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Trial Evaluation

of

Fuel Performance Catalyst - 1 (FPC-1)

by

United Telephone

Butler, PA.

October 2, 1988

Report Prepared for United Telephone

by

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Provo, Utah

and

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Eastern Region Sales Manager
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 United Telephone, Butler, Pennsylvania. It will be shown that the catalyst can provide significant cost savings to the diesel fleet operated by United Telephone. 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 United Telephone 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 (Appendix 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 CO2

* 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 Ed Nusser uses a state-of-the-art, non-dispersive infrared (NDIR) exhaust gas analyzer made by Sun Electric Corporation to measure CO2 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 Appendix B.

The method used by UHI and Ed Nusser 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 United Telephone, 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 2500 rpm, followed by a test at 2000 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 test. Several readings were taken on each truck and at each rpm. The raw data sheets are found in Appendix C.

After control testing, the fuel storage tank from which the United Telephone is exclusively fueled, was treated with FPC-1 at the recommended 1 to 5000 ratio (1 oz. FPC-1 to 40 gallons diesel). This took place on Aug. 10, 1988.

On September 27, 1988, after accumulating a fleet average of 89.3 hours per truck with FPC-1 treated fuel, the above procedure was repeated. The treated fuel raw data sheets are attached in Appendix 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 2500 and 2000 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 2500 to 2000 and it shows up readily during the baseline test. This validates the concept of fuel flow measurement with exhaust gas analysis.

2.) The 2500 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 in the exhaust was visibly reduced in the treated fuel filter. The control test filter was subjected to exhaust sampling for forty-five (45) minutes. The treated test filter was subjected to exhaust sampling for fifty-seven minutes (57) on the identical fleet of trucks. A comparison photograph of the two filters is found in Appendix E.

4.) Ambient temperature was fifteen 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	Hours
35011	Cat	3208	3826.5
37016	Detroit	8.2	851.4
37015	Detroit	8.2	1013.9
37013	Detroit	8.2	1018.6
36019	Detroit	8.2	1721.0

Summary

The data from the 2500 rpm test control and treated fuel is summarized on Table I. The data for the 2000 rpm segment is summarized on Table II.

Table I

Summary of Exhaust Gas Data at 2500 RPM

	CO	HC	CO2	O2	Exh. Temp.
Control	0.0424%	19.12ppm	1.74%	17.88%	332.92 *F
Treated	0.0424%	18.08ppm	1.71%	18.21%	345.50 *F

Table II

Summary of Exhaust Gas Data at 2000 RPM

	CO	HC	CO2	O2	Exh. Temp.
Control	0.032%	18.48ppm	1.432%	18.34%	299.80 *F
Treated	0.038%	18.4ppm	1.438%	18.54%	308.95 *F

From the above data volume fractions can be 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 2500 rpm are found on Table III. The same for the 2000 rpm data is found on Table IV. The engineering formulae from which these are calculated are found in Exhibit F.

Table III

Volume Fractions for the 2500 RPM Data

	Control	Treated
VfCO	0.000424	0.000424
VfHC	0.00001912	0.00001808
VfCO2	0.01744	0.01715
VfO2	0.1788	0.1821

Total Molecular Weight and Performance Factors

Mwt1	28.9953	Mwt2	29.0038
pf1	342719.9390	pf2	348566.5151
PF1	194106.7814	PF2	200764.3536

Percent Change in Fuel Flow

$$200764.3536 - 194106.7814 = 6657.5722$$

$$\frac{6657.5722}{194106.7814} (100) = + 3.43\%$$

Table IV

Volume Fractions for the 2000 RPM Data

	Control	Treated
VfCO	0.00032	0.000385
VfHC	0.00001845	0.00001772
VfCO2	0.01432	0.01438
VfO2	0.1834	0.1854

Total Molecular Weight and Performance Factors

Mwt1	28.9664	**Mwt2**	28.9727
pf1	411363.7557	**pf2**	413881.8689
PF1	250043.3453	**PF2**	254603.5705

Percent Change in Fuel Consumption

$$254603.5705 - 250043.4353 = 4560.2252$$

$$\frac{4560.2252}{250043.4353}(100) = .42\%$$

Discussion

From the calculations above and the improved cleanliness of the engine exhaust demonstrated by the filter trap comparison, it is apparent the FPC-1 is providing United Telephone with a fuel savings, although lower than those of previous tests in similar fleets. There are several explanations for this which will be discussed below.

