Fuel Factor XFuel Catalyst Evaluation
For
Fuel Efficiency and Emissions Reductions
With
Logan City Environmental Department
Utilizing
The Carbon Mass Balance Test Procedure

Final Report
March 2011

Prepared by:

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For

MyDailyChoice Inc.

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WHAT IS
THE
CARBON BALANCE TEST PROCEDURE?

PREFACE

Fuel consumption measurements by reliable and accredited methods have been under constant review for many years. The weight of engineering evidence and scientific theory favors the carbon balance method by which carbon measured in the engine exhaust gas is related to the carbon content of the fuel consumed. This method has certainly proven to be the most suitable for field-testing where minimizing equipment down time is a factor.

The inquiries of accuracy and reliability to which we refer include discussions from international commonwealth and government agencies responsible for the test procedure discussed herein. This procedure enumerates the data required for fuel consumption measurements by the "carbon balance" or "exhaust gas analysis" method. The studies conducted show that the carbon balance has been found to be a more precise fuel consumption test method than the alternative volumetric-gravimetric methods.

The carbon balance test is a fundamental part of the Australian Standards **AS2077-1982**. Further, the carbon balance test procedure has proven to be an intricate part of the United States EPA, FTP, HFET Fuel Economy Tests and the CARB 511 test procedure. Also, Ford Motor Company characterized the Carbon Balance test procedure as being "at least as accurate as any other method of volumetric-gravimetric testing." (**SAE Paper No. 750002 Bruce Simpson, Ford Motor Company**) Finally, the Carbon Balance procedure is incorporated in the Federal Register Voluntary Fuel Economy Labeling Program, Volume 39.

The following photographic report captures a few of the applicable steps necessary for conducting a reliable and accurate carbon balance test. As will be documented, every effort is made to insure that each test is consistent, repeatable, and precise. More importantly, it will be even clearer as to why the Carbon Balance Test has such a high degree of acceptance and reliability.

EXECUTIVE SUMMARY

The Fuel Factor X a fuel borne catalyst manufactured and marketed by MyDailyChoice Inc. is a fuel borne catalyst wherein the primary active ingredient is a soluble organo-metallic chemistry that helps to reduce ignition delay by improving combustion chamber mixing through improved molecular dispersion.

The catalyst is comprised of a proprietary organo-metallic compound with the formula $Fe(C_5H_5)_2$. It is the prototypical metallocene, a type of organo-metallic chemical compound consisting of two cyclopentadienyl rings bound on opposite sides of a central soluble metal atom. Such organo-metallic compounds are also known as sandwich compounds. The rapid growth of organo-metallic chemistry is often attributed to the novelty arising from the discovery of the soluble metal crystalline structure and its many analogues.

The proprietary organo-metallic derivative has many niche uses that exploit the unusual structure (ligand scaffolds, pharmaceutical candidates), robustness (anti-knock formulations, precursors to materials), and redox (reagents and redox standards). Such organo-metallic components and its derivatives are antiknock agents used in the fuel for gasoline and diesel engines; they are safer than tetraethyl lead, previously used. The harmless Ferric Oxide deposits formed from the catalysts organo-metallic component can form a conductive coating that assists in catalytic activation of the combustion process.

Following discussions with Chris Robinson, Fuel Factor X Representative, John Christensen, Landfill Manager and Warren Hullinger, Landfill Crew Chief, Logan City Environmental Department, it was determined that an emissions and fuel consumption analysis should be conducted utilizing at least five (5) pieces of landfill equipment. The equipment selected was a 1999 John Deere 744H Loader (unit no. 1037), a 2005 John Deere 755C Crawler (unit no. 1099), a 2005 Caterpillar 963C Crawler (unit no. 1095), a 2006 826H Caterpillar Compactor (unit no. 1165) and a 2008 Caterpillar 966H loader (unit no. 1229). Varying engine types with dissimilar accumulated operating hours were evaluated in an attempt to determine the effects of the Fuel Factor X fuel combustion catalyst on multiple engine types and emissions configurations.

Logan City Environmental Department is a landfill operation for the greater Logan Valley area. They operate approximately 25 pieces of heavy equipment, which in general, includes mostly site preparation and waste burial equipment. They currently consume approximately 20,000 gallons of fuel monthly.

Baseline tests (untreated) were conducted on January 7, 2011 using the Carbon Mass Balance test procedure after which the pre-selected test equipment was treated by hand dosing the Fuel Factor X fuel catalyst to the 4,000 gallon on-site diesel fuel storage tank located and identified in the following photograph. On March 18, 2011, the test was then repeated (Fuel Factor X treated) following the same parameters. The results are contained within this report.

The data showed that the average improvement in fuel consumption for all equipment tested was 7.7%**.** The treated engines also demonstrated a large percentage reduction in soot particulates in the range 22% and reductions in harmful exhaust related carbon fractions **(see Appendix V: Emissions Reductions Averages)**. Carbon dioxide reductions, based upon the measured reduction in fuel consumption, are also substantial.

INTRODUCTION

Baseline (untreated) fuel efficiency tests were conducted on all five pieces of equipment on January 7, 2011, employing the Carbon Mass Balance test procedure. Fuel Factor X supplied sufficient product to correctly and sufficiently hand treat the mobile equipment bulk storage tank located near the maintenance shop facility. The test equipment was then operated on Fuel Factor X catalyst treated fuel to approximate the optimal required conditioning period (approximately 300 hours) to maximize the reported benefits by using the fuel catalyst. The bulk fuel storage tank was Fuel Factor X catalyst treated by employees of Logan City Land Fill.

At the end of the engine-conditioning period (March 18, 2011), the engine tests were repeated, reproducing all engine parameters. The final results, along with the data sheets, are contained within this report.

TEST METHOD

Carbon Mass Balance (CMB) is a procedure whereby the mass of carbon in the exhaust is calculated as a measure of the fuel being burned. The elements measured in this test include the exhaust gas composition, its temperature, and the gas flow rate calculated from the differential pressure and exhaust stack cross sectional area. The Carbon Mass Balance test procedure is central to the both US-EPA (FTP and HFET) and Australian engineering standard tests (AS2077-1982). When performing field-testing we are unable to employ a chassis dynamometer so static testing procedures are utilized. It should be noted that in the case of a stationary equipment test the engine can be loaded sufficiently to demonstrate fuel consumption trends and potential.

The Carbon Mass Balance formula and equations employed in calculating the carbon flow are supplied, in part, by doctors of Combustion Engineering at the university and scientific research facility level.

The Carbon Mass Balance test procedure follows a prescribed regimen, wherein every possible detail of engine operation is monitored to ensure the accuracy of the test procedure. Cursory to performing the test, it is imperative to understand the quality of fuel utilized in the evaluation. As important, the quality of fuel must be consistent throughout the entirety of the process. If fuel specifications are not consistent, standard mathematical calculations are used to account for deviations in fuel specifications.

Fuel density and temperature tests are performed for both the baseline and treated segments of the evaluation to determine the energy content of the fuel. A .800 to .910 Precision Hydrometer, columnar flask and Raytek Minitemp are used to determine the fuel density for each prescribed segment of the evaluation.

Next, and essential to the Carbon Balance procedure, is test equipment that is mechanically sound and free from defect. Careful consideration and equipment screening is utilized to verify the mechanical stability of each piece of test equipment. Preliminary data is scrutinized to disqualify all equipment that may be mechanically suspect. Once the equipment selection process is complete, the Carbon Balance test takes only 10 to 20 minutes, per unit, to perform.

Once the decision is made to test a certain piece of equipment, pertinent engine criteria needs to be evaluated as the Carbon Mass Balance procedure continues.

When the selection process is complete, engine RPM is increased and locked in position. This allows the engine fluids, block temperature and exhaust stream gasses to stabilize. Data cannot be collected when there is irregular fluctuation in engine RPM and exhaust constituent levels. Therefore, all engine operating conditions must be stable and consistent.

A factory equipped throttle control or an individual depressing the throttle pedal to the full throttle position are implemented as a means to secure engine RPM. This provides a steady state condition in which consistent data can be collected. Should the engine RPM fluctuate erratically and uncontrollably, the test unit would be disqualified from further consideration.

Next, engine RPM and fluid temperatures are monitored throughout the Carbon Mass Balance evaluation. As important, exhaust manifold temperatures are monitored to ensure that engine combustion is consistent in all cylinders. It is imperative that the engine achieve normal operating conditions before any testing begins.

Once engine fluid levels have reached optimal operating conditions the Carbon Mass Balance study may begin. Although, for the purpose of this procedure, all test units were evaluated at full throttle, the above photograph identifies the target engine speed, on one of the test units, at full throttle (2200 RPM). It should be noted that any deviation in RPM, temperature, either fluid or exhaust, would cause this unit to be eliminated from the evaluation due to mechanical inconsistencies.

Once all of the mechanical criteria are met data acquisition can commence. It is necessary to monitor the temperature and pressure of the exhaust stream. Carbon Mass Balance data cannot be collected until the engine exhaust temperature has peaked. Exhaust temperature is monitored carefully for this reason.

Once the exhaust temperature has stabilized the test unit has reached its peak operating temperature. Exhaust temperature is critical to the completion of a successful evaluation since fluctuating temperatures identify changes in load and RPM. As previously discussed, RPM and load must remain constant during the Carbon Mass Balance study.

When all temperatures are stabilized, and the desired operating parameters are achieved it is time to insert the emissions sampling probe into the exhaust tip of each piece of equipment included in the study group. The probe has a non-dispersive head which allows for random exhaust sampling throughout the cross section of the exhaust.

While the emission-sampling probe is in place, and data is being collected, exhaust temperature and pressure are monitored throughout the entirety of the Carbon Mass Balance procedure. This photograph shows the typical location of the exhaust emissions sampling probe.

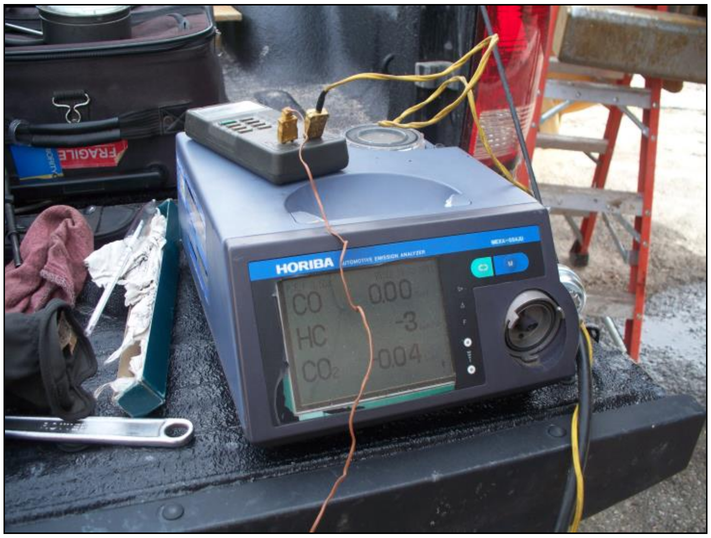
While data is being collected, exhaust pressure is monitored, once again, as a tool to control load and RPM fluctuations. Exhaust pressure is proportional to load. Therefore, as one increases, or decreases, so in turn does the other. The Carbon Mass Balance test is unique in that all parameters that have a dramatic effect on fuel consumption, in a volumetric test, are controlled and monitored throughout the entire evaluation. This ensures the accuracy of the data being collected. Exhaust pressure is nothing more than an accumulation of combustion events that are distributed through the exhaust matrix.

The above photograph shows one method in which exhaust pressure can be monitored during the Carbon Mass Balance test procedure. In this case, exhaust pressure is ascertained through the use of a Magnahelic gauge. This type of stringent regime further documents the inherent accuracy of the Carbon Mass Balance test.

The same data was collected for air inlet velocities. This procedure is utilized to ensure that engine air inlet velocities are not restricted during the course of the evaluation. This process helps to prevent an artificially lean to rich or converse performance condition.

At the conclusion of the Carbon Mass Balance test, a soot particulate test is performed to determine the engine exhaust particulate level. This valuable procedure helps to determine the soot particulate content in the exhaust stream. Soot particulates are the most obvious and compelling sign of pollution. Any attempt to reduce soot particulates places all industry in a favorable position with environmental policy and the general public.

The above photograph demonstrates a typical method in which soot particulate volume is monitored during the Carbon Mass Balance test. This method is the Bacharach Smoke Spot Test. It is extremely accurate, portable, and repeatable. It is a valuable tool in smoke spot testing when comparing baseline (untreated) exhaust to the Fuel Factor X catalyst treated exhaust.



Finally, the data being recorded is collected through a non-dispersive, infrared analyzer. Equipment such as this is EPA approved and CFR 40 rated. This analyzer has a high degree of accuracy and repeatability. It is central to the Carbon Mass Balance procedure in that it identifies baseline carbon and oxygen levels, relative to their change with the catalyst treated fuel in the exhaust stream. The data accumulated is very accurate as long as the criteria leading up to the accumulation of data is accurately controlled. For this reason, the Carbon Mass Balance test is superior to any other test method utilized. It eliminates a multitude of variables that can adversely effect the outcome and reliability of any volumetric fuel consumption evaluation.

The above photograph identifies one type of analyzer used to perform the Carbon Mass Balance test. The analyzer is calibrated with known reference gases before the baseline and treated test segments begin. The data collected from the analyzer for each segment of the evaluation is compared and computed to determine overall carbon change when compared to the carbon contained within the raw diesel fuel. A fuel consumption performance factor is then calculated from the data. The baseline performance factor is compared with the catalyst treated performance factor. The difference between the two performance factors identifies the change in fuel consumption during the Carbon Mass Balance test procedure.

Note: **The Horiba MEXA emissions analyzer is calibrated with the same reference gas for both the baseline and treated segments of the evaluation.**

Essential to performing the aforementioned test procedure is the method in which the task for dosing fuel is performed. It is critical to the success of the Carbon Mass Balance procedure to ensure that the equipment evaluated be given meticulous care and consideration to advance the process of testing. For the purpose of this evaluation, an onsite 4,000 gallon diesel fuel storage tank was treated with the Fuel Factor X fuel catalyst, wherein the equipment being evaluated during the course of the Carbon Mass Balance test procedure was fueled.

