_L10_C15_RMC_C1x4_CMD_9_18_2014		
CMD Cycle Name:	781_RMC-C1_CMD_9_18_2014		
Idle Speed	650 [rpm]	CITT	0 ft-lb
Transmission Type:	Manual	Cycle Length	1800.0 [s]

Ref Cycle Work	125.85 hp-hr	93.85 kW-hr	
Cycle Work	124.18 hp-hr	92.60 kW-hr	-1.3%

Barometer (ave)	98.2 kPaA		
Intake Air Humidity (ave)	12.0 g/kg	Kh_cfr1065_ci	1.020
Dilution Air Humidity (ave)	11.8 g/kg		
Total Flow	119844 mol	Primary Filter	4633
Total PM Flow	9.1 mol	PM Filter Media	47MM-PTFE-WHATMAN
		Filter Weight Gain	1.312 mg

Drift Corrected Gaseous Emissions Results:

PM	17.338 [g]	0.140 [g/hp-hr]	0.187 [g/kW-hr]
CO	225.2 [g]	1.813 [g/hp-hr]	2.43 [g/kW-hr]
CO2	73816 [g]	594 [g/hp-hr]	797 [g/kW-hr]
THC	16.60 [g]	0.134 [g/hp-hr]	0.179 [g/kW-hr]
NMHC*	16.27 [g]	0.131 [g/hp-hr]	0.176 [g/kW-hr]
NOx	300.24 [g]	2.418 [g/hp-hr]	3.242 [g/kW-hr]
NMHC+NOx	316.5 [g]	2.549 [g/hp-hr]	3.418 [g/kW-hr]
Fuel CB	23.316 [kg]	0.414 [lb/hp-hr]	252 [g/kW-hr]
Fuel Measured	23.400 [kg]	0.415 [lb/hp-hr]	253 [g/kW-hr]

Statistical Criteria:		40CFR1065	Statistics Validation:		N_MTS	2084 rpm
Drop Points:		T_P PTS AT WOT	PASS		Tmax	1859 ft-lb
Time Delay =		0.5 [sec]			Pmax	481 hp
Cycle Statistics	Speed Limit	Value	Torque Limit	Value	Power Limit	Value
SEE	<5.0% of MTS	0.2	<10%Tmax	1.4	< 10%Pmax	1.5
R2	>0.970	1.000	>0.850	0.997	>0.910	0.998
M	0.950<M<1.030	1.000	0.830<a1<1.030	0.974	0.830<M<1.030	0.970
B	<10% of IDLE	0.0	<2.0%Tmax	0.5	<2.0%Pmax	0.9
# of Points		1800		1800		1800

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*NMHC Method: m_nmhc_0.98thc

Date	10/6/2014
Time / Eng Hrs at Start	2:29:35 PM 219.4 hrs
Cell	L10
Engine Model:	Caterpillar C15
Engine SN:	BSX08383
Fuel:	#2 Diesel
File Name:	848D_L10_C15_51445_RMC_C1_100614_Report.xlsm
Cycle Type	RMC C1
Notes:	Fuel Additive Mixture



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Exhaust Flow Method: dil: ntot1

Calculations: 40CFR1065

PM Sample = CVS

Torque Map Filename:	TM_L10_781_51445_TM5_091814_0930_TMrept		
Ref Cycle Name:	781_L10_C15_RMC_C1x4_CMD_9_18_2014		
CMD Cycle Name:	781_RMC-C1_CMD_9_18_2014		
Idle Speed	650 [rpm]	CITT	0 ft-lb
Transmission Type:	Manual	Cycle Length	1799.9 [s]

Ref Cycle Work	125.85 hp-hr	93.85 kW-hr	
Cycle Work	124.08 hp-hr	92.52 kW-hr	-1.4%

Barometer (ave)	98.2 kPaA		
Intake Air Humidity (ave)	12.0 g/kg	Kh_cfr1065_ci	1.020
Dilution Air Humidity (ave)	11.5 g/kg		
Total Flow	119858 mol	Primary Filter	4634
Total PM Flow	9.1 mol	PM Filter Media	47MM-PTFE-WHATMAN
		Filter Weight Gain	1.306 mg

Drift Corrected Gaseous Emissions Results:

