Trial Evaluation

of

Fuel Performance Catalyst - 1 (FPC-1)

by

Robert M. Neff, Inc.

Mars, PA

July 7, 1987

Report prepared for Neff Trucking

by

UHI Corporation
Provo, Utah

and

Research Development Products
Evans City, PA

Abstract

This paper will discuss the effect of an iron based fuel catalyst (ferrous picrate) upon fuel economy and exhaust gas emissions in a fleet of diesel powered trucks operated by Robert M. Neff, Inc., Mars, Pennsylvania. It will be shown that the catalyst can provide significant cost savings to the diesel fleet operated by Neff Trucking. It will also be shown that a test method that measures changes in the carbon containing gases in the exhaust stream is an accurate means of determining changes in fuel flow to the engine.

Introduction

An aftermarket combustion improver called Fuel Performance Catalyst - 1 (FPC-1) contains an iron based catalyst (ferrous picrate) that has undergone extensive testing in EPA recognized independent and university affiliated laboratories. These tests, in both gasoline and diesel powered passenger vehicles, have demonstrated that the catalyst can provide fuel savings of 2% to 10%, depending upon vehicle operating parameters, fuel quality, equipment condition, vehicle age and engine mileage.

Test procedures have included the EPA standardized Federal Test Procedures (FTP) and Highway Fuel Economy Test (HFET), the SAE J-1082 Suburban and Interstate Test Cycles, CRC cold start driveability test, and a computerized engine dynamometer test sequence.

Field testing, primarily in heavy duty diesel fleets, substantiates laboratory findings with even greater average improvements and also reveals the catalyst can be an effective means of further reducing operating costs by inhibiting the buildup of hard carbon deposits on critical engine components.

This report summarizes the results of the Neff Trucking test of the effect of FPC-1 on fuel economy in it's fleet of diesel powered trucks.

Measurement of Fuel Economy - Carbon Balance vs Direct Measurement

Until late 1973, vehicle fuel economy had been determined primarily by using various test track or road test procedures. In September 1973, the U.S. Environmental Protection Agency (EPA) introduced a method of determining vehicle fuel economy in conjunction with its chassis dynamometer emissions test. This method determines fuel consumption based upon vehicle exhaust emissions through a "carbon balance" calculation rather than a direct measurement of fuel consumed.

Starting in 1974, the carbon balance method was used solely in the EPA, CVS cold start emissions test cycle (LA-4 Cycle). In 1975, the cycle was modified adding a hot start (FTP). Later, a highway test was also developed (HFET).

A series of tests done by Ford Motor Company compared the traditional fuel measurement techniques (volumetric or gravimetric) to the carbon balance method. The results, published in SAE Technical Paper Series 75002 (Exhibit A) entitled " Improving the Measurement of Chassis Dynamometer Fuel Economy", confirmed;

> "... fuel economy results obtained by carbon mass balance calculation of carbon containing components in the vehicle exhaust are at least as accurate and repeatable as those obtained by direct fuel measurement of fuel consumed."

The Ford Motor study determined that the most important factors in the measurement of fuel consumption with the carbon balance method are:

* For fuel consumption, the measurement of CO_2

* For distance traveled, the dynamometer to vehicle interface conditions, precision and manner in which the vehicle is driven.

* Use of standardized test equipment and procedures, calibration and ambient condition correction methods.

The exhaust gas analysis/carbon balance method of determining fuel consumption changes used by UHI and RDP personnel uses a state-of-the-art, non-dispersive infrared (NDIR) exhaust gas analyzer made by Sun Electric Corporation to measure CO_2 and other carbon containing exhaust gases. The Sun Electric SGA-9000 Exhaust Gas Analyzer is approved by the EPA for vehicle emissions analysis. The SGA-9000 is calibrated internally using Scott Calibration Gases as recommended by Sun Electric. Specifications for the SGA-9000 are found in Exhibit B.