INSTRUMENTATION

Precision state of the art instrumentation was used to measure the concentrations of carbon containing gases in the exhaust stream, and other factors related to fuel consumption and engine performance. The instruments and their purpose are listed below:

> *Measurement of exhaust gas constituents HC, CO, CO_2 and O_2, by Horiba Mexa Series, four gas infrared analyser.*

Note: The Horiba MEXA emissions analyser is calibrated with the same reference gas for both the baseline and treated segments of the evaluation.

> *Temperature measurement; by Fluke Model 52K/J digital thermometer.*
>
> *Exhaust differential pressure by Dwyer Magnahelic.*
>
> *Ambient pressure determination by use of Brunton ADC altimeter/barometer.*
>
> *The exhaust soot particulates are also measured during this test program.*
>
> *Exhaust gas sample evaluation of particulate by use of a Bacharach True Spot smoke meter.*
>
> **The Horiba infrared gas analyser was serviced and calibrated prior to each series of engine efficiency tests.**

TEST RESULTS

Fuel Efficiency

A summary of the Carbon Mass Balance fuel efficiency results achieved in this test program is provided in the following tables and appendices. **See Table I, and Individual Carbon Mass Balance results in Appendix II.**

Table I provides the average test results for the test equipment before and after Fuel Factor X fuel catalyst treatment **(see Graph II, Appendix I)**.

TABLE I

Test Segment	Acc. Hours	Fuel Change

1037		
Treated	309	**- 8.0%**
1095		
Treated	291	- 7.3%
1099		
Treated	290	- 7.3%
1165		
Treated	412	- 9.4%
1229		
Treated	205	- 6.3%
Average (Absolute)		**- 7.7%**

The computer printouts of the calculated Carbon Mass Balance test results are located in **Appendix II.** The raw engine data sheets used to calculate the Carbon Mass Balance are contained in **Appendix III**. The raw data sheets, and carbon balance sheets show and account for the environmental and ambient conditions during the evaluation.

Soot Particulate Tests

Concurrent with Carbon Mass Balance data extraction, soot particulate measurements were conducted. The results of these tests are summarized in **Table II**. Reductions in soot particulates are the most apparent and immediate.

Laboratory testing indicates that carbon and solid particulate reductions occur before observed fuel reductions. Studies show that a minimum of 300 to 400 hours of Fuel Factor X fuel catalyst treated engine operation are necessary before the conditioning period is complete. Then, and only then, will fuel consumption improvements be maximized.

Table II

Fuel Type Density	**Soot Particulates**
.835 @ 3.8 C. Diesel	

1037	
Untreated	8.14 mg/m^3
Treated	6.19 mg/m^3
	- 24%
1095	
Untreated	1.29 mg/m^3
Treated	1.03 mg/m^3
	- 20%
1099	
Untreated	1.38 mg/m^3
Treated	1.09 mg/m^3
	- 21%
1165	
Untreated	8.35 mg/m^3
Treated	6.10 mg/m^3
	- 27%
1229	
Untreated	9.04 mg/m^3
Treated	7.32 mg/m^3
	- 19%
Average	**- 22%**

The reduction in soot particulate density (the mass of the smoke particles) was reduced by a minimum average of 22% after fuel treatment and engine conditioning with the Fuel Factor X fuel catalyst **(See Graph 1, Appendix I).** Concentration levels were provided through the use of a Bacharach Smoke Spot Tester.

Conclusion

These carefully controlled engineering standard test procedures conducted on all five pieces of test equipment provide clear evidence of reduced fuel consumption in the range of 7.7%.

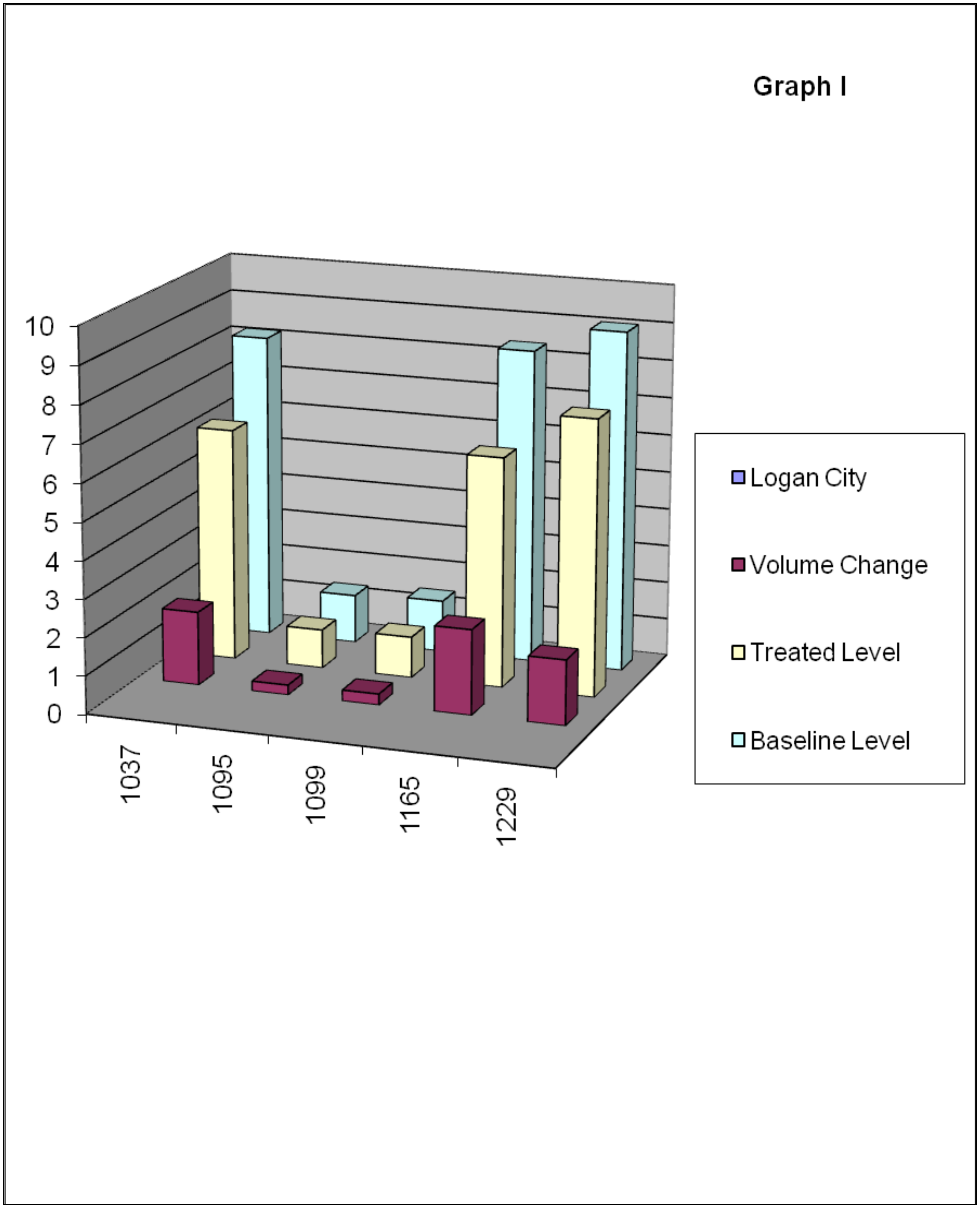
The Fuel Factor X fuel catalyst's effect on improved combustion is also evidenced by the substantial reduction in soot particulates (smoke) in the range of 22% **(see Appendix I)**. Similar reductions in other harmful carbon emissions likewise substantiate the combustion improvement created through the use of the Fuel Factor X fuel combustion catalyst **(see Raw Data Sheets, Appendix III and Emissions Reductions: Appendix V)**.

In addition to the fuel consumption analysis, a detailed compilation of carbon emissions reductions were determined. The study documented a significant reduction in annual C02 emissions of 189 metric tonnes. Reductions in Nitrogen and Methane levels were also observed **(see Appendix IV, Carbon Footprint Data).**

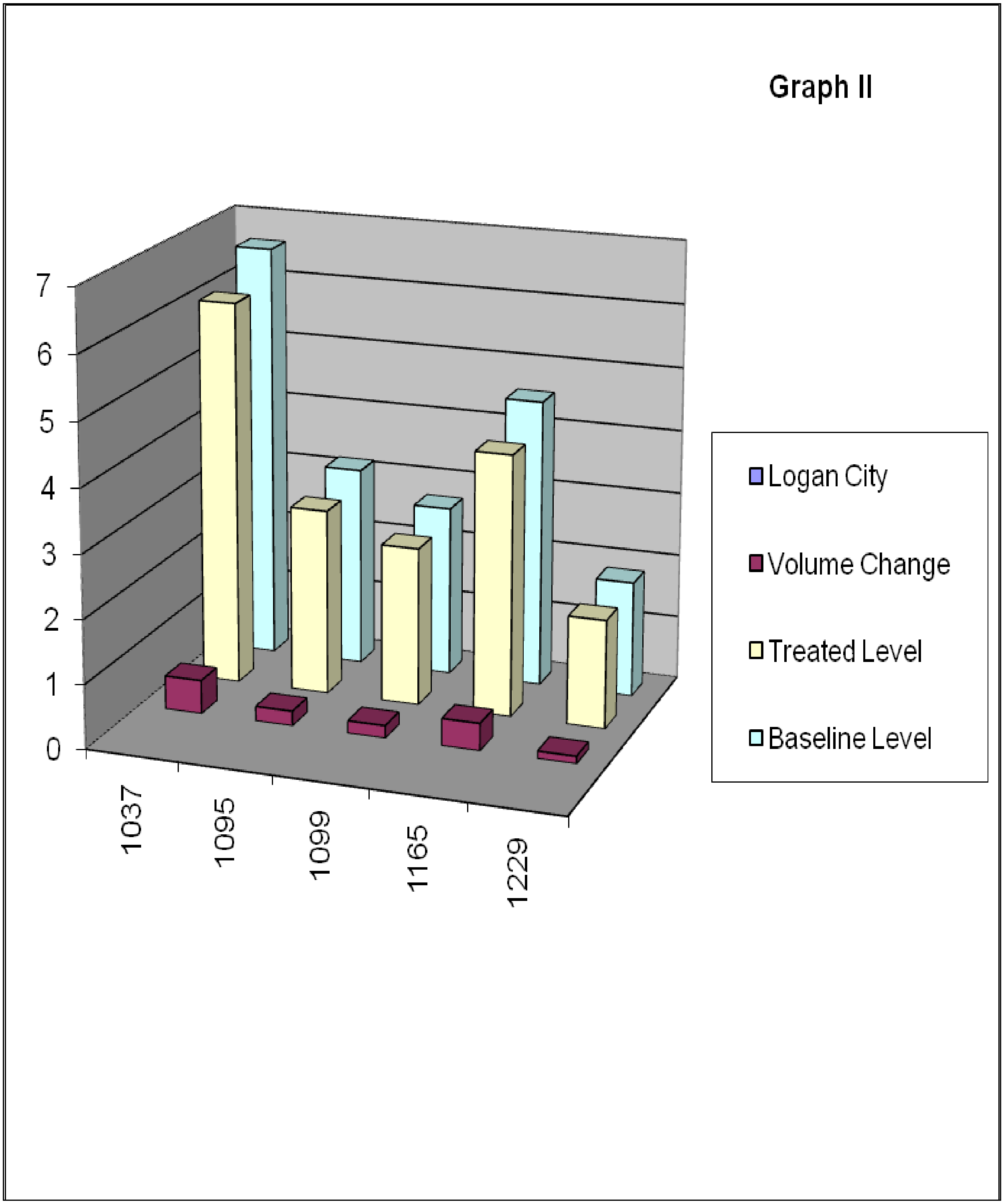
Additional to the fuel economy benefits measured and a reduction in soot particulates, product claims suggest that over time a significant reduction in engine maintenance costs will be realized following treatment with the catalyst. Claims suggest that the savings are achieved through lower soot levels in the engine lubricating oil, which is a result of more complete combustion of the fuel. Engine wear rates are reduced resulting in less carbon build-up in the combustion area. The catalyst also acts as an effective biocide should you experience water bottoms in fuel storage tanks; and, an excellent fuel system lubricant, which improves fuel system lubrication with today's low sulphur diesel fuels.

Appendix I

Exhaust Particulate and Fuel Graphs



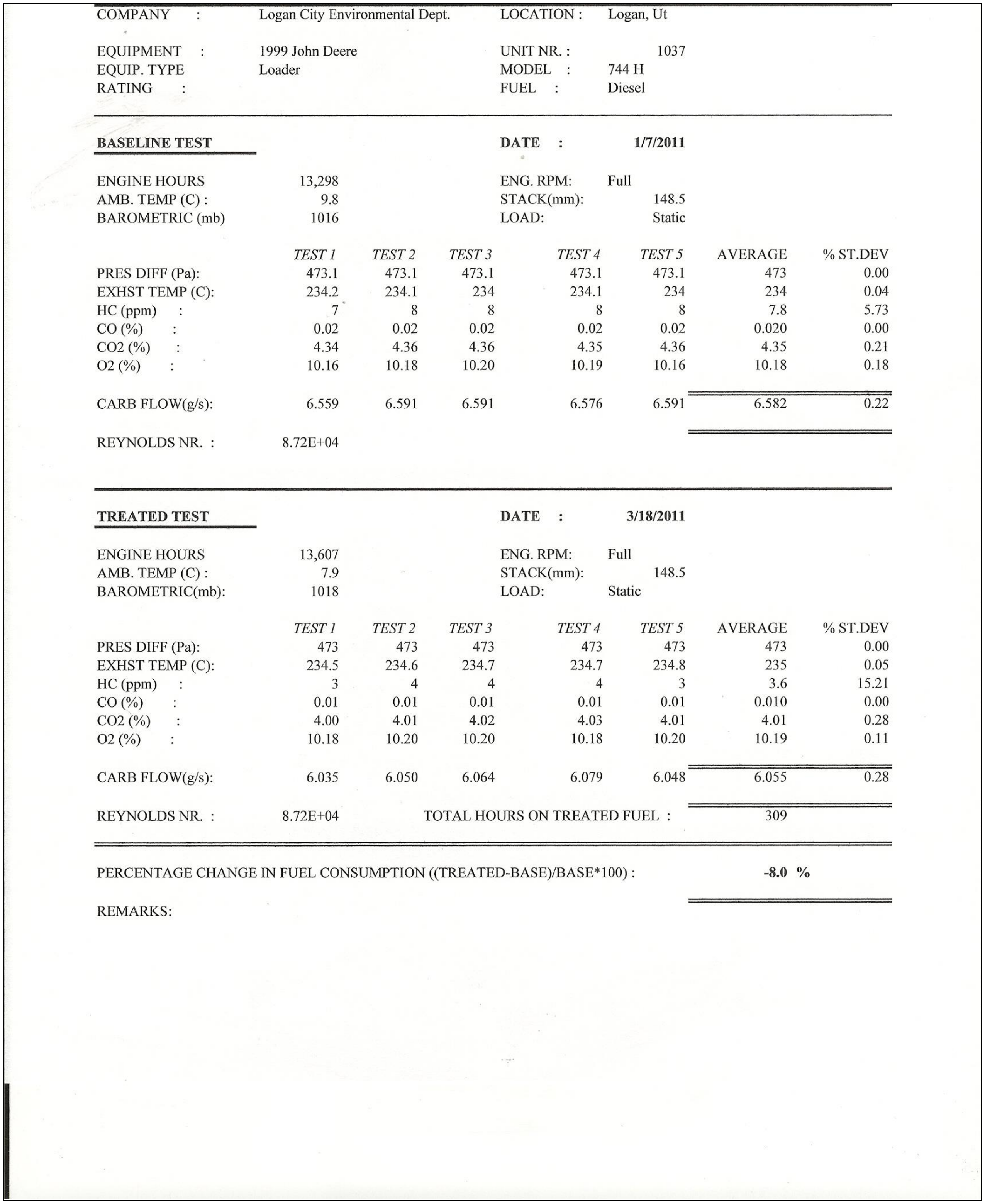
Soot Particulate Graph: Expressed in mg/m^3