PM	17.265 [g]	0.139 [g/hp-hr]	0.187 [g/kW-hr]
CO	224.2 [g]	1.807 [g/hp-hr]	2.42 [g/kW-hr]
CO2	73749 [g]	594 [g/hp-hr]	797 [g/kW-hr]
THC	16.56 [g]	0.133 [g/hp-hr]	0.179 [g/kW-hr]
NMHC*	16.23 [g]	0.131 [g/hp-hr]	0.175 [g/kW-hr]
NOx	300.85 [g]	2.425 [g/hp-hr]	3.252 [g/kW-hr]
NMHC+NOx	317.1 [g]	2.556 [g/hp-hr]	3.427 [g/kW-hr]
Fuel CB	23.294 [kg]	0.414 [lb/hp-hr]	252 [g/kW-hr]
Fuel Measured	23.389 [kg]	0.416 [lb/hp-hr]	253 [g/kW-hr]

Statistical Criteria:	40CFR1065	Statistics Validation:	N_MTS	2084 rpm
Drop Points:	T_P PTS AT WOT	PASS	Tmax	1859 ft-lb
Time Delay =	0.5 [sec]		Pmax	481 hp
Cycle Statistics	Speed Limit	Torque Limit	Power Limit	
	Value	Value	Value	
SEE	<5.0% of MTS0.3	<10%Tmax1.4	< 10%Pmax1.5	
R2	>0.9701.000	>0.8500.997	>0.9100.998	
M	0.950<M<1.0301.000	0.830<a1<1.0300.974	0.830<M<1.0300.969	
B	<10% of IDLE0.0	<2.0%Tmax0.5	<2.0%Pmax0.9	
# of Points	1800	1800	1800	

Last Saved: 10/17/2014 10:37

*NMHC Method: m_nmhc_0.98thc

Date	10/6/2014	 Intertek AR 5404 Bandera Road San Antonio, TX 78238
Time / Eng Hrs at Start	4:28:52 PM 220.7 hrs	
Cell	L10	
Engine Model:	Caterpillar C15	
Engine SN:	BSX08383	
Fuel:	#2 Diesel	Exhaust Flow Method: dil: ntot1
File Name:	850B_L10_C15_51445_NRTC_100614_Report.xlsm	Calculations: 40CFR1065
Cycle Type	NRTC	PM Sample = CVS
Notes:	Baseline Fuel	H/C: α = 1.800
		O/C: β = 0.000
		Su/C: γ = 0.000
		N/C: δ = 0.000

Torque Map Filename:	TM_L10_781_51445_TM5_091814_0930_TMrept		
Ref Cycle Name:	781_L10_C15_NRTCx4_CMD_9_18_2014		
CMD Cycle Name:	781_NRTC_CMD_9_18_2014		
Idle Speed	650 [rpm]	CITT	0 ft-lb
Transmission Type:	Manual	Cycle Length	1237.8 [s]

Ref Cycle Work	59.59 hp-hr	44.43 kW-hr	
Cycle Work	58.07 hp-hr	43.31 kW-hr	-2.5%

Barometer (ave)	98.1 kPaA		
Intake Air Humidity (ave)	12.0 g/kg	Kh_cfr1065_ci	1.020
Dilution Air Humidity (ave)	11.5 g/kg		
Total Flow	82555 mol	Primary Filter	4635
Total PM Flow	9.7 mol	PM Filter Media	47MM-PTFE-WHATMAN
		Filter Weight Gain	1.132 mg

Drift Corrected Gaseous Emissions Results:

PM	9.600 [g]	0.165 [g/hp-hr]	0.222 [g/kW-hr]
CO	298.7 [g]	5.143 [g/hp-hr]	6.90 [g/kW-hr]
CO2	37127 [g]	639 [g/hp-hr]	857 [g/kW-hr]
THC	15.56 [g]	0.268 [g/hp-hr]	0.359 [g/kW-hr]
NMHC*	15.25 [g]	0.263 [g/hp-hr]	0.352 [g/kW-hr]
NOx	118.79 [g]	2.046 [g/hp-hr]	2.743 [g/kW-hr]
NMHC+NOx	134.0 [g]	2.308 [g/hp-hr]	3.095 [g/kW-hr]
Fuel CB	11.826 [kg]	0.449 [lb/hp-hr]	273 [g/kW-hr]
Fuel Measured	11.873 [kg]	0.451 [lb/hp-hr]	274 [g/kW-hr]

