EVALUATION OF

FPC-1 FUEL PERFORMANCE CATALYST

at

GREYHOUND LINES, INC.

Report Prepared For

GREYHOUND LINES, INC.

By

U.H.I. CORPORATION
Provo, Utah

J.R.C. ENTERPRISES, INC.
Tempe, Arizona

And

GREYHOUND FLORIDA BASED FLEET MANAGEMENT

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I. INTRODUCTION

This report will discuss the results and conclusions of an extensive three phase engine performance evaluation using FPC-1 fuel combustion catalyst. The test was conducted for Greyhound Lines, Inc., by in house personnel, UHI Corporation and J.R.C. Enterprises. An explanation of the test procedures used to determine the effect of the catalyst on fuel economy, harmful emissions and engine performance is given, data tabulated, and results will be documented.

The purpose of the evaluation and documentation contained herein is to provide meaningful and accurate information on the performance of FPC-1 so that Greyhound Management will be able to determine the economic benefit from system fuel treatment.

II. THE PRODUCT

FPC-1 Fuel Performance Catalyst is the designation of a ferrous picrate based catalyst developed to enhance the combustion of all liquid hydrocarbon fuels. The catalyst has undergone extensive testing at independent and university affiliated laboratories in light duty gasoline and diesel powered vehicles. The test procedures have included the EPA Standardized Federal Test Procedures (FTP) hot and cold cycles, the Highway Fuel Economy Test (HFET), (both use carbon mass balance procedures), the SAE J-1082 Interstate and Suburban Fuel Economy tests, the Coordinated Research Council Cold Start Driveability Test and steady-state engine dynamometer testing.

These tests have provided documentation which show that FPC-1 creates the following benefits:

1) Improved fuel economy. (3% to 10%)
2) Reduced emissions of harmful pollutants.
3) Improved driveability (engine performance).

III. **EVALUATION**

The evaluation was done in three phases, comprising fuel economy tests, an analysis of harmful emissions, and observations by Greyhound fleet personnel on smoke reduction and engine performance.

A. Phase 1 - Preliminary Single Engine Test

A trial study to indicate FPC-1's potential economic benefit to the Greyhound fleet (Phase 1), was initiated by Mr. J.A. Malcomb , Senior Vice-President Maintenance/Engineering. The study was conducted on an 8V-71 D.D.A. powered Inter-Branch Transport operating in the Chicago area. The truck was monitored for approximately eight months, from January 1983 to August of the same year.

Reports by Mr. Malcomb showed the result to be a significant improvement in fuel economy with the FPC-1 treated fuel. The success of this single engine evaluation provided the impetus for a more conclusive, wider range test using a larger test fleet.

Long Term Testing

A group of fifteen (15) Greyhound buses was selected by Mr. Malcomb as the test fleet for the next two phases of testing. These buses, operating primarily out of Miami, Florida, were selected because Mr. Malcomb's high level of confidence in the fleet's good mechanical condition, consistency of routing and loading and the quality personnel overseeing the Florida based operation. These characteristics are essential if variables that mask product effects are to be minimized. Baseline data was accumulated from December 1983 to June 1984.

The buses were then treated with FPC-1 from July 1984 to February 1985. In conjunction with the extended fuel consumption comparison, a carbon mass balance method of determining fuel economy was conducted on the same fifteen buses. For the purpose of clarity, these two methodologies will be discussed separately as Phase 2 and Phase 3.

B. Phase 2 - Carbon Mass Balance

The results of the Phase 2 study, documented in an earlier report, show a fuel economy improvement with FPC-1 of 9.4% over baseline, (Appendix A). The fuel economy improvement was supported by significant reductions in smoke, (particulate), (Appendix B). Mr. Hopkins agrees with the carbon balance figures and reported in writing to Mr. Malcomb that smoke was reduced significantly.

C. Phase 3 - Fifteen Month Road Test

Test Evaluation Procedures

Bus numbers 4990 through 4999 and 6685 through 6689, operating primarily out of the Miami, Florida Terminal, were specified by Mr. Malcomb as the test fleet. Mr. Lee Hopkins was placed in charge of the test for Greyhound. Miles per gallon (MPG) for these buses was recorded during an eight month baseline period to accumulate sufficient data to insure a conclusive comparison to the MPG data collected during an eight month FPC-1 treated fuel period. The baseline period began December 1983 and ended July 1984. In late July, the fuel tanks at Miami, Orlando, St. Petersburg and Jacksonville were treated with FPC-1 at a one part catalyst to 1600 parts fuel ratio. The test fleet was fueled exclusively at these locations from July 1984 to March 1985. Data was collected "as usual" by Greyhound personnel throughout the entire fifteen month test and reported in letter form to JRC Enterprises on a monthly basis by Mr. Malcomb.(February and March sample letters found in (Appendix C).