Fuel Consumption Graph: Expressed in grams/second

Appendix II

Carbon Mass Balance Compilation Sheets



COMPANY : Logan City Environmental Dept. LOCATION : Logan, Ut

EQUIPMENT : 1999 John Deere UNIT NR. : 1037
EQUIP. TYPE Loader MODEL : 744 H
RATING : FUEL : Diesel

BASELINE TEST **DATE : 1/7/2011**

ENGINE HOURS 13,298 ENG. RPM: Full
AMB. TEMP (C) : 9.8 STACK(mm): 148.5
BAROMETRIC (mb) 1016 LOAD: Static

	TEST 1	*TEST 2*	*TEST 3*	*TEST 4*	*TEST 5*	AVERAGE	% ST.DEV
PRES DIFF (Pa):	473.1	473.1	473.1	473.1	473.1	473	0.00
EXHST TEMP (C):	234.2	234.1	234	234.1	234	234	0.04
HC (ppm) :	7	8	8	8	8	7.8	5.73
CO (%) :	0.02	0.02	0.02	0.02	0.02	0.020	0.00
CO2 (%) :	4.34	4.36	4.36	4.35	4.36	4.35	0.21
O2 (%) :	10.16	10.18	10.20	10.19	10.16	10.18	0.18
CARB FLOW(g/s):	6.559	6.591	6.591	6.576	6.591	6.582	0.22

REYNOLDS NR. : 8.72E+04

TREATED TEST **DATE : 3/18/2011**

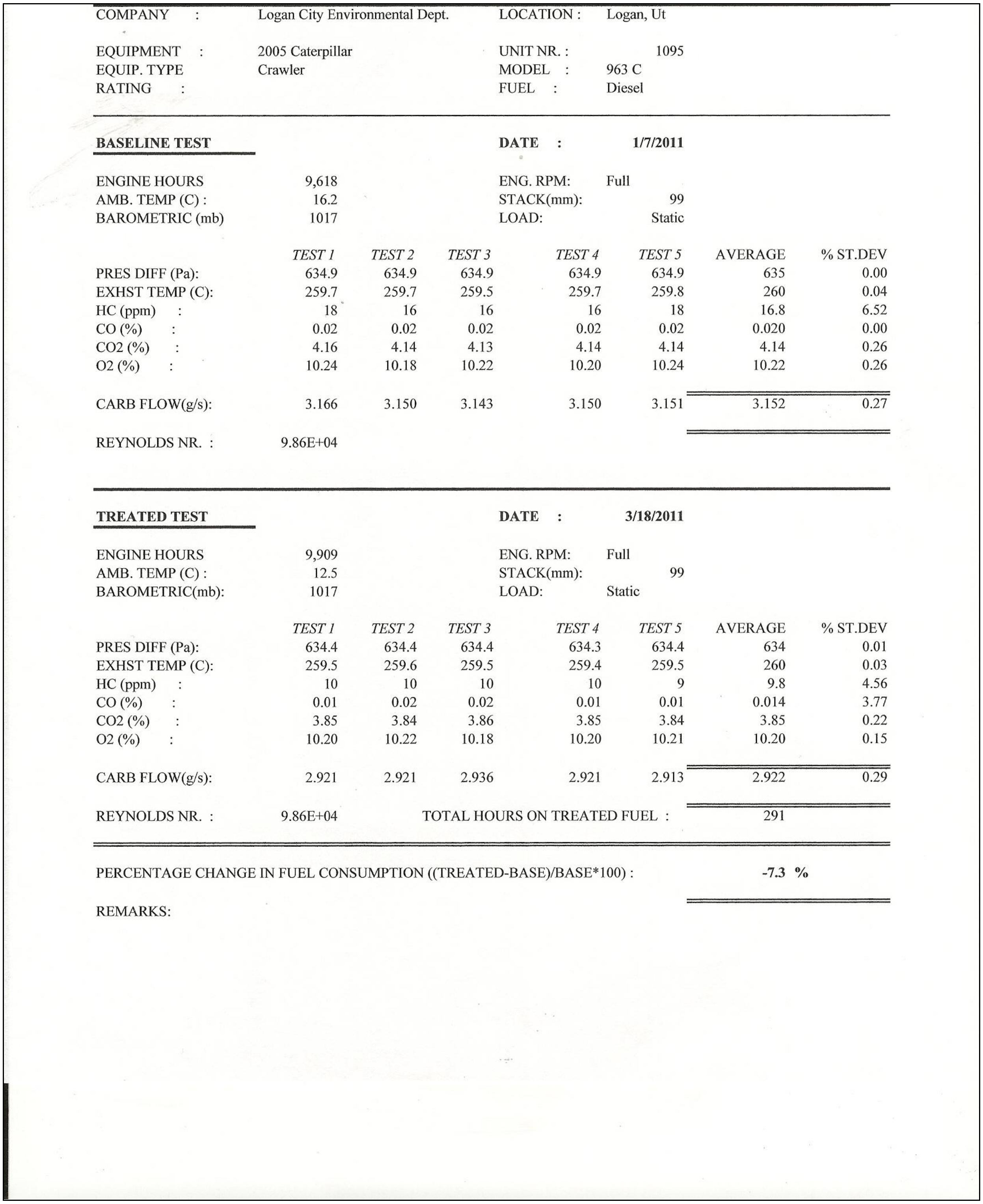
ENGINE HOURS 13,607 ENG. RPM: Full
AMB. TEMP (C) : 7.9 STACK(mm): 148.5
BAROMETRIC(mb): 1018 LOAD: Static

	TEST 1	*TEST 2*	*TEST 3*	*TEST 4*	*TEST 5*	AVERAGE	% ST.DEV
PRES DIFF (Pa):	473	473	473	473	473	473	0.00
EXHST TEMP (C):	234.5	234.6	234.7	234.7	234.8	235	0.05
HC (ppm) :	3	4	4	4	3	3.6	15.21
CO (%) :	0.01	0.01	0.01	0.01	0.01	0.010	0.00
CO2 (%) :	4.00	4.01	4.02	4.03	4.01	4.01	0.28
O2 (%) :	10.18	10.20	10.20	10.18	10.20	10.19	0.11
CARB FLOW(g/s):	6.035	6.050	6.064	6.079	6.048	6.055	0.28

REYNOLDS NR. : 8.72E+04 TOTAL HOURS ON TREATED FUEL : 309

PERCENTAGE CHANGE IN FUEL CONSUMPTION ((TREATED-BASE)/BASE*100) : **-8.0 %**

REMARKS:



COMPANY :	Logan City Environmental Dept.	LOCATION :	Logan, Ut
EQUIPMENT :	2005 Caterpillar	UNIT NR. :	1095
EQUIP. TYPE	Crawler	MODEL :	963 C
RATING :		FUEL :	Diesel

BASELINE TEST DATE : **1/7/2011**

ENGINE HOURS	9,618	ENG. RPM:	Full
AMB. TEMP (C) :	16.2	STACK(mm):	99
BAROMETRIC (mb)	1017	LOAD:	Static

	TEST 1	*TEST 2*	*TEST 3*	*TEST 4*	*TEST 5*	AVERAGE	% ST.DEV
PRES DIFF (Pa):	634.9	634.9	634.9	634.9	634.9	635	0.00
EXHST TEMP (C):	259.7	259.7	259.5	259.7	259.8	260	0.04
HC (ppm) :	18	16	16	16	18	16.8	6.52
CO (%) :	0.02	0.02	0.02	0.02	0.02	0.020	0.00
CO2 (%) :	4.16	4.14	4.13	4.14	4.14	4.14	0.26
O2 (%) :	10.24	10.18	10.22	10.20	10.24	10.22	0.26
CARB FLOW(g/s):	3.166	3.150	3.143	3.150	3.151	3.152	0.27

REYNOLDS NR. : 9.86E+04

TREATED TEST DATE : **3/18/2011**

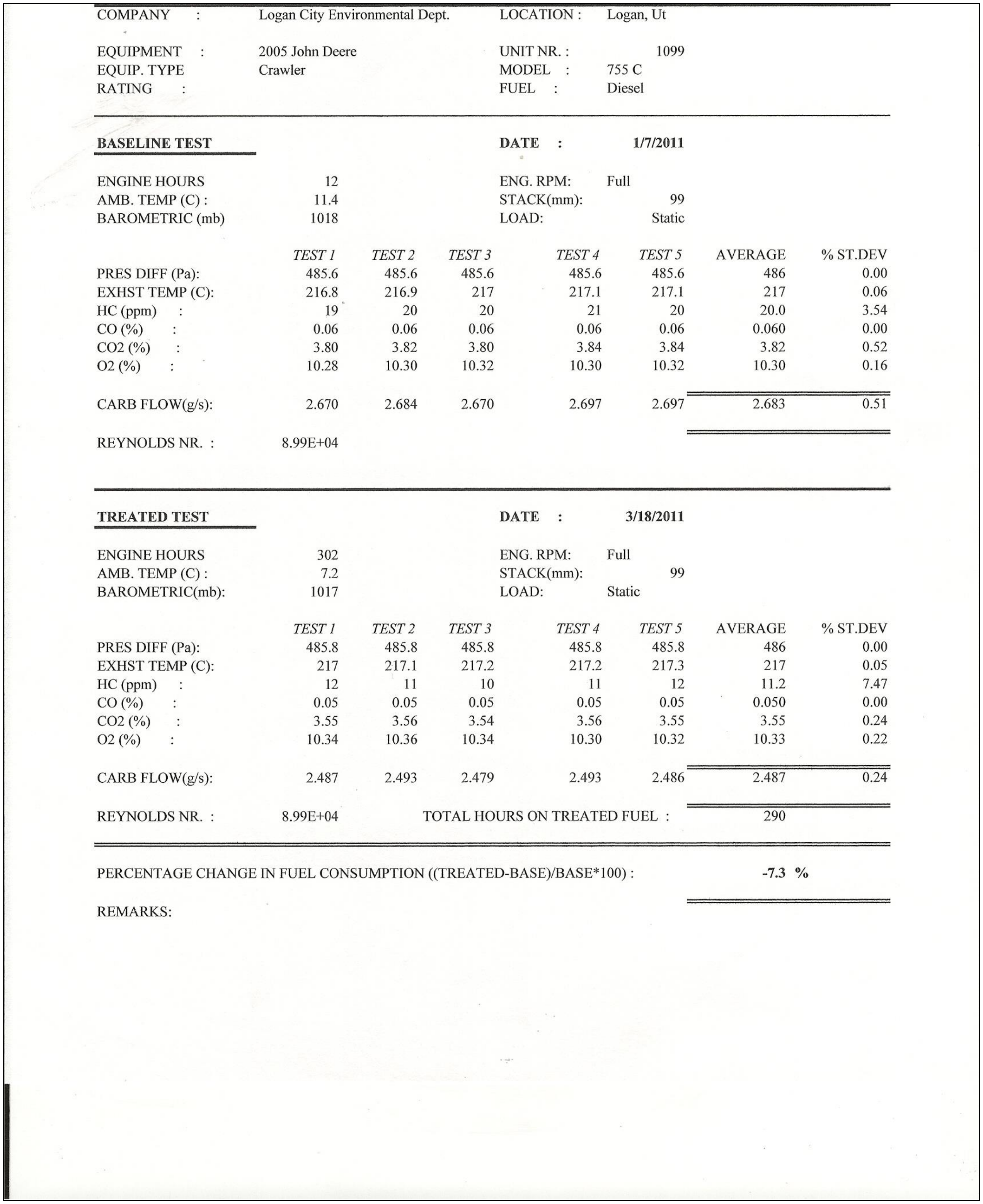
ENGINE HOURS	9,909	ENG. RPM:	Full
AMB. TEMP (C) :	12.5	STACK(mm):	99
BAROMETRIC(mb):	1017	LOAD:	Static

	TEST 1	*TEST 2*	*TEST 3*	*TEST 4*	*TEST 5*	AVERAGE	% ST.DEV
PRES DIFF (Pa):	634.4	634.4	634.4	634.3	634.4	634	0.01
EXHST TEMP (C):	259.5	259.6	259.5	259.4	259.5	260	0.03
HC (ppm) :	10	10	10	10	9	9.8	4.56
CO (%) :	0.01	0.02	0.02	0.01	0.01	0.014	3.77
CO2 (%) :	3.85	3.84	3.86	3.85	3.84	3.85	0.22
O2 (%) :	10.20	10.22	10.18	10.20	10.21	10.20	0.15
CARB FLOW(g/s):	2.921	2.921	2.936	2.921	2.913	2.922	0.29