Statistical Criteria:		40CFR1065	Statistics Validation:		N_MTS	2084 rpm
Drop Points:		T_P PTS AT WOT	PASS		Tmax	1859 ft-lb
Time Delay =		0.4 [sec]			Pmax	481 hp
Cycle Statistics	Speed Limit	Value	Torque Limit	Value	Power Limit	Value
SEE	<5.0% of MTS	2.9	<10%Tmax	6.2	< 10%Pmax	6.3
R2	>0.970	0.979	>0.850	0.900	>0.910	0.938
M	0.950<M<1.030	0.983	0.830<a1<1.030	0.938	0.830<M<1.030	0.957
B	<10% of IDLE	5.2	<2.0%Tmax	1.4	<2.0%Pmax	1.0
# of Points		1238		1199		1199

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*NMHC Method: m_nmhc_0.98thc

Date	10/6/2014
Time / Eng Hrs at Start	4:50:29 PM 221.0 hrs
Cell	L10
Engine Model:	Caterpillar C15
Engine SN:	BSX08383
Fuel:	#2 Diesel
File Name:	850C_L10_C15_51445_NRTC_100614_Report.xlsm
Cycle Type	NRTC
Notes:	Baseline Fuel



Intertek AR
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San Antonio, TX 78238

Exhaust Flow Method: dil: ntot1

Calculations: 40CFR1065

PM Sample = CVS

Torque Map Filename:	TM_L10_781_51445_TM5_091814_0930_TMrept		
Ref Cycle Name:	781_L10_C15_NRTCx4_CMD_9_18_2014		
CMD Cycle Name:	781_NRTC_CMD_9_18_2014		
Idle Speed	650 [rpm]	CITT	0 ft-lb
Transmission Type:	Manual	Cycle Length	1237.9 [s]

Ref Cycle Work	59.59 hp-hr	44.43 kW-hr	
Cycle Work	58.09 hp-hr	43.32 kW-hr	-2.5%

Barometer (ave)	98.1 kPaA		
Intake Air Humidity (ave)	12.0 g/kg	Kh_cfr1065_ci	1.020
Dilution Air Humidity (ave)	11.4 g/kg		
Total Flow	82549 mol	Primary Filter	4636
Total PM Flow	9.7 mol	PM Filter Media	47MM-PTFE-WHATMAN
		Filter Weight Gain	1.177 mg

Drift Corrected Gaseous Emissions Results:

PM	9.978 [g]	0.172 [g/hp-hr]	0.230 [g/kW-hr]
CO	301.2 [g]	5.185 [g/hp-hr]	6.95 [g/kW-hr]
CO2	37084 [g]	638 [g/hp-hr]	856 [g/kW-hr]
THC	16.06 [g]	0.276 [g/hp-hr]	0.371 [g/kW-hr]
NMHC*	15.74 [g]	0.271 [g/hp-hr]	0.363 [g/kW-hr]
NOx	118.33 [g]	2.037 [g/hp-hr]	2.732 [g/kW-hr]
NMHC+NOx	134.1 [g]	2.308 [g/hp-hr]	3.095 [g/kW-hr]
Fuel CB	11.814 [kg]	0.448 [lb/hp-hr]	273 [g/kW-hr]
Fuel Measured	11.863 [kg]	0.450 [lb/hp-hr]	274 [g/kW-hr]

Statistical Criteria:	40CFR1065	Statistics Validation:	N_MTS	2084 rpm
Drop Points:	T_P PTS AT WOT	PASS	Tmax	1859 ft-lb
Time Delay =	0.5 [sec]		Pmax	481 hp

Cycle Statistics	Speed Limit	Value	Torque Limit	Value	Power Limit	Value
SEE	<5.0% of MTS	2.7	<10%Tmax	6.2	<10%Pmax	6.3
R2	>0.970	0.982	>0.850	0.904	>0.910	0.938
M	0.950<M<1.030	0.987	0.830<a1<1.030	0.956	0.830<M<1.030	0.967
B	<10% of IDLE	4.3	<2.0%Tmax	1.0	<2.0%Pmax	0.8
# of Points		1238		1194		1194

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*NMHC Method: m_nmhc_0.98thc

Date	10/6/2014	
Time / Eng Hrs at Start	5:12:07 PM	221.4 hrs
Cell	L10	
Engine Model:	Caterpillar C15	
Engine SN:	BSX08383	
Fuel:	#2 Diesel	H/C: α = 1.800
File Name:	850D_L10_C15_51445_NRTC_100614_Report.xlsm	O/C: β = 0.000
Cycle Type	NRTC	Su/C: γ = 0.000
Notes:	Baseline Fuel	N/C: δ = 0.000



