BEC/allwaste Field Trial of
of FPC-1 Fuel Performance Catalyst

Test conducted for BEC/allwaste
by
UHI Corporation
Provo, Utah
and
FPC Limited
Houston, Texas

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Abstract

This paper discusses the results of a field test conducted by BEC/allwaste, Birmingham, Alabama, to determine the economic and environmental benefits from fuel treatment with a unique combustion catalyst called FPC-1. The study was planned in cooperation with and approved by Mr. Frank Montgomery, Equipment Coordinator. The test was conducted by Mr. Mike Cencula, Purchasing Coordinator for BEC/allwaste, Mr. Craig Flinders, VP Tech Services for UHI Corporation, and Messrs. Mark Newman and David Doctor of FPC Limited. The study conducted on a fleet of Cat and Cummins powered trucks and front loaders concluded the following:

(1) All engines realized reductions in fuel consumption after FPC-1 fuel treatment. The fleet averaged a 11.63% reduction in fuel consumption.

(2) FPC-1 treated fuel combusted more completely than the standard diesel. Unburned hydrocarbons (measured as n-hexane) were reduced 22.2%.

(3) Smoke density was reduced 23.9% after FPC-1 fuel treatment.

These results verify substantial fuel cost savings and environmental benefits can be derived from FPC-1 use throughout the entire BEC/allwaste fleet operation. Along with the obvious fuel cost savings, maintenance cost reductions are inevitable with FPC fuel treatment. Smoke is simply soot, which is comprised of unburned fuel droplets. It is soot that builds up on critical engine components (injectors, valves, rings, seats, pistons, etc.) reducing engine efficiency and accelerating wear. That very fact that FPC reduces visible smoke attests to it's ability to prevent hard carbon (hardened soot) upon these critical engine components.

Motor oil will also stay carbon (soot) free longer, and thus maintain designed viscosity between oil changes. In this manner, abrasion wear of bearings, liners and rings is reduced.

The paper also discusses a unique, recognized test method for determining the benefits of FPC-1 in the field. The method is known as the carbon mass balance, which is central to the EPA standardized Federal Test Procedures and Highway Fuel Economy Test. The method uses exhaust gas analysis under steady-state engine operation to determine both fuel consumption and exhaust emissions.

I. Introduction

FPC-1 Fuel Performance Catalyst is a burn rate modifier or catalyst, proven to reduce fuel consumption and increase engine horsepower in several recognized, independent laboratory tests, and dozens of independent field trials. The catalyst also has a remarkable impact upon the products of incomplete combustion that are regulated by emissions reduction legislation (smoke and carbon monoxide).

The intent of the trial by BEC/allwaste was to determine the degree of fuel consumption, and emissions reduction resulting from the addition of the FPC-1 catalyst to the blended diesel fueling a select fleet of compression-ignition engine powered buses. The test methodology for determining fuel consumption is the carbon mass balance (cmb). The cmb method measures the carbon containing products of the combustion process (CO_2, CO, HC) found in the exhaust, rather than directly measuring fuel flow into the engine. Also, while conducting the cmb procedure, a Bacharach Smoke Spot method is used to determine smoke density in the exhaust of the diesel powered equipment.

This report summarizes the results of baseline and FPC-1 treated fuel consumption and emissions data, and computes and compares the mass flow rates (engine performance factors or PFs) for the same.

II. Discussion of Carbon Mass Balance Method

The carbon mass balance eliminates virtually all of the variables associated with field testing for fuel consumption changes. The method requires no modifications to fuel lines or engines, and can be conducted in a short period of time at minimal expense.

Instead of measuring fuel flow into the engine (ie., the weight or volume of the fuel), measurements are made of the exhaust gases leaving the engine. More precisely, the carbon containing gases in the exhaust are measured. The method is based upon the Law of Conservation of Matter, which states that atoms can neither be created nor destroyed. Since the engines only source of carbon is the fuel it consumes, the carbon measured in the exhaust must come from the fuel. By measuring the carbon going out of the engine in the form of products of combustion, the amount of carbon entering the engine can be determined.

Carbon Balance Calculation

The carbon leaving the engine is mainly in the form of carbon dioxide (CO_2), carbon monoxide (CO), unburned hydrocarbons (HC), and particulate (smoke). By collecting this data while the engine is operating at a given load and speed, the fuel flow rate into the engine can be accurately determined. When engine load and speed, along with other factors influencing fuel consumption are reproduced and/or monitored to make appropriate corrections, the carbon balance can be used to confidently determine changes in fuel consumption that might result from the use of a fuel catalyst, such as FPC-1.

With the carbon balance, engine efficiency is expressed in terms of engine performance factors. To calculate any change in engine performance, separate measurements are made with the engine running on base fuel (untreated) and FPC-1 treated fuel. Any changes are stated as percentage changes from the baseline.

A copy of the carbon balance equations is found on Figure 1 (Appendix 5). A sample calculation for illustration purposes is also attached (see Figure 2, Appendix 5). Additionally, the carbon balance can be used to determine the effect of FPC-1 upon harmful emissions, such as carbon monoxide and smoke.

III. Instrumentation

Precision, state-of-the-art instrumentation is 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 purposes are listed below:

1) A Sun Electric SGA-9000 non-dispersive infrared (NDIR) four gas analyzer - measures the volume percent of CO2, CO, and oxygen (O2) in the exhaust, and the parts per million (ppm) of HC.

2) EPA I/M Calibration Gases - known gases used internally to calibrate the NDIR analyzer.

3) A twenty (20) foot sampling train and stainless steel exhaust gas probe - inserted into the engine exhaust pipe and used to draw a sample of exhaust gases to the analyzer.

4) A Fluke Model 52 hand held digital thermometer and wet/dry thermocouple probe - measures exhaust, ambient, and fuel temperature.

5) A Dwyer Magnehelic 2000 Series Pressure Gauge and pitot tube - measures exhaust air velocity and/or pressure.

6) A Monarch Contact/Noncontact digital tachometer and magnetic tape - measures engine rpm when dash mounted tachometers are unavailable.

7) A hydrometer and flask - determines fuel specific gravity (density).

8) Barometric pressure is acquired from local airport or weather station.

9) A Bacharach Truespot Smokemeter - for smoke density determination.

Except for engine speed, fuel density, and ambient readings, all data are collected by simply inserting probes into the exhaust stream while the engine is running at a fixed rpm and load, and the vehicle is stationary. No modifications or device installations are made to the fuel system, nor are normal equipment work cycles disrupted.

IV. Technical Approach

The following technical approach was observed during both test segments:

1) All instruments are calibrated according to accepted protocol.

2) A sample of fuel is drawn from the fuel tank on each piece of equipment. Using a hydrometer and wet/dry temperature probe, fuel specific gravity and temperature are recorded.

3) Each piece of equipment to be tested is parked, brakes locked, and run out-of-gear at a specific engine speed (RPM) until engine water, oil, and exhaust temperature, and exhaust pressure have stabilized. Engine speed is controlled using either a hand held phototach, or the tachometer in the cab, and either a Snap-On throttle lock, a high idle switch, or the programmable computer onboard the truck or bus.

4) Engine hours (or mileage) are taken from hour meters or odometers installed on the equipment.

5) After engine stabilization, the exhaust gas sampling probe is inserted into the exhaust stream. The Autocal button is depressed and after the LED readouts clear, test personnel take multiple readings of carbon dioxide, carbon monoxide, unburned hydrocarbons, and oxygen, along with engine speed, exhaust temperature and pressure. Smoke readings are taken on the diesel engines after exhaust gas testing.

6) Periodically, ambient air temperature, atmospheric pressure, and relative humidity are recorded. Temperature readings are taken at the test site. Other ambient readings are acquired from local weather information services.

7) All data are recorded until technicians are confident the information is consistent and reproducible.