REYNOLDS NR. : 9.86E+04 TOTAL HOURS ON TREATED FUEL : 291

PERCENTAGE CHANGE IN FUEL CONSUMPTION ((TREATED-BASE)/BASE*100) : **-7.3 %**

REMARKS:



COMPANY : Logan City Environmental Dept.   LOCATION : Logan, Ut

EQUIPMENT : 2005 John Deere   UNIT NR. : 1099
EQUIP. TYPE Crawler   MODEL : 755 C
RATING :   FUEL : Diesel

BASELINE TEST   **DATE : 1/7/2011**

ENGINE HOURS 12   ENG. RPM: Full
AMB. TEMP (C) : 11.4   STACK(mm): 99
BAROMETRIC (mb) 1018   LOAD: Static

	TEST 1	*TEST 2*	*TEST 3*	*TEST 4*	*TEST 5*	AVERAGE	% ST.DEV
PRES DIFF (Pa):	485.6	485.6	485.6	485.6	485.6	486	0.00
EXHST TEMP (C):	216.8	216.9	217	217.1	217.1	217	0.06
HC (ppm) :	19	20	20	21	20	20.0	3.54
CO (%) :	0.06	0.06	0.06	0.06	0.06	0.060	0.00
CO2 (%) :	3.80	3.82	3.80	3.84	3.84	3.82	0.52
02 (%) :	10.28	10.30	10.32	10.30	10.32	10.30	0.16
CARB FLOW(g/s):	2.670	2.684	2.670	2.697	2.697	2.683	0.51
REYNOLDS NR. :	8.99E+04						

TREATED TEST   **DATE : 3/18/2011**

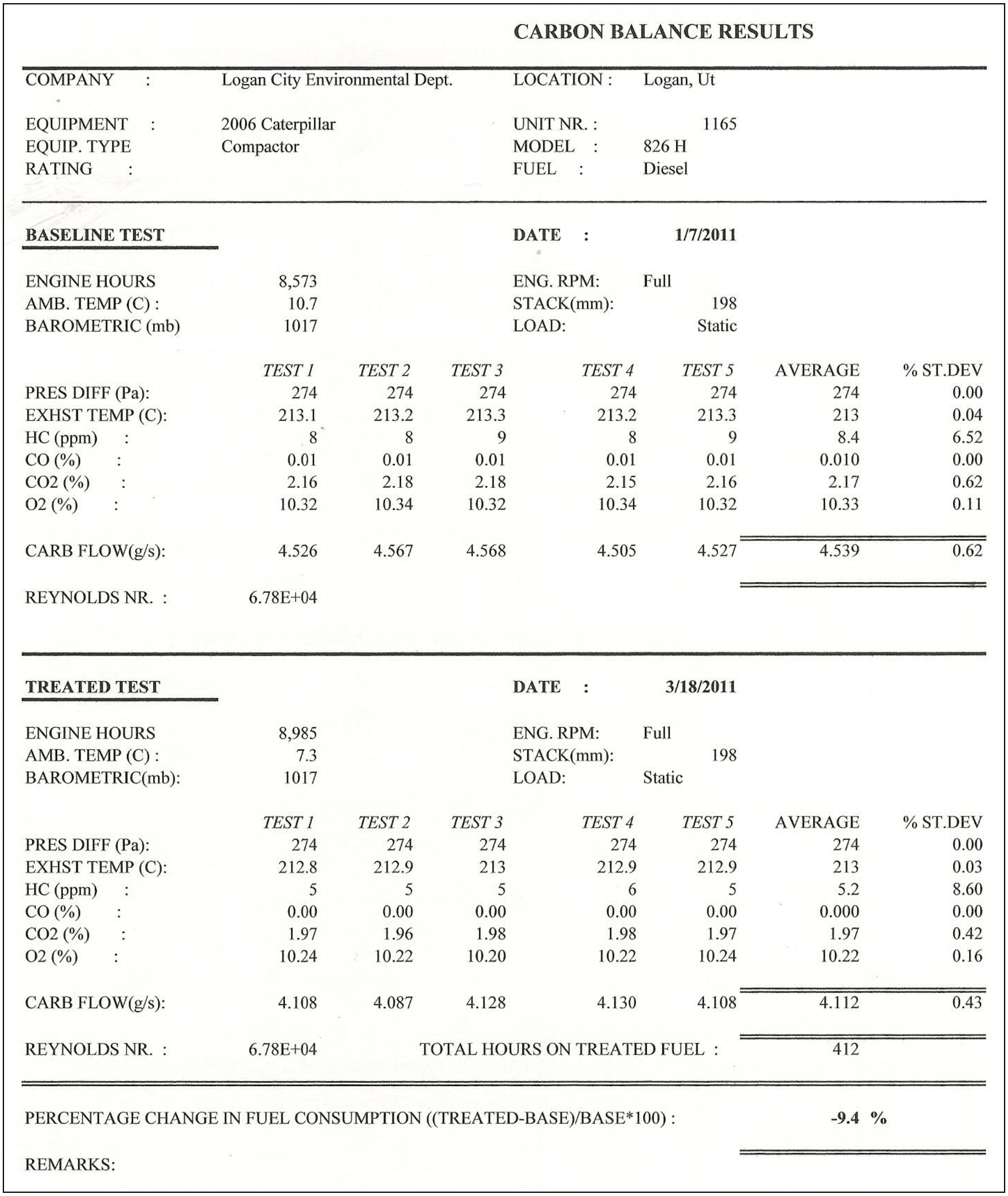
ENGINE HOURS 302   ENG. RPM: Full
AMB. TEMP (C) : 7.2   STACK(mm): 99
BAROMETRIC(mb): 1017   LOAD: Static

	TEST 1	*TEST 2*	*TEST 3*	*TEST 4*	*TEST 5*	AVERAGE	% ST.DEV
PRES DIFF (Pa):	485.8	485.8	485.8	485.8	485.8	486	0.00
EXHST TEMP (C):	217	217.1	217.2	217.2	217.3	217	0.05
HC (ppm) :	12	11	10	11	12	11.2	7.47
CO (%) :	0.05	0.05	0.05	0.05	0.05	0.050	0.00
CO2 (%) :	3.55	3.56	3.54	3.56	3.55	3.55	0.24
02 (%) :	10.34	10.36	10.34	10.30	10.32	10.33	0.22
CARB FLOW(g/s):	2.487	2.493	2.479	2.493	2.486	2.487	0.24
REYNOLDS NR. :	8.99E+04						

TOTAL HOURS ON TREATED FUEL : 290

PERCENTAGE CHANGE IN FUEL CONSUMPTION ((TREATED-BASE)/BASE*100) : **-7.3 %**

REMARKS:



CARBON BALANCE RESULTS

COMPANY :	Logan City Environmental Dept.	LOCATION :	Logan, Ut
EQUIPMENT :	2006 Caterpillar	UNIT NR. :	1165
EQUIP. TYPE	Compactor	MODEL :	826 H
RATING :		FUEL :	Diesel

BASELINE TEST **DATE : 1/7/2011**

ENGINE HOURS	8,573	ENG. RPM:	Full
AMB. TEMP (C) :	10.7	STACK(mm):	198
BAROMETRIC (mb)	1017	LOAD:	Static

	TEST 1	*TEST 2*	*TEST 3*	*TEST 4*	*TEST 5*	AVERAGE	% ST.DEV
PRES DIFF (Pa):	274	274	274	274	274	274	0.00
EXHST TEMP (C):	213.1	213.2	213.3	213.2	213.3	213	0.04
HC (ppm) :	8	8	9	8	9	8.4	6.52
CO (%) :	0.01	0.01	0.01	0.01	0.01	0.010	0.00
CO2 (%) :	2.16	2.18	2.18	2.15	2.16	2.17	0.62
O2 (%) :	10.32	10.34	10.32	10.34	10.32	10.33	0.11
CARB FLOW(g/s):	4.526	4.567	4.568	4.505	4.527	4.539	0.62
REYNOLDS NR. :	6.78E+04						

TREATED TEST **DATE : 3/18/2011**

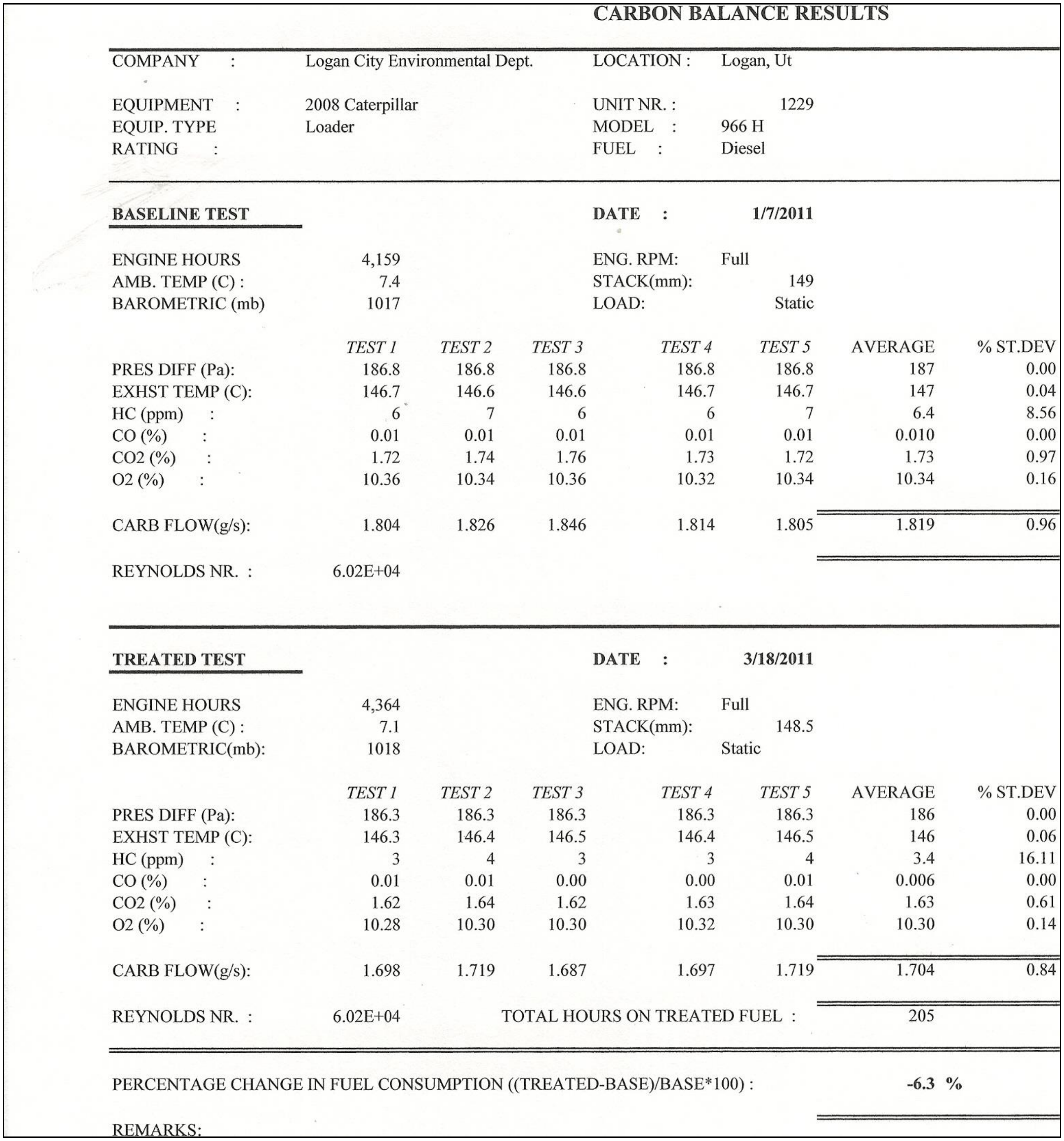
ENGINE HOURS	8,985	ENG. RPM:	Full
AMB. TEMP (C) :	7.3	STACK(mm):	198
BAROMETRIC(mb):	1017	LOAD:	Static

	TEST 1	*TEST 2*	*TEST 3*	*TEST 4*	*TEST 5*	AVERAGE	% ST.DEV
PRES DIFF (Pa):	274	274	274	274	274	274	0.00
EXHST TEMP (C):	212.8	212.9	213	212.9	212.9	213	0.03
HC (ppm) :	5	5	5	6	5	5.2	8.60
CO (%) :	0.00	0.00	0.00	0.00	0.00	0.000	0.00
CO2 (%) :	1.97	1.96	1.98	1.98	1.97	1.97	0.42
O2 (%) :	10.24	10.22	10.20	10.22	10.24	10.22	0.16
CARB FLOW(g/s):	4.108	4.087	4.128	4.130	4.108	4.112	0.43

REYNOLDS NR. : 6.78E+04 TOTAL HOURS ON TREATED FUEL : 412

PERCENTAGE CHANGE IN FUEL CONSUMPTION ((TREATED-BASE)/BASE*100) : **-9.4 %**

REMARKS:



CARBON BALANCE RESULTS

COMPANY : Logan City Environmental Dept.
LOCATION : Logan, Ut

EQUIPMENT : 2008 Caterpillar
EQUIP. TYPE Loader
RATING :
UNIT NR. : 1229
MODEL : 966 H
FUEL : Diesel

BASELINE TEST

DATE : 1/7/2011

ENGINE HOURS 4,159
AMB. TEMP (C) : 7.4
BAROMETRIC (mb) 1017
ENG. RPM: Full
STACK(mm): 149
LOAD: Static

	TEST 1	*TEST 2*	*TEST 3*	*TEST 4*	*TEST 5*	AVERAGE	% ST.DEV
PRES DIFF (Pa):	186.8	186.8	186.8	186.8	186.8	187	0.00
EXHST TEMP (C):	146.7	146.6	146.6	146.7	146.7	147	0.04
HC (ppm) :	6	7	6	6	7	6.4	8.56
CO (%) :	0.01	0.01	0.01	0.01	0.01	0.010	0.00
CO2 (%) :	1.72	1.74	1.76	1.73	1.72	1.73	0.97
O2 (%) :	10.36	10.34	10.36	10.32	10.34	10.34	0.16
CARB FLOW(g/s):	1.804	1.826	1.846	1.814	1.805	1.819	0.96