The method used by UHI and RDP does not require the vehicle to travel any distance, nor does the vehicle interface with a chassis dynamometer during testing. Consequently, inaccuracies created by improper dynamometer to vehicle interfacing and errors in driving do not occur. Additionally, a miles per gallon figure is not computed since no mileage is accumulated. The method measures fuel flow to the engine at a specified load and rpm, and makes comparisons on a percentage basis between the consumption of control fuel (not treated with FPC-1) and the consumption of FPC-1 treated fuel at that load.

Although not as controlled as an EPA laboratory test, the carbon balance method utilized by UHI is the most accurate and practical means of measuring fuel consumption changes in the field. Additionally, the carbon balance method has consistently proven to be more accurate than monthly mpg fleet records.

The technique measures exhaust concentrations of carbon dioxide (CO_2), carbon monoxide (CO), oxygen (O_2), and unburned hydrocarbons (HC). Exhaust gas temperature is also measured and engine load is determined from engine tachometer readings.

Methodology

A fleet of diesel powered trucks owned and operated by Neff Trucking, was selected as the test fleet.

After calibrating the SGA-9000 analyzer and the IMC thermocouple, and performing a leak test on the sampling hose and connections, each truck engine was brought up to stable operating temperature as verified with engine water temperature and exhaust temperature. No exhaust data was recorded until each truck engine had stabilized.

The fleet was first tested, operating at 1900 rpm, followed by a test at 1600 rpm. Readings of CO_2, CO, HC (measured as CH_4), O_2 and exhaust temperature were taken at approximately 30 second intervals.

After recording the first two readings, the SGA-9000 auto calibrating button was depressed and the instrument "checked itself" to prevent any drift. This self checking procedure was repeated after each set of two data points throughout the entire 1900 and 1600 rpm test. Several readings were taken on each truck and at each rpm. The data sheets are enclosed in Exhibit C.

After control testing, the fuel storage tank from which the Neff fleet is exclusively fueled, was treated with FPC-1 at the recommended 1 to 1600 ratio (1 oz. FPC-1 to 12.5 gallons diesel). This took place on the evening of May 22, 1987.

On July 1, 1987, after accumulating a fleet average of 12,206 miles per truck with FPC-1 treated fuel, the above procedure was repeated. The treated fuel data sheets are attached in Exhibit D.

All fuel used during the baseline and treated test segments was #2 diesel.

Special Notes:

1.) The test procedure calls for a sequence of rpm testing at 1900 and 1600 rpm, on the same equipment, to show that the change in fuel flow between the two loads can be demonstrated with the SGA-9000 Exhaust Gas Analyzer. It is obvious that a drop in fuel consumption will occur when reducing rpm from 1900 to 1600 and it shows up readily during the baseline test. This validates the concept of fuel flow measurement with exhaust gas analysis.

2.) The 1900 rpm load is more indicative of actual engine operation and improvements at this rpm are more meaningful.

3.) A qualitative technique for determining reductions in smoke and particulate was performed during both control and treated fuel test segments. This was done by attaching a new 25 micron filter to the SGA-9000 sampling hose at the beginning of each test segment. The filter traps unburned fuel that is exhausted from the engine as particulate or soot. A comparison of the control fuel and treated fuel filters revealed that the fuel was burning much cleaner with FPC-1 as particulate volume was visibly reduced in the treated fuel filter. The control test segment involved seventy-four minutes of sampling on eleven trucks; the treated segment was also seventy-four minutes, but on five trucks.

4.) Although control testing was done on eleven trucks, four of these were unavailable for the treated test segment, and two others could not be tested because of severe weather conditions.

5.) Ambient temperature was approximately ten degrees lower during the treated test segment. This discrepancy is corrected for in the summary tables and in the carbon mass balance calculation.

Equipment List

Unit #	Make	Engine	Mileage
7804	Cummins	300	444,680
46	Mack	237	54,309
8012	Mack	300	176,670
8207	Mack	300	26,487
462	Detroit	466	79,477

Summary

The data from the 1900 rpm test control and treated fuel is summarized on Table I. The data for the 1600 rpm segment is summarized on Table II.

