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EVALUATION OF FPC-1® FUEL PERFORMANCE CATALYST

AT

CHERAN STATE ROAD TRANSPORT CORPORATION

Report Prepared by

UHI CORPORATION
PROVO, UTAH,

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CONTENTS

INTRODUCTION

FPC-1® is a combustion catalyst which, when added to liquid hydrocarbon fuels, improves the combustion reaction resulting in increased engine efficiency and reduced fuel consumption. The products of incomplete combustion are also positively affected.

Field and laboratory tests alike indicate a potential to reduce fuel consumption in diesel fleets in the range of 5% to 10%. Smoke and carbon monoxide emissions are typically reduced 15 to 30%. This report summarizes the results of controlled back-to-back field tests conducted by UHI Corporation and Cheran State Road Transportation Corporation (CSRTC) engineers, with and without FPC-1® added to the high speed diesel fuel. The fuel consumption determination procedure applied was the Carbon Balance Exhaust Emission Test at a given engine load and speed. This same method also measures the exhaust concentrations of carbon monoxide and unburned hydrocarbons. Smoke testing was also conducted using the Bacharach Smokemeter method.

ENGINES TESTED

5 x Hinos

TEST INSTRUMENTS:

The equipment and instruments involved in the carbon balance test program were:

Sun Electric SGA-9000 non-dispersive, infrared analyzer (NDIR) for measuring the exhaust gas constituents, HC (unburned hydrocarbons as hexane gas), CO, CO_2, and O_2.

Scott Specialty BAR 90 calibration gases for SGA-9000 internal calibration of the SGA-9000.

A Fluke Model 51 type "k" thermometer and wet/dry probe for measuring exhaust, fuel, and ambient temperature.

A Dwyer magnehelic and pitot tube for exhaust pressure differential measurement and exhaust air flow determination (CFM).

Monarch Phototachometer and magnetic tape to determine and control engine speed (rpm).

A Bacharach True-Spot smokespot meter to determine the density of exhaust smoke from diesel engines.

A hydrometer and flask for fuel specific gravity (density) measurement.

A Hewlett Packard Model 42S programmable calculator for the calculation of the engine performance factors.

A Snap On throttle control for setting and holding engine speed at a fixed rpm.

TEST PROCEDURE

Carbon Balance

The carbon balance technique for determining changes in fuel consumption has been recognized by the US Environment Protection Agency (EPA) since 1973 and is central to the EPA-Federal Test Procedures (FTP) and Highway Fuel Economy Test (HFET). The method relies upon the measurement of vehicle exhaust emissions to determine fuel consumption rather than direct measurement (volumetric or gravimetric) of fuel consumption.

The application of the carbon balance test method utilized in this study involves the measurement of exhaust gases of a stationary vehicle under steady-state engine conditions. The method produces a value of engine fuel consumption with FPC-1® relative to a baseline value established with the same vehicle.
Engine speed and load are duplicated from test to test, and measurements of carbon containing exhaust gases (CO_2, CO, HC), oxygen (O_2), exhaust and ambient temperature, and exhaust and ambient pressure are made. A minimum of five readings are taken for each of the above parameters after engine stabilization has taken place (rpm, and exhaust, oil, and water temperature have stabilized). The technical approach to the carbon balance method is detailed in the Appendices.

Fuel specific gravity or density is measured enabling corrections to be made to the final engine performance factors based upon the energy content of the fuel reaching the injectors.

Smoke density was determined by drawing a fixed quantity of exhaust gases through a filter medium. The particulate's were collected onto the filter surface and the density determined by comparing the discoloration of the filter paper to a color calibrated scale.

Five buses made up the final test fleet. Table 1 below summarizes the percent change in fuel consumption.

Table 1:
Summary of Carbon Balance Fuel Consumption Changes

Bus #	Engine	Base RPM	FPC-1 RPM	% Change Fuel Consumption
*1498	Hino	2031	2025	- 0.78
1767	Hino	2075	2070	- 6.01
1584	Hino	1988	1980	- 4.86
1850	Hino	2055	2050	- 13.15
1443	Hino	2040	2050	- 4.94

*** Anomaly (see Discussion No. 3)**

DISCUSSION

1. Fuel Density

High speed diesel was taken from the fuel tank on each bus to determine the fuel density (fuel specific gravity) for the baseline and treated fuel test segments. The fuel specific gravity for the treated test segment was generally higher than the baseline fuel specific gravity. The correction factor for each bus is shown on the computer printouts which also show the calculation of the baseline and FPC-1 treated fuel performance factors (or mass flow rates). The correction factor adjusts the energy content of the treated fuel to that of the baseline fuel.

2. The Effect of FPC-1 upon Smoke Density

Smoke density was determined using the Bacharach smoke spot method. The Bacharach True-Spot Smokemeter measures smoke density by drawing a specific volume of exhaust gas through a fine paper filter medium (5 micron) while the engine is operating at a fixed rpm and under steady-state engine conditions. The smoke particles are trapped on the surface of the filter paper as the exhaust gases are drawn through it forming a darkened area called a "smoke spot". The filter paper is then removed from the smoke tester and the smoke spot visually compared to a precoded smoke scale. A smoke number is then assigned to the smoke spot according to the darkness of the spot. The smoke number scale ranges from 0 to 9. Higher smoke numbers correspond to darker smoke spots, which correspond to a greater smoke density in the exhaust. The baseline and treated fuel smoke spot numbers are tabled below.

Table 2:
Comparison of Smoke Spot Numbers (SS#)

Bus #	Base SS#	Treated SS#	% Change
*1498	2.2	5.5	+150
1767	7.5	3.0	- 60
1584	5.5	6.0	+ 8
1850	8.2	6.0	- 27
1447	7.7	3.0	- 61

*** Anomalies (see Discussion Number 3.)**

A reduction in smoke is prime evidence of improved combustion (Germane, SAE Technical Paper # 831204). Further, reduced exhaust smoking has been shown to be one of first evidences that engine carbon residue and soot blowby into the motor oil are also being reduced (ibid). The reductions in exhaust smoke are logical extensions of improved combustion created by FPC-1.

3. Anomalies

Bus number 1498 had the nozzles replaced between the baseline and treated segments of the test. The data indicate that the nozzle change had a detrimental impact upon engine performance since there was little change in fuel consumption and a large increase in smoke density. In any case, this type of mechanical alteration renders the data from Bus 1498 invalid.

CONCLUSIONS

1) With the anomalies removed from the sample, the fuel consumption change determined by the carbon balance method ranged from - 4.86 to - 13.15%. The fleet averaged a 7.24% reduction in fuel consumed after FPC-1 fuel treatment.

2) Smoke density, with anomalies removed, was reduced approximately 35%.

APPENDICES

CARBON BALANCE METHOD TECHNICAL APPROACH:

All test instruments were calibrated and zeroed prior to both baseline and treated fuel data collection. The SGA-9000 NDIR exhaust gas analyzer was internally calibrated using Scott Calibration Gases (BAR 90 Gases), and a leak test on the sampling hose and connections was performed. The same procedure was repeated after each test segment to determine any instrument drift.