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Exhaust Flow Method: dil: ntot1

Calculations: 40CFR1065

PM Sample = CVS

Torque Map Filename:	TM_L10_781_51445_TM5_091814_0930_TMrept		
Ref Cycle Name:	781_L10_C15_NRTCx4_CMD_9_18_2014		
CMD Cycle Name:	781__NRTC_CMD_9_18_2014		
Idle Speed	650 [rpm]	CITT	0 ft-lb
Transmission Type:	Manual	Cycle Length	1237.9 [s]

Ref Cycle Work	59.59 hp-hr	44.43 kW-hr	
Cycle Work	58.06 hp-hr	43.30 kW-hr	-2.6%

Barometer (ave)	98.1 kPaA		
Intake Air Humidity (ave)	12.0 g/kg	Kh_cfr1065_ci	1.020
Dilution Air Humidity (ave)	11.3 g/kg		
Total Flow	82540 mol	Primary Filter	4637
Total PM Flow	9.7 mol	PM Filter Media	47MM-PTFE-WHATMAN
		Filter Weight Gain	1.209 mg

Drift Corrected Gaseous Emissions Results:

PM	10.250 [g]	0.177 [g/hp-hr]	0.237 [g/kW-hr]
CO	304.2 [g]	5.239 [g/hp-hr]	7.03 [g/kW-hr]
CO2	37040 [g]	638 [g/hp-hr]	855 [g/kW-hr]
THC	16.35 [g]	0.282 [g/hp-hr]	0.378 [g/kW-hr]
NMHC*	16.02 [g]	0.276 [g/hp-hr]	0.370 [g/kW-hr]
NOx	117.28 [g]	2.020 [g/hp-hr]	2.709 [g/kW-hr]
NMHC+NOx	133.3 [g]	2.296 [g/hp-hr]	3.079 [g/kW-hr]
Fuel CB	11.802 [kg]	0.448 [lb/hp-hr]	273 [g/kW-hr]
Fuel Measured	11.852 [kg]	0.450 [lb/hp-hr]	274 [g/kW-hr]

Statistical Criteria:		40CFR1065	Statistics Validation:		N_MTS	2084 rpm
Drop Points:		T_P PTS AT WOT	PASS		Tmax	1859 ft-lb
Time Delay =		0.5 [sec]			Pmax	481 hp
Cycle Statistics	Speed Limit	Value	Torque Limit	Value	Power Limit	Value
SEE	<5.0% of MTS	2.6	<10%Tmax	6.4	< 10%Pmax	6.6
R2	>0.970	0.984	>0.850	0.896	>0.910	0.931
M	0.950<M<1.030	0.988	0.830<a1<1.030	0.949	0.830<M<1.030	0.958
B	<10% of IDLE	4.0	<2.0%Tmax	1.1	<2.0%Pmax	1.0
# of Points		1238		1198		1198

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*NMHC Method: m_nmhc_0.98thc

Date	10/7/2014
Time / Eng Hrs at Start	11:05:32 AM 222.6 hrs
Cell	L10
Engine Model:	Caterpillar C15
Engine SN:	BSX08383
Fuel:	#2 Diesel
File Name:	851B_L10_C15_51445_RMC_C1_100714_Report.xlsm
Cycle Type	RMC C1
Notes:	Baseline Fuel



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San Antonio, TX 78238

Exhaust Flow Method: dil: ntot1

Calculations: 40CFR1065

PM Sample = CVS

Torque Map Filename:	TM_L10_781_51445_TM5_091814_0930_TMrept		
Ref Cycle Name:	781_L10_C15_RMC_C1x4_CMD_9_18_2014		
CMD Cycle Name:	781_RMC-C1_CMD_9_18_2014		
Idle Speed	650 [rpm]	CITT	0 ft-lb
Transmission Type:	Manual	Cycle Length	1799.9 [s]

Ref Cycle Work	125.85 hp-hr	93.85 kW-hr	
Cycle Work	124.07 hp-hr	92.52 kW-hr	-1.4%