8) After completing the baseline, the test fleet fuel was treated with FPC-1. All equipment operated as normal for approximately 400 to 500 hours, at which time the above procedure was reproduced without alteration, except FPC-1 fuel treatment in the test fleet.

V. Discussion

The data collected during the tests are summarized on the attached computer printouts (Appendix 1). From these data the volume fraction (VF) of each gas is determined and the average molecular weight (Mwt) of the exhaust gases computed. Next, the engine performance factor (pf) based upon the carbon mass in the exhaust is computed. The pf is finally corrected for intake air temperature and pressure (barometric), and total exhaust mass yielding a corrected engine performance factor (PF). The PFs for the diesel engines are tabulated on Table 1 of Appendix 3. The carbon monoxide percentages are tabulated on Table 2 of Appendix 3. The smoke spot (smoke density) numbers for the diesel engines are found on Table 3 of Appendix 3.

Fuel consumption was reduced by 11.6% in the BEC/allwaste study. This is a slightly larger change than observed in prior tests on similar equipment. The results are consistent from engine to engine, therefore, the confidence level in the results is high. However, it is most likely that the reduction in fuel consumption will be similar to that observed by other fleets under actual operating conditions (8% to 9%).

VI. Conclusions

(1) The addition of FPC-1 to the diesel fleet created an 11.63% reduction in fuel consumption.

(2) Unburned hydrocarbon emissions were reduced 22.2% on a fleet average basis.

(3) Smoke density was reduced 23.9% after FPC-1 fuel treatment.

Company Name:	BEC Allwaste	*Location:*	Birmingham		*Date:*	7/10/96
Test Portion:	Baseline	*Stack Diam.*	5	Inches		
Engine Type:	Cummins 400	*Mile/Hrs*	435249			
Equipment Type:		*ID #:*	1247		*Baro*	30.08
Fuel Sp. Gravity(SG	.850	*Temp:*	68			
					Time:	8:35

RPM	Exh Temp	Pv Inch	CO	HC	CO2	O2	
2200	381	1.05	0.04	36	1.86	18.3	
2200	382	1.05	0.04	35	1.86	19	
2200	381	1.05	0.04	36	1.86	19	
2200	382	1.05	0.04	35	1.83	18.9	
2200	382	1.05	0.04	35	1.83	18.9	
2200	383	1.05	0.04	36	1.86	19	
2200	383	1.05	0.04	37	1.84	19	
2200.000	**382.000**	**1.050**	**.040**	**35.714**	**1.849**	**18.871**	Mean
0	**.816**	**.000**	**.000**	**.756**	**.015**	**.256**	Std Dev

VFHC	VFCO	VFCO2	VFO2	Mtw1	pf1	PF1
3.57E-05	0.0004	.018	.189	29.053	339,177	405,879

Company Name:	BEC Allwaste	*Location:*	Birmingham		*Test Date:*	9/12/96
Test Portion:	Treated	*Stack Diam:*	5	Inches		
Engine Type:	Cummins 400	*Mile/Hrs:*	444766			
Equipment Type	Kenworth	*ID #:*	1247		*Baro:*	29.92
Fuel Sp. Gravity:	.850	*Temp:*	64			
SG Corr Factor:	1.000				*Time:*	7:40

RPM	Exh Temp	Pv Inch	CO	HC	CO2	O2	
2200	374.4	1.05	0.04	28	1.63	19.2	
2200	374	1.05	0.03	30	1.62	19.2	
2200	372.8	1.05	0.04	30	1.62	19.3	
2200	373.2	1.05	0.03	31	1.63	19.3	
2200	372	1.1	0.03	32	1.63	19.3	
2200	371.4	1.1	0.03	32	1.61	19.4	
2200.000	**372.967**	**1.067**	**.033**	**30.500**	**1.623**	**19.283**	Mean
0	**1.148**	**.026**	**.005**	**1.517**	**.008**	**.075**	Std Dev

VFHC	VFCO	VFCO2	VFO2	Mtw2	pf2	PF2
3.05E-05	0.000333333	.016	.193	29.033	386,513	455,214

Performance factor adjusted for fuel density: 455,214

****% Change PF= 12.16 %**

*** A positive change in PF equates to a reduction in fuel consumption.*

Company Name:	BEC Allwaste	*Location:*	Birmingham	*Date:*	7/10/96
Test Portion:	Baseline	*Stack Diam.*	5 Inches		
Engine Type:	Cat 3406	*Mile/Hrs*	112701		
Equipment Type:	Lo Boy	*ID #:*	4368	*Baro*	30.08
Fuel Sp. Gravity(SG	.845	*Temp:*	70		
				Time:	9:00

RPM	Exh Temp	Pv Inch	CO	HC	CO2	O2	
1800	309	0.5	0.01	8	1.68	19.1	
1800	310.4	0.5	0.01	7	1.65	19.1	
1800	311.4	0.5	0.01	9	1.65	19.1	
1800	311.2	0.5	0.01	10	1.64	19	
1800	312	0.55	0.01	10	1.64	19.3	
1800	312	0.55	0.01	10	1.67	19.3	
1800	313	0.55	0.01	10	1.65	19.3	
1800	313.4	0.55	0.01	10	1.66	19.2	
1800.000	**311.550**	**.525**	**.010**	**9.250**	**1.655**	**19.175**	Mean
0	**1.409**	**.027**	**.000**	**1.165**	**.014**	**.116**	Std Dev

VFHC	VFCO	VFCO2	VFO2	Mtw1	pf1	PF1
9.25E-06	0.0001	.017	.192	29.032	387,729	628,117

Company Name:	BEC Allwaste	*Location:*	Birmingham	*Test Date:*	9/12/96
Test Portion:	Treated	*Stack Diam:*	5 Inches		
Engine Type:	Cat 3406	*Mile/Hrs:*	121613		
Equipment Type	Lo Boy	*ID #:*	4368	*Baro:*	29.92
Fuel Sp. Gravity:	.844	*Temp:*	64		
SG Corr Factor:	1.001			*Time:*	8:00

RPM	Exh Temp	Pv Inch	CO	HC	CO2	O2	
1800	308.4	0.5	0.01	6	1.52	19.2	
1800	309.4	0.5	0.01	6	1.5	19	
1800	310.5	0.5	0.01	6	1.51	19.5	
1800	310.8	0.5	0.01	6	1.51	19.6	
1800	311.4	0.55	0.01	9	1.5	19.5	
1800	312.2	0.55	0.01	7	1.49	19.5	
1800	312.6	0.55	0.01	6	1.48	19.6	
1800.000	**310.757**	**.521**	**.010**	**6.571**	**1.501**	**19.414**	Mean
0	**1.492**	**.027**	**.000**	**1.134**	**.013**	**.227**	Std Dev

VFHC	VFCO	VFCO2	VFO2	Mtw2	pf2	PF2
6.57E-06	0.0001	.015	.194	29.017	427,231	692,271

Performance factor adjusted for fuel density: 693,090

****% Change PF= 10.34 %**

***** A positive change in PF equates to a reduction in fuel consumption.***

Company Name:	BEC Allwaste	*Location:*	Birmingham		*Date:*	7/10/96
Test Portion:	Baseline	*Stack Diam.*	4	Inches		
Engine Type:	Cat 3114	*Mile/Hrs*	5384			
Equipment Type:	Front End Loader	*ID #:*			*Baro*	30.08
Fuel Sp. Gravity(SG	.842	*Temp:*	70			
					Time:	9:30

RPM	Exh Temp	Pv Inch	CO	HC	CO2	O2	
2538	439	0.7	0.01	6	2.45	18.5	
2538	445.8	0.7	0.01	7	2.46	18.4	
2538	455	0.7	0.01	8	2.44	18.5	
2538	455	0.7	0.01	6	2.45	18.5	
2538	457.8	0.7	0.01	8	2.42	18.5	
2538	458	0.7	0.01	8	2.41	18.5	
2538	457	0.7	0.01	6	2.4	18.5	
2538.000	**452.514**	**.700**	**.010**	**7.000**	**2.433**	**18.486**	Mean
0	**7.283**	**.000**	**.000**	**1.000**	**.023**	**.038**	Std Dev