Each vehicle's engine was brought up to operating temperature at a set rpm and allowed to stabilize as indicated by the engine water and exhaust temperature, and exhaust pressure. No exhaust gas measurements were made until each engine had stabilized at the rpm selected for the test. Engine rpm was set using the dash mounted tachometer (with the exception of shovel's #1 and #4) and checked periodically to prevent any change in engine speed during the data collection period. # 2 diesel was used exclusively throughout the evaluation. Fuel specific gravity (density) and temperature were also taken.

The baseline fuel consumption test consisted of a minimum of five sets of measurements of CO_2, CO, HC, O_2, and exhaust temperature and pressure made at 90 second intervals. Each engine was tested in the same manner. Engine rpm were also recorded at approximately 90 second intervals.

After the baseline test the fuel storage tanks were treated with FPC-1® at the recommended level of 1 oz. of catalyst to 40 gallons of fuel (1:5000 volume ratio). Each succeeding fuel shipment was also treated with FPC-1®. The equipment was operated on treated fuel until the final test was run.

During the two test segments, an internal self-calibration of the exhaust analyzer was performed after every two sets of measurements to correct instrument drift, if any.

From the exhaust gas concentrations of $C0_2$, CO, HC, and O_2 measured during the test, the average molecular weight of these gases, and the temperature and volumetric flow rate of the exhaust stream, the mass flow rate of the fuel to the engine (rate of fuel consumption) may be expressed as a engine "performance factor" which relates the fuel consumption of the treated fuel to the baseline. The calculations are based on the assumption that engine operating conditions are essentially the same throughout the test. Engines with known mechanical problems or having undergone repairs affecting fuel consumption are removed from the sample.

A sample calculation is found in Figure 2.

Details of Analysis

Figure 1

CARBON MASS BALANCE FORMULAE

ASSUMPTIONS: C_8H_{18} and SG = 0.78
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 ^oF

VFHC = "reading" ÷ 1,000,000
VFCO = "reading" ÷ 100
$VFCO_2$ = "reading" ÷ 100
VFO_2 = "reading" ÷ 100

EQUATIONS:

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

$$pf1 \text{ or } pf2 = \frac{2952.3 \times Mwt}{86(VFHC)+13.89(VFCO)+13.89(VFCO_2)}$$

$$CFM = (d/2)^2\pi/144 \bullet 1096.2\sqrt{\frac{Pv}{1.325\,(P_B/ET + 460)}}$$

$$PF1 \text{ or } PF2 = \frac{pf \times (Te+460)}{CFM}$$

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)

$$pf1 = \frac{2952.3 \times 28.995}{86(0.0000132) + 13.89(0.00017) + 13.89(0.01937)}$$

$$pf1 = 314{,}083$$

Equation 4 (CFM Calculations)

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

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

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

CFM = 2358.37

Equation 5 (Corrected Performance Factor)

$$PF1 = \frac{314,083\ (313.1\ deg\ F + 460)}{2358.37\ CFM}$$

PF1 = 102,960

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)

$$pf2 = \frac{2952.3 \times 28.980}{86(0.0000146)+13.89(0.00013)+13.89(0.01826)}$$

$$pf2 = 333{,}308$$

Equation 4 (CFM Calculations)

$$CFM = \frac{(d/2)^2\pi}{144} \bullet 1096.2\sqrt{\frac{Pv}{1.325\ \{P_B/(Te + 460)\}}}$$

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

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

$$CFM = 2320.51$$

Equation 5 (Corrected Performance Factor)

$$PF2 = \frac{333{,}308\ (309.02 \text{ deg F} + 460)}{2320.51\ \text{CFM}}$$

$$= 110{,}459$$

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 = 110,459 x Specific Gravity Correction

PF2 = 110,459 x 1.0036

PF2 = 110,857

Equation 6 (Percent Change in Engine Performance Factor:)

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

% Change PF = [(110,857 - 102,960)/102,960](100)

= +7.67

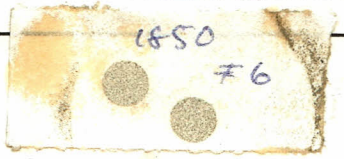
Note: A positive change in PF equates to a reduction in fuel consumption.

RAW DATA WORK SHEETS

Carbon Mass Balance Field Data Form

Company: Cheran. Location: CBE Test Date: 05/26/94.
Test Portion: Baseline:_____ Treated:_____ Exhaust Stack Diameter: __Inches

233100.
Engine Make/Model: Hino. Miles/Hours:_____ I.D.#: 1850.
Type of Equipment: _____ AIR 87.2.



Fuel Specfic Gravity: .833 @:_____ (°F)

Barometric Pressure: 24.6 inches of Mercury Start Time: 0105

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	NO_x
2050	206	.36	0.04	28	1.31	18.1	
	206		0.04	26	1.31	18.1	
	206		0.04	27	1.34	18.2	
	206		0.04	26	1.34	18.2	
	206		0.04	28	1.34	18.2	
	206		0.04	28	1.34	18.2	
	206		0.04	28	1.34	18.2	
	206		0.04	27	1.338	18.2	
	206		0.04	26	1.338	18.2	
2050	206	.36	0.04	27	1.338	18.2	

Smoke #6

Names of Customer Personnel Participating in Test: Finish 0120.

_____ (K.S. SRIDHARAN)

206 .36 .04 27 1.338 18.48 (.9936)

Signature of Technicians:

_____ _____

Carbon Mass Balance Field Data Form

Company: Cheran. Location: CBE. Test Date: 05/25/94 / 05/26/94.
Test Portion: Baseline:_____ Treated: ✓ Exhaust Stack Diameter: ___Inches

Engine Make/Model: Leyland 370. Miles/Hours: 91,510 I.D.#: 1443
Type of Equipment: _____ 1443 — Air Temp 85.4.

Fuel Specfic Gravity: 0.832 @: 89.2 (°F)

#3 #3

Barometric Pressure: _____ inches of Mercury Start Time: 0230

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	NO_x
2050	220	.40	0.07	24	1.68	17.5	
	220		0.09	23	1.69	17.6	
	220		0.05	27	1.70	17.5	
	220		0.05	28	1.70	17.5	
	220		0.05	27	1.70	17.5	
	220		0.04	28	1.70	17.5	
	220		0.04	28	1.70	17.5	
	220		0.04	28	1.70	17.5	
	220		0.04	28	1.70	17.4	
	220	.40	0.04	28	1.70	17.4	

Smoke. #3.

Names of Customer Personnel Participating in Test:

Finish.

_____ (K.SSRIDHARAN)

220.0 .41 .044 27.75 1.697 17.49

Signature of Technicians:

_____ _____

Carbon Mass Balance Field Data Form

1584 #6

Company: Cheran Location: CBE Test Date: 05/26/94.
Test Portion: Baseline:_____ Treated:_____ Exhaust Stack Diameter: ___Inches

Engine Make/Model: Leyland 370. Miles/Hours: 186087 I.D.#: 1584
Type of Equipment: _____ Air 85.4

Fuel Specfic Gravity: 0.833 @:_____ (°F)

Barometric Pressure: _____ inches of Mercury Start Time: 0140.