Barometer (ave)	98.6 kPaA		
Intake Air Humidity (ave)	12.0 g/kg	Kh_cfr1065_ci	1.020
Dilution Air Humidity (ave)	13.0 g/kg		
Total Flow	120093 mol	Primary Filter	4638
Total PM Flow	9.1 mol	PM Filter Media	47MM-PTFE-WHATMAN
		Filter Weight Gain	1.235 mg

Drift Corrected Gaseous Emissions Results:

PM	16.363 [g]	0.132 [g/hp-hr]	0.177 [g/kW-hr]
CO	226.0 [g]	1.822 [g/hp-hr]	2.44 [g/kW-hr]
CO2	73977 [g]	596 [g/hp-hr]	800 [g/kW-hr]
THC	17.70 [g]	0.143 [g/hp-hr]	0.191 [g/kW-hr]
NMHC*	17.34 [g]	0.140 [g/hp-hr]	0.187 [g/kW-hr]
NOx	292.92 [g]	2.361 [g/hp-hr]	3.166 [g/kW-hr]
NMHC+NOx	310.3 [g]	2.501 [g/hp-hr]	3.354 [g/kW-hr]
Fuel CB	23.368 [kg]	0.415 [lb/hp-hr]	253 [g/kW-hr]
Fuel Measured	23.388 [kg]	0.416 [lb/hp-hr]	253 [g/kW-hr]

Statistical Criteria:		40CFR1065	Statistics Validation:		N_MTS	2084 rpm
Drop Points:		T_P PTS AT WOT	PASS		Tmax	1859 ft-lb
Time Delay =		0.5 [sec]			Pmax	481 hp
Cycle Statistics	Speed Limit	Value	Torque Limit	Value	Power Limit	Value
SEE	<5.0% of MTS	0.2	<10%Tmax	1.4	< 10%Pmax	1.6
R2	>0.970	1.000	>0.850	0.997	>0.910	0.998
M	0.950<M<1.030	1.000	0.830<a1<1.030	0.975	0.830<M<1.030	0.969
B	<10% of IDLE	0.0	<2.0%Tmax	0.5	<2.0%Pmax	0.9
# of Points		1800		1800		1800

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*NMHC Method: m_nmhc_0.98thc

Date	10/7/2014
Time / Eng Hrs at Start	11:36:32 AM 223.2 hrs
Cell	L10
Engine Model:	Caterpillar C15
Engine SN:	BSX08383
Fuel:	#2 Diesel
File Name:	851C_L10_C15_51445_RMC_C1_100714_Report.xlsm
Cycle Type	RMC C1
Notes:	Baseline Fuel



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Exhaust Flow Method: dil: ntot1

Calculations: 40CFR1065

PM Sample = CVS

Torque Map Filename:	TM_L10_781_51445_TM5_091814_0930_TMrept		
Ref Cycle Name:	781_L10_C15_RMC_C1x4_CMD_9_18_2014		
CMD Cycle Name:	781_RMC-C1_CMD_9_18_2014		
Idle Speed	650 [rpm]	CITT	0 ft-lb
Transmission Type:	Manual	Cycle Length	1799.9 [s]

Ref Cycle Work	125.85 hp-hr	93.85 kW-hr	
Cycle Work	124.01 hp-hr	92.48 kW-hr	-1.5%

Barometer (ave)	98.6 kPaA		
Intake Air Humidity (ave)	12.0 g/kg	Kh_cfr1065_ci	1.020
Dilution Air Humidity (ave)	12.9 g/kg		
Total Flow	120013 mol	Primary Filter	4639
Total PM Flow	9.1 mol	PM Filter Media	47MM-PTFE-WHATMAN
		Filter Weight Gain	1.317 mg

Drift Corrected Gaseous Emissions Results:

PM	17.424 [g]	0.141 [g/hp-hr]	0.188 [g/kW-hr]
CO	225.2 [g]	1.816 [g/hp-hr]	2.44 [g/kW-hr]
CO2	73832 [g]	595 [g/hp-hr]	798 [g/kW-hr]
THC	17.70 [g]	0.143 [g/hp-hr]	0.191 [g/kW-hr]
NMHC*	17.34 [g]	0.140 [g/hp-hr]	0.188 [g/kW-hr]
NOx	295.15 [g]	2.380 [g/hp-hr]	3.192 [g/kW-hr]
NMHC+NOx	312.5 [g]	2.520 [g/hp-hr]	3.379 [g/kW-hr]
Fuel CB	23.322 [kg]	0.415 [lb/hp-hr]	252 [g/kW-hr]
Fuel Measured	23.381 [kg]	0.416 [lb/hp-hr]	253 [g/kW-hr]