Fleet Operation Comparison: Baseline vs. Treated Fuel Periods

The data showed the buses experienced a major change in operation during the treated test period, manifested by a 30%

reduction in total miles driven per month. Monthly mile per gallon figures also became more erratic during the treated program as shown on Tables VI and VII. UHI technicians visited with Mr. Hopkins to investigate the following possible reasons why this would occur.

1) DID THE TEST FLEET ROUTES REMAIN REASONABLY CONSISTENT THROUGHOUT THE TEST? DID LOADS REMAIN CONSISTENT DURING BOTH BASELINE AND TREATED PERIODS, OR DID LOADS VARY SIGNIFICANTLY?

Mr. Hopkins' records show that the test fleet experienced a significant change in routing near the time the treated fuel period started. The greatest change occurred in the 6600 fleet, which, during baseline ran exclusively the Walt Disney World Route, (Miami to Orlando to Miami) on a one or two day cycle. The fleet was taken off this route near the beginning of the treated fuel test period and put into regular charter service. Mr. Hopkins reports the 6600 fleet experienced more idle time in stop-and-go driving and more variable routing during this period than during the baseline period. This information was confirmed by Ted Shelby, Service Foreman at the Orlando Terminal. Mr. Shelby also reported that buses on charter typically carry heavier loads than those operating on the Walt Disney World Route. For these reasons, Mr. Hopkins recommended the 6600 fleet be dropped from the test.

The 4900 fleet has also experienced operation changes as indicated again by the drop in miles driven. However, Mr. Hopkins' records show these changes are less likely to impact the MPG figures because the type of driving and the loads remained fairly consistent. Therefore, the 4900 fleet experienced enough common factors in both baseline and treated segments to provide an accurate comparison.

2) ARE ALL BUSES STILL IN GOOD MECHANICAL CONDITION?

The buses maintained good working order except unit #4990 which suffered turbo charger and aftercooler problems throughout the entire test program. Also, bus #4992 experienced a seized engine after the completion of the treated test period. Service Records require that bus #4990 be excluded from MPG comparison.

3) WAS THE FUEL CONTINUALLY TREATED WITH FPC-1?

In early October, UHI was informed by the product manufacturer that containers in one batch of FPC-1 were contaminated. UHI recalled the entire batch, five drums of which had been shipped to Greyhound locations. Jack Challis (JRC) contacted these locations with this information and rushed replacement product to Jacksonville; it arrived there on October 12, 1984. Unfortunately, the interline carrier in Jacksonville, (FFF) did not get the replacement product to Miami in time to treat fuel shipments received by Mr. Hopkins on October 19, 26, and 27, 1984. It is difficult to determine the absolute effect of this on the MPG numbers in October and November. However, this does provide the opportunity to do an A-B-A (treated-return to baseline-treated analysis) comparison. Such a comparison shows substantial gains in MPG when the fuel was again fully treated with FPC-1. Still, when the total fleet averages are compiled, the October,(possibly November), data should be treated as baseline data and excluded from the treated fuel analysis.

4) WHAT IS THE CORRELATION BETWEEN FEWER MILES DRIVEN PER BUS, LOAD CHANGES, IDLE TIME AND MILES PER GALLON?

Typically, a major drop in mileage has an adverse effect on fleet miles per gallon because it indicates that the idle time and acceleration/deceleration is increased. This fact held true in the Greyhound test, particularly the 6600 fleet. Loads increased as routes were economized and the fleet spent a larger percentage of its time in stop-and- go and high idle driving.

Nevertheless, 9 of the 15 buses were found to have data that Mr. Hopkins felt to be acceptable for MPG comparisons; a number that is sufficient for a high level of confidence.

D. Emissions Evaluation

In order to fully understand the correlation between elevated harmful emissions levels and internal combustion engine operation, it must be understood how the different exhaust gases react to the combustion cycle in terms of time and mechanical efficiency.

Excessive hydrocarbons (HC) levels are a result of inefficient combustion which takes place when the fuel is burned without enough air to allow complete combustion.

Oxygen (O_2) and Carbon Dioxide (CO_2) levels are an excellent indicator of a lean running engine. If O_2 levels are high, and CO_2 levels are low, the engine is running lean. Conversely, if the O_2 levels are low, and the CO_2 levels are high, then the engine is running rich.