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	NO_x
1489	226.	0.~~075~~ 7	0.04	27	1.64.	17.5.	
	227		0.04	27	1.62	17.5.	
	225	0.120	0.04	27	1.62	17.4.	
	228		0.04	27	1.62	17.4.	
	228		0.04	27	1.62	17.5.	
	228		0.04	27	1.62	17.5.	
	228	~~0.120~~	0.04	26.	1.62	17.5	
	228		0.04	28	1.62	17.5.	
	227		0.03	28	1.62	17.5	
	227	0.120	0.03	30	1.62	17.5	

Smoke. #6

Finish. 0148

Names of Customer Personnel Participating in Test:

[signature] (K.S.SRIDHARAN)

227.2 0.12 0.038 27.4 1.622 17.48

Signature of Technicians:

28.3603
362,060
~~364,302~~ 5,149,937 (.9891) =

History of Testing at Cheran, Andhra Pradesh, and Gujarat

On January 19, 1994, a team of technicians from UHI Corporation traveled to India at the request of the Petroleum Conservation Research Association (PCRA) to conduct field trials of FPC-1 in bus fleets operated by Gujarat and Andhra Pradesh State Road Transort Corporations. Mr. Natarajan had also arranged for a test at Coimbotore, for Cheran Road Tranport Corporation. This was not a PCRA sponsored test, but something arranged through local sales people (Cheran is not a State Road Transport Corporation because it only covers a small portion of the State of Tamil Nadu, whereas the others service an entire State). The Andhra Pradesh test was not conducted due to communication problems, but the tests were conducted at Gujarat and Cheran.

The Cheran test was conducted on February 5, 1994. Twelve buses were baselined using carbon mass balance. All pertinent personnel, including the Chief Mechanical Officer and Fleet Manager, as well as dozens of mechanics and staff engineers.

The Gujarat test was conducted on February 11, 1994. Eight buses were baselined using carbon mass balance. Again, all managers attended the test.

The fuel was treated approximately one week after the baseline for both fleets. The test buses ran on treated fuel until May of 1994, when the UHI team returned to conduct the treated tests.

The Cheran treated was conducted May 26, 1994. Only five buses were available for the treated segment. The Gujarat test was conducted May 31, 1994. All eight buses were available for this test.

Fuel consumption reductions averaged 7.24% for Cheran, and 6.56% for Gujarat. Smoke reductions averaged 35% and 27.7%, respectively. FPC-1 had little effect upon carbon monoxide emissions, indicating the engines may not have achieved complete breakin before final testing.

During both trips to India by UHI, visits were made to Mr. Ghosh and Mr. Das of the PCRA. Mr. Agarwal of the Indian Railways was also visited. Both groups were given a full two hour presentation on FPC-1, as were the engineering staffs at Cheran, Gujarat, and Andhra Pradesh.

Also, during the second trip to India, Bob Platt and I conducted the baseline for Andhra Pradesh (approx. June 2nd). Bob has since completed that study and has forwarded a final report to UHI.

Figure 1

CARBON MASS BALANCE FORMULAE

ASSUMPTIONS: $C_{12}H_{26}$ and SG = 0.78
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
ET = Exhaust temperature ^oF

VFHC = "reading" ÷ 1,000,000
VFCO = "reading" ÷ 100
$VFCO_2$ = "reading" ÷ 100
VFO_2 = "reading" ÷ 100

EQUATIONS:

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

$$pf1 \text{ or } pf2 = \frac{2952.3 \times Mwt}{86(VFHC)+13.89(VFCO)+13.89(VFCO_2)}$$

$$CFM = (d/2)^2\pi/144 \bullet 1096.2 \sqrt{\frac{Pv}{1.325\,(P_B/ET + 460)}}$$

$$PF1 \text{ or } PF2 = \frac{pf \times (ET+460)}{CFM}$$

FUEL ECONOMY:
PERCENT INCREASE (OR DECREASE) $\frac{PF2 - PF1}{PF1} \times 100$

Company Name:	Gujarat	*Location*	Ambaji		*Date:*	11-Feb-94
Test Portion:	Baseline	*Stack Diam.*	2	Inches		
Engine Type:	Leyland 665	*Mile/Hrs*	107628			
Equipment Type:	Bus	*ID #:*	GJ1Z2750		*Baro*	28.17
Fuel Sp. Gravity(SG	0.8330	*Temp:*	80.2			
					Time:	935

RPM	Exh Temp	Pv Inch	CO	HC	CO2	O2	
2016	214.4	0.58	0	26	1.49	18.1	
2016	214.4	0.6	0	26	1.49	18.1	
2016	214.4	0.56	0	19.5	1.46	18.2	
2026	215	0.6	0	23	1.44	18.2	
2030	214	0.6	0	28.5	1.44	18.3	
2030	212.6	0.58	0	24	1.43	18.3	
2022.333	**214.133**	**.587**	**.000**	**24.500**	**1.458**	**18.200**	Mean
7.089898918	**0.816496581**	**0.01632993**	**0**	**3.09838668**	**0.02639444**	**0.08944272**	Std Dev

VFHC	VFCO	VFCO2	VFO2	Mtw1	pf1	PF1
2.45E-05	0	0.01458333	0.182	28.9627543	417,630	3,618,369

Company Name:	Gujarat	*Location:*	Ambaji		*Test Date:*	5/3194
Test Portion:	Treated	*Stack Diam:*	2	Inches		
Engine Type:	Leyland 665	*Mile/Hrs:*	181190			
Equipment Type	Bus	*ID #:*	GJ1Z2750		*Baro:*	28.17
Fuel Sp. Gravity:	0.824	*Temp:*	104			
SG Corr Factor:	1.01				*Time:*	1635

RPM	Exh Temp	Pv Inch	CO	HC	CO2	O2	
2024	235	0.6	0	31	1.22	18.2	
2024	235	0.6	0	30	1.23	18.2	
2024	235.6	0.6	0	31	1.22	18.2	
2024	235.8	0.6	0	27.5	1.22	18.2	
2024	236	0.6	0	31	1.22	18.2	
2024	237	0.44	0	27.5	1.25	18.2	
2024	237	0.5	0	29	1.23	18.3	
2024	237.4	0.5	0	25	1.23	18.3	
2024	238	0.5	0	28	1.22	18.3	
2024.000	**236.311**	**.549**	**.000**	**28.889**	**1.227**	**18.233**	Mean
0	**1.077548658**	**0.06333333**	**0**	**2.07330922**	**0.01**	**0.05**	Std Dev

VFHC	VFCO	VFCO2	VFO2	Mtw2	pf2	PF2
2.89E-05	0	0.01226667	0.182333333	28.9272756	493,781	4,495,091

Performance factor adjusted for fuel density: 4,540,042

****% Change PF = 25.47 %**

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

Company Name:	Gujart	*Location*	Ambaji	*Date:*	11-Feb-94
Test Portion:	Baseline	*Stack Diam.*	2 Inches		
Engine Type:	665 New	*Mile/Hrs*	52240		
Equipment Type:	Bus	*ID #:*	GJ1Z3125	*Baro*	28.17
Fuel Sp. Gravity(SG	0.8330	*Temp:*	80.2		
				Time:	1255