Table I

Summary of Exhaust Gas Data at 1900 RPM

	CO	HC	CO2	O2	Exh. Temp.
Control	0.0316%	25.56ppm	2.247%	17.86%	344.00 *F
Treated	0.0320%	27.04ppm	2.127%	18.00%	352.76 *F

Table II

Summary of Exhaust Gas Data at 1600 RPM

	CO	HC	CO2	O2	Exh. Temp.
Control	0.0332%	27.28ppm	1.917%	18.30%	320.52 *F
Treated	0.0384%	29.88ppm	1.809%	18.38%	321.40 *F

From the above data volume fractions can be easily calculated and weighed using the known molecular weight of each gas. A total molecular weight and engine performance factors can then be calculated from which fuel consumption changes can be determined. The volume fractions, total molecular weight and engine performance factors for the fleet at 1900 rpm are found on Table III. The same for the 1600 rpm data is found on Table VI. The engineering formulae from which these are calculated are found in Exhibit E.

Table III

Volume Fractions for the 1900 RPM Data

	Control	Treated
VfCO	0.000316	0.00032
VfHC	0.00002556	0.00002704
VfCO2	0.02247	0.02127
VfO2	0.1786	0.1800

Total Molecular Weight and Performance Factors

Mwt1	29.0754	Mwt2	29.0619
pf1	269345.6822	pf2	283906.0904
PF1	180509.7519	PF2	192289.5950

Percent Change in Fuel Flow

192289.5950 - 180509.7519 = 11779.8431

$$\frac{11779.8431}{180509.7519} \times 100 = +\ 6.53\%$$

Table IV

Volume Fractions for the 1600 RPM Data

	Control	Treated
VfCO	0.000332	0.000384
VfHC	0.00002728	0.00002988
VfCO2	0.01917	0.01809
VfO2	0.1830	0.1838

Total Molecular Weight and Performance Factors

Mwt1	29.040	Mwt2	29.0264
pf1	313787.0732	pf2	330645.4861
PF1	242492.1648	PF2	255808.2998

Percent Change in Fuel Consumption

255808.2998 - 242492.1648 = 13316.1350

$$\frac{13316.1350}{242492.1648} \times 100 = 5.5\%$$

Conclusion

Based upon the data gathered during exhaust gas testing with and without the FPC-1 Fuel Performance Catalyst, the addition of FPC-1 to the fuel used by the Neff Trucking test fleet created an average 6.53% reduction in fuel consumption at 1900 rpm and a 5.5% reduction in fuel consumption at 1600 rpm.

The qualitative filter trap analysis shows that the FPC-1 treated fuel burned cleaner as manifested by a marked reduction in particulate accumulation in the filter trap.

Baseline Treated

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EXHAUST GAS ANALYSIS FORM

NAME OF COMPANY NEFF

DATE OF TEST JULY 1, 1987

TYPE OF EQUIPMENT TESTED

ENGINE TYPE AND SPECS DT. 466 INTERNATIONAL TURBO

I.D. NUMBER 462 MILEAGE (OR HOURS) 93771 HUB

TYPE OF TEST

AMBIENT AIR TEMPERATURE

EXHAUST READINGS

	CO	HC	CO_2	O_2	EX. TEMP.	RPM
1.	.04	26	2.26	17.8	319	1900
2.	.04	26	2.25	17.7	319	1900
3.	.04	27	2.20	17.9	320	1900
4.	.04	28	2.20	17.8	319	1900
5.	.04	28	2.22	17.9	319	1900
6.	.03	30	1.88	18.2	295	1600
7.	.04	29	1.88	18.2	293	1600
8.	.04	29	1.90	18.2	295	1600
9.	.04	29	1.91	18.1	291	1600
10.	.04	29	1.92	18.1	290	1600

START TIME: 11:03 END TIME: 11:12 LENGTH OF TEST: 9 mins.