1. Low Hour Accumulation with FPC-1 Treated Fuel.

Laboratory tests, at EPA approved facilities, have demonstrated that the full effect of FPC-1 is not obtained immediately. In fact, may require 200 to 300 hours of use to achieve maximum effect. It is for this reason that UHI recommends a minimum 200 hours of treated fuel operation between the control or untreated baseline testing, and the final FPC-1 treated fuel test for fuel economy.

The United Telephone fleet has accumulated a fleet average of 89.32 hours of FPC-1 treated fuel use between the two test segments. This average is less than half of the recommended average. A carbon balance calculation on the truck with the highest hours of FPC-1 use (Unit 35011, 140.5 hrs.) reveals a 4.5% fuel economy improvement at both rpms. This is more typical of improvements experienced by other customers.

It is likely that the fuel economy improvement will be greater after an additional 100 to 130 hours of FPC-1 use.

2. Testing in New or Low Hour Equipment.

Laboratory testing indicates that the effect of the active ingredient in FPC-1 is twofold.

First, the catalyst shortens the induction period by burning the fuel slightly faster, thereby bringing about an increase in the engines efficient use of the available energy in the fuel. Second, the catalyst gradually restores engine thermal efficiency by slowly removing existing engine carbon deposits. It is the combined effect of these two related functions that creates the overall fuel economy improvement. Consequently, fuel economy improvements are typically lower in new or rebuilt engines, as there is less carbon accumulation and, therefore, less efficiency loss to be regained.

The United Telephone fleet is one of extremely low engine hours averaging only 1,597.16 hours of operation per truck prior to FPC-1 treatment. In fact, three of the five trucks in the fleet had less than 1000 hours before the FPC-1 test began. It is doubtful that such a fleet is an accurate representation of the entire fleet operated by United Telephone.

It is recommended that the United Telephone test fleet be allowed to accumulate more hours of FPC-1 use. However, with such a low hour fleet to begin with, it is likely that the fuel economy improvement will not be as great as that seen in fleets with higher average engine hours.

Conclusion

Based upon the data gathered during exhaust gas testing with and without FPC-1 Fuel Performance Catalyst, the addition of FPC-1 to the fuel used by the United Telephone test fleet created an average 3.43% reduction in fuel consumption at 2500 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.

45 Total Mins

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EXHAUST GAS ANALYSIS FORM

NAME OF COMPANY: UNITED TELEPHONE

DATE OF TEST: AUG 10, 1988.

TYPE OF EQUIPMENT TESTED:

ENGINE TYPE AND SPECS: 8.2 D.D.

I.D. NUMBER: 36019 MILEAGE (OR HOURS): 1639.8 HRS

TYPE OF TEST:

AMBIENT AIR TEMPERATURE: 86

EXHAUST READINGS

	CO	HC	CO_2	O_2	EX. TEMP.	RPM
1.	.06	17	1.81	17.8	319	2500
2.	.05	17	1.79	17.8	320	2500
3.	.04	18	1.78	17.9	327	2500
4.	.06	19	1.77	17.8	327	2500
5.	.04	17	1.78	17.9	322	2500
	.046	17.6	1.786	17.84	323	
6.	.03	16	1.42	18.3	297	2000
7.	.04	17	1.52	18.2	297	2000
8.	.03	17	1.48	18.2	294	2000
9.	.03	13	1.48	18.3	293	2000
10.	.04	17	1.49	18.3	292	2000
	.034	16	1.478	18.26	294.6	

START TIME: 4:10 END TIME: 4:19 LENGTH OF TEST: 9

Signature of technicians ______________________

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EXHAUST GAS ANALYSIS FORM

NAME OF COMPANY: UNITED TELEPHONE

DATE OF TEST: Sept 27, 1988

TYPE OF EQUIPMENT TESTED:

ENGINE TYPE AND SPECS: 3208

I.D. NUMBER: 35011 MILEAGE (OR HOURS): 3827.5

TYPE OF TEST:

AMBIENT AIR TEMPERATURE:

EXHAUST READINGS

	CO	HC	CO_2	O_2	EX. TEMP.	RPM
1.	.05	18	1.88	18.0	325	2500
2.	.04	19	1.88	17.9	327	2500
3.	.04	22	1.91	18.0	333	2500
4.	.04	22	1.91	17.9	334	2500
5.	.04	22	1.91	18.0	338	2500
6.	.04	21	1.62	18.4	305	2000
7.	.04	21	1.61	18.3	305	2000
8.	.04	21	1.63	18.2	302	2000
9.	.04	22	1.62	18.2	302	2000
10.	.04	22	1.63	18.4	301	2000