RPM	Exh Temp	Pv Inch	CO	HC	CO2	O2	
2007	213	0.52	0	27.5	1.33	18.4	
2010	213	0.54	0	46	1.33	18.4	
2010	209.6	0.54	0	28.5	1.32	18.4	
2010	208	0.52	0	31	1.32	18.4	
2010	208	0.54	0	29	1.31	18.4	
2010	207.8	0.54	0	29.5	1.3	18.4	
2009.500	**209.900**	**.533**	**.000**	**31.917**	**1.318**	**18.400**	Mean
1.224744871	**2.487569095**	**0.01032796**	**0**	**6.99583209**	**0.01169045**	**0**	Std Dev

VFHC	VFCO	VFCO2	VFO2	Mtw1	pf1	PF1
3.19E-05	0	0.01318333	0.184	28.9487845	459,598	4,163,208

Company Name:	Gujart	*Location:*	Ambaji	*Test Date:*	5/31/94
Test Portion:	Treated	*Stack Diam:*	2 Inches		
Engine Type:	665 New	*Mile/Hrs:*	130518		
Equipment Type	Bus	*ID #:*	GJ1Z3125	*Baro:*	28.17
Fuel Sp. Gravity:	0.824	*Temp:*	100		
SG Corr Factor:	1.01			*Time:*	1235

RPM	Exh Temp	Pv Inch	CO	HC	CO2	O2	
2015	233	0.52	0	24.5	1.23	18	
2015	233	0.54	0	26.5	1.2	18	
2015	229	0.54	0	25	1.2	18.1	
2015	238.5	0.54	0	27	1.2	18.2	
2015	236.5	0.54	0	26	1.19	18.2	
2015	238	0.56	0	25.5	1.18	18.3	
2015.000	**234.667**	**.540**	**.000**	**25.750**	**1.200**	**18.133**	Mean
0	**3.656045222**	**0.01264911**	**0**	**0.93541435**	**0.0167332**	**0.12110601**	Std Dev

VFHC	VFCO	VFCO2	VFO2	Mtw2	pf2	PF2
2.58E-05	0	0.012	0.181333333	28.9188268	505,274	4,631,939

Performance factor adjusted for fuel density: 4,678,258

****% Change PF= 12.37 %**

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

Company Name:	Gujarat	*Location*	Ambaji	*Date:*	11-Feb-94
Test Portion:	Baseline	*Stack Diam.*	2 Inches		
Engine Type:	Wiking BW	*Mile/Hrs*	47597		
Equipment Type:	Bus	*ID #:*	GJ1Z3029	*Baro*	28.17
Fuel Sp. Gravity(SG	0.8330	*Temp:*	80.2		
				Time:	

RPM	Exh Temp	Pv Inch	CO	HC	CO2	O2	
2011	213.4	0.6	0	27	1.42	18.2	
2011	213.6	0.56	0	30.5	1.41	18.2	
2016	221.2	0.56	0	29.5	1.4	18.2	
2016	217	0.58	0	37.5	1.38	18.2	
2016	217.2	0.58	0	32.5	1.39	18.3	
2016	217	0.54	0	28	1.37	18.3	
2014.333	**216.567**	**.570**	**.000**	**30.833**	**1.395**	**18.233**	Mean
2.581988897	**2.86612398**	**0.02097618**	**0**	**3.7903386**	**0.01870829**	**0.05163978**	Std Dev

VFHC	VFCO	VFCO2	VFO2	Mtw1	pf1	PF1
3.08E-05	0	0.01395	0.182333333	28.9543217	435,001	3,830,472

Company Name:	Gujarat	*Location:*	Ambaji	*Test Date:*	5/31/94
Test Portion:	Treated	*Stack Diam:*	2 Inches		
Engine Type:	Wiking BW	*Mile/Hrs:*	126235		
Equipment Type	Bus	*ID #:*	GJ1Z3029	*Baro:*	28.17
Fuel Sp. Gravity:	0.824	*Temp:*	104		
SG Corr Factor:	1.01			*Time:*	1550

RPM	Exh Temp	Pv Inch	CO	HC	CO2	O2	
2019	239	0.58	0	26	1.4	17.7	
2019	240	0.58	0	26	1.39	17.7	
2019	240	0.56	0	28	1.39	17.7	
2019	241	0.56	0	29	1.39	17.8	
2019	241.2	0.56	0	26	1.37	17.8	
2019	241.6	0.56	0	28	1.37	17.8	
2019.000	**240.467**	**.567**	**.000**	**27.167**	**1.385**	**17.750**	Mean
0	**0.968848113**	**0.01032796**	**0**	**1.32916014**	**0.01224745**	**0.05477226**	Std Dev

VFHC	VFCO	VFCO2	VFO2	Mtw2	pf2	PF2
2.72E-05	0	0.01385	0.1775	28.9331757	438,511	3,940,530

Performance factor adjusted for fuel density: 3,979,935

****% Change PF= 3.90 %**

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

Company Name:	Gujarat	*Location*	Ambaji		*Date:*	11-Feb-94
Test Portion:	Baseline	*Stack Diam.*	2	Inches		
Engine Type:	Hino (new)	*Mile/Hrs*	201840			
Equipment Type:	Bus	*ID #:*	2263		*Baro*	28.17
Fuel Sp. Gravity(SG	0.8330	*Temp:*	80.2			
					Time:	

RPM	Exh Temp	Pv Inch	CO	HC	CO2	O2	
2020	209.4	0.48	0	23.5	1.36	18.5	
2020	209.2	0.5	0	23.5	1.36	18.5	
2020	209.8	0.48	0	24	1.36	18.6	
2020	205.6	0.47	0	27	1.33	18.5	
2020	207.8	0.48	0	33	1.32	18.4	
2022	209.6	0.48	0	21	1.33	18.5	
2022	209	0.48	0	23.5	1.33	18.4	
2020.571	**208.629**	**.481**	**.000**	**25.071**	**1.341**	**18.486**	Mean
0.975900073	**1.485164734**	**0.00899735**	**0**	**3.90969491**	**0.01772811**	**0.06900656**	Std Dev

VFHC	VFCO	VFCO2	VFO2	Mtw1	pf1	PF1
2.51E-05	0	0.01341429	0.184857143	28.9555113	453,369	4,318,399

Company Name:	Gujarat	*Location:*	Ambaji		*Test Date:*	5/31/94
Test Portion:	Treated	*Stack Diam:*	2	Inches		
Engine Type:	Hino (new)	*Mile/Hrs:*	262283			
Equipment Type	Bus	*ID #:*	2263		*Baro:*	28.17
Fuel Sp. Gravity:	0.824	*Temp:*	104			
SG Corr Factor:	1.01				*Time:*	1510

RPM	Exh Temp	Pv Inch	CO	HC	CO2	O2	
1978	234	0.44	0	29	1.32	17.9	
1978	238	0.44	0	28	1.32	17.9	
1978	239	0.44	0	28	1.3	17.9	
1978	242	0.44	0	28	1.3	17.9	
1978	242	0.44	0	31	1.3	17.9	
1978	241	0.44	0	28	1.3	17.9	
1978.000	**239.333**	**.440**	**.000**	**28.667**	**1.307**	**17.900**	Mean
0	**3.076794869**	**0**	**0**	**1.21106014**	**0.01032796**	**0**	Std Dev