VFHC	VFCO	VFCO2	VFO2	Mtw1	pf1	PF1
7.00E-06	0.0001	.024	.185	29.129	265,605	633,193

Company Name:	BEC Allwaste	*Location:*	Birmingham		*Test Date:*	9/12/96
Test Portion:	Treated	*Stack Diam:*	4	Inches		
Engine Type:	Cat 3114	*Mile/Hrs:*				
Equipment Type	Front End Loader	*ID #:*			*Baro:*	29.92
Fuel Sp. Gravity:	.847	*Temp:*	62			
SG Corr Factor:	.994				*Time:*	9:00

RPM	Exh Temp	Pv Inch	CO	HC	CO2	O2	
Full	416.4	0.7	0.01	4	2.18	18.7	
Full	416.4	0.7	0.01	4	2.18	18.7	
Full	414.4	0.75	0.01	4	2.17	18.9	
Full	414.4	0.75	0.01	4	2.15	18.9	
Full	413.2	0.75	0.01	4	2.16	18.9	
Full	413.2	0.75	0.01	4	2.15	18.8	
Full	412.8	0.75	0.01	4	2.15	18.9	
Full	412.8	0.75	0.01	4	2.15	18.8	
#DIV/0!	**414.200**	**.738**	**.010**	**4.000**	**2.161**	**18.825**	Mean
#DIV/0!	**1.497**	**.023**	**.000**	**.000**	**.014**	**.089**	Std Dev

VFHC	VFCO	VFCO2	VFO2	Mtw2	pf2	PF2
4.00E-06	0.0001	.022	.188	29.099	298,717	677,261

Performance factor adjusted for fuel density: 673,239

****% Change PF= 6.32 %**

*** A positive change in PF equates to a reduction in fuel consumption.*

Company Name:	BEC Allwaste	*Location*	Birmingham	*Date:*	7/10/96
Test Portion:	Baseline	*Stack Diam.*	4 Inches		
Engine Type:	Cummins 5.9	*Mile/Hrs*	131507		
Equipment Type:	Ford Lube Truck	*ID #:*	1442	*Baro*	30.07
Fuel Sp. Gravity(SG	.845	*Temp:*	70		
				Time:	9:50

RPM	Exh Temp	Pv Inch	CO	HC	CO2	O2	
2500	381.4	1.25	0.03	9	1.79	18.9	
2500	377	1.25	0.03	10	1.8	18.9	
2500	378	1.25	0.03	10	1.78	18.8	
2500	379	1.25	0.03	9	1.78	19	
2500.000	**378.850**	**1.250**	**.030**	**9.500**	**1.788**	**18.900**	Mean
0	**1.886**	**.000**	**.000**	**.577**	**.010**	**.082**	Std Dev

VFHC	VFCO	VFCO2	VFO2	Mtw1	pf1	PF1
9.50E-06	0.0003	.018	.189	29.043	355,395	607,794

Company Name:	BEC Allwaste	*Location:*	Birmingham	*Test Date:*	9/12/96
Test Portion:	Treated	*Stack Diam:*	4 Inches		
Engine Type:	Cummins 5.9	*Mile/Hrs:*	139784		
Equipment Type	Ford Lube Truck	*ID #:*	1442	*Baro:*	29.92
Fuel Sp. Gravity:	.845	*Temp:*	62		
SG Corr Factor:	1.000			*Time:*	9:30

RPM	Exh Temp	Pv Inch	CO	HC	CO2	O2	
2500	374.4	1.25	0.03	6	1.53	19	
2500	385.4	1.25	0.03	6	1.53	18.9	
2500	371	1.25	0.03	6	1.53	19.3	
2500	375.4	1.35	0.03	7	1.52	19.2	
2500	379.6	1.35	0.03	8	1.52	19.2	
2500.000	**377.160**	**1.290**	**.030**	**6.600**	**1.526**	**19.120**	Mean
0	**5.534**	**.055**	**.000**	**.894**	**.005**	**.164**	Std Dev

VFHC	VFCO	VFCO2	VFO2	Mtw2	pf2	PF2
6.60E-06	0.0003	.015	.191	29.009	414,909	696,040

Performance factor adjusted for fuel density: 696,040

****% Change PF= 14.52 %**

***** A positive change in PF equates to a reduction in fuel consumption.***

Company Name:	BEC Allwaste	*Location*	Birmingham	*Date:*	7/10/96
Test Portion:	Baseline	*Stack Diam.*	5 Inches		
Engine Type:	Cat 3406-B	*Mile/Hrs*	393677		
Equipment Type:	Lo Boy	*ID #:*	9354	*Baro*	30.07
Fuel Sp. Gravity(SG	.844	*Temp:*	72		
				Time:	10:00

RPM	Exh Temp	Pv Inch	CO	HC	CO2	O2	
1855	309	0.35	0.02	8	1.31	19.4	
1855	312.8	0.35	0.02	8	1.29	19.4	
1855	319	0.35	0.02	7	1.29	19.4	
1855	319	0.35	0.02	7	1.31	19.4	
1855	320	0.35	0.02	8	1.33	19.4	
1855	320	0.35	0.02	8	1.32	19.4	
1855.000	**316.633**	**.350**	**.020**	**7.667**	**1.308**	**19.400**	Mean
0	**4.622**	**.000**	**.000**	**.516**	**.016**	**.000**	Std Dev

VFHC	VFCO	VFCO2	VFO2	Mtw1	pf1	PF1
7.67E-06	0.0002	.013	.194	28.986	485,152	965,584

Company Name:	BEC Allwaste	*Location:*	Birmingham	*Test Date:*	9/12/96
Test Portion:	Treated	*Stack Diam:*	5 Inches		
Engine Type:	Cat 3406-B	*Mile/Hrs:*	402736		
Equipment Type	Lo Boy	*ID #:*	9354	*Baro:*	29.92
Fuel Sp. Gravity:	.850	*Temp:*	62		
SG Corr Factor:	.993			*Time:*	10:20

RPM	Exh Temp	Pv Inch	CO	HC	CO2	O2	
1865	304.4	0.35	0.02	7	1.1	19.7	
1865	307.4	0.35	0.02	7	1.09	19.6	
1865	310.8	0.35	0.02	6	1.09	19.7	
1865	311.8	0.35	0.02	6	1.09	19.7	
1850	316.8	0.4	0.02	6	1.07	19.8	
1850	314	0.4	0.02	6	1.07	19.8	
1850	313.4	0.4	0.02	5	1.08	19.8	
1850	313.2	0.4	0.02	5	1.07	19.8	
1857.500	**311.475**	**.375**	**.020**	**6.000**	**1.083**	**19.738**	Mean
8.017837257	**3.939**	**.027**	**.000**	**.756**	**.012**	**.074**	Std Dev