In most cases, HC and CO levels can be altered by increasing or decreasing the amount of time the engine configuration allows for combustion to take place. For instance, modern slow speed diesel engines run more efficiently than do modern high speed diesel engines. The slow speed diesel engine has considerably more time to burn the fuel. SAE Technical Paper #831204, entitled "The Effects of an Iron Based Fuel Catalyst Upon Diesel Fleet Operation", explains that the FPC-1 formulation decreases the amount of time necessary for combustion to take place. As a result, "pressure is higher and more work can be accomplished for the same energy supplied." Further, HC and CO levels will be reduced. In the case of Greyhound Lines, Inc., there was a 94% reduction in CO and a 92% reduction in HC. These results qualitatively demonstrate an improvement in fuel combustion under the operating conditions outlined. Regarding O_2 and CO_2 levels, the Greyhound test fleet showed a definite leaning out. The baseline fleet average showed levels of CO_2 to be 5.2% with O_2 levels of 12.97%. This compares to the leaning affect of the treated period in which the CO_2 levels were 4.73% with O_2 levels of 13.70%.

The actual fuel usage records correlate directly with the above mentioned emissions data. Bus #4990 has had a significantly lower MPG performance than any other bus in the test fleet. With the mechanical problems that #4990 experienced, it is not surprising that the HC and CO levels were significantly higher than the fleet average. These "mechanical inefficiencies" caused emission level increases in bus #4990 with baseline CO levels of 0.513% as compared to the fleet average of 0,008%, and HC levels of 13 ppm as compared to the fleet average of 9.67 ppm. All of the above data was taken under identical loads and engine temperatures.

Additional evidence to indicate improved combustion was shown when smoke and solid particulate levels were monitored. A letter from Lee Hopkins with accompanying photos provide visual documentation into the reduction of solid particulates. Further, Messrs. Lee Hopkins and H.B. Swann acknowledge the elimination of complaints of heavy smoke during the treated portion of the test.

E. Manager Observations

Greyhound fleet manager observations related to product performance were positive and are summarized as follows:

MR. LEE HOPKINS: Mr. Hopkins states that the buses smoke less when fully loaded and that since FPC-1 treatment, drivers have stopped complaining about the sluggish acceleration of the buses operating on congested driving routes. It is Mr. Hopkins opinion that FPC-1 should be used by Greyhound Lines, Inc.

MR. TED SHELBY: Mr. Shelby commented that the product helps to eliminate fuel problems associated with water. (This is most likely due to the alcohol carrier in the FPC-1 catalyst.)

MR. H.B. SWANN: Mr. Swann reports that since FPC-1 treatment began he has not had the usual complaints of buses smoking.

IV. SUMMARY

In even the most controlled field evaluations it is impossible to control all the variables. This test was no exception. However, the test was monitored over a significant period of time (15 months), and enough data has been accumulated on 9 buses to provide a meaningful fuel economy comparison between the baseline and treated segments of the evaluation. Although the data contained in this report may lead to several different conclusions, it is obvious that a significant improvement in fuel economy was demonstrated.

After careful review of all data by Mr. Lee Hopkins, Messrs. Craig Flinders and Kim LeBaron of UHI Corporation, and Mr. Jack Challis of JRC Enterprises, the following conclusions have been reached:

1) 6600 Fleet: The entire 6600 fleet was eliminated from the data base due to dramatic route and load changes.

2) Bus #4990: Bus #4990 was eliminated from the data base because of mechanical problems during both baseline and treated segments.

3) October/November: The month of October was eliminated from the data base because the fuel that month was not fully treated. November would also have been effected by beginning the month with fuel systems diluted. However, since the month of November was regularly treated, it has been left in the data base.

4) Reduction in Mileage: When fleets have a significant reduction in mileage it normally has a negative effect on fuel economy if idle time and stop-and-go driving increase. As Mr. Hopkins stated, the treated segment of the evaluation shows a

significant reduction in miles driven, as well as an increase in idle time per bus over baseline which generally shows a corresponding reduction in fuel economy. However, the treated segment consistently documented fuel economy improvements. Although a correction factor to compensate for the reduction in mileage would be justified (which would further increase fuel economy during the treated segment), no adjustment was made because it is impossible to know the direct impact this reduced mileage had on fuel consumed.

5) <u>Harmful Emissions:</u>

Documentation during the treated segment of the test using gas analysis equipment shows signigicant reductions in harmful emissions. CO was reduced 94% and HC reduced 92%. These reductions have a positive impact on engine cleanliness, performance and air quality.

6) <u>Fuel Economy:</u>

Fuel economy derived from monthly fuel usage reports shows an improvement with FPC-1 treated fuel of 3.13% to 7.23% depending upon which data is included in tables I through V. Based on the above conclusions the data base which most accurately represents changes in fuel economy from baseline to treated segments is shown in table 3 and 5, representing a 5.08% fuel economy improvement. Based upon the results of the Greyhound evaluation, an estimated net fuel savings of $.02 to $.05 per gallon of fuel can be saved.