Signature of technicians

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EXHAUST GAS ANALYSIS FORM

NAME OF COMPANY NEFF

DATE OF TEST JULY 1, 1987

TYPE OF EQUIPMENT TESTED

ENGINE TYPE AND SPECS 237 MACK TURBO

I.D. NUMBER 46 MILEAGE (OR HOURS) ~~218245 (HUB 54309)~~ HUB 69689

TYPE OF TEST

AMBIENT AIR TEMPERATURE

EXHAUST READINGS

	CO	HC	CO_2	O_2	EX. TEMP.	RPM
1.	.03	27	2.18	18.0	342	1900
2.	.03	31	2.17	18.0	343	1900
3.	.03	32	2.15	18.2	345	1900
4.	.03	35	2.14	18.1	346	1900
5.	.03	36	2.13	18.2	347	1900
6.	.03	39	1.83	18.5	313	1600
7.	.03	40	1.83	18.4	312	1600
8.	.03	40	1.84	18.5	309	1600
9.	.03	40	1.84	18.4	308	1600
10.	.03	40	18.3	18.5	307	1600

START TIME: 10:13 END TIME: 10:23 LENGTH OF TEST: 10

Signature of technicians

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EXHAUST GAS ANALYSIS FORM

NAME OF COMPANY NEFF

DATE OF TEST JULY 1, 1987

TYPE OF EQUIPMENT TESTED

ENGINE TYPE AND SPECS 300 CUM TURBO

I.D. NUMBER 7804 MILEAGE (OR HOURS) Hub 300,308 457,695

TYPE OF TEST

AMBIENT AIR TEMPERATURE

EXHAUST READINGS

	CO	HC	CO_2	O_2	EX. TEMP.	RPM
1.	.01	23	1.89	18.2	348	1900
2.	.01	23	1.89	18.2	350	1900
3.	.01	24	1.87	18.4	354	1900
4.	.01	24	1.86	18.3	354	1900
5.	.01	24	1.85	18.3	355	1900
6.	.01	24	1.58	18.7	325	1600
7.	.01	24	1.57	18.6	326	1600
8.	.01	24	1.56	18.7	320	1600
9.	.01	24	1.55	18.7	319	1600
10.	.01	24	1.55	18.8	318	1600

START TIME: 10:31 END TIME: 10:41 LENGTH OF TEST: 10 mins

Signature of technicians

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EXHAUST GAS ANALYSIS FORM

NAME OF COMPANY NEFF

DATE OF TEST JULY 1, 1987

TYPE OF EQUIPMENT TESTED

ENGINE TYPE AND SPECS 300 MACK TURBO

I.D. NUMBER 8207 MILEAGE (OR HOURS) 33429 HUB

TYPE OF TEST

AMBIENT AIR TEMPERATURE

EXHAUST READINGS

	CO	HC	CO_2	O_2	EX. TEMP.	RPM
1.	.04	23	2.04	18.1	350	1900
2.	.04	23	2.04	18.1	350	1900
3.	.04	25	2.03	18.2	350	1900
4.	.04	25	2.03	18.1	350	1900
5.	.04	27	1.99	18.2	351	1900
6.	.04	26	1.69	18.6	319	1600
7.	.04	27	1.69	18.6	317	1600
8.	.04	27	1.69	18.6	313	1600
9.	.05	27	1.69	18.6	312	1600
10.	.04	27	1.69	18.6	311	1600

START TIME: 3:23 END TIME: 3:31 LENGTH OF TEST: 8

Signature of technicians

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EXHAUST GAS ANALYSIS FORM

NAME OF COMPANY NEFF

DATE OF TEST JULY 1, 1987

TYPE OF EQUIPMENT TESTED ____

ENGINE TYPE AND SPECS 300 MACK TURBO

I.D. NUMBER 8012 MILEAGE (OR HOURS) 185 069 - HUB (100,184)