START TIME: 4:28 END TIME: 4:40 LENGTH OF TEST: 12

Signature of technicians

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EXHAUST GAS ANALYSIS FORM

NAME OF COMPANY United Telephone

DATE OF TEST Sept 27, 1988

TYPE OF EQUIPMENT TESTED

ENGINE TYPE AND SPECS 8.2 D.D

I.D. NUMBER 37013 MILEAGE (OR HOURS) 1018.6

TYPE OF TEST

AMBIENT AIR TEMPERATURE

EXHAUST READINGS

	CO	HC	CO_2	O_2	EX. TEMP.	RPM
1.	.04	15	1.65	18.4	335	2500
2.	.04	15	1.67	18.3	335	2500
3.	.04	12	1.62	18.4	338	2500
4.	.04	13	1.64	18.3	338	2500
5.	.04	15	1.63	18.4	341	2500
6.	.04	15	1.36	18.7	294	2000
7.	.04	15	1.37	18.6	291	2000
8.	.03	15	1.35	18.7	285	2000
9.	.03	15	1.33	18.7	285	2000
10.	.04	15	1.35	18.7	285	2000

START TIME: 4:08 END TIME: 4:20 LENGTH OF TEST: 12

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EXHAUST GAS ANALYSIS FORM

NAME OF COMPANY United Telephone

DATE OF TEST Sept. 27, 1988

TYPE OF EQUIPMENT TESTED

ENGINE TYPE AND SPECS 8.2

I.D. NUMBER 37015 MILEAGE (OR HOURS) 1013.9

TYPE OF TEST

AMBIENT AIR TEMPERATURE

EXHAUST READINGS

	CO	HC	CO_2	O_2	EX. TEMP.	RPM
1.	.04	17	1.66	18.3	330	2500
2.	.04	17	1.66	18.2	331	2500
3.	.04	15	1.71	18.2	336	2500
4.	.04	17	1.69	18.1	337	2500
5.	.04	15	1.70	18.3	340	2500
6.	.03	15	1.45	18.6	305	2000
7.	.04	15	1.43	18.5	305	2000
8.	.03	15	1.44	18.6	304	2000
9.	.04	15	1.44	18.5	304	2000
10.	.04	15	1.42	18.6	304	2000

START TIME: 4:54 END TIME: 5:06 LENGTH OF TEST: 12

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EXHAUST GAS ANALYSIS FORM

NAME OF COMPANY United Telephone

DATE OF TEST Sept 27, 1988

TYPE OF EQUIPMENT TESTED

ENGINE TYPE AND SPECS 8.2 D.D.

I.D. NUMBER 37016 MILEAGE (OR HOURS) 851.4

TYPE OF TEST

AMBIENT AIR TEMPERATURE

EXHAUST READINGS

	CO	HC	CO_2	O_2	EX. TEMP.	RPM
1.	.05	18	1.66	18.3	316	2500
2.	.05	18	1.65	18.3	318	2500
3.	.05	19	1.67	18.3	326	2500
4.	.05	19	1.66	18.3	327	2500
5.	.05	19	1.66	18.3	332	2500
6.	.04	18	1.35	18.7	294	2000
7.	.04	18	1.35	18.6	294	2000
8.	.03	18	1.37	18.6	292	2000
9.	.04	17	1.36	18.6	291	2000
10.	.04	17	1.36	18.6	288	2000

START TIME: 4:42 END TIME: 4:52 LENGTH OF TEST: 10

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EXHAUST GAS ANALYSIS FORM

NAME OF COMPANY United Telephone

DATE OF TEST Sept 27, 1988

TYPE OF EQUIPMENT TESTED

ENGINE TYPE AND SPECS ~~3208~~ 8.2 D.D.

I.D. NUMBER 36019 MILEAGE (OR HOURS) 1721.0

TYPE OF TEST

AMBIENT AIR TEMPERATURE 71

EXHAUST READINGS

	CO	HC	CO_2	O_2	EX. TEMP.	RPM
1.	.04	22	1.73	18.1	324	2500
2.	.04	22	1.71	18.1	325	2500
3.	.04	26	1.69	18.3	331	2500
4.	.04	19	1.70	18.2	332	2500
5.	.04	22	1.71	18.4	335	2500
6.	.04	19	1.41	18.8	295	2000
7.	.04	19	1.40	18.7	295	2000
8.	.04	20	1.45	18.6	293	2000
9.	.04	20	1.39	18.6	291	2000
10.	.04	20	1.48	18.6	293	2000