VFHC	VFCO	VFCO2	VFO2	Mtw2	pf2	PF2
6.00E-06	0.0002	.011	.197	28.963	584,194	1,116,746

Performance factor adjusted for fuel density: 1,108,807

****% Change PF= 14.83 %**

***** A positive change in PF equates to a reduction in fuel consumption.***

APPENDIX 3

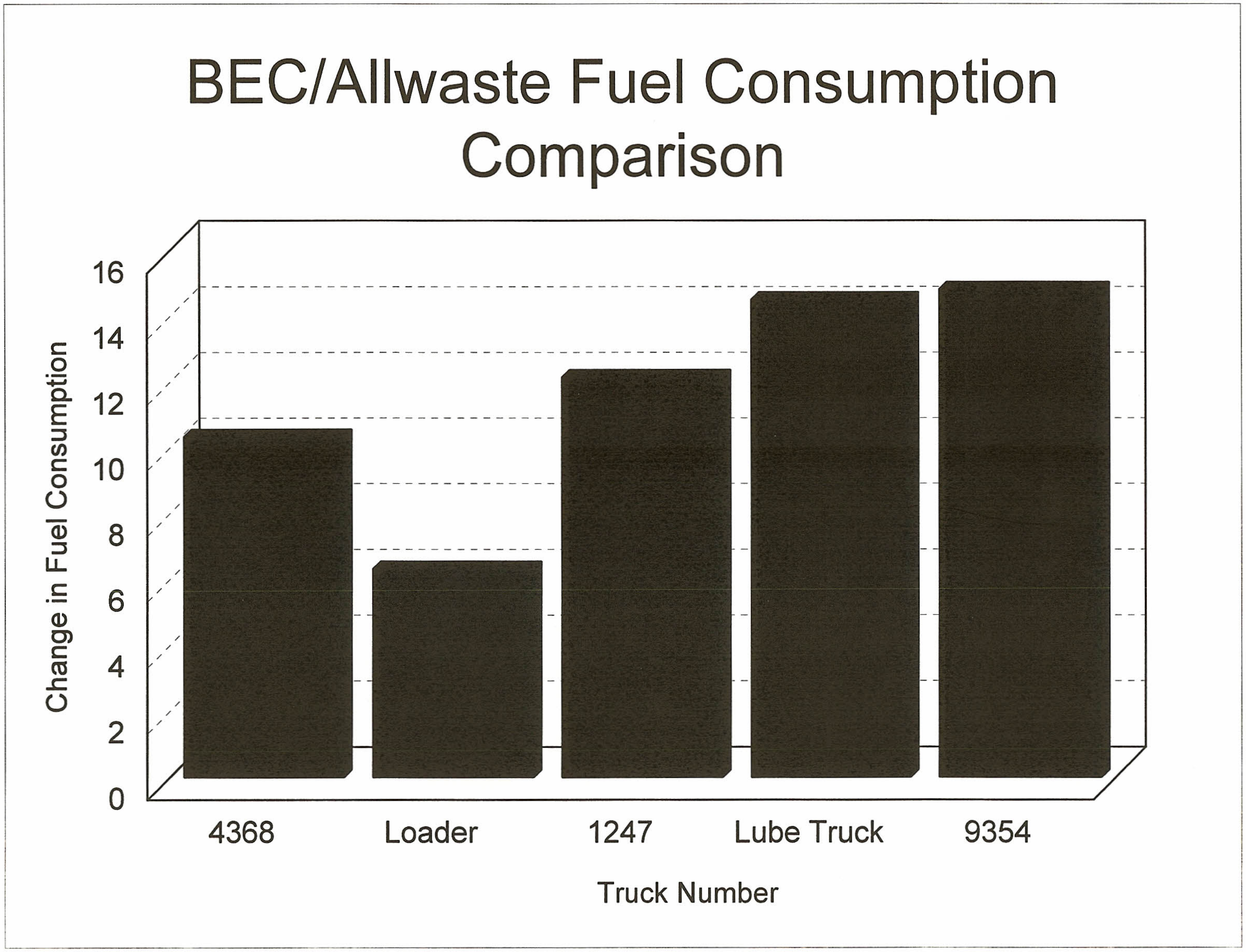
Table 1. Changes in Fuel Flow Rate (PFs)

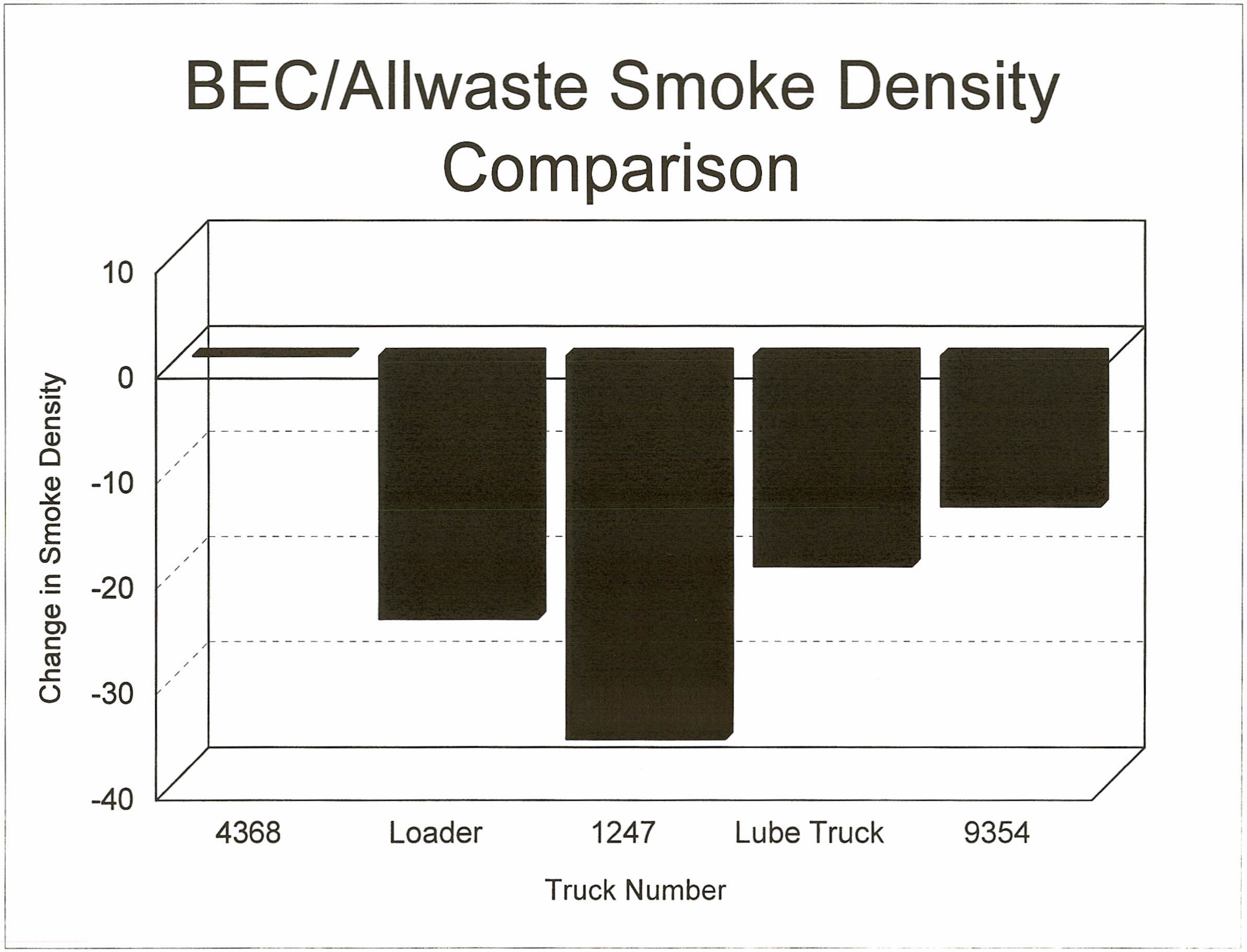
Unit #	Base PF	FPC PF	% Change
4368	628,117	693,090	10.34
Loader	633,193	673,239	6.32
1247	405,879	455,214	12.16
Lube Truck	607,794	696,040	14.52
9354	965,584	1,108,807	14.83
		Fleet Average:	11.63

Note: An increase in PF equals a reduction in fuel consumption since the PF is a measure of the length of time required to consumed the same amount of fuel. The more efficient the engine, the longer it takes to consume the same amount of fuel, so the PF is higher.