TYPE OF TEST ____

AMBIENT AIR TEMPERATURE ____

EXHAUST READINGS

	CO	HC	CO_2	O_2	EX. TEMP.	RPM
	04	29	2.35	17.7	348	
	.04	29	2.36	17.8	348	
1.	~~.05~~	~~27~~	~~2.43~~	~~17.5~~	~~346~~	1900
2.	~~.05~~	~~27~~	~~2.43~~	~~17.5~~	~~347~~	1900
3.	.04	27	2.37	17.6	347	1900
4.	.04	27	2.36	17.6	347	1900
5.	.04	27	2.36	17.6	348	1900
6.	.06	29	2.07	18.0	325	1600
7.	.06	29	2.06	18.0	322	1600
8.	.06	29	2.07	18.0	317	1600
9.	.06	31	2.06	18.0	316	1600
10.	.06	30	2.06	18.1	312	1600

START TIME: 10:46 END TIME: 10:56 LENGTH OF TEST: 10 MIN

Signature of technicians ____

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4:04
3:57

Exhaust Gas Analysis Form

Name of Company: NKFF

Date of Test: MAY 22, 1987

Type of Equipment Tested:

Engine Type and Specs: 237 MACK Turbo
54309-HOB

Identification No.: 46 Milage: 218245

Type of Test:

Ambient Air Temp.:

Exhaust Readings

	CO	HC	CO_2	O2	Exh. Temp.	RPM
1.	.03	30	2.28	17.6	340	1900
2.	.03	30	2.28	17.6	341	1900
3.	.03	31	2.23	18.2	346	1900
4.	.02	31	2.24	17.7	347	1900
5.	.03	31	2.21	18.3	347	1900
6.	.03	35	1.87	18.6	318	1600
7.	.03	35	1.86	18.1	319	1600
8.	.03	35	1.91	18.6	319	1600
9.	.03	35	1.91	18.1	321	1600
10.	.03	36	1.91	18.5	320	1600

Length of Test in minutes: 7 min

Signature of Technicians:

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1:39
1:30

CHEM

21

Exhaust Gas Analysis Form

Name of Company NEFF

Date of Test MAY 22 1987

Type of Equipment Tested

Engine Type and Specs 300 MACK TURBO

026487-HUB

Identification No. 8207 Milage 022668

Type of Test

Ambient Air Temp. 85

Exhaust Readings

	CO	HC	CO_2	02	Exh. Temp.	RPM
1.	.03	24	2.13	18.0	361	1900
2.	.03	24	2.11	17.8	362	1900
3.	.03	25	2.15	18.4	364	1900
4.	.03	24	2.15	17.9	364	1900
5.	.03	25	2.14	18.5	363	1900
6.	.03	25	1.79	18.5	338	1600
7.	.03	25	1.79	18.2	338	1600
8.	.03	25	1.79	18.3	336	1600
9.	.03	25	1.79	18.2	335	1600
10.	.03	26	1.81	18.7	334	1600

Length of Test in minutes 7

Signature of Technicians

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5:19
6:26

C. Hem C. Hem
MACK Rubicl

Exhaust Gas Analysis Form

Name of Company NeFF

Date of Test MAY 22, 1987

Type of Equipment Tested 300 MACK TURBO

Engine Type and Specs 8012

173670-HuB

Identification No. ______ Milage 99107

Type of Test ______

Ambient Air Temp. ______

Exhaust Readings

	CO	HC	CO_2	O2	Exh. Temp.	RPM
1.	.03	23	2.39	17.3	340	1900
2.	.03	23	2.40	17.3	342	1900
3.	.03	23	2.41	17.4	~~333~~ 344	1900
4.	.03	23	2.38	17.4	347	1900
5.	.03	23	2.41	17.7	351	1900
6.	.04	25	2.14	18.1	327	1600
7.	.04	25	2.15	17.7	325	1600
8.	.04	26	2.19	18.1	323	1600
9.	.04	24	2.19	17.8	324	1600
10.	.04	26	2.13	18.2	324	1600

Length of Test in minutes 6

Signature of Technicians ______

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12:00
11:50

Exhaust Gas Analysis Form

Name of Company NEFF

Date of Test May 22, 1987

Type of Equipment Tested

Engine Type and Specs D.T 466 INTERNATIONAL TURBO

Identification No. 462 Milage 079477 HUB

Type of Test

Ambient Air Temp.