TABLE I

4900 Fleet Baseline MPG Excluding 4990

Unit No.	Mileage	Fuel	MPG
4991	54,553	10,234	5.34
4992	58,599	11,741	4.99
4993	54,311	10,579	5.13
4994	66,639	13,072	5.10
4995	62,997	12,003	5.25
4996	64,392	12,483	5.16
4997	58,311	12,160	4.80
4998	52,208	10,313	5.06
4999	54,879	10,294	5.33
Fleet Total	526,889	102,869	5.12

TABLE II

4900 Fleet Treated MPG Average Excluding Unit 4990

Unit NO.	Mileage	Fuel	MPG
4991	42,827	7,870	5.44
4992	25,900	4,565	5.67
4993	52,433	9,568	5.48
4994	35,908	6,737	5.33
4995	39,515	6,947	5.68
4996	38,616	7,930	4.86
4997	31,387	6,048	5.19
4998	30,683	6,188	4.95
4999	30,885	6,282	4.91
Total Fleet	328,154	62,135	5.28

TABLE III

4900 Fleet Treated MPG Average Excluding Unit 4990 and October

Unit No.	Mileage	Fuel	MPG
4991	33,544	6,249	5.37
4992	20,761	3,413	6.08
4993	45,070	7,970	5.65
4994	29,252	5,523	5.30
4995	33,199	5,656	5.87
4996	33,712	6,893	4.89
4997	27,380	5,171	5.29
4998	26,898	5,070	5.30
4999	25,612	5,270	4.86
Total Fleet	275,428	51,215	5.38

TABLE IV

4900 Fleet Treated MPG Average Excluding 4990, October and November Data

Unit No.	Mileage	Fuel	MPG
4991	26,922	4,975	5.41
4992	17,422	2,687	6.48
4993	35,738	6,163	5.80
4994	24,525	4,563	5.37
4995	30,331	4,907	6.18
4996	29,156	5,972	4.88
4997	23,706	4,449	5.33
4998	24,252	4,494	5.40
4999	21,936	4,430	4.95
Total Fleet	233,988	42,640	5.49

TABLE V

Comparison of 4900 Fleet Baseline (Table I) and
Treated MPG Averages (Tables II, III, IV)

Table I vs. Table II

5.28	MPG Treated	(0.16 / 5.12) 100 = 3.13%
-5.12	MPG Baseline	

Table I vs. Table III

5.38	MPG Treated	(0.26 / 5.12) 100 = 5.08%
-5.12	MPG Baseline	

Table I vs. Table IV

5.49	MPG Treated	(0.37 / 5.12) 100 = 7.23%
-5.12	MPG Baseline	

Greyhound Lines, Inc.
Greyhound Tower Phoenix, Arizona 85077
Phone: (602) 248-5000

April 9, 1985

Mr. J. R. Challis
President
J.R.C. Enterprises, Inc.
P.O. Box 8999
Mesa, AZ 85204-0390

Re: Fuel Consumption Records on Pool 23 Buses

Dear Jack:

The statistics for the month of February 1985 are as follows:

Bus	Miles	Fuel	M.P.G.
4990	3,368	809	4.16
4991	3,170	540	5.87
4992	1,756	327	5.37
4993	6,660	1,198	5.56
4994	4,027	833	4.83
4995	4,325	763	5.67
4996	5,806	1,312	4.43
4997	3,467	629	5.51
4998	3,936	687	5.73
4999	2,543	541	4.70
6685	3,576	733	4.88
6686	3,864	603	6.41
6687	5,401	1,001	5.40
6688	3,356	747	4.49
6689	4,804	1,030	4.66
	60,059	11,753	

The above information is not to be published, reproduced, or used in any manner other than base information between GLI and J.R.C. Enterprises, Inc.

Yours truly,

J. A. Malcomb /gp

J. A. Malcomb
Senior Vice President
Maintenance/Engineering

Greyhound Lines, Inc.
Greyhound Tower Phoenix, Arizona 85077
Phone: (602) 248-5000

5/6/85

J. R. C. ENTERPRISES, INC.
MAY 8 1985
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April 29, 1985

Mr. J. R. Challis
President
J.R.C. Enterprises, Inc.
P.O. Box 8999
Mesa, AZ 85204-0390

Re: Fuel Consumption Records on Pool 23 Buses

Dear Jack:

The statistics for the month of March 1985 are as follows:

Bus	Miles	Fuel	M.P.G.
4990	3,507	809	4.33
4991	3,805	540	7.05
4992	1,568	327	4.80
4993	3,223	1,198	2.69
4994	3,645	833	4.38
4995	1,418	763	1.86
4996	4,949	1,204	4.11
4997	2,539	629	4.04
4998	2,441	687	3.55
4999	5,479	541	10.13
6685	2,776	733	3.79
6686	5,446	603	9.03
6687	2,644	1,001	2.64
6688	5,247	643	8.16
6689	3,079	1,030	2.99

The above information is not to be published, reproduced, or used in any manner other than base information between GLI and J.R.C. Enterprises, Inc.