Table 2. Changes in Smoke Density (Smoke Spot Numbers)

Unit #	Base No.	FPC No.	% Change
4368	na	4.0	na
Loader	4.0	3.0	-25.0
1247	5.5	3.5	-36.4
Lube Truck	5.0	4.0	-20.0
9354	7.0	6.0	-14.3
		Fleet Average:	**-23.9**


BEC/Allwaste Fuel Consumption Comparison
Change in Fuel Consumption
16
14
12
10
8
6
4
2
0
4368
Loader
1247
Lube Truck
9354
Truck Number


BEC/Allwaste Smoke Density
Comparison
10
0
-10
-20
-30
-40
Change in Smoke Density
4368
Loader
1247
Lube Truck
9354
Truck Number

APPENDIX 4

Figure 1
CARBON MASS BALANCE FORMULAE

ASSUMPTIONS: $C_{12}H_{26}$ and SG = 0.82
Time is constant
Load is constant

DATA:

Mwt = Molecular Weight
pf1 = Calculated Performance Factor (Baseline)
pf2 = Calculated Performance Factor (Treated)
PF1 = Performance Factor (adjusted for Baseline exhaust mass)
PF2 = Performance Factor (adjusted for Treated exhaust mass)
CFM = Volumetric Flow Rate of the Exhaust
SG = Specific Gravity of the Fuel
VF = Volume Fraction
d = Exhaust stack diameter in inches
Pv = Velocity pressure in inches of H_20
P_B = Barometric pressure in inches of mercury
Te = Exhaust temperature ^{O}F
VFHC = "reading" ÷ 1,000,000
VFCO = "reading" ÷ 100
$VFCO_2$ = "reading" ÷ 100
VFO_2 = "reading" ÷ 100

EQUATIONS:

Mwt =

$$(VFHC)(86)+(VFCO)(28)+(VFCO_2)(44)+(VFO_2)(32)+[(1-VFHC-VFCO-VFCO_2-VFO_2)(28)]$$

pf1 or pf2 =

$$\frac{3099.6 \times Mwt}{86(VFHC)+13.89(VFCO)+13.89(VFCO_2)}$$

CFM =

$$\frac{(d/2)^2\pi}{144}\left(1096.2\sqrt{\frac{Pv}{1.325(PB/ET+460)}}\right)$$

PF1 or PF2 =

$$\frac{pf \times (Te+460)}{CFM}$$

FUEL ECONOMY:
PERCENT INCREASE (OR DECREASE)

$$\frac{PF2 - PF1}{PF1} \times 100$$

Figure 2.

SAMPLE CALCULATION FOR THE CARBON MASS BALANCE

BASELINE:

Equation 1 (Volume Fractions)

$$VFHC = 13.20/1{,}000{,}000 = 0.0000132$$

$$VFCO = 0.017/100 = 0.00017$$

$$VFCO_2 = 1.937/100 = 0.01937$$

$$VFO_2 = 17.10/100 = 0.171$$

Equation 2 (Molecular Weight)

$$Mwt1 = (0.0000132)(86)+(0.00017)(28)+(0.01937)(44)+(0.171)(32) + [(1-0.0000132-0.00017-0.01937-0.171)(28)]$$

$$Mwt1 = 28.995$$

Equation 3 (Calculated Performance Factor)

$$pf1 = \frac{3099.6 \times 28.995}{86(0.0000132)+13.89(0.00017)+13.89(0.01937)}$$

$$pf1 = 329{,}809$$

Equation 4 (CFM Calculations)

$$CFM = \frac{(d/2)^2\pi}{144}\left(1096.2\sqrt{\frac{Pv}{1.325(PB/ET+460)}}\right)$$

d =Exhaust stack diameter in inches
Pv =Velocity pressure in inches of H_20
P_B =Barometric pressure in inches of mercury
Te =Exhaust temperature ^oF

$$CFM = \frac{(10/2)^2\pi}{144}\left(1096.2\sqrt{\frac{.80}{1.325(30.00/313.100+460)}}\right)$$

CFM =2358.37

Equation 5 (Corrected Performance Factor)

$$PF1 = \frac{329{,}809(313.1 \text{ deg F} + 460)}{2358.37 \text{ CFM}}$$

PF1 = 108,115

TREATED:

Equation 1 (Volume Fractions)

VFHC = 14.6/1,000,000
= 0.0000146

VFCO = .013/100
= 0.00013

$VFCO_2$ = 1.826/100
= 0.01826

VFO_2 = 17.17/100
= 0.1717

Equation 2 (Molecular Weight)

Mwt2 $= (0.0000146)(86) + (0.00013)(28) + (0.01826)(44) + (0.1717)(32) + [(1-0.0000146-0.00013-0.01826-0.1717)(28)]$

Mwt2 $= 28.980$

Equation 3 (Calculated Performance Factor)

$$pf2 = \frac{3099.6 \times 28.980}{86(0.0000146) + 13.89(0.00013) + 13.89(0.01826)}$$

pf2 $=$ 349,927

Equation 4 (CFM Calculations)

$$CFM = \frac{(d/2)^2 \pi}{144}\left(1096.2\sqrt{\frac{Pv}{1.325(PB/ET+460)}}\right)$$

d =Exhaust stack diameter in inches
Pv =Velocity pressure in inches of H_2O
P_B =Barometric pressure in inches of mercury
Te =Exhaust temperature ^{o}F

$$CFM = \frac{(10/2)^2 \pi}{144}\left(1096.2\sqrt{\frac{.775}{1.325(29.86/309.02+460)}}\right)$$

CFM = 2320.51

Equation 5 (Corrected Performance Factor)

$$PF2 = \frac{349{,}927(309.02 \text{ deg F} + 460)}{2320.51 \text{ CFM}}$$

= 115,966

Fuel Specific Gravity Correction Factor

Baseline Fuel Specific Gravity - Treated Fuel Specific Gravity/Baseline Fuel Specific Gravity +1

.840-.837/.840+1=1.0036

PF2 = 115,966 x Specific Gravity Correction

PF2 = 115,966 x 1.0036

PF2 = 116,384

Equation 6 (Percent Change in Engine Performance Factor:)

$$\% \text{ Change PF} = \frac{PF2 - PF1}{PF1} \times 100$$

$$\% \text{ Change PF} = [(116{,}384 - 108{,}115)/108{,}115](100)$$

$$= +7.65$$

Note: A positive change in PF equates to a reduction in fuel consumption.

APPENDIX 2

TERRY CALLIS

Carbon Mass Balance Field Data Form

Company: BEC Allwest Location: B-han Test Date: 7/10/96

Test Portion: Baseline:________ Treated:________ Exhaust Stack Diameter: 4 Inches

Engine Make/Model: Cum 5.9 Miles/Hours: 131507 I.D.#: 1442

Type of Equipment: Ford lub truck

Water temp center

Fuel Specific Gravity: .845 @:________ (°F)

Barometric Pressure: ________ Inches of Mercury

Intake Air Temperature: ________ (°F) Start Time: 9:50

AC on

~~Fan On~~ fan off

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	Smoke Number
2500	381.4	1.25	.03	9	1.79	18.9	5
	377	1.25	.03	9	1.67	18.9	
		1.25	.03	10	1.80	18.9	
	378	1.25	.03	10	1.79	18.8	
			.03	10	1.73	19.1	
	379		.03	9	1.78	19.	