START TIME: 3:24 END TIME: 3:35 LENGTH OF TEST: 11

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EXHAUST GAS ANALYSIS FORM

NAME OF COMPANY UNITED

DATE OF TEST Aug 10, 1988

TYPE OF EQUIPMENT TESTED

ENGINE TYPE AND SPECS 3208

I.D. NUMBER 35011 MILEAGE (OR HOURS) 3687

TYPE OF TEST

AMBIENT AIR TEMPERATURE

EXHAUST READINGS

	CO	HC	CO_2	O_2	EX. TEMP.	RPM
1.	.04	26	1.93	17.7	319	2500
2.	.04	26	1.93	17.5	321	2500
3.	.04	26	1.93	17.6	330	2500
4.	.04	26	1.93	17.5	331	2500
5.	.04	25	1.92	17.6	338	2500
	.04	25.8	1.928	17.58	327.8	
6.	.04	23	1.65	18.0	308	2000
7.	.04	23	1.65	18.0	307	2000
8.	.04	24	1.66	18.1	307	2000
9.	.04	23	1.66	18.0	306	2000
10.	.04	24	1.66	18.0	306	2000
	.04	23.4	1.656	18.02	306.8	

START TIME: 5:07 END TIME: 5:16 LENGTH OF TEST: 9

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EXHAUST GAS ANALYSIS FORM

NAME OF COMPANY: United

DATE OF TEST: Aug 10, 1988

TYPE OF EQUIPMENT TESTED:

ENGINE TYPE AND SPECS: 8.2 D.D.

I.D. NUMBER: 37013   MILEAGE (OR HOURS): 948.1

TYPE OF TEST:

AMBIENT AIR TEMPERATURE:

EXHAUST READINGS

	CO	HC	CO_2	O_2	EX. TEMP.	RPM
1.	.03	14	1.58	18.2	332	2500
2.	.03	14	1.64	18.1	335	2500
3.	.03	14	1.64	18.1	341	2500
4.	.03	14	1.63	18.0	340	2500
5.	.03	14	1.62	18.0	344	2500
	.03	14	1.622	18.08	338.4	
6.	.02	14	1.28	18.5	300	2000
7.	.03	14	1.32	18.5	299	2000
8.	.02	14	1.26	18.6	294	2000
9.	.02	15	1.26	18.5	291	2000
10.	.03	14	1.28	18.6	293	2000

START TIME: 4:37   END TIME: 4:46   LENGTH OF TEST: 9

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EXHAUST GAS ANALYSIS FORM

NAME OF COMPANY United

DATE OF TEST Aug 10, 1988

TYPE OF EQUIPMENT TESTED

ENGINE TYPE AND SPECS 8.2 D.D.

I.D. NUMBER 37015 MILEAGE (OR HOURS) 939.7

TYPE OF TEST

AMBIENT AIR TEMPERATURE

EXHAUST READINGS

	CO	HC	CO_2	O_2	EX. TEMP.	RPM
1.	.05	15	1.71	17.9	328	2500
2.	.05	15	1.69	17.9	330	2500
3.	.04	18	1.63	18.0	338	2500
4.	.04	17	1.62	~~[illegible]~~ 17.9	339	2500
5.	.04	18	~~[illegible]~~ 1.62	18.1	344	2500
	.044	16.6	1.654	17.96	335.8	
6.	.03	17	1.36	18.4	312	2000
7.	.03	17	1.37	18.4	312	2000
8.	.03	17	1.35	18.5	307	2000
9.	.03	17	1.33	18.4	307	2000
10.	.03	17	1.33	18.4	306	2000
			1.348	18.42	308.8	

START TIME: 4:24 END TIME: 4:33 LENGTH OF TEST: 9

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EXHAUST GAS ANALYSIS FORM

NAME OF COMPANY United

DATE OF TEST Aug 10, 1988

TYPE OF EQUIPMENT TESTED

ENGINE TYPE AND SPECS 8.2 D.D.