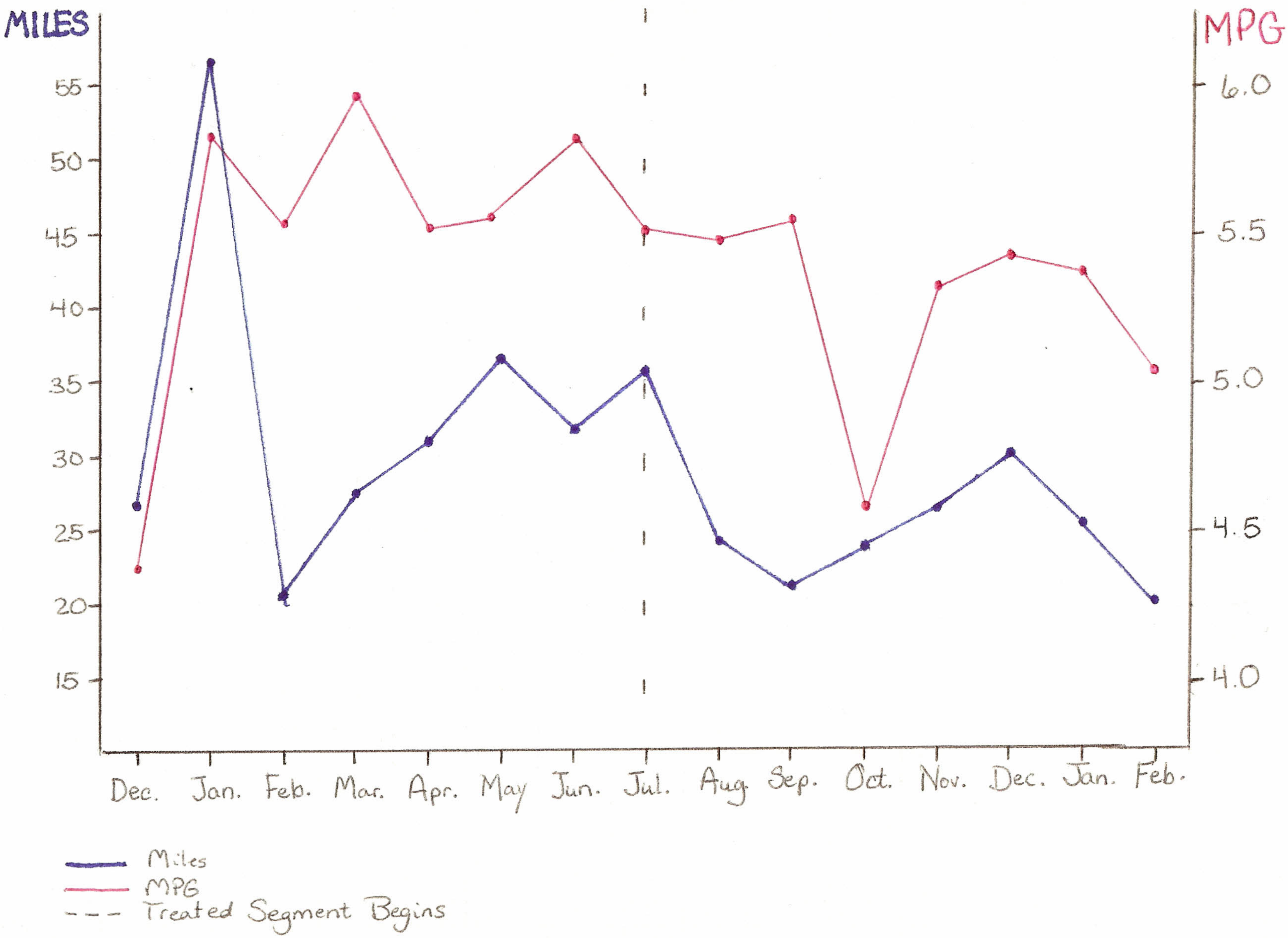
Yours truly,

J. A. Malcomb

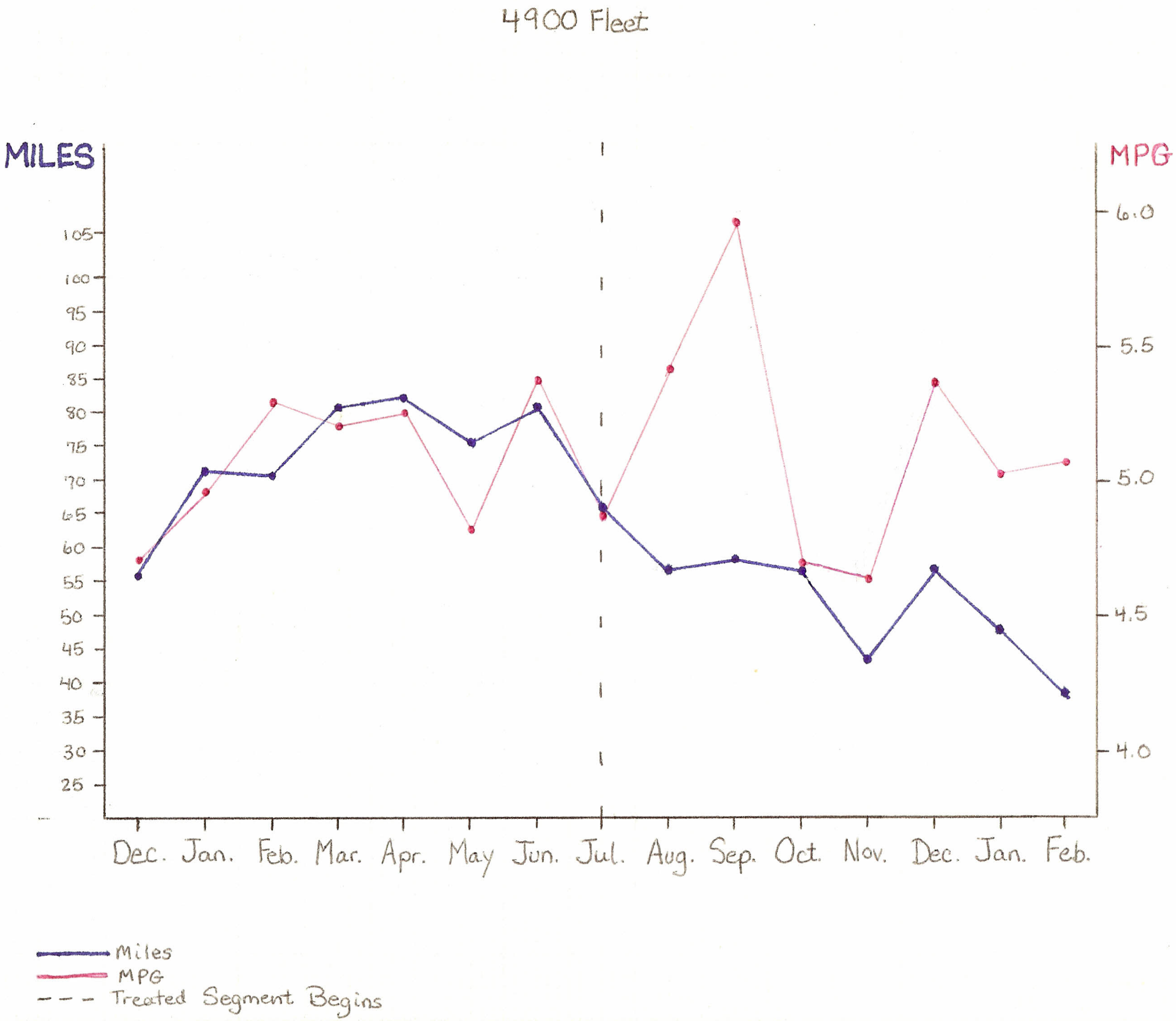
J. A. Malcomb
Senior Vice President
Maintenance/Engineering

OF ___
BY ___
SUBJECT ___
CLIENT ___
W/NUMBER

6600 Fleet



HARRY HODSON P.E.



HARRY HODSON P.E.