End Time: 10:05

Names of Customer Personnel Participating in Test:

________________ ________________

Signature of Technicians:

FT-12

Carbon Mass Balance Field Data Form

Company: BEC Allwaste Location: B-ham Test Date: 7/10/96
Test Portion: Baseline: X Treated: ______ Exhaust Stack Diameter: 4 Inches

Engine Make/Model: Cat 3114 Miles/Hours: 5384 I.D.#: ______
Type of Equipment: Front end loader

water temp 165 F

Fuel Specific Gravity: .842 @: ______ (°F)
Barometric Pressure: ______ Inches of Mercury
Intake Air Temperature: ______ (°F) Start Time: ______

AC off

All the way (2538 RPM Rustic)

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	Smoke Number
	439	.7 ~~.07~~	.01	6	2.45	18.5	4
	445.8		.01	7	2.46	18.4	
	455		.01	8	2.44	18.5	
	455	.7 ~~.07~~	.01	6	2.45	18.5	
	457.8		.01	8	2.42	18.5	
	458	.7	.01	8	2.41	18.5	
	457		.01	6	2.40	18.5	

End Time ______

Names of Customer Personnel Participating in Test:

______ ______

Signature of Technicians:

Carbon Mass Balance Field Data Form

Company: BEC Allwaste Location: B-ham Test Date: 7/10/96
Test Portion: Baseline: X Treated: ___ Exhaust Stack Diameter: ___ Inches

Engine Make/Model: Cat 3406-B Miles/Hours: 393677 I.D.#: 9354
Type of Equipment: 10 bay FORD

Fuel Specific Gravity: .844 @: ___ (°F)
Barometric Pressure: ___ Inches of Mercury
Intake Air Temperature: ___ (°F) Start Time: ___

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	Smoke Number
1855	308	.35	.03	8	1.37	19.4	7
	309		.02	8	1.31	19.4	
	311		.02	8	1.35	19.4	
	312.8	.35	.02	8	1.29	19.4	
	319		.02	7	1.29	19.4	
	319		.02	7	1.31	19.4	
	320	.35	.02	8	1.33	19.4	
	320		.02	8	1.32	19.4	

Fan off
AC off

End Time ___

Names of Customer Personnel Participating in Test:

___ ___

Signature of Technicians:

LARRY

Carbon Mass Balance Field Data Form

Company: BEC Allwash Location: B'ham Test Date: 7/10/96
Test Portion: Baseline: X Treated: ___ Exhaust Stack Diameter: 4 Inches 5
Engine Make/Model: Kenworth 3176 Cat. Miles/Hours: 19521 I.D.#: 303635
Type of Equipment: 3406

FAN RUNNING

Fuel Specific Gravity: .84 @: ______ (°F)
Barometric Pressure: ______ Inches of Mercury
Intake Air Temperature: ______ (°F) Start Time: 8:00

H_2O ~180°

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	Smoke Number
2000	342	.7	.01	6	1.73	19.	4
	340	.7	.01	8	1.73	18.9	
	339	.7	.01	5	1.72	19.2	
	339	.7	.01	5	1.72	19.0	
	338	.7	.01	5	1.72	19.3	
	338	.75	.01	5	1.73	19.3	
	338	.7	.01	5	1.73	19.2	

AC on
fax on

End Time 4:30

1-WADE
2-JAMES
3-LARRY
4-FORD

Names of Customer Personnel Participating in Test:

______________________ ______________________

Signature of Technicians:

Carbon Mass Balance Field Data Form

James

Company: B Allwaste Location: B-ham Test Date: 7/10/96
Test Portion: Baseline: X Treated: ___ Exhaust Stack Diameter: ___ Inches

Engine Make/Model: Cat ~~3176~~ 3406 Miles/Hours: 112701 I.D.#: 4368
Type of Equipment: ___

Fuel Specific Gravity: .845 @: ___ (°F)
Barometric Pressure: ___ Inches of Mercury
Intake Air Temperature: ___ (°F) Start Time: 9:00

fax on AC On

Water temp 190

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	Smoke Number
1800	309	.5	.01	8	1.68	19.1	
	310.4		.01	7	1.65	19.1	
	311.4	.5	.01	9	1.65	19.1	
	311.2		.01	10	1.64	19.1	
	312.0	.55	.01	10	1.64	19.3	
	312		.01	10	1.67	19.3	
	313	.55	.01	10	1.65	19.3	
	313.4		.01	10	1.66	19.2	

End Time ___

Names of Customer Personnel Participating in Test:

___ ___

Signature of Technicians:

WADE

Carbon Mass Balance Field Data Form

Company: BEC All Location: B-ham Test Date: 7/10/96
Test Portion: Baseline: X Treated: ____ Exhaust Stack Diameter: 5 Inches

Engine Make/Model: Cumm 400 Miles/Hours: 435249 I.D.#: 1247
Type of Equipment: KENWORTH

Fuel Specific Gravity: .85 @: ______ (°F)
Barometric Pressure: ______ Inches of Mercury
Intake Air Temperature: ______ (°F) Start Time: 8:35

AC off

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	Smoke Number
2200	381.4	1.05	.04	35	1.91	18	5.5
	381	1.05	.04	36	1.86	18.3	
	382	1.05	.04	35	1.86	19.0	
	381	1.05	.04	36	1.86	19.0	
	382	1.05	.04	35	1.83	18.9	
	382	1.05	.04	35	1.83	18.9	
	383	1.05	.04	36	1.86	19.0	
	383	1.05	.04	37	1.84	19.0	

Water temp 160
Oil temp 140
Fan on

End Time: 8:50

Names of Customer Personnel Participating in Test:

______________________ ______________________

Signature of Technicians:

Carbon Mass Balance Field Data Form

Company: Bec/ALLWASTE Location: Birmingham Test Date: 9-12-96
Test Portion: Baseline: ______ Treated: ______ Exhaust Stack Diameter: ___ Inches

Engine Make/Model: CAT 3406-B Miles/Hours: 402736 I.D.#: 9354
Type of Equipment: LoBoy FORD

Fuel Specific Gravity: .850 @: ______ (°F)
Barometric Pressure: ______ Inches of Mercury
Intake Air Temperature: ______ (°F) Start Time: ______

FAN-OFF
AC-OFF

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	Smoke Number
1865	304.4	.35	.02	7	1.10	19.7	6.0
⊥	307.4	.35	.02	7	1.09	19.6	
1865	310.8	.35	.02	6	1.09	19.7	
⊥	311.8	.35	.02	6	1.09	19.7	
1850	316.8	.40	.02	6	1.07	19.8	
⊥	314.0	.40	.02	6	1.07	19.8	
1850	313.4	⊥	.02	5	1.08	19.8	
⊥	313.2	⊥	.02	5	1.07	19.8	

End Time ______

Names of Customer Personnel Participating in Test:

______ ______

Signature of Technicians:

Carbon Mass Balance Field Data Form

Company: BEC/ALLWASTE Location: Birmingham Test Date: 9-12-96
Test Portion: Baseline: ______ Treated: X Exhaust Stack Diameter: 5 Inches

Engine Make/Model: Cummings 400 Miles/Hours: 444766 I.D.#: 1247
Type of Equipment: KENWORTH

Fuel Specific Gravity: .85 @: ______ (°F)
Barometric Pressure: ______ Inches of Mercury
Intake Air Temperature: ______ (°F) Start Time: 7:40 AM

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	Smoke Number
2200	374.4	1.05	.104	28	1.63 ~~1.7~~	19.2	3.5
	374.	1.05	.103	30	1.62	19.2	
	372.8	1.05	.04	30	1.62	19.3	
	373.2	1.05	.103	31	1.63	19.3	
	372.	1.10	.103	32	1.63	19.3	
	371.4	1.10	.03	32	1.61	19.4	

A/C OFF
FAN - ON
W/TEMP 160°F
Oil Temp 140°F

End Time 8:10 A

Names of Customer Personnel Participating in Test:

WADE

Signature of Technicians:

Carbon Mass Balance Field Data Form

Company: BEC/ ALLWAY Location: Birmingham Test Date: 9-12-96
Test Portion: Baseline:_____ Treated:_____ Exhaust Stack Diameter: ___ Inches

Engine Make/Model: Cummins 5.9 Miles/Hours: 139784 I.D.#: 1042
Type of Equipment: FORD LUBE

Fuel Specific Gravity: .845 @:_____ (°F)
Barometric Pressure: _____ Inches of Mercury
Intake Air Temperature: _____ (°F) Start Time:_____

WATER TEMP CENTER

AC-ON

FAN-OFF

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	Smoke Number
2500	374.4	1.25	.02	6	1.55	19.0	4
	385.4		.02	6	1.53	18.9	
	371.0		.03	6	1.53	19.3	
	375.4	1.35	.03	7	1.52	19.2	
	375.4	1.35	.03	8	1.55	19.2	
	379.4	1.35	.03	8	1.52	19.2	
	379.0	1.35	.03	7	1.56	19.2	