Exhaust Readings

	CO	HC	CO_2	O2	Exh. Temp.	RPM
1.	.05	28	2.59	17.3	314	1900
2.	.05	28	2.59	17.3	317	1900
3.	.05	28	2.55	17.8	322	1900
4.	.05	28	2.55	17.3	324	1900
5.	.05	30	2.53	17.9	328	1900
6.	.04	28	2.13	18.2	305	1600
7.	.04	28	2.14	17.8	304	1600
8.	.05	31	2.16	18.2	303	1600
9.	.05	30	2.16	17.7	303	1600
10.	.05	32	2.15	18.4	302	1600

Length of Test in minutes 8 min

Signature of Technicians

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11:44
11:37

Exhaust Gas Analysis Form

Name of Company NEFF

Date of Test MAY 22, 1987

Type of Equipment Tested

Engine Type and Specs 300 CUM TURBO

Identification No. 7804 Milage 444,680

Type of Test

Ambient Air Temp.

Exhaust Readings

	CO	HC	CO_2	O2	Exh. Temp.	RPM
1.	.02	21	1.89	18.2	345	1900
2.	.02	21	1.92	18.2	345	1900
3.	.02	22	1.88	18.5	347	1900
4.	.02	21	1.87	18.2	348	1900
5.	.02	22	1.89	18.8	351	1900
6.	.02	21	1.60	18.6	317	1600
7.	.02	21	1.57	18.5	318	1600
8.	.02	24	1.10	19.3	319	1600
9.	.02	20	1.58	18.6	320	1600
10.	.02	19	1.60	18.5	321	1600

FAN 174 Koerner

Length of Test in minutes 7

Signature of Technicians

65
95°
17
9/12
65 95° 17/9 12

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RAINING HARD!
CRAIG GOT WET

EXHAUST GAS ANALYSIS FORM

NAME OF COMPANY NEFF

DATE OF TEST JULY 1, 1987

TYPE OF EQUIPMENT TESTED

ENGINE TYPE AND SPECS 300 MACK TURBO

I.D. NUMBER 7913 MILEAGE (OR HOURS)

TYPE OF TEST

AMBIENT AIR TEMPERATURE

WATER TEMP 140!

EXHAUST READINGS

	CO	HC	CO_2	O_2	EX. TEMP.	RPM
1.	.06	32	2.36	17.6	342	1900
2.	.06	33	2.35	17.6	344	1900
3.	.06	32	2.34	17.7	344	1900
4.						
5.						
6.	.07	33	1.97	18.1	322	1600
7.	.07	33	2.01	18.1	317	1600
8.	.07	34	2.06	18.0	317	1600
9.						
10.						

START TIME: 9:55 END TIME: 10:12 LENGTH OF TEST:

Signature of technicians

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11:08

Exhaust Gas Analysis Form

Name of Company NEFF

Date of Test MAY 22, 1987

Type of Equipment Tested

Engine Type and Specs 240 cum Turbo

Identification No. 8205 Milage 393,041

Type of Test

Ambient Air Temp. 78

Exhaust Readings

	CO	HC	CO_2	02	Exh. Temp.	RPM
1.	.03	27	2.15	17.8	356	1900
2.	.03	28	2.14	17.8	355	1900
3.	.03	29	2.11	18.4	362	1900
4.	.02	27	2.14	18.0	361	1900
5.	.03	27	2.15	18.4	362	1900
6.	.03	30	1.72	18.5	340	1600
7.	.03	30	1.69	18.4	339	1600
8.	.03	31	1.68	18.5	339	1600
9.	.03	31	1.73	18.4	337	1600
10.	.03	31	1.74	18.8	339	1600

Length of Test in minutes 8 min

Signature of Technicians

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12:07

Exhaust Gas Analysis Form

Name of Company NEFF

Date of Test May 22 1987

Type of Equipment Tested

Engine Type and Specs 300 MACK TURBO

Identification No. 7913 Milage 057632.4 HUB

Type of Test

Ambient Air Temp.