OF
BY
SUBJECT
CLIENT
W/NUMBER

VI. GREYHOUND LINES, INC.

BASELINE

Unit	Dec.'83	Jan.'84	Feb.'84	Mar.'84	Apr.'84	May'84	Jun.'84	Jul.'84	Totals (B)	Average (B)
4990	7800/1504 5.19	8901/1855 4.80	7424/1607 4.62	8202/1820 4.51	7418/1584 4.68	8811/2005 4.39	7843/1655 4.74	6559/1421 4.62	62958/13451	4.68
4991	3978/797 4.99	7858/1542 5.10	8200/1412 5.81	4722/1005 4.70	8525/1548 5.51	9152/1479 6.19	7798/1436 5.43	4320/1005 4.30	54553/10224	5.34
4992	6961/1322 5.27	7971/1488 5.36	7091/1364 5.20	6226/1217 5.12	7985/1410 5.66	6712/1582 4.24	8850/1701 5.20	6803/1657 4.11	58599/11741	4.99
4993	2279/444 5.13	8614/1707 5.05	8531/1495 5.71	9853/1862 5.29	6741/1607 4.19	4155/1003 4.14	9292/1569 5.92	4846/892 5.43	54311/10579	5.13
4994	8663/1464 5.92	6738/1799 3.75	7142/1449 4.93	9457/1641 5.76	8726/1817 4.80	7698/1744 4.41	10036/1503 6.68	8179/1655 4.94	66639/13072	5.10
4995	7205/1708 4.22	8643/1493 5.79	7265/1139 6.38	8806/1870 4.71	7874/1490 5.28	6147/1368 4.49	10130/1553 6.52	6927/1382 5.01	62997/12003	5.25
4996	3319/768 4.32	7907/1570 5.04	5640/1161 4.86	10982/1773 6.19	8033/1548 5.19	12164/2490 4.89	8639/1659 5.21	7708/1514 5.09	64392/12483	5.16
4997	6130/1932 3.17	5212/1200 4.34	8370/1560 5.37	6843/1127 6.07	9921/1952 5.08	7457/1501 4.97	5862/1369 4.28	8516/1519 5.61	58311/12160	4.80
4998	504/49 10.29	6020/1175 5.12	5207/1282 4.06	9955/1919 5.19	9648/1551 6.22	8013/1590 5.04	6770/1424 4.75	6091/1323 4.60	52208/10313	5.06
4999	4562/863 5.29	5687/976 5.83	7208/1198 6.02	7426/1655 4.49	9309/1515 6.14	6344/1273 4.98	7485/1420 5.27	6858/1394 4.92	54879/10294	5.33
Monthly Totals	51401/10851 4.74	73551/14805 4.96	72078/13667 5.27	82472/15889 5.19	84180/16022 5.25	76653/16035 4.78	82705/15289 5.41	66807/13762 4.85	589847/116320	5.07
6685	5628/1458 3.86	7457/1404 5.31	8505/1509 5.64	7013/1197 5.86	6644/1267 5.24	5844/1197 4.88	7252/1285 5.64	6674/1378 4.84	55017/10695	5.14
6686	5485/857 6.40	8928/1964 4.55	2651/686 3.86	5639/1023 5.51	7149/1107 6.46	8341/1622 5.14	5574/1163 4.79	7263/1027 7.07	51030/9449	5.40

Greyhound Lines Inc.
Baseline cont.
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6687	10395/2113 4.92	16881/3233 5.22	3548/535 6.63	7792/1162 6.71	5661/1281 4.42	10115/1379 7.34	7267/1319 5.51	6580/1450 4.54	68239/12472	5.47
6688	2699/878 3.07	16618/2327 7.14	4378/571 7.67	6182/1283 4.82	8624/1463 5.89	6717/1329 5.05	7687/998 7.70	7547/1414 5.34	60452/10263	5.89
6689	3065/850 3.61	8903/1192 7.47	2886/646 4.47	2064/164 12.59	4438/727 6.10	6754/1231 5.49	5850/1038 5.64	8245/1263 6.53	42205/7111	5.94
Monthly Totals	27272/6156 4.43	58787/10120 5.81	21968/3947 5.57	28690/4829 5.94	32516/5845 5.56	37771/6758 5.59	33630/5803 5.80	36309/6532 5.56	276943/49990	5.54