End Time 10:20A

Names of Customer Personnel Participating in Test:

TERRY CAUDLE

Signature of Technicians:

Carbon Mass Balance Field Data Form

Company: BEC/ALLWASTE Location: Birmingham Test Date: 9-12-96

Test Portion: Baseline:________ Treated:______ Exhaust Stack Diameter: ___Inches

Engine Make/Model: CAT 3114 Miles/Hours: 5490 I.D.#:________

Type of Equipment: IT-12

Fuel Specific Gravity: .847 @:________ (°F)

Barometric Pressure: ________ Inches of Mercury

Intake Air Temperature: ________ (°F) Start Time:________

Water Temp 180°F

A.C. OFF

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	Smoke Number
FULL	416.4	.7	.01	4	2.18	18.7	3
	416.4	⊥	.01	4	2.18	18.7	
	414.4	.75	.01	4	2.17	18.9	
	414.4	⊥	.01	4	2.15	18.9	
	413.2	.75	.01	4	2.16	18.9	
	413.2	⊥	.01	4	2.15	18.8	
	412.8	.75	.01	4	2.15	18.9	
⊥	412.8	⊥	.01	4	2.15	18.8	

End Time________

Names of Customer Personnel Participating in Test:

________________ ________________

Signature of Technicians:

Carbon Mass Balance Field Data Form

Company: BEC/ALLWASTE Location: Birmingham Test Date: 9-12-96
Test Portion: Baseline: ________ Treated: ________ Exhaust Stack Diameter: ___ Inches

Engine Make/Model: CAT 3406 Miles/Hours: 121613 I.D.#: 4368
Type of Equipment: ________

Fuel Specific Gravity: .844 @: ________ (°F)
Barometric Pressure: ________ Inches of Mercury
Intake Air Temperature: ________ (°F) Start Time: ________

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	Smoke Number
1800	308.4	0.50	.01	6	1.52	19.2	4
1800	309.4	0.50	.01	6	1.50	19.0	
1800	310.5	0.50	.01	6	1.51	19.5	
1800	310.8	0.50	.01	6	1.51	19.6	
1800	311.4	0.55	.01	9	1.50	19.5	
1800	312.2	0.55	.01	7	1.49	19.5	
1800	312.6	0.55	.01	6	1.48	19.6	

FAN-ON
AC-ON

End Time ________

Names of Customer Personnel Participating in Test:

JAMES

Signature of Technicians:

APPENDIX 5

WEATHERBANK, INC.

HIGH TECHNOLOGY SOLUTIONS TO CURRENT ENVIRONMENTAL CHALLENGES

Time	Pressure	Temp
12am	29.97	72
1am	29.98	72
2am	29.99	72
3am	29.99	71
4am	29.99	71
5am	30.01	69
6am	30.03	68
7am	30.05	65
8am	30.08	68
9am		No Report
10am		No Report
11am		No Report
12pm		No Report
1pm		No Report
2pm		No Report
3pm		No Report
4pm	30.06	85

Michael J. Ruocco
Information Management & Customer Service
WeatherBank, Incorporated

WBI1 More info on how to call up WeatherBank files
WIND How to get specific upper level wind forecasts
WWC How to obtain the NWS Weekly Crop outlook
ZONES How to obtain the new NWS state zone forecasts Interactively
800NET More information on the 800 network and prices
7DTF How to call up 7-day temperature forecasts

EXAMPLE:

HELP HOURLY Will call up help on the HOURLY command.

NOTES:
To download information about the WeatherBrief Software and how to obtain the service, type HELP INFO.
To control data flow, hit a <CONTROL> S to pause, and <CONTROL> Q to go.
To kill current command in a command file, hit a <CONTROL> X.
To abort transmission of any product, hit a single CONTROL C.
To recall last command, hit a <CONTROL> R.

STATION FILE: AL 09-12-08 GMT

DY-HR	TOWN	TMP	DEW	HUM	FLK	WIND GST	PRSSR	VSBLY-WX	CLOUD COVER
12-08A	*Muscle Shoal								
12-09A	*Muscle Shoal								
12-10A	*Muscle Shoal								
12-11A	Muscle Shoal	62	60	93	62	W 4	29.97	3 BR	SKC
12-12P	Muscle Shoal	60	60	100	60	W 4	29.98	3 BR	SKC
12-01P	Muscle Shoal	66	64	93	66	NW 4	29.98	3 BR	SKC
12-02P	Muscle Shoal	71	64	79	69	NW 5	29.98	5 HZ	SKC

DY-HR	TOWN	TMP	DEW	HUM	FLK	WIND GST	PRSSR	VSBLY-WX	CLOUD COVER
12-08A	Huntsville	62	62	100	62	N 0	29.93	5 BR	CLR
12-09A	Huntsville	60	60	100	58	NW 5	29.95	4 BR	CLR
12-10A	Huntsville	60	60	100	60	NW 4	29.96	7	CLR
12-11A	Huntsville	60	60	100	60	N 0	29.96	7	CLR
12-12P	Huntsville	60	60	100	60	N 0	29.98	7	CLR
12-01P	Huntsville	64	62	93	64	N 0	29.98	7	CLR
12-02P	Huntsville	69	62	79	69	N 0	29.98	6 HZ	CLR

DY-HR	TOWN	TMP	DEW	HUM	FLK	WIND GST	PRSSR	VSBLY-WX	CLOUD COVER
12-08A	Tuscaloosa	66	64	93	66	N 0	29.91	5 BR	SKC
12-09A	Tuscaloosa	64	64	100	64	N 0	29.91	4 BR	SKC
12-10A	Tuscaloosa	64	64	100	64	N 0	29.90	5 VCFG	SKC
12-11A	Tuscaloosa	64	62	93	64	N 0	29.90	5 BR	SKC
12-12P	Tuscaloosa	64	62	93	62	N 5	29.95	5 BR	SKC
12-01P	Tuscaloosa	68	64	87	66	N 5	29.96	6 BR	SKC
12-02P	Tuscaloosa	73	66	79	76	NE 5		7	SKC