Exhaust Readings

	CO	HC	CO_2	02	Exh. Temp.	RPM
1.	.03	26	2.39	17.4	340	1900
2.	.03	26	2.39	17.4	339	1900
3.	.03	30	2.36	17.8	347	1900
4.	.03	27	2.34	17.5	343	1900
5.	.03	28	2.33	18.0	345	1900
6.	.04	30	2.08	17.9	319	1600
7.	.04	31	2.11	17.8	320	1600
8.	.04	27	2.04	17.9	314	1600
9.	.04	28	2.05	1.79	314	1600
10.	.04	28	2.01	17.9	316	1600

Length of Test in minutes 7

Signature of Technicians

55

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6447
6:41

FIGEN TEST
74 MINUTE / 11 TRUCKS

Exhaust Gas Analysis Form

Name of Company NEFF

Date of Test MAY 22, 1987

Type of Equipment Tested

Engine Type and Specs 237 MACK TURBO
86337-HUB

Identification No. 7302 Milage 405749

Type of Test

Ambient Air Temp.

Exhaust Readings

	CO	HC	CO_2	02	Exh. Temp.	RPM
1.	.03	28	2.87	16.9	371	1900
2.	.03	30	2.82	16.9	372	1900
3.	.03	28	2.76	17.3	376	1900
4.	.03	28	2.75	17.0	375	1900
5.	.03	29	2.74	17.3	378	1900
6.	.04	31	2.30	18.0	336	1600
7.	.03	28	2.29	17.6	337	1600
8.	.04	31	2.32	17.8	~~334~~ 334	1600
9.	.03	30	2.31	17.5	~~345~~ 33 335	1600
10.	.04	31	2.32	18.1	334	1600

Length of Test in minutes 6

Signature of Technicians

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5:12

Exhaust Gas Analysis Form

Name of Company: NEFF

Date of Test: MAY 22 1987

Type of Equipment Tested:

Engine Type and Specs: 237 MACK TURBO

Identification No. 7407 Milage 86948

Type of Test:

Ambient Air Temp.:

Exhaust Readings

	CO	HC	CO_2	02	Exh. Temp.	RPM
1.	.03	25	2.55	17.4	393	1900
2.	.03	25	2.52	17.3	396	1900
3.	.02	27	2.49	17.6	396	1900
4.	.02	28	2.49	17.4	395	1900
5.	.03	27	2.49	17.8	394	1900
6.	.03	28	2.06	18.2	355	1600
7.	.03	27	2.05	18.0	354	1600
8.	.04	31	2.04	18.5	352	1600
9.	.03	28	2.04	18.0	348	1600
10.	.03	31	2.05	18.3	349	1600

Length of Test in minutes: 5

Signature of Technicians:

RDP INC
Research Development Products • P.O. Box 53, Evans City, PA 16033 • 412/538-8842
4:49

Exhaust Gas Analysis Form

Name of Company NEFF

Date of Test MAY 22, 1987

Type of Equipment Tested

Engine Type and Specs 237 MACK TURBO
131651-HUB

Identification No. 7902 Milage 713686

Type of Test

Ambient Air Temp.