REYNOLDS NR. : 6.02E+04

TREATED TEST

DATE : 3/18/2011

ENGINE HOURS 4,364
AMB. TEMP (C) : 7.1
BAROMETRIC(mb): 1018
ENG. RPM: Full
STACK(mm): 148.5
LOAD: Static

	TEST 1	*TEST 2*	*TEST 3*	*TEST 4*	*TEST 5*	AVERAGE	% ST.DEV
PRES DIFF (Pa):	186.3	186.3	186.3	186.3	186.3	186	0.00
EXHST TEMP (C):	146.3	146.4	146.5	146.4	146.5	146	0.06
HC (ppm) :	3	4	3	3	4	3.4	16.11
CO (%) :	0.01	0.01	0.00	0.00	0.01	0.006	0.00
CO2 (%) :	1.62	1.64	1.62	1.63	1.64	1.63	0.61
O2 (%) :	10.28	10.30	10.30	10.32	10.30	10.30	0.14
CARB FLOW(g/s):	1.698	1.719	1.687	1.697	1.719	1.704	0.84

REYNOLDS NR. : 6.02E+04

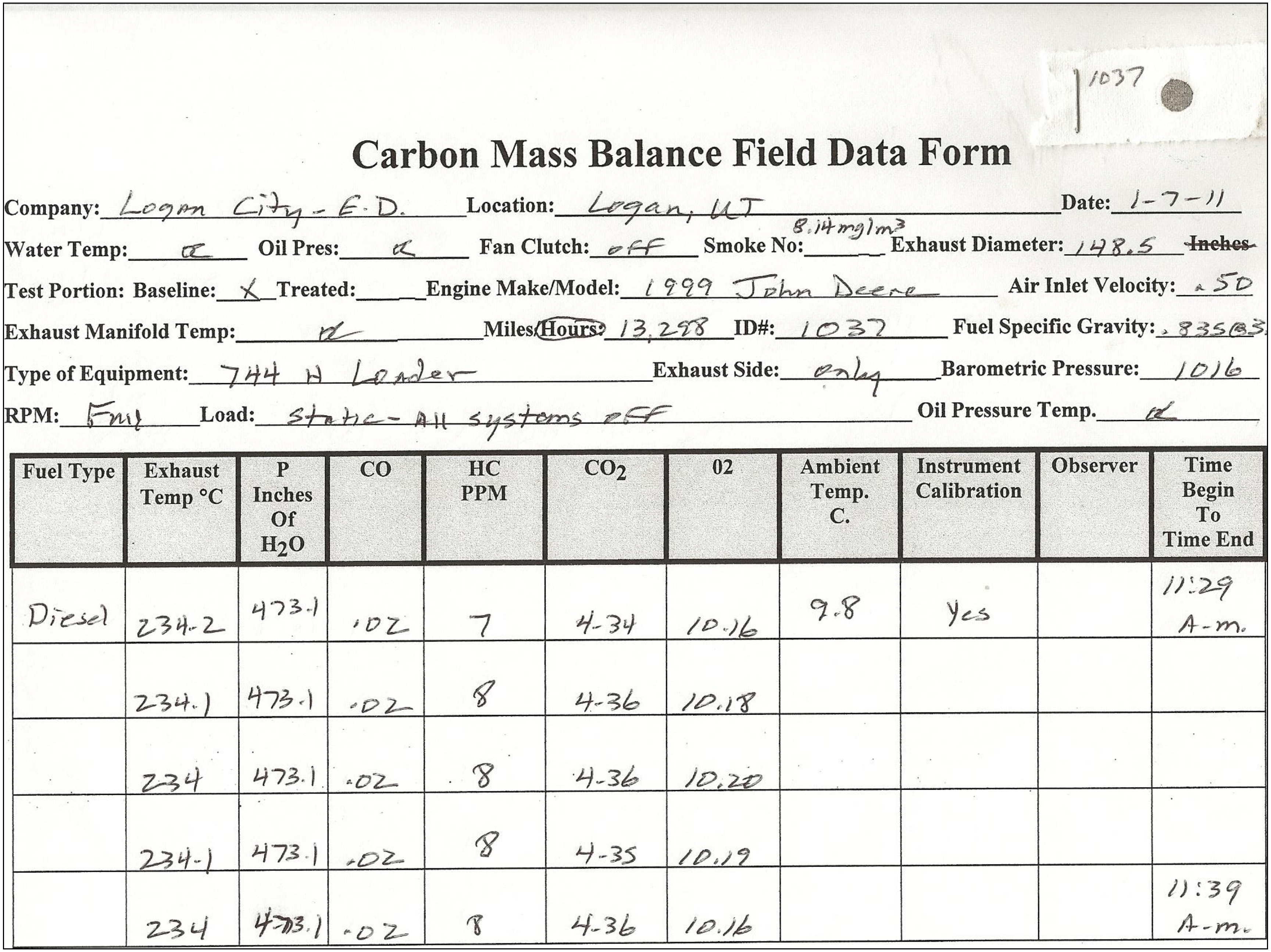
TOTAL HOURS ON TREATED FUEL : 205

PERCENTAGE CHANGE IN FUEL CONSUMPTION ((TREATED-BASE)/BASE*100) : **-6.3 %**

REMARKS:

Appendix III

Raw Data Sheets



1037

Carbon Mass Balance Field Data Form

Company: Logan City - E.D. **Location:** Logan, UT **Date:** 1-7-11

Water Temp: ø **Oil Pres:** ø **Fan Clutch:** off **Smoke No:** 8.14mg/m³ **Exhaust Diameter:** 148.5 ~~**Inches**~~

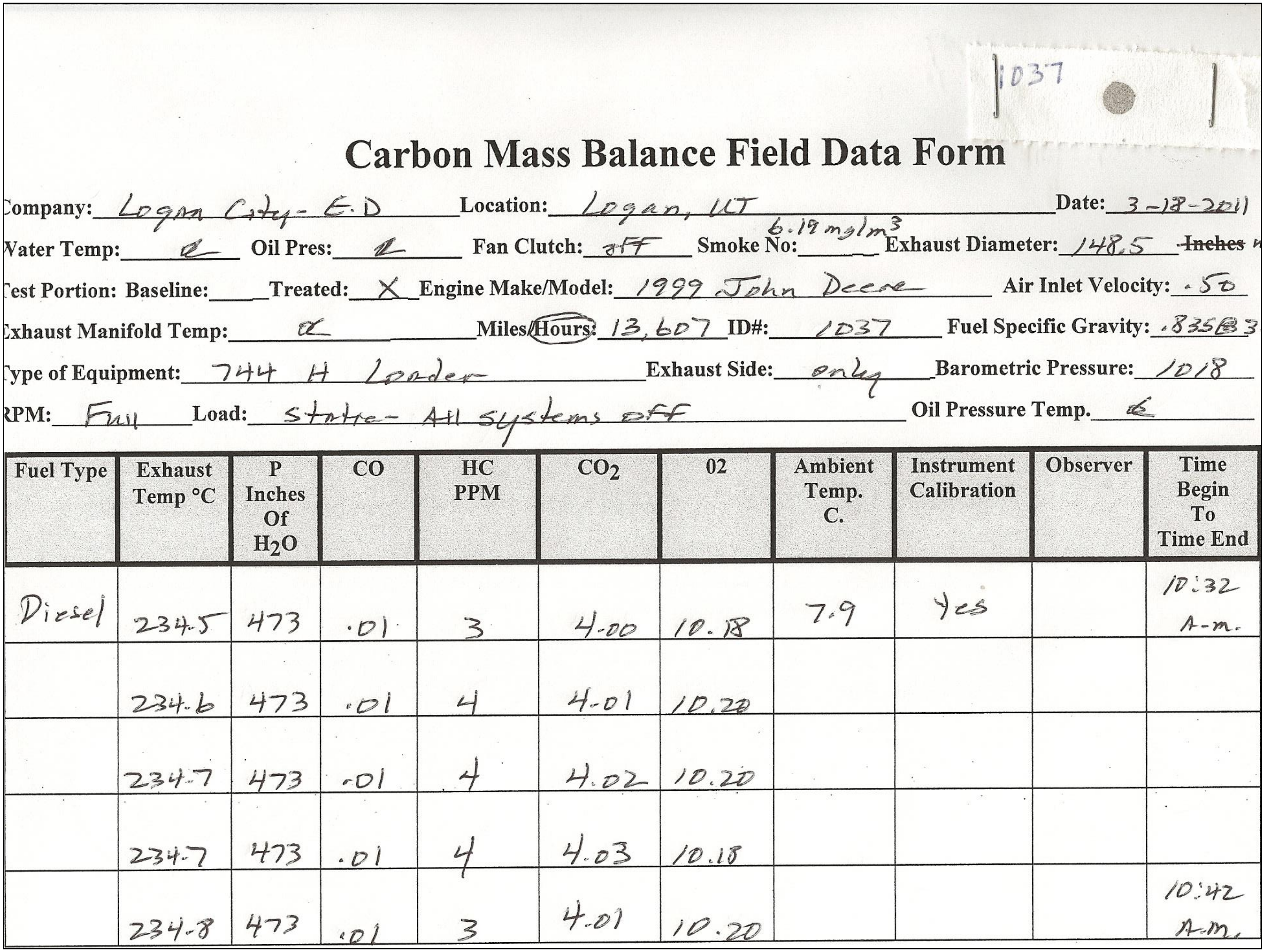
Test Portion: Baseline: X **Treated:** ____ **Engine Make/Model:** 1999 John Deere **Air Inlet Velocity:** .50

Exhaust Manifold Temp: ø **Miles/[✓ Hours]:** 13,298 **ID#:** 1037 **Fuel Specific Gravity:** .83583

Type of Equipment: 744 H Loader **Exhaust Side:** only **Barometric Pressure:** 1016

RPM: Full **Load:** static - All systems off **Oil Pressure Temp.** ø

Fuel Type	Exhaust Temp °C	P Inches Of H_2O	CO	HC PPM	CO_2	02	Ambient Temp. C.	Instrument Calibration	Observer	Time Begin To Time End
Diesel	234.2	473.1	.02	7	4.34	10.16	9.8	Yes		11:29 A-m.
	234.1	473.1	.02	8	4.36	10.18				
	234	473.1	.02	8	4.36	10.20				
	234.1	473.1	.02	8	4.35	10.19				
	234	~~47~~3.1	.02	8	4.36	10.16				11:39 A-m.



1037

Carbon Mass Balance Field Data Form

ompany: Logan City - E.D Location: Logan, UT Date: 3-18-2011

Vater Temp: 0 Oil Pres: 0 Fan Clutch: off Smoke No: 6.19 mg/m³ Exhaust Diameter: 148.5 ~~Inches~~

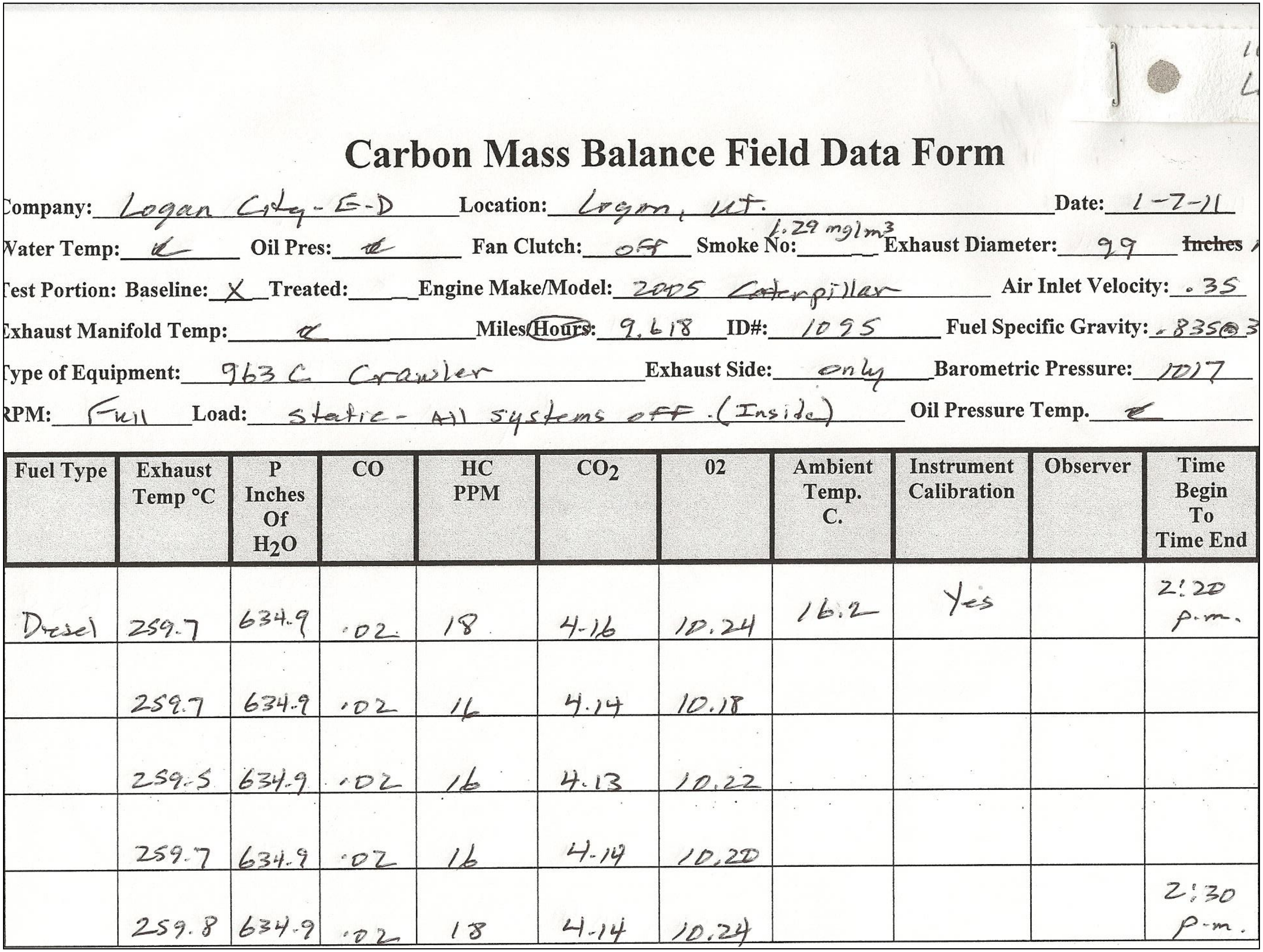
est Portion: Baseline: ___ Treated: X Engine Make/Model: 1999 John Deere Air Inlet Velocity: .50

xhaust Manifold Temp: 0 Miles/[✓ Hours]: 13,607 ID#: 1037 Fuel Specific Gravity: .8353

ype of Equipment: 744 H Loader Exhaust Side: only Barometric Pressure: 1018

PM: Full Load: static - All systems off Oil Pressure Temp. 0

Fuel Type	Exhaust Temp °C	P Inches Of H_2O	CO	HC PPM	CO_2	02	Ambient Temp. C.	Instrument Calibration	Observer	Time Begin To Time End
Diesel	234.5	473	.01	3	4.00	10.18	7.9	Yes		10:32 A-m.
	234.6	473	.01	4	4.01	10.20				
	234.7	473	.01	4	4.02	10.20				
	234.7	473	.01	4	4.03	10.18				
	234.8	473	.01	3	4.01	10.20				10:42 A-m.