DY-HR	TOWN	TMP	DEW	HUM	FLK	WIND GST	PRSSR	VSBLY-WX	CLOUD COVER
12-08A	Birmingham	64	62	93	64	N 0	29.92	8	SKC
12-09A	Birmingham	62	60	93	62	N 0	29.92	7	SKC
12-10A	Birmingham	62	60	93	62	N 0	29.92	7	SKC
12-11A	Birmingham	62	62	100	62	N 0	29.94	5 BR	SKC
12-12P	Birmingham	62	60	93	62	NE 3	29.95	4 BR	SKC
12-01P	Birmingham	66	64	93	66	N 0	29.96	4 BRHZ	SKC
12-02P	Birmingham	69	64	84	69	N 4	29.96	5 HZ	SKC

```
DY-HR      TOWN         TMP DEW HUM FLK WIND GST  PRSSR VSBLY-WX   CLOUD COVER
====== ============ === === === === ========  ===== ======== ===============
12-08A Anniston     64  64  100  64 N    0     29.90  3  BR        SKC
12-08A*Anniston     KANB 120842Z 00000KT 1/8SM FG VV001 18/18 A2991 RMK
                    SLP124
12-09A Anniston     64  64  100  64 N    0     29.91  0.1FG       1 VV
12-10A Anniston     64  64  100  64 N    0     29.91  0.1FG       1 VV
12-11A Anniston     64  64  100  64 N    0     29.91  0.1FG       1 VV
12-12P Anniston     62  62  100  62 N    0     29.94  0.1FG       1 VV
12-01P Anniston     64  64  100  64 N    0     29.95  0.1FG       2 VV
12-01P*Anniston     KANB 121325Z 00000KT 1/2 SM FG VV004 18/18 A2995 RMK
                    SLP141
12-02P Anniston     64  64  100  64 N    0     29.96  0.5FG       4 VV
12-02P*Anniston     KANB 121405Z 00000KT 1 1/2SM BR SCT005 19/19 A2995 RMK
                    SLP141
12-02P*Anniston     KANB 121411Z 00000KT 4SM BR HZ FEW008 20/20 A2996 RMK
                    SLP144

DY-HR      TOWN         TMP DEW HUM FLK WIND GST  PRSSR VSBLY-WX   CLOUD COVER
====== ============ === === === === ========  ===== ======== ===============
12-08A*Centreville
12-09A*Centreville
12-10A*Centreville
12-11A*Centreville
12-12P*Centreville
12-01P*Centreville
12-02P*Centreville

DY-HR      TOWN         TMP DEW HUM FLK WIND GST  PRSSR VSBLY-WX   CLOUD COVER
====== ============ === === === === ========  ===== ======== ===============
12-08A Maxwell AFB  71  68   90  71 NW   2     29.87  7              SKC
12-09A Maxwell AFB  69  68   97  69 N    2     29.87  7              SKC
12-10A Maxwell AFB  69  66   90  69 W    1     29.88  7              SKC
12-11A Maxwell AFB  68  64   87  68 W    3     29.89  6  BR          SKC
12-12P Maxwell AFB  68  66   93  68 N    0     29.90  4  BR          SKC
12-01P Maxwell AFB  71  66   84  69 VR   5     29.91  5  BR          SKC
12-02P*Maxwell AFB

DY-HR      TOWN         TMP DEW HUM FLK WIND GST  PRSSR VSBLY-WX   CLOUD COVER
====== ============ === === === === ========  ===== ======== ===============
12-08A Montgomery   69  66   90  69 N    0     29.88  4  BR          CLR
12-09A Montgomery   66  66  100  66 N    0     29.88  3  BR          CLR
12-10A Montgomery   64  64  100  64 N    0     29.88  3  BR          CLR
12-10A*Montgomery   KMGM 120959Z 00000KT 1 3/4SM BR CLR 18/18 A2988 RMK
                    AO2
12-10A*Montgomery   KMGM 121027Z 22003KT 2 1/2SM BR SCT001 18/18 A2989 RMK
                    AO2
12-11A Montgomery   66  66  100  66 N    0     29.89  0.3FG       1 VV
12-11A*Montgomery   KMGM 121046Z 00000KT 2 1/2SM BR BKN001 18/18 A2989 RMK
                    AO2 VIS 1/2SM S-W
12-11A*Montgomery   KMGM 121101Z 00000KT 3SM BR BKN001 18/18 A2990 RMK AO2
12-11A*Montgomery   KMGM 121122Z 26004KT 3SM BR FEW001 18/18 A2990 RMK AO2
12-12P Montgomery   64  64  100  64 SW   3     29.90  3  BR          CLR
12-01P Montgomery   69  68   97  69 N    0     29.92  3  BR          CLR
12-02P Montgomery   73  69   87  77 VR   3     29.93  5  HZ          CLR

DY-HR      TOWN         TMP DEW HUM FLK WIND GST  PRSSR VSBLY-WX   CLOUD COVER
====== ============ === === === === ========  ===== ======== ===============
12-08A*Troy
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12-09A*	Troy									
12-10A*	Troy									
12-11A*	Troy									
12-12P	Troy	64	62	93	64	SW 1		29.90	4 BR	SKC
12-01P	Troy	69	66	90	69	W 2		29.91	5 BR	SKC
12-02P	Troy	75	66	74	78	N 3		29.91	7	SKC

DY-HR	TOWN	TMP	DEW	HUM	FLK	WIND	GST	PRSSR	VSBLY-WX	CLOUD COVER
12-08A	Mobile Brkly	71	69	93	71	NW 4		29.87	4 BR	CLR
12-09A	Mobile Brkly	71	62	73	69	NW 6		29.87	4 HZ	CLR
12-10A	Mobile Brkly	71	69	93	69	NW 6		29.88	4 BR	CLR
12-11A	Mobile Brkly	69	68	97	66	NW 6		29.89	4 BR	CLR
12-11A*	Mobile Brkly	KBFM 121144Z 32003KT 2 1/2SM BR CLR 21/19 A2989 RMK AO2								
12-12P	Mobile Brkly	71	69	93	71	N 0		29.90	2.5BR	CLR
12-01P	Mobile Brkly	75	71	87	78	N 6		29.91	2.5BR	CLR
12-02P	Mobile Brkly	78	71	79	82	VR 3		29.91	2.5HZ	CLR

DY-HR	TOWN	TMP	DEW	HUM	FLK	WIND	GST	PRSSR	VSBLY-WX	CLOUD COVER
12-08A	Mobile Bates	71	68	90	71	N 0		29.89	5 BR	CLR
12-09A	Mobile Bates	71	69	93	71	N 4		29.90	4 BR	CLR
12-10A	Mobile Bates	71	68	90	71	N 0		29.90	4 BR	CLR
12-11A	Mobile Bates	69	66	90	69	N 3		29.91	4 BR	CLR
12-12P	Mobile Bates	69	66	90	69	N 3		29.92	3 BR	CLR
12-12P*	Mobile Bates	KMOB 121205Z 01004KT 2 1/2SM BR CLR 22/20 A2992 RMK AO2								
12-12P*	Mobile Bates	KMOB 121213Z 02003KT 3SM BR CLR 22/20 A2992 RMK AO2								
12-01P	Mobile Bates	73	68	84	76	NE 5		29.93	4 HZ	CLR
12-02P	Mobile Bates	77	68	74	80	NE 5		29.93	5 HZ	CLR

DY-HR	TOWN	TMP	DEW	HUM	FLK	WIND	GST	PRSSR	VSBLY-WX	CLOUD COVER
12-08A	Ozark FtRcke	69	66	90	69	N 3		29.85	7	SKC
12-09A	Ozark FtRcke	69	69	100	69	N 3		29.85	7	SKC
12-10A	Ozark FtRcke	69	69	100	69	N 2		29.86	7	SKC
12-11A	Ozark FtRcke	69	68	97	69	N 3		29.87	7	SKC
12-12P	Ozark FtRcke	69	68	97	69	N 3		29.89	5 BR	SKC
12-01P	Ozark FtRcke	71	68	90	71	N 4		29.90	6 BR	SKC
12-02P	Ozark FtRcke	77	66	69	79	N 5		29.90	6 HZ	SKC

DY-HR	TOWN	TMP	DEW	HUM	FLK	WIND	GST	PRSSR	VSBLY-WX	CLOUD COVER
12-08A	Dothan	71	68	90	69	N 5		29.88	6 BR	120 FEW
12-09A	Dothan	73	68	84	76	N 0		29.87	6 BR	SKC
12-10A	Dothan	71	68	90	71	N 3		29.88	5 BR	SKC
12-11A	Dothan	69	68	97	69	N 3		29.89	3 BR	250 SCT
12-11A*	Dothan	KDHN 121117Z 25005KT 2SM BR SCT250 21/19 A2990								
12-12P	Dothan	69	68	97	67	NW 5		29.91	2 BR	250 SCT
12-01P*	Dothan									
12-02P	Dothan	77	68	74	80	NW 4		29.92	3 BR	CLR

DY-HR	TOWN	TMP	DEW	HUM	FLK	WIND	GST	PRSSR	VSBLY-WX	CLOUD COVER
12-08A	Auburn	66	62	87	64	N 5		29.89	7	CLR
12-09A	Auburn	66	62	87	64	N 5		29.89	7	CLR
12-10A	Auburn	64	62	93	64	N 3		29.90	7	CLR
12-11A	Auburn	64	62	93	64	N 4		29.91	3.5	CLR
12-12P	Auburn	66	62	87	63	NE 6		29.92	7	CLR