VFHC	VFCO	VFCO2	VFO2	Mtw2	pf2	PF2
2.87E-05	0	0.01306667	0.179	28.9267293	464,013	4,728,142

Performance factor adjusted for fuel density: 4,775,423

****% Change PF = 10.58 %**

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

Company Name:	Gujarat	*Location*	Ambaji	*Date:*	11-Feb-94
Test Portion:	Baseline	*Stack Diam.*	2 Inches		
Engine Type:	Hino	*Mile/Hrs*	439958		
Equipment Type:	Bus	*ID #:*	GJ1Z657	*Baro*	28.17
Fuel Sp. Gravity(SG	0.8330	*Temp:*	80.2		
				Time:	1015

RPM	Exh Temp	Pv Inch	CO	HC	CO2	O2	
2018	222	0.62	0	31.5	1.31	18.2	
2019	223	0.62	0	30	1.31	18.2	
2019	224	0.62	0	25.5	1.29	18.5	
2019	224.8	0.62	0	9	1.28	18.5	
2019	224.4	0.62	0	29.5	1.26	18.6	
2019	225	0.62	0	21.5	1.26	18.8	
2018.833	**223.867**	**.620**	**.000**	**24.500**	**1.285**	**18.467**	Mean
0.40824829	**1.157007635**	**0**	**0**	**8.42021377**	**0.02258318**	**0.23380904**	Std Dev

VFHC	VFCO	VFCO2	VFO2	Mtw1	pf1	PF1
2.45E-05	0	0.01285	0.184666667	28.9456877	473,005	4,015,132

Company Name:	Gujarat	*Location:*	Ambaji	*Test Date:*	5/31/94
Test Portion:	Treated	*Stack Diam:*	2 Inches		
Engine Type:	Hino	*Mile/Hrs:*	503725		
Equipment Type	Bus	*ID #:*	GJ1Z657	*Baro:*	28.17
Fuel Sp. Gravity:	0.824	*Temp:*	100		
SG Corr Factor:	1.01			*Time:*	1635

RPM	Exh Temp	Pv Inch	CO	HC	CO2	O2	
2034	239	0.62	0	29	1.27	18.1	
2034	245	0.62	0	31	1.26	18.1	
2034	245	0.62	0	28	1.25	18.1	
2034	246	0.62	0	29.5	1.25	18	
2034	246.6	0.6	0	31	1.25	18	
2034	247	0.6	0	31	1.24	18	
2034.000	**244.767**	**.613**	**.000**	**29.917**	**1.253**	**18.050**	Mean
0	**2.940521496**	**0.01032796**	**0**	**1.28127541**	**0.01032796**	**0.05477226**	Std Dev

VFHC	VFCO	VFCO2	VFO2	Mtw2	pf2	PF2
2.99E-05	0	0.01253333	0.1805	28.9242685	483,128	4,185,823

Performance factor adjusted for fuel density: 4,227,681

****% Change PF= 5.29 %**

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

Company Name:	Gujarat	*Location*	Ambaji	*Date:*	11-Feb-94
Test Portion:	Baseline	*Stack Diam.*	2 Inches		
Engine Type:	Hino	*Mile/Hrs*			
Equipment Type:	Bus	*ID #:*	GJ1Z1805	*Baro*	28.17
Fuel Sp. Gravity(SG	0.8330	*Temp:*	80.2		
				Time:	1145

RPM	Exh Temp	Pv Inch	CO	HC	CO2	O2	
2019	219.6	0.6	0	22	1.33	18.5	
2019	218.6	0.64	0	20	1.32	18.6	
2007	220.4	0.64	0	25	1.28	18.4	
2007	220	0.62	0	25	1.27	18.4	
2008	220	0.64	0	22	1.25	18.5	
2008	220	0.64	0	22.5	1.26	18.5	
2011.333	**219.767**	**.630**	**.000**	**22.750**	**1.285**	**18.483**	Mean
5.955389716	**0.625033332**	**0.0167332**	**0**	**1.94293592**	**0.03271085**	**0.07527727**	Std Dev

VFHC	VFCO	VFCO2	VFO2	Mtw1	pf1	PF1
2.28E-05	0	0.01285	0.184833333	28.9462528	473,422	3,974,684

Company Name:	Gujarat	*Location:*	Ambaji	*Test Date:*	5/31/94
Test Portion:	Treated	*Stack Diam:*	2 Inches		
Engine Type:	Hino	*Mile/Hrs:*	357460		
Equipment Type	Bus	*ID #:*	GJ1Z1805	*Baro:*	28.17
Fuel Sp. Gravity:	0.824	*Temp:*	100		
SG Corr Factor:	1.01			*Time:*	1415

RPM	Exh Temp	Pv Inch	CO	HC	CO2	O2	
2010	221	0.62	0	26	1.28	17.9	
2010	224	0.62	0	24	1.26	17.8	
2010	225	0.64	0	23	1.25	17.8	
2010	228	0.64	0	26	1.24	18	
2010	228	0.62	0	26	1.24	18	
2010	229	0.62	0	24	1.24	18	
2010.000	**225.833**	**.627**	**.000**	**24.833**	**1.252**	**17.917**	Mean
0	**3.060501048**	**0.01032796**	**0**	**1.32916014**	**0.01602082**	**0.09831921**	Std Dev

VFHC	VFCO	VFCO2	VFO2	Mtw2	pf2	PF2
2.48E-05	0	0.01251667	0.179166667	28.9183737	484,906	4,100,083

Performance factor adjusted for fuel density: 4,141,084

****% Change PF= 4.19 %**

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

Company Name:	Gujarat	*Location*	Ambaji	*Date:*	11-Feb-94
Test Portion:	Baseline	*Stack Diam.*	2 Inches		
Engine Type:	Hino	*Mile/Hrs*			
Equipment Type:	Bus	*ID #:*	GJ1Z1804	*Baro*	28.17
Fuel Sp. Gravity(SG	0.8330	*Temp:*			
				Time:	1215

RPM	Exh Temp	Pv Inch	CO	HC	CO2	O2	
2024	222.2	0.54	0	24.5	1.43	18	
2024	222.6	0.54	0	22.5	1.41	18.1	
2024	223	0.52	0	55	1.38	18.3	
2024	224.6	0.54	0	28	1.37	18.3	
2024	225.2	0.5	0	58	1.36	19.1	
2024	224.6	0.52	0	49	1.33	18.5	
2029	224.2	0.52	0	17.5	1.31	18.5	
2024.714	**223.771**	**.526**	**.000**	**36.357**	**1.370**	**18.400**	Mean
1.889822365	**1.157172251**	**0.01511858**	**0**	**16.9992997**	**0.04203173**	**0.36055513**	Std Dev

VFHC	VFCO	VFCO2	VFO2	Mtw1	pf1	PF1
3.64E-05	0	0.0137	0.184	28.9573087	441,746	4,071,909

Company Name:	Gujarat	*Location:*	Ambaji	*Test Date:*	5/31/94
Test Portion:	Treated	*Stack Diam:*	2 Inches		
Engine Type:	Hino	*Mile/Hrs:*	351629		
Equipment Type	Bus	*ID #:*	GJ1Z1804	*Baro:*	28.17
Fuel Sp. Gravity:	0.824	*Temp:*	99.6		
SG Corr Factor:	1.01			*Time:*	1215