Exhaust Readings

	CO	HC	CO_2	02	Exh. Temp.	RPM
1.	.04	25	2.56	17.3	358	1900
2.	.04	25	2.55	17.3	359	1900
3.	.04	25	2.56	17.8	364	1900
4.	.04	25	2.56	17.4	366	1900
5.	.04	24	2.54	17.6	370	1900
6.	.05	28	2.13	17.8	331	1600
7.	.05	28	2.11	17.8	332	1600
8.	.05	26	2.13	18.1	332	1600
9.	.05	26	2.15	17.8	333	1600
10.	.05	28	2.17	18.0	334	1600

Length of Test in minutes 6

Signature of Technicians

RDP INC
Research Development Products • P.O. Box 53, Evans City, PA 16033 • 412/538-8842

3.09
3.02

CHEM

Exhaust Gas Analysis Form

Name of Company NEFF

Date of Test MAY 22, 1987

Type of Equipment Tested

Engine Type and Specs 300 MACK TURBO

Identification No. 8010 Milage 341,293

Type of Test

Ambient Air Temp.

Exhaust Readings

	CO	HC	CO_2	02	Exh. Temp.	RPM
1.	.05	26	2.27	18.3	380	1900
2.	.04	26	2.27	17.7	381	1900
3.	.04	26	2.29	17.8	378	1900
4.	.04	26	2.30	17.6	378	1900
5.	.04	26	2.28	18.2	379	1900
6.	.06	27	1.89	18.1	335	1600
7.	.05	27	1.89	18.1	334	1600
8.	.05	30	1.90	18.7	330	1600
9.	.05	26	1.89	18.1	329	1600
10.	.05	26	1.90	18.4	328	1600

Length of Test in minutes 7

Signature of Technicians

SPECIAL SERVICES:
Bulldozer
High Lift
Low Boy
Heavy Wrecker
Rigging

ROBERT M. NEFF

Phone 452-0222 — 454-0128
120 SHAWNEE AVE. • SO. ZANESVILLE, OHIO 43701

REGULAR SERVICES:
Freight
Industrial Material
Industrial Machinery
Emergency Shipments
Air Freight

June 30, 1989

Edward J. Nusser
FPC Enterprises
P.O. Box 156
Evans City, PA 16033

Dear Ed:

Below, as per your request, is a summary of my experience with FPC-1 and the improvements I have seen in the Neff fleet since we began using the product.

In the two years that Neff has used FPC-1, this predominantly Mack mail hauling fleet has logged over 5 million miles. I have been quite satisfied with the fleet fuel mileage increase, which has averaged between 5.5% and 6%. The carbon mass balance test you performed on the fleet had quite accurately predicted a 5.5% - 6.5% increase.

Besides increased mileage, I have seen significant improvement in two major areas. First is the very obvious elimination of soot in the exhaust. When the carbon balance test was performed, I was impressed by how much cleaner the exhaust gas analyzer filter was after the treated period, as compared to the baseline segment. This cleaning up of the exhaust has since been very evident in the trucks themselves. The trucks and the trailers, which are both white, are now clean and remain that way. The trucks no longer emit a thick cloud of black, sooty exhaust on startup, and the trailers have no tell-tale black streaks down the side. In fact, we really notice the difference when we get trucks from other terminals, because they belch black smoke until we get them on FPC-1 treated fuel.

The other improvement I've seen is in the lack of carbon buildup in the engines. Cylinder heads can be hand-wiped, where before carbon had to be chiseled off of them. A definite cleaning up of pre-existing carbon became noticeable after about 20,000 miles on FPC-1. Also, there is no longer carbon on the injectors, and they are lasting twice as long as before.

I have been more than satisfied with the results I have seen in this fleet since we began using FPC-1. From a maintenance standpoint, I've become so accustomed to clean exhaust and clean engine components that I can't imagine going back to running a fleet without it.

Sincerely,

Glenn Smith

Glenn Smith
Mars, PA, Terminal Manager

(412) 776-5440

"Your Partner In Progress"

— OVER 30 YEARS IN BUSINESS —

SPECIAL SERVICES:
Bulldozer
High Lift
Low Boy
Heavy Wrecker
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ROBERT M. NEFF

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