Carbon Mass Balance Field Data Form

ompany: Logan City - E-D Location: Logan, ut. Date: 1-7-11

ater Temp: ¢ Oil Pres: ¢ Fan Clutch: off Smoke No: 1.29 mg/m3 Exhaust Diameter: 99 ~~Inches~~

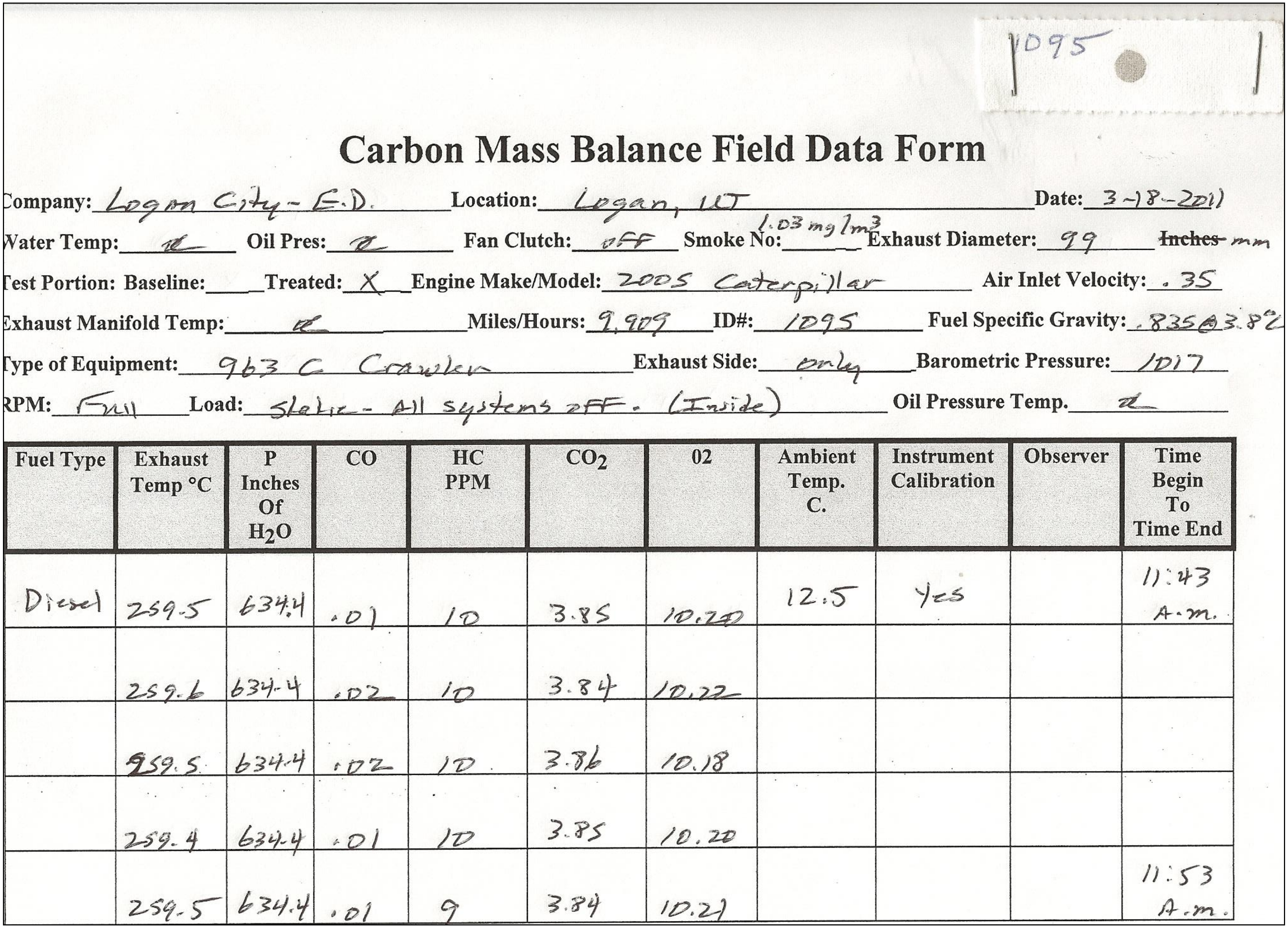
est Portion: Baseline: X Treated: ____ Engine Make/Model: 2005 Caterpillar Air Inlet Velocity: .35

xhaust Manifold Temp: ¢ Miles/[✓ Hours]: 9,618 ID#: 1095 Fuel Specific Gravity: .835@3

ype of Equipment: 963 C Crawler Exhaust Side: only Barometric Pressure: 1017

PM: Full Load: static - All systems off. (Inside) Oil Pressure Temp. ¢

Fuel Type	Exhaust Temp °C	P Inches Of H_2O	CO	HC PPM	CO_2	02	Ambient Temp. C.	Instrument Calibration	Observer	Time Begin To Time End
Diesel	259.7	634.9	.02	18	4.16	10.24	16.2	Yes		2:20 p.m.
	259.7	634.9	.02	16	4.14	10.18				
	259.5	634.9	.02	16	4.13	10.22				
	259.7	634.9	.02	16	4.14	10.20				
	259.8	634.9	.02	18	4.14	10.24				2:30 p.m.



1095

Carbon Mass Balance Field Data Form

Company: Logan City - E.D. Location: Logan, UT Date: 3-18-2011

Water Temp: 0 Oil Pres: 0 Fan Clutch: off Smoke No: 1.03 mg/m3 Exhaust Diameter: 99 ~~Inches~~ mm

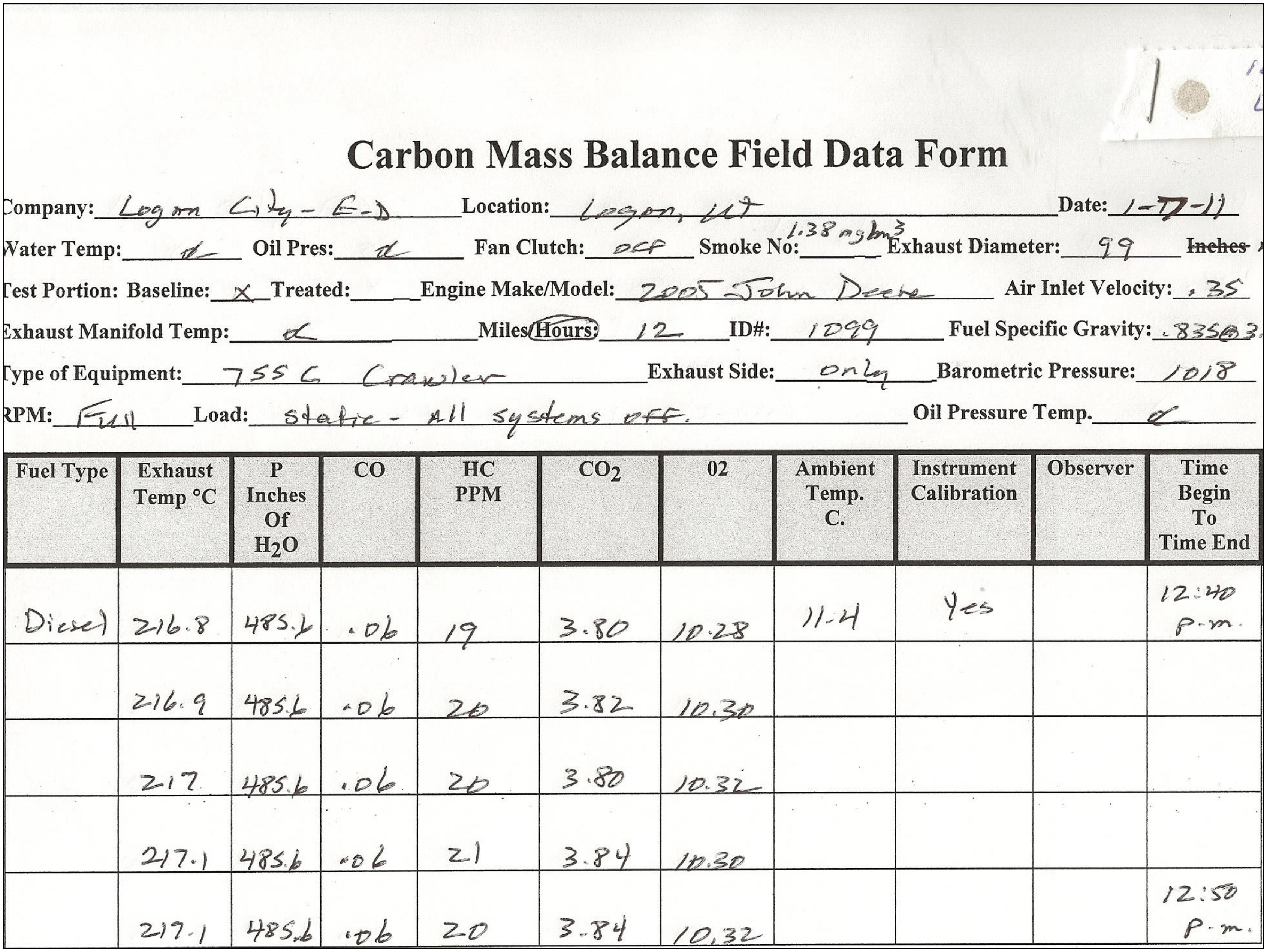
Test Portion: Baseline: ____ Treated: X Engine Make/Model: 2005 Caterpillar Air Inlet Velocity: .35

Exhaust Manifold Temp: 0 Miles/Hours: 9,909 ID#: 1095 Fuel Specific Gravity: .835@3.8°C

Type of Equipment: 963 C Crawler Exhaust Side: only Barometric Pressure: 1017

RPM: Full Load: Static - All systems off. (Inside) Oil Pressure Temp. 0

Fuel Type	Exhaust Temp °C	P Inches Of H_2O	CO	HC PPM	CO_2	02	Ambient Temp. C.	Instrument Calibration	Observer	Time Begin To Time End
Diesel	259.5	634.4	.01	10	3.85	10.20	12.5	Yes		11:43 A.m.
	259.6	634.4	.02	10	3.84	10.22				
	259.5	634.4	.02	10	3.86	10.18				
	259.4	634.4	.01	10	3.85	10.20				
	259.5	634.4	.01	9	3.84	10.21				11:53 A.m.



Carbon Mass Balance Field Data Form

ompany: Logan City - E-D Location: Logan, UT Date: 1-17-11

ater Temp: 0 Oil Pres: 0 Fan Clutch: off Smoke No: 1.38 mg/m3 Exhaust Diameter: 99 ~~Inches~~

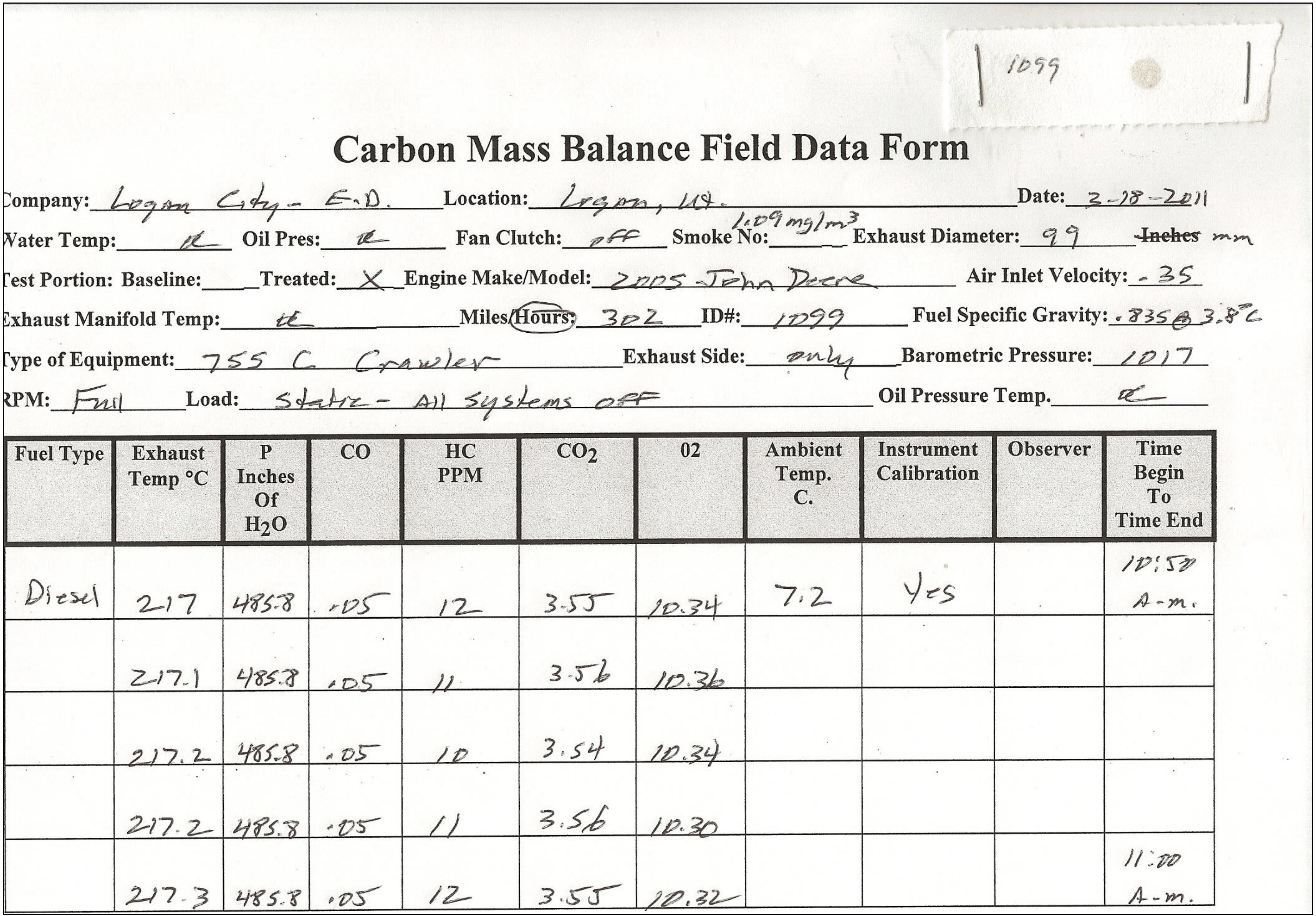
est Portion: Baseline: X Treated: ___ Engine Make/Model: 2005 John Deere Air Inlet Velocity: .35

xhaust Manifold Temp: 0 Miles/[✓ Hours]: 12 ID#: 1099 Fuel Specific Gravity: .835@3.

ype of Equipment: 755 C Crawler Exhaust Side: only Barometric Pressure: 1018

PM: Full Load: static - All systems off. Oil Pressure Temp. 0

Fuel Type	Exhaust Temp °C	P Inches Of H_2O	CO	HC PPM	CO_2	02	Ambient Temp. C.	Instrument Calibration	Observer	Time Begin To Time End
Diesel	216.8	485.6	.06	19	3.80	10.28	11.4	Yes		12:40 p.m.
	216.9	485.6	.06	20	3.82	10.30				
	217	485.6	.06	20	3.80	10.32				
	217.1	485.6	.06	21	3.84	10.30				
	217.1	485.6	.06	20	3.84	10.32				12:50 p.m.