RPM	Exh Temp	Pv Inch	CO	HC	CO2	O2	
2019	237.8	0.54	0	27	1.35	18.4	
2019	238.4	0.52	0	27	1.35	18.1	
2019	239	0.52	0	27	1.35	18.2	
2019	239	0.52	0	27	1.34	18.1	
2019	238.6	0.52	0	31	1.34	18.2	
2019	238.6	0.5	0	27	1.35	18.2	
2019	239	0.5	0	27	1.35	18.3	
2019	239	0.5	0	27	1.35	18.3	
2019	239	0.5	0	30	1.35	18.3	
2019	238.6	0.5	0	27	1.36	18.3	
2019.000	**238.700**	**.512**	**.000**	**27.700**	**1.349**	**18.240**	Mean
0	**0.391578004**	**0.01398412**	**0**	**1.49443412**	**0.00567646**	**0.09660918**	Std Dev

VFHC	VFCO	VFCO2	VFO2	Mtw2	pf2	PF2
2.77E-05	0	0.01349	0.1824	28.9470466	450,167	4,250,388

Performance factor adjusted for fuel density: 4,292,892

****% Change PF= 5.43 %**

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

Company Name:	Gujarat	*Location*	Ambaji	*Date:*	11-Feb-94
Test Portion:	Baseline	*Stack Diam.*	2 Inches		
Engine Type:	Hino	*Mile/Hrs*	301670		
Equipment Type:	Bus	*ID #:*	GJ1Z1955	*Baro*	28.17
Fuel Sp. Gravity(SG	0.8330	*Temp:*	80.2		
				Time:	

RPM	Exh Temp	Pv Inch	CO	HC	CO2	O2	
2028	194.4	0.52	0	22.5	1.3	19.9	
2002	201.2	0.52	0	3.5	1.29	18.1	
2002	201	0.58	0	22	1.29	18.5	
2000	203.2	0.54	0	29.5	1.29	18.6	
2000	206	0.56	0	32	1.32	18.6	
2000	210	0.56	0	35	1.32	18.6	
2005.333	**202.633**	**.547**	**.000**	**24.083**	**1.302**	**18.717**	Mean
11.14749598	**5.261812109**	**0.0242212**	**0**	**11.3287981**	**0.0147196**	**0.6112828**	Std Dev

VFHC	VFCO	VFCO2	VFO2	Mtw1	pf1	PF1
2.41E-05	0	0.01301667	0.187166667	28.9583302	467,319	4,158,468

Company Name:	Gujarat	*Location:*	Ambaji	*Test Date:*	5/31/94
Test Portion:	Treated	*Stack Diam:*	2 Inches		
Engine Type:	Hino	*Mile/Hrs:*	360727		
Equipment Type	Bus	*ID #:*	GJ1Z1955	*Baro:*	28.17
Fuel Sp. Gravity:	0.824	*Temp:*	100		
SG Corr Factor:	1.01			*Time:*	1700

RPM	Exh Temp	Pv Inch	CO	HC	CO2	O2	
2015	210	0.5	0	23	1.32	18.1	
2015	213	0.5	0	22	1.34	18.1	
2015	216	0.5	0	28.5	1.33	18	
2015	216	0.5	0	26.5	1.32	18	
2015	218	0.5	0	25	1.33	18.1	
2015	219	0.5	0	26.5	1.33	18.1	
2015	221	0.52	0	27.5	1.325	18.1	
2015.000	**216.143**	**.503**	**.000**	**25.571**	**1.328**	**18.071**	Mean
0	**3.716116765**	**0.00755929**	**0**	**2.37045304**	**0.00698638**	**0.048795**	Std Dev

VFHC	VFCO	VFCO2	VFO2	Mtw2	pf2	PF2
2.56E-05	0	0.01327857	0.180714286	28.9367974	457,542	4,288,176

Performance factor adjusted for fuel density: 4,331,057

****% Change PF= 4.15 %**

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

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)

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

d =Exhaust stack diameter in inches
Pv =Velocity pressure in inches of H_20
Pb =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)

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

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

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

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.

Carbon Mass Balance Field Data Form

#3 1767

Company: Chevron Location: CBE ✓ Test Date: 05/25/94

Test Portion: Baseline:_____ Treated: ✓ Exhaust Stack Diameter: ___Inches

Engine Make/Model: Leyland 402 Miles/Hours: 169,208 TCB I.D.#: 1767

Type of Equipment: _____

Fuel Specfic Gravity: ~~1767~~ 0.832 @: 89.2 (°F)

Barometric Pressure: _____ inches of Mercury Start Time: 11.45

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	NO_x
2070	258	0.5	0.02	15	1.63	17.5	
	258		0.02	15	1.64	17.5	
	259		0.02	15	1.62	17.5	
	258		0.02	15	1.62	17.5	
	258			15	1.62	17.5	
	258			15	1.62	17.5	
	258			15	1.62	17.5	
	258		0.02	19	1.64	17.5	
	258		0.02	19	1.64	17.4	
2050	258	0.5	0.02	19	1.64	17.4	

Smoke. #3.

Fin 11.50a

Names of Customer Personnel Participating in Test:

_____ K. S. SRIDHARAN

258 .050 .02 16.2 1.629 17.48 (0.554)

Signature of Technicians:

_____ _____

Carbon Mass Balance Field Data Form

1498 6 5

Company: Cheran Location: CBE Test Date: 05/26/94

Test Portion: Baseline:_____ Treated:_____ Exhaust Stack Diameter: ___Inches

Engine Make/Model: Leyland 402 Miles/Hours: 163141 I.D.#: 1498

Type of Equipment: _____ Air 82.6.

Fuel Specfic Gravity: 0.833 @:_____ (°F)

Barometric Pressure: _____ inches of Mercury Start Time: 0200

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	NO_x
2025	234	0.44	0.015	34	1.55	17.5	
	229		0.015	31	1.56	17.4	
	230		0.015	31	1.57	17.4	
	230		0.015	37	1.57	17.4	
	227		0.015	36	1.56	17.4	
	227		0.015	34	1.55	17.4	
	227		0015	34	1.55	17.4	
	230		005?	18?	1.55	17.5	
	228		0.05?	19?	1.54	17.4	
	230	0.42	0.05?	20?	1.54	17.4	

Smoke. 1/6.0 2/5.0

Names of Customer Personnel Participating in Test: Finish. 0210-

M. S. SRIDHARAN

222.20 .43 .005 33.86 1.554 (.9935)

Signature of Technicians:

1850

1 2

Carbon Mass Balance Field Data Form

Company: CHERAN Location: COIMBATORE Test Date: 05.02.94.
Test Portion: Baseline:_____ Treated:_____ Exhaust Stack Diameter: ___Inches

Engine Make/Model: HIND Miles/Hours: kmn: 1,81,555 I.D.#: TCB 1850
Type of Equipment: _____

Barometric Pressure: _____ inches of Mercury @:_____ (°F)

Fuel Specfic Gravity: 0.827 @: 84.2 (°F)

Smoke
1 - 7.5
2 - 9

Start Time: 2.20 AM

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	NO_x
2053	229.0	0.42	0.04	39	1.46	18.2	
	228.6	0.42	0.04	38	1.46	18.2	
	229	0.42	0.04	39	1.46	18.2	
2049	228	0.42	0.04	39	1.42	18.3	
	228	0.42	0.04	40	1.42	18.3	
	228.2	0.42	0.04	40	1.42	18.3	
2065	229.8	0.42	0.04	40	1.41	18.4	
	229.8	0.42	0.04	42	1.42	18.4	
	229.8	0.42	0.04	40	1.42	18.4.	