I.D. NUMBER 37016 MILEAGE (OR HOURS) 771.2

TYPE OF TEST

AMBIENT AIR TEMPERATURE

EXHAUST READINGS

	CO	HC	CO_2	O_2	EX. TEMP.	RPM
1.	.05	22	1.76	18.0	331	2500
2.	.05	23	1.78	17.9	335	2500
3.	.04	21	1.70	17.9	342	2500
4.	.04	23	1.74	17.9	344	2500
5.	.04	19	1.69	18.0	346	2500
	.052	21.6	1.734	17.94	339.6	
6.	.04	21	1.39	18.5	303	2000
7.	.04	21	1.39	18.4	304	2000
8.	.04	22	1.42	18.4	304	2000
9.	.04	22	1.42	18.4	304	2000
10.	.03	23	1.38	18.4	297	2000

START TIME: 4:52 END TIME: 5:01 LENGTH OF TEST: 9

Signature of technicians

UNITED

I.D. # 35011 3827.5 HRS 12 min (140.5 Hrs)

	CO	HC	CO_2	O_2	EX	RPM
1	.105	18	1.88	18.0	325	2500
2	.104	19	1.88	17.9	327	↓
3	↓	22	1.91	18.0	333	↓
4	↓	↓	1.91	17.9	334	↓
5	↓	↓	1.91	18.0	338	↓
	.042[illegible]	20.6	1.898	17.96	331.4	
6	.104	21	1.62	18.4	305	2000
7	↓	21	1.61	18.3	305	↓
8	↓	21	1.63	18.2	302	↓
9	↓	22	1.62	18.2	302	↓
10	↓	22	1.63	18.4	301	↓
	.04	21.4	1.622	18.3	303	

ID # 37016 851.4 10 min

(80.2 Hrs)

	CO	HC	CO_2	O_2	EX	RPM
1.	.105	18	1.66	18.3	316	2500
2	↓	18	1.65	↓	318	↓
3	↓	19	1.67	↓	326	↓
4	↓	↓	1.66	↓	327	↓
5	↓	↓	1.66	↓	332	↓
	.05	18.6	1.66	18.3	323.8	
6	.04	18	1.35	18.7	294	2000
7	↓	18	1.35	18.6	294	↓
8	↓	18	1.37	↓	292	↓
9	↓	17	1.36	↓	291	↓
10	.03	17	1.36	↓	288	↓
	.038	17.6	1.358	18.62	291.8	

57 Total Mins.

09/29/88 17:10 P.01 UHI EASTERN 4125388842

UNITED

ID# 37015 1013.9 HRS 12 min (74.2 Hrs)

	CO	HC	CO_2	O_2	EX	RPM
1	.04	17	1.66	18.3	330	2500
2	↓	17	1.66	18.2	331	↓
3		15	1.71	18.2	336	
4		17	1.69	18.1	337	
5		15	1.70	18.3	340	
	.04	16.2	1.684	18.22	334.8	
6	.03	15	1.45	18.6	305	2000
7	.04	↓	1.43	18.5	305	↓
8	.03		1.44	18.6	304	
9	.04		1.44	18.5	304	
10	.04		1.42	18.6	304	
	.036	15	1.436	18.56	304.4	

ID. 37013 1018.6 HRS. 12 min (70.5 Hrs)

	CO	HC	CO_2	O_2	EX	RPM
1	.04	15	1.65	18.4	335	2500
2	↓	15	1.67	18.3	335	↓
3		12	1.62	18.4	338	
4		13	1.64	18.3	338	
5		15	1.63	18.4	341	
	.04	14	1.642	18.36	337.4	
6	.04	15	1.36	18.7	294	2000
7	.04	↓	1.37	18.6	291	↓
8	.03		1.35	18.7	285	
9	.03		1.33	18.7	285	
10	.04		1.35	18.7	285	
	.036	15	1.352	18.68	288	

UNITED TELEPHONE - BUTLER Sept 27, 1988

AMB Temp 71°

I.D.# 36019 - 1721.0 HRS - 11 min

(82 HRS)

	CO	HC	CO_2	O_2	EX Temp	RPM
1	.04	22	1.73	18.1	324	2500
2	↓	22	1.71	18.1	325	↓
3		20	1.69	18.3	331	
4		19	1.70	18.2	332	
5		22	1.71	18.4	335	
	.04	21	1.708	18.22	329.4	
6	.04	19	1.41	18.8	295	2000
7	↓	19	1.40	18.7	295	↓
8		20	1.45	18.6	293	
9		20	1.39	18.6	291	
10		20	1.48	18.6	293	
	.04	19.6	1.426	18.66	293.4	

~~[illegible] BRO[illegible] 1018.9 HRS~~

	CO	HC	CO_2	O_2	EX.	RPM
1	.04	15	1.45	18.6	305	2000
2	↓	↓	1.43	18.5	30[illegible]	↓
3			1.44	18.6	304	
4			1.44	18.5	304	
5			1.42	18.6	304	
6						
7						
8						
9						
10						

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