1099

Carbon Mass Balance Field Data Form

Company: Logan City - E.D. Location: Logan, Ut. Date: 2-18-2011

Water Temp: Oil Pres: Fan Clutch: off Smoke No: 1.09 mg/m³ Exhaust Diameter: 99 ~~Inches~~ mm

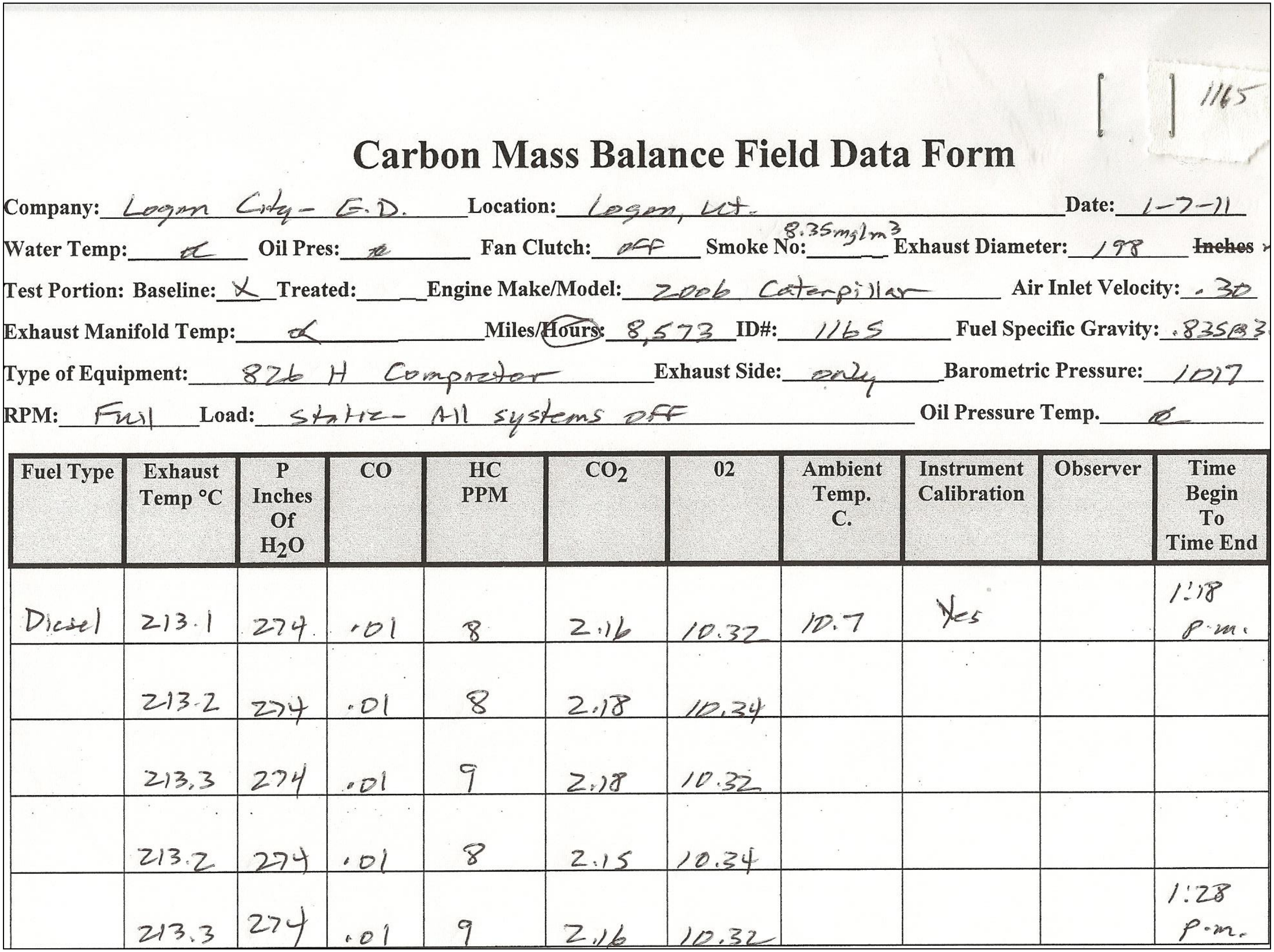
Test Portion: Baseline: Treated: X Engine Make/Model: 2005 John Deere Air Inlet Velocity: .35

Exhaust Manifold Temp: Miles/[✓ Hours]: 302 ID#: 1099 Fuel Specific Gravity: .835@3.8°C

Type of Equipment: 755 C Crawler Exhaust Side: only Barometric Pressure: 1017

RPM: Full Load: Static - All systems off Oil Pressure Temp.

Fuel Type	Exhaust Temp °C	P Inches Of H_2O	CO	HC PPM	CO_2	02	Ambient Temp. C.	Instrument Calibration	Observer	Time Begin To Time End
Diesel	217	485.8	.05	12	3.55	10.34	7.2	Yes		10:50 A-m.
	217.1	485.8	.05	11	3.56	10.36				
	217.2	485.8	.05	10	3.54	10.34				
	217.2	485.8	.05	11	3.56	10.30				
	217.3	485.8	.05	12	3.55	10.32				11:00 A-m.



1165

Carbon Mass Balance Field Data Form

Company: Logan City- E.D. Location: Logan, Ut. Date: 1-7-11

Water Temp: 0 Oil Pres: 0 Fan Clutch: off Smoke No: 8.35mg/m3 Exhaust Diameter: 198 ~~Inches~~

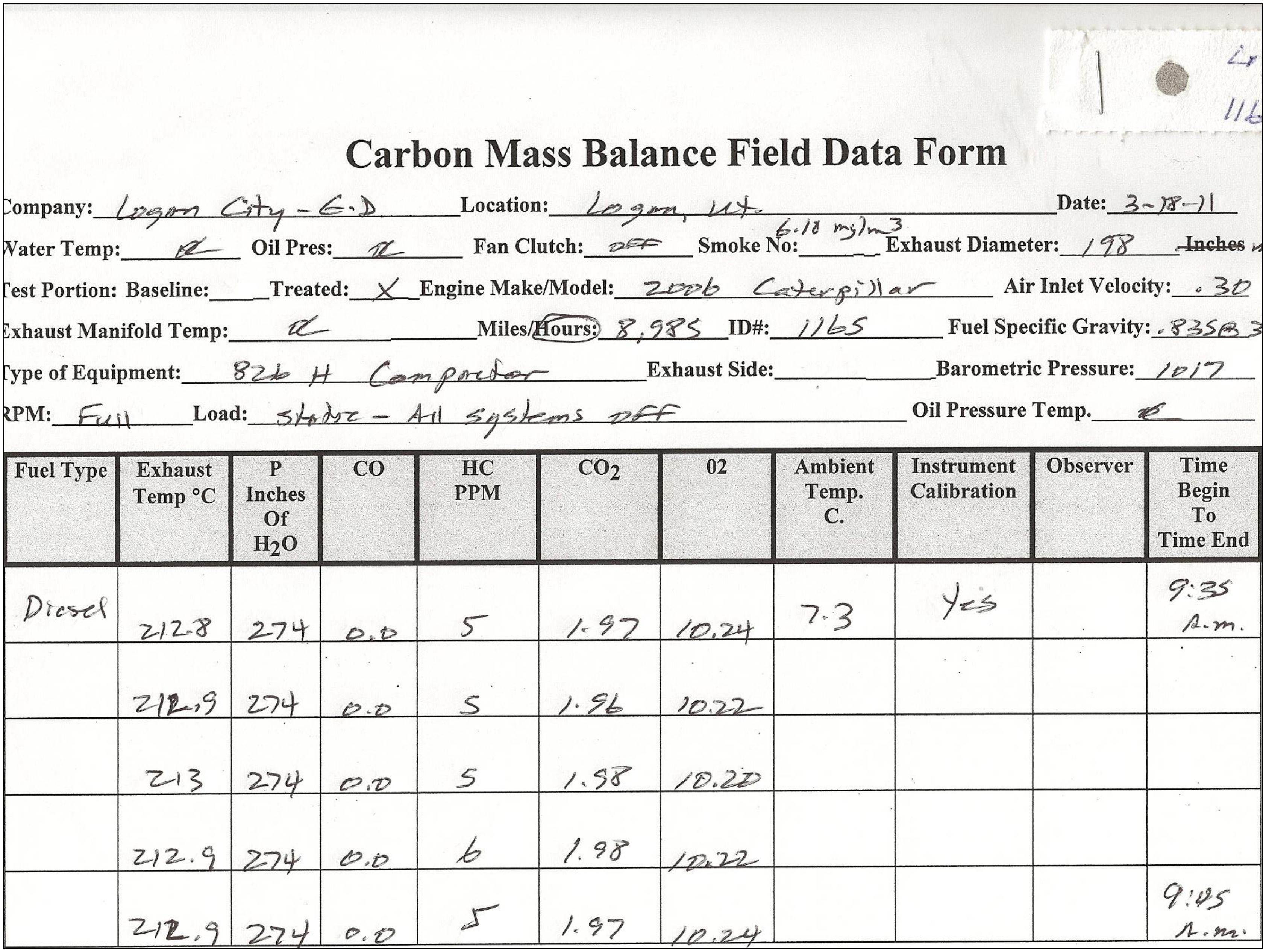
Test Portion: Baseline: X Treated: ___ Engine Make/Model: 2006 Caterpillar Air Inlet Velocity: .30

Exhaust Manifold Temp: 0 Miles/[✓ Hours]: 8,573 ID#: 1165 Fuel Specific Gravity: .835@3

Type of Equipment: 826 H Compactor Exhaust Side: only Barometric Pressure: 1017

RPM: Full Load: static- All systems off Oil Pressure Temp. 0

Fuel Type	Exhaust Temp °C	P Inches Of H_2O	CO	HC PPM	CO_2	02	Ambient Temp. C.	Instrument Calibration	Observer	Time Begin To Time End
Diesel	213.1	274	.01	8	2.16	10.32	10.7	Yes		1:18 p.m.
	213.2	274	.01	8	2.18	10.34				
	213.3	274	.01	9	2.18	10.32				
	213.2	274	.01	8	2.15	10.34				
	213.3	274	.01	9	2.16	10.32				1:28 p.m.



Carbon Mass Balance Field Data Form

ompany: Logan City - G.D Location: Logan, Ut. Date: 3-18-11

ater Temp: 0 Oil Pres: 0 Fan Clutch: off Smoke No: 6.18 mg/m3 Exhaust Diameter: 198 ~~Inches~~