Finish Time: 2.45 AM

Signature of Technicians:

104 37.89 1.432

_____ _____

Names of Customer Personnel Participating in Test:

_____ _____

1443 9 6.5

Carbon Mass Balance Field Data Form

Company: CHERAN Location: LOUISBURG Test Date: 05.02.94
Test Portion: Baseline:_____ Treated:_____ Exhaust Stack Diameter: ___Inches

Engine Make/Model: 370 Miles/Hours: 1,56,819 km I.D.#: 1443
Type of Equipment: _____

Barometric Pressure: _____ inches of Mercury @:_____ (°F)

Fuel Specfic Gravity: 0.826 @: 88.2 (°F)

Smoke
1- 9
2- 6.5

Start Time: 1.25AM

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	NO_x
2040	228.4	0.44	0.09	40	1.71	17.8	
	228.4	0.44	0.09	40	1.71	17.8	
	228.2	0.44	0.09	40	1.70	17.8	
2040	228.0	0.44	0.09	44	1.68	17.9	
	228.4	0.44	0.09	43	1.67	17.9	
	228.4	0.44	0.09	44	1.67	17.9	

2041 228.2 0.42 0.09 43 1.67 17.8
228.2 0.42 0.09 43 1.66 17.8
228.0 0.42 0.09 43 1.67 17.8

Finish Time: 1.55AM

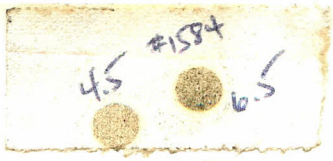
Signature of Technicians:

.09 42.22 1.682

_____ _____

Names of Customer Personnel Participating in Test:

_____ _____



Water Temp. ___
Water Press. ___
Oil Press. ___

Carbon Mass Balance Field Data Form

UHI
SGA-9000

Company: Cherun Location: Coimbatore Test Date: Feb. 4, '94
Test Portion: Baseline: X Treated: ___ Exhaust Stack Diameter: ___ Inches

Smoke Spot
1 – 4.5
2 – 6.5

Engine Make/Model: 370 Miles/Hours: ~~Miles~~ Km 153,446 I.D.#: 1584
Type of Equipment: ___

Barometric Pressure: ___ inches of Mercury @: ___ (°F)

Fuel Specfic Gravity: .824 @: 92.8 (°F)

Start Time: 11.50 PM

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	NO_x
1977 ~~1980~~	219.2 ~~197~~	0.10	0.07	49	1.64	17.9	
"	219.6	0.12	0.07	49	1.62	17.9	
	219.8	0.12 ~~0.07~~	0.07	49	1.62	17.9	
1993	219.6	0.14	0.07	52	1.61	18.0	
	219.8	0.14	0.07	52	1.59	18.1	
	219.6	0.14	0.07	52	1.59	18.1	
1988	223.0	0.14	0.07	52	1.57	18.0	
	222.6	0.14	0.07	52	1.55	18.0	
	222.0	0.14	0.07	52	1.57	18.0	
1995	221.6		0.07	52	1.58	18.1	
	221.6		0.07	53	1.58	18.1	
	221.4		0.07	53	1.58	18.1	
	.1311	.07	55.25	1.052	18.0		

Finish Time: 12'05 AM

Signature of Technicians:

___ ___

Names of Customer Personnel Participating in Test:

___ ___

1498

1 2

Carbon Mass Balance Field Data Form

Company: CHERAN Location: COIMBATORE Test Date: 05.02.94.
Test Portion: Baseline:_____ Treated:_____ Exhaust Stack Diameter: ___Inches

Engine Make/Model: 402 ~~Miles/Hours~~ kms : 1,20,874 I.D.#: TCB 1498.
Type of Equipment: _____

Barometric Pressure: _____ inches of Mercury @:_____ (°F)

Fuel Specfic Gravity: 0.827 @: 82.6 (°F)

Surface
1 – 2.5
2 – 2.

Start Time: 4.25 AM

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	NO_x
2027	229	0.46	0.05	38	1.51	18.2	
	229	0.46	0.05	38	1.51	18.2	
	229	0.46	0.05	38	1.51	18.2	
2035	229.2	0.46	0.06	35	1.51	18.2	
	229.2	0.46	0.06	35	1.51	18.2	
	229.4	0.46	0.05	35	1.49	18.2	

228.30 .46 .053 36.5 1.507 18.2

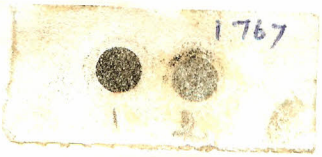
Finish Time: 4.40 AM

Signature of Technicians:

_____ _____

Names of Customer Personnel Participating in Test:

_____ _____



Carbon Mass Balance Field Data Form

Company: CHERAN Location: ~~COIMBATORE~~ Test Date: 05.02.94.
Test Portion: Baseline:_____ Treated:_____ Exhaust Stack Diameter: ___Inches

Engine Make/Model: 402 Miles/~~Hours~~: kms : 1,39,865 I.D.#: TCB 1767
Type of Equipment: _____

Barometric Pressure: _____ inches of Mercury @:_____ (°F)

Fuel Specfic Gravity: 0.827 @: 84.4 (°F)

Smoke
1 – 9
2 – 6

Start Time: 3.10 AM

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	NO_x
2074 ~~2056~~	238	0.54	0.03	27	1.67	18.2	
	238.4	0.54	0.03	27	1.67	18.2	
	238.6	0.54	0.03	27	1.67	18.2	
2076	240	0.52	0.03	28	1.63	18.0	
	240.2	0.52	0.03	28	1.63	18.0	
	240	0.52	0.03	30	1.63	18.0	

Finish Time: 3.25AM

Signature of Technicians:

_____ _____

Names of Customer Personnel Participating in Test:

_____ _____

Carbon Mass Balance Field Data Form

Company: UHERAN Location: CBE Test Date: 05.02.94
Test Portion: Baseline:_____ Treated:_____ Exhaust Stack Diameter: ___Inches

Engine Make/Model: 402 Miles/Hours: kms: 2,69,103 I.D.#: TCB 1504
Type of Equipment: _____

Barometric Pressure: _____ inches of Mercury @:_____ (°F)

Fuel Specfic Gravity: 0.828. @: 82.2 (°F)

Smoke
1 - b
2 - b

Start Time: 4.05AM

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	NO_x
2059 ~~2056~~	230	0.40	0.04	37	1.72	17.6	
	230	0.40	0.04	37	1.72	17.6	
	229.8	0.40	0.04	38	1.73	17.6	
2058	231.8	0.40	0.04	40	1.69	~~17.8~~ 17.8	
	232	0.40	0.04	39	1.69	17.9	
	232	0.40	0.04	40	1.69	17.9	

Finish Time: 4.25AM

Signature of Technicians:

_____ _____

Names of Customer Personnel Participating in Test:

_____ _____

Carbon Mass Balance Field Data Form

Company: Cheran Location: Coimbatore Test Date: Feb. 4, '94
Test Portion: Baseline: X Treated: _____ Exhaust Stack Diameter: ___Inches

Engine Make/Model: 402 Miles/~~Hours~~ KM: 254,655 I.D.#: ~~4921~~

Type of Equipment: _____

Smoke no.
1. above 9
2. 8.5

Barometric Pressure: _____ inches of Mercury @: _____ (°F)

Fuel Specfic Gravity: 0.825 @: 86.8 (°F)

Start Time: 12.35 AM

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	NO_x
2012	236.4	0.44	0.04	32	1.51	18.0	
	236.4		0.04	32	1.50	18.0	
	236.4		0.04	32	1.50	18.0	
2015	236.8		0.04	34	1.50	18.2	
	237.2	0.42	0.04	34	1.48	18.3	
	239.8		0.04	33	1.48	18.3	
2019	238.6	0.44	0.04	34	1.48	18.3	
	237.4		0.04	34	1.48	18.3	
	237.6	0.42	0.04	33	1.48	18.3	

Finish Time: 12.50 PM

Signature of Technicians:

_____ _____

Names of Customer Personnel Participating in Test:

_____ _____

1544

Carbon Mass Balance Field Data Form

Company: HERAN Location: COIMBATORE Test Date: 05.02.94
Test Portion: Baseline:_____ Treated:_____ Exhaust Stack Diameter: ___Inches

Engine Make/Model: 370. Miles/~~Hours~~: Kms 2,34,240 I.D.#: TCB 1544
Type of Equipment: _____

Barometric Pressure: _____ inches of Mercury @:_____ (°F)

Fuel Specfic Gravity: 0.825 @: 85.8 (°F)

Sample
1 - 8.5
2 - 7.5

Start Time: 1.55AM

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	NO_x
2032	240	0.44 ~~0.42~~	0.06	55	1.67	17.7	
	239	0.44	0.06	55	1.67	17.7	
	240	0.44	0.06	55	1.67	17.7	
2035	238	0.44	0.06	52	1.63	17.9	
	238	0.44	0.06	52	1.63	17.9	
	237.8	0.44	0.06	52	1.63	17.9	
2035	234.6	0.42	0.06	53	1.61	18.0	
	233.8	0.42	0.06	53	1.61	18.0	
	233.4	0.42	0.06	53	1.61	18.0	

Finish Time: 2.15AM

Signature of Technicians:

_____ _____

Names of Customer Personnel Participating in Test:

_____ _____

4518

Carbon Mass Balance Field Data Form

Company: EMERAN Location: COIMBATORE Test Date: 05.02.24.

Test Portion: Baseline:_____ Treated:_____ Exhaust Stack Diameter: ___Inches

Engine Make/Model: 370 ~~Miles/Hours~~: Kms : 1,74,952 I.D.#: TML 4518

Type of Equipment: _____

Barometric Pressure: _____ inches of Mercury @:_____ (°F)

Fuel Specfic Gravity: 0.827 @: 85.2 (°F)

Smoke
1 — 4
2 — 5

Start Time: 2.50 AM

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	NO_x
2022	234	0.36	0.06	43	1.63	18.0	
	234.4	0.36	0.06	43	1.63	18.0	
	234.8	0.36	0.06	43	1.67	18.0	
2064	236.4	0.36	0.06	42	1.61	17.9	
	236.8	0.36	0.06	43	1.61	18.0	
	236.6	0.36	0.06	43	1.60	18.0	

Finish Time: 3.05AM

Signature of Technicians:

_____ _____

Names of Customer Personnel Participating in Test:

_____ _____

#1889 75

UHI SGA-9000

Water Temp - functioning
Oil Temp: -
Oil Press. -

Carbon Mass Balance Field Data Form

Company: Cheran Location: Coimbatore Test Date: Feb 4, '94
Test Portion: Baseline: X Treated: _____ Exhaust Stack Diameter: ___Inches

Engine Make/Model: HINO Km ~~Miles~~/Hours: 229289 I.D.#: 1889
Type of Equipment: Bus

Smoke Spot
1- 7.5
2-

Barometric Pressure: _____ inches of Mercury @: _____ (°F)

Fuel Specfic Gravity: .823 @: 99.6 (°F)

0 - 1.0

Ambient 82.3

Start Time: 11:05

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	NO_x
2014 ~~1999~~	197.8	~~0.15~~	.03	28	1.25	18.4	
	198.4	~~0.10~~	.03	28	1.24	18.5	
	198.6	.06	.03	28	1.24	18.5	
2006	199.2	.08	.03	27	1.25	18.6	
	199.0	.08	.03	27	1.25	18.6	
	199.2	.08	.03	27	1.26	18.6	

Finish Time: 11:15

Signature of Technicians:

_____ _____

Names of Customer Personnel Participating in Test:

_____ _____

0483

Carbon Mass Balance Field Data Form

Company: Cheran Location: Coimbatore Test Date: Feb. 4, '94
Test Portion: Baseline: X Treated: _____ Exhaust Stack Diameter: ___Inches

Engine Make/Model: HINO Km Miles/Hours: 204122 I.D.#: 0483
Type of Equipment: _____

Smoke Spot
1 - 4
2 - 4.5

Barometric Pressure: _____ inches of Mercury @: _____ (°F)

Fuel Specfic Gravity: 0.825 @: 88.2 (°F)

Start Time: 1.05 AM

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	NO_x
1988	214.8	0.62	0.05	32	1.54	18.0	
	214.8	0.62	0.05	32	1.54	18.0	
	214.6	0.62	0.05	32	1.55	17.9	
1988	216	0.64	0.04	32	1.54	18.1	
	216.4	0.64	0.04	32	1.53	18.1	
	216.4	0.64	0.04	32	1.53	18.1	

Finish Time: 1.15 AM

Signature of Technicians:

_____ _____

Names of Customer Personnel Participating in Test:

_____ _____

N.0039

Mb ÷ 33.86

Carbon Mass Balance Field Data Form

Company: CHERAN Location: CBE Test Date: 5.2.94.
Test Portion: Baseline:_____ Treated:_____ Exhaust Stack Diameter: ___Inches

Engine Make/Model: HINO Miles/Hours: kms:- 2,58,968 I.D.#: N. 0039.
Type of Equipment: _____

Barometric Pressure: 966 Millibars 28.53 inches of Mercury @:_____ (°F)

Smoke
1 - 5
2 - 4

Fuel Specfic Gravity: 0.825 @: 86.0 (°F)

Start Time: 3.35 AM

RPM	Exhaust Temp °F	P Inches of H_2O	% CO	HC ppm	% CO_2	% O_2	NO_x
2004	219.4	0.52	0.04	35	1.35	18.3	
	219.8	0.52	0.04	34	1.35	18.4	
	220	0.52	0.04	35	1.34	18.4	
2015	221.6	0.54	0.04	32	1.34	18.5	
	222	0.54	0.04	32	1.33	18.5	
	222	0.54	0.04	32	1.34	18.5	

Finish Time: 4.00 AM

Signature of Technicians:

_____ _____

Names of Customer Personnel Participating in Test:

_____ _____