Statistical Criteria:	40CFR1065	Statistics Validation:	N_MTS	2084 rpm
Drop Points:	T_P PTS AT WOT	PASS	Tmax	1859 ft-lb
Time Delay =	0.5 [sec]		Pmax	481 hp
Cycle Statistics	Speed Limit	Torque Limit	Power Limit	
	Value	Value	Value	
SEE	<5.0% of MTS 0.2	<10%Tmax 1.4	< 10%Pmax 1.5	
R2	>0.970 1.000	>0.850 0.997	>0.910 0.998	
M	0.950<M<1.030 1.000	0.830<a1<1.030 0.973	0.830<M<1.030 0.968	
B	<10% of IDLE 0.0	<2.0%Tmax 0.5	<2.0%Pmax 0.9	
# of Points	1800	1800	1800	

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*NMHC Method: m_nmhc_0.98thc

Date	10/8/2014
Time / Eng Hrs at Start	4:22:01 PM 225.2 hrs
Cell	L10
Engine Model:	Caterpillar C15
Engine SN:	BSX08383
Fuel:	#2 Diesel
File Name:	853B_L10_C15_51445_RMC_C1_100814_Report.xlsm
Cycle Type	RMC C1
Notes:	Baseline Fuel



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Exhaust Flow Method: dil: ntot1

Calculations: 40CFR1065

PM Sample = CVS

Torque Map Filename:	TM_L10_781_51445_TM5_091814_0930_TMrept		
Ref Cycle Name:	781_L10_C15_RMC_C1x4_CMD_9_18_2014		
CMD Cycle Name:	781_RMC-C1_CMD_9_18_2014		
Idle Speed	650 [rpm]	CITT	0 ft-lb
Transmission Type:	Manual	Cycle Length	1800.0 [s]

Ref Cycle Work	125.85 hp-hr	93.85 kW-hr	
Cycle Work	124.15 hp-hr	92.58 kW-hr	-1.3%

Barometer (ave)	98.4 kPaA		
Intake Air Humidity (ave)	12.0 g/kg	Kh_cfr1065_ci	1.021
Dilution Air Humidity (ave)	11.0 g/kg		
Total Flow	119986 mol	Primary Filter	4641
Total PM Flow	9.1 mol	PM Filter Media	47MM-PTFE-WHATMAN
		Filter Weight Gain	1.201 mg

Drift Corrected Gaseous Emissions Results:

PM	15.898 [g]	0.128 [g/hp-hr]	0.172 [g/kW-hr]
CO	220.3 [g]	1.775 [g/hp-hr]	2.38 [g/kW-hr]
CO2	73725 [g]	594 [g/hp-hr]	796 [g/kW-hr]
THC	15.87 [g]	0.128 [g/hp-hr]	0.171 [g/kW-hr]
NMHC*	15.56 [g]	0.125 [g/hp-hr]	0.168 [g/kW-hr]
NOx	304.26 [g]	2.451 [g/hp-hr]	3.286 [g/kW-hr]
NMHC+NOx	319.8 [g]	2.576 [g/hp-hr]	3.454 [g/kW-hr]
Fuel CB	23.284 [kg]	0.413 [lb/hp-hr]	252 [g/kW-hr]
Fuel Measured	23.388 [kg]	0.415 [lb/hp-hr]	253 [g/kW-hr]

Statistical Criteria:		40CFR1065	Statistics Validation:		N_MTS	2084 rpm
Drop Points:		T_P PTS AT WOT	PASS		Tmax	1859 ft-lb
Time Delay =		0.5 [sec]			Pmax	481 hp
Cycle Statistics	Speed Limit	Value	Torque Limit	Value	Power Limit	Value
SEE	<5.0% of MTS	0.3	<10%Tmax	1.4	< 10%Pmax	1.5
R2	>0.970	1.000	>0.850	0.998	>0.910	0.998
M	0.950<M<1.030	1.000	0.830<a1<1.030	0.976	0.830<M<1.030	0.970
B	<10% of IDLE	0.1	<2.0%Tmax	0.5	<2.0%Pmax	0.9
# of Points		1800		1800		1800

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*NMHC Method: m_nmhc_0.98thc