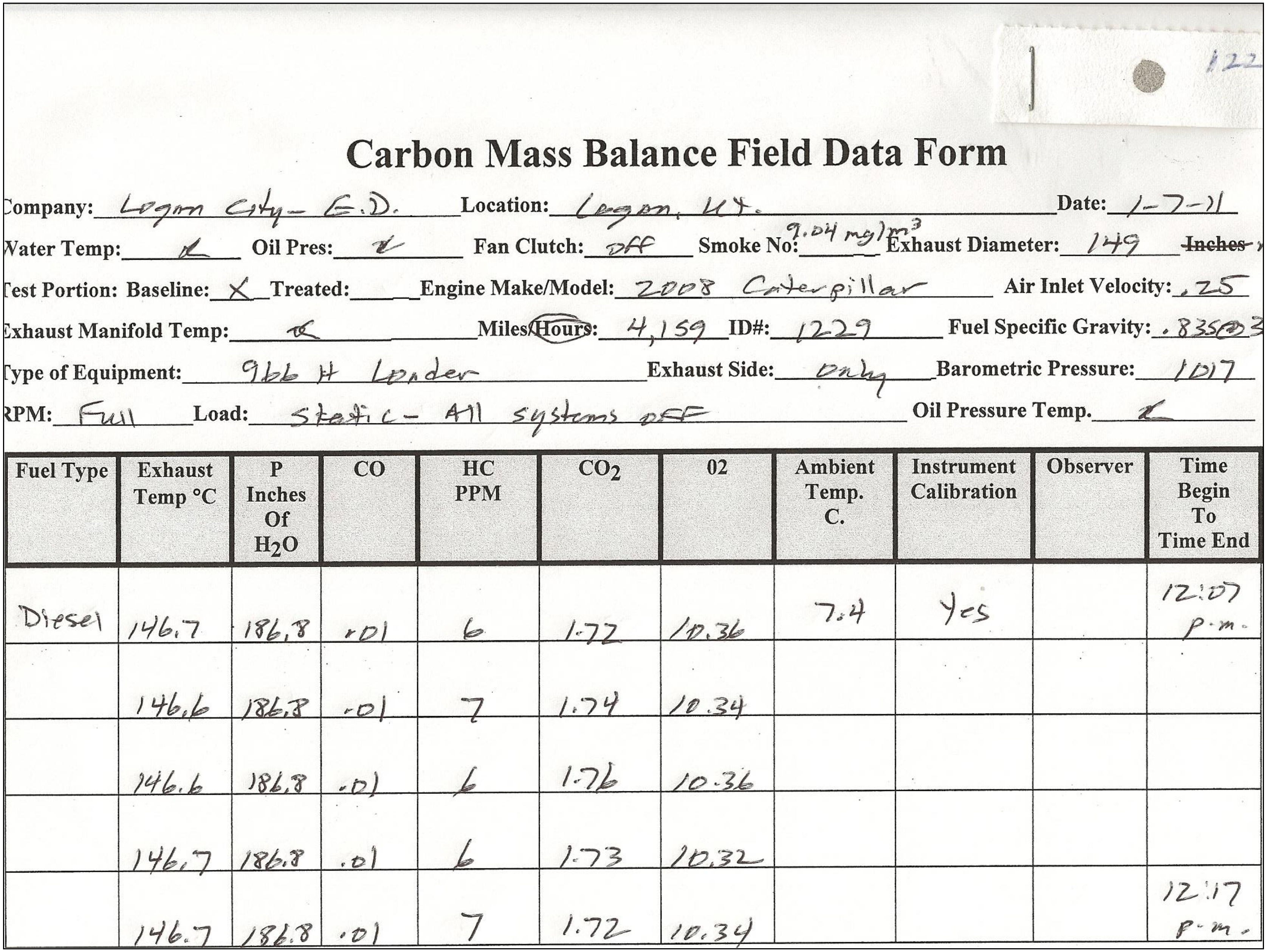
est Portion: Baseline: ___ Treated: X Engine Make/Model: 2006 Caterpillar Air Inlet Velocity: .30

xhaust Manifold Temp: 0 Miles/[✓ Hours]: 8,985 ID#: 1165 Fuel Specific Gravity: .835

ype of Equipment: 826 H Compactor Exhaust Side: ___ Barometric Pressure: 1017

PM: Full Load: static - All systems off Oil Pressure Temp. 0

Fuel Type	Exhaust Temp °C	P Inches Of H_2O	CO	HC PPM	CO_2	02	Ambient Temp. C.	Instrument Calibration	Observer	Time Begin To Time End
Diesel	212.8	274	0.0	5	1.97	10.24	7.3	Yes		9:35 A.m.
	212.9	274	0.0	5	1.96	10.22				
	213	274	0.0	5	1.98	10.20				
	212.9	274	0.0	6	1.98	10.22				
	212.9	274	0.0	5	1.97	10.24				9:45 A.m.



122

Carbon Mass Balance Field Data Form

Company: Logan City - E.D. Location: Logan, UT. Date: 1-7-11

Water Temp: 0 Oil Pres: 0 Fan Clutch: off Smoke No: 9.04 mg/m³ Exhaust Diameter: 149 ~~Inches~~

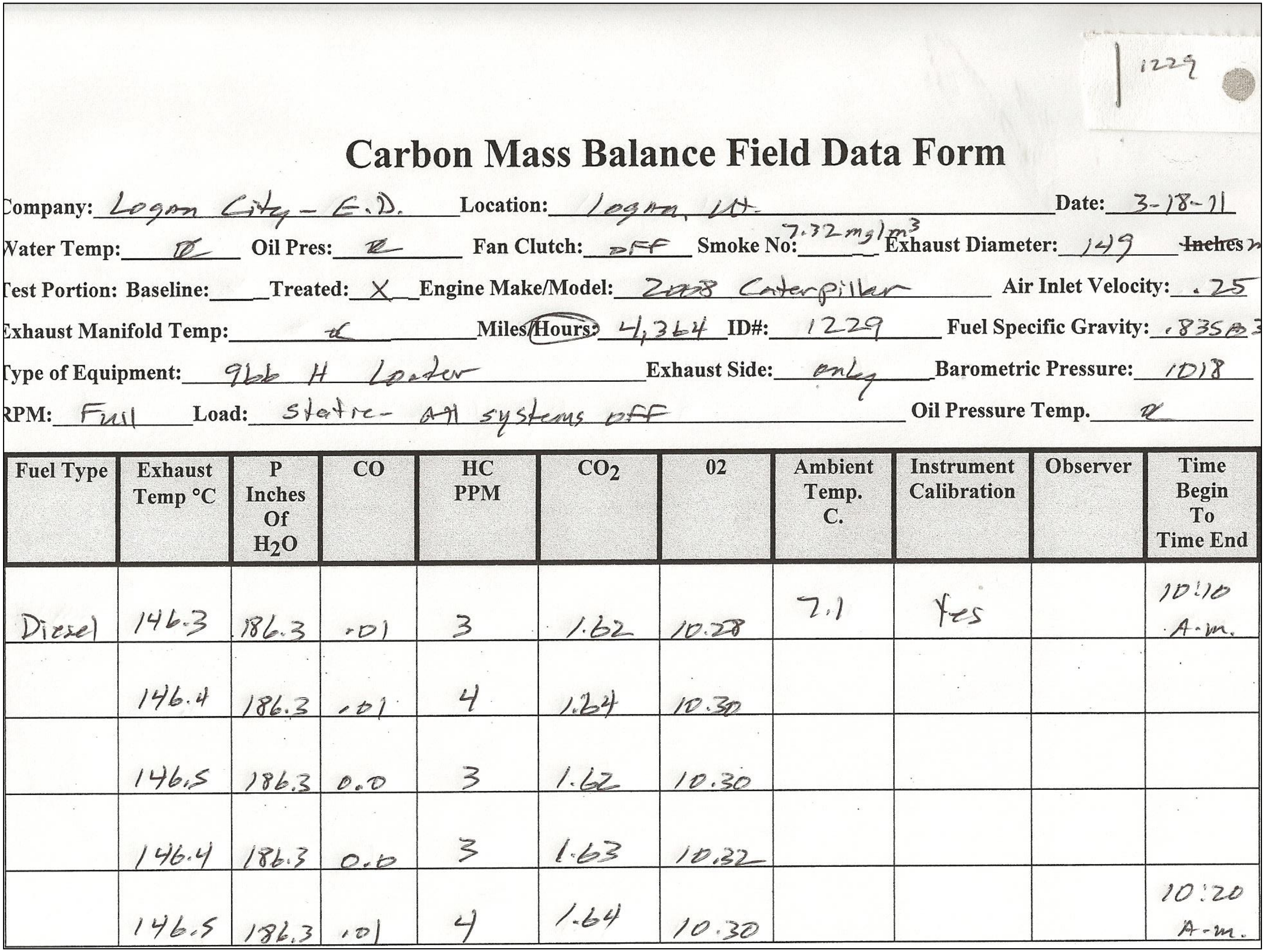
Test Portion: Baseline: X Treated: ____ Engine Make/Model: 2008 Caterpillar Air Inlet Velocity: .25

Exhaust Manifold Temp: 0 Miles/[✓ Hours]: 4,159 ID#: 1229 Fuel Specific Gravity: .835@3

Type of Equipment: 966 H Loader Exhaust Side: Only Barometric Pressure: 1017

RPM: Full Load: Static - All systems off Oil Pressure Temp. 0

Fuel Type	Exhaust Temp °C	P Inches Of H_2O	CO	HC PPM	CO_2	02	Ambient Temp. C.	Instrument Calibration	Observer	Time Begin To Time End
Diesel	146.7	186.8	.01	6	1.72	10.36	7.4	Yes		12:07 p.m.
	146.6	186.8	.01	7	1.74	10.34				
	146.6	186.8	.01	6	1.76	10.36				
	146.7	186.8	.01	6	1.73	10.32				
	146.7	186.8	.01	7	1.72	10.34				12:17 p.m.



1229

Carbon Mass Balance Field Data Form

Company: Logan City - E.D. Location: Logan, Ut. Date: 3-18-11

Water Temp: 0 Oil Pres: 0 Fan Clutch: off Smoke No: 7.32 mg/m^3 Exhaust Diameter: 149 ~~Inches~~ m

Test Portion: Baseline: ___ Treated: X Engine Make/Model: 2008 Caterpillar Air Inlet Velocity: .25

Exhaust Manifold Temp: 0 [✓ Miles/Hours]: 4,364 ID#: 1229 Fuel Specific Gravity: .835

Type of Equipment: 966 H Loader Exhaust Side: only Barometric Pressure: 1018

RPM: Full Load: static - All systems off Oil Pressure Temp. 0

Fuel Type	Exhaust Temp °C	P Inches Of H_2O	CO	HC PPM	CO_2	02	Ambient Temp. C.	Instrument Calibration	Observer	Time Begin To Time End
Diesel	146.3	186.3	.01	3	1.62	10.28	7.1	Yes		10:10 A.m.
	146.4	186.3	.01	4	1.64	10.30				
	146.5	186.3	0.0	3	1.62	10.30				
	146.4	186.3	0.0	3	1.63	10.32				
	146.5	186.3	.01	4	1.64	10.30				10:20 A.m.

Appendix IV

Carbon Footprint Data

All calculations are estimates only and are not based on actual fuel consumption:

Calculation of Greenhouse Gas Reductions

Assumptions: **Fleet Average (Estimate)**

* Fuel Type = Diesel
*Annual Fuel Usage = 240,000 gallons, or 912,000 litres.
*Average 7.7% reduction in fuel usage with Fuel Factor Xfuel catalyst.

Discussion:

When fuel containing carbon is burned in an engine, there are emissions of carbon dioxide (CO_2) methane (CH_4), nitrous oxide (N_20), oxides of nitrogen (NO_x), carbon monoxide (CO), non methane volatile organic compounds (NMVOC's) and sulfur dioxide (SO_2). The amount of each gas emitted depends on the type and quantity of fuel used (the "activity"), the type of combustion equipment, the emissions control technology, and the operating conditions.

The International Greenhouse Partnerships Office section of the Federal Government Department of Science Industry and Technology has produced a workbook outlining how to calculate the quantities of greenhouse gas emissions and is accepted internationally as the accepted approach. The workbook illustrates an example of how to calculate the mass of CO_2 for example on page 21, Table 3.1 and Example 3.1:

> The CO_2 produced from burning 100 litres of diesel oil is calculated as follows:
>
> * the CO_2 emitted if the fuel is completely burned is 2.716 kg CO2/litre (see Appendix A, Table A1)
>
> * the oxidation factor for oil-derived fuels is 99% (see Table 3.1)
> Therefore, the CO_2 produced from burning 100 litres of fuel is:
>
> 100 litres x 2.716 kg CO_2/litre x .99 = 268.88 kg

Based on the above calculations, the Greenhouse gas reductions for C02 are as follows:

Test Data Basis	Fuel Usage litres	kg CO_2 per litre fuel	Oxidation Factor	System CO_2 kg	System CO_2 tonnes
"Baseline"	912,000	2.716	0.99	2,452,222	2,452
"Treated"	841,776	2.716	0.99	2,263,401	2,263
C02 reductions with Fuel Factor Xfuel catalyst				**188,821**	**189**

The reduction of C02 greenhouse emissions in the amount of 189 tonnes (208 U.S. tons) is significant! Carbon Dioxide accounts for approximately 99.6% of the total greenhouse gas emissions produced. In other words, when diesel oil is burned in an internal combustion engine, the CH4 and N20 emissions contribute less than 0.4% of the greenhouse emissions. This low level is typical of most fossil fuel combustion systems and often is not calculated.

However, by way of additional information, the reduction in CH_4 and $N_2$0 are calculated as follows:

CH_4 Emissions Reduction

* the specific energy content of the fuel is 36.7 MJ/liter (see Table A1), so the total energy in 100 litres is 3,670 MJ, or 3.67 GJ

* the CH_4 emissions factor for diesel oil used in an internal combustion engine is 4.0 g/GJ (see Table A2) so the total CH_4 emitted is 3.67 x 4 = 18.0g

"Baseline" [18.0g/100 litres] x [912,000] x [1kg/1000g] = 164.16 kg

"Treated" [18.0g/100 litres] x [841,776] x [1kg/1000g] = 151.52 kg

CH_4 Reduction = 12.64 kg

N_2O Emissions Reduction

* the N_2O emissions factor for diesel oil used in an internal combustion engine is 1,322 g/GJ so the total N2O emitted is 3.67 x 0.6 = 2.7 g

"Baseline" [2.7g/100 litres] x [912,000] x [1kg/1000g] = 24.62 kg

"Treated" [2.7g/100 litres] x [841,776] x [1kg/1000g] = 22.73 kg

N_2O Reduction = 1.89 kg

Appendix V

Emissions Reductions Averages

The averages for all emissions monitored during the Carbon Mass Balance test procedure are tabulated and are included in **Table III**. The Horiba analyzer used to monitor exhaust emissions was gas calibrated with a known reference gas before each scheduled test procedure. The emissions averages are tabulated based on segment type and unit. The data is as follows:

Table III

Baseline (Untreated) 1/7/2011

	<u>HC</u>	<u>C02</u>	<u>C0</u>
1037:	7.8 ppm	4.35%	.020%
1095:	16.8 ppm	4.14%	.020%
1099:	20.0 ppm	3.82%	.060%
1165:	8.4 ppm	2.17%	.010%
1229:	6.4 ppm	1.73%	.010%
Average:	**11.9 ppm**	**3.24%**	**.024%**

Catalyst Treated 3/18/2011

	<u>HC</u>	<u>C02</u>	<u>C0</u>
1037:	3.6 ppm	4.01%	.010%
1095:	9.8 ppm	3.85%	.014%
1099:	11.2 ppm	3.55%	.050%
1165:	5.2 ppm	1.97%	.000%
1229:	3.4 ppm	1.63%	.010%
Average:	**6.6 ppm**	**3.00%**	**.018%**
Pct. Change: **(Baseline to Treated)**	**- 44.5%**	**- 7.4%**	**- 25%**

The data for the entirety of the evaluation clearly documents reductions in carbon emissions fractions for the catalyst treated segment of the evaluation.