VII. GREYHOUND LINES, INC.

TREATED

Unit	Aug.'84	Sep.'84	Oct.'84	Nov.'84	Dec.'84	Jan.'85	Feb.'85	Mar.'85	Totals (B)	Average (B)
4990	6506/1306 4.98	6069/1303 4.66	4628/1177 3.93	3538/1052 3.36	4811/ 778 6.16	4291/1028 4.16	3368/ 809 4.16	3507/ 809 4.33	33211/7453	4.46
4991	7399/1192 6.21	5595/1115 5.02	9283/1621 5.73	6622/1274 5.20	5701/1031 5.53	5057/1097 4.61	3170/ 540 5.87	3805/ 540 7.05	42827/7870	5.44
4992	6080/ 851 7.14	3483/ 468 7.44	5139/1152 4.46	3339/ 726 4.60	4614/ 859 5.37	1489/ 182 8.18	1756/ 327 5.37	1568/ 327 4.80	25900/4565	5.67
4993	5606/1087 5.16	8330/1045 7.97	7363/1598 4.61	9332/1807 5.16	6508/1137 5.72	8634/1696 5.09	6660/1198 5.56	3223/1198 2.69	52433/9568	5.48
4994	5039/1045 4.82	6397/ 933 6.86	6656/1214 5.48	4727/ 960 4.92	6836/1303 5.25	2226/ 449 4.98	4027/ 833 4.83	3645/ 833 4.38	35908/6737	5.33
4995	4935/ 924 5.34	9018/1007 8.96	6316/1291 4.89	2868/ 749 3.83	5828/1043 5.59	6225/1170 5.32	4325/ 763 5.67	1418/ 763 1.86	39515/6947	5.69
4996	4972/1090 4.56	4814/ 987 4.88	4904/1037 4.73	4556/ 921 4.95	7856/1443 5.44	5708/1140 5.01	5806/1312 4.43	4949/1204 4.11	38616/7930	4.87
4997	5767/ 973 5.93	5409/1104 4.69	4007/ 877 4.57	3674/ 722 5.09	4574/ 747 6.12	4489/ 946 4.75	3467/ 629 5.51	2539/ 629 4.04	31387/6048	5.19
4998	6506/1093 5.95	5245/ 921 5.69	3785/1118 3.39	2646/ 576 4.59	4665/1072 4.35	3900/ 721 5.41	3936/ 687 5.73	2441/ 687 3.55	30683/6188	4.96
4999	5019/1053 4.77	4320/ 920 4.70	5273/1012 5.21	3676/ 840 4.38	4969/ 994 5.00	5085/ 922 5.52	2543/ 541 4.70	5479/ 541 10.13	30885/6282	4.91
Monthly Totals	57829/10614 5.45	58680/ 9853 5.96	57354/12097 4.74	44978/ 9627 4.67	56362/10407 5.41	47104/ 9351 5.04	39058/ 7639 5.11	32574/ 7531 4.33	361365/69588	5.19
6685	6380/1047 6.09	4968/1043 4.76	3952/1049 3.77	4150/ 847 4.90	5459/ 934 5.84	5874/1128 5.21	3576/ 733 4.88	2776/ 733 3.79	34359/6781	5.07
6686	5669/1161 4.88	5814/1104 5.27	4544/1125 4.04	5218/ 919 5.68	6653/1141 5.83	2018/ 417 4.84	3864/ 603 6.41	5446/ 603 9.03	33780/6470	5.22

Greyhound Lines Inc.
Treated cont.
page 2

6687	5455/1047	7342/ 999	7672/1510	5827/1177	4203/ 879	6378/1051	5401/1001	2644/1001	42278/7664	
	5.21	7.35	5.08	4.95	4.78	6.07	5.40	2.64		5.52
6688	5608/ 927	3844/ 792	5561/1126	6436/1156	6253/1145	6573/1176	3356/ 747	5247/ 643	37631/7069	
	6.05	4.85	4.94	5.57	5.46	5.59	4.49	8.16		5.32
6689	1821/ 357	1069/ 0	2694/ 483	5775/1044	7539/1425	5804/1154	4804/1030	3079/1030	29506/5493	
	5.10		5.58	5.53	5.29	5.03	4.66	2.99		5.37
Monthly	24933/4539	23037/3938	24423/5293	27406/5143	30107/5524	26647/4926	21001/4114	19192/4010	177554/33478	
Totals	5.49	5.85	4.61	5.32	5.45	5.40	5.10	4.78		5.30

Exhibit H

Greyhound Lines, Inc.

Carbon Mass Balance Filter Comparison

Pool 23, (Buses 4990 – 4999 & 6685 – 6689)

Baseline Test Filter Utilized
July 21, 22, 23 & 24, 1984.

Treated Test Filter Utilized
October 5, 6, 7 & 8, 1984.

Greyhound Lines Inc.
MPG Comparison

Baseline Data (12/83 – 7/84)				Treated Data (8/84 – 4/85) (See Note 2)				
Pool 23, 4900 Series								
Bus No.	Mileage	Fuel	MPG	Bus No.	Mileage	Fuel	MPG	Percent Change in MPG
4990	62,958	13,451	4.68	4990	*****See Note 1***************			
4991	54,553	10,234	5.34	4991	36,030	6,092	5.91	
4992	58,599	11,741	4.99	4992	23,243	3,877	6.00	
4993	54,311	10,579	5.13	4993	44,812	7,585	5.91	
4994	66,639	13,072	5.10	4994	30,315	5,774	5.25	
4995	62,997	12,003	5.25	4995	34,908	6,076	5.75	
4996	64,392	12,483	5.16	4996	39,763	7,690	5.17	
4997	58,311	12,160	4.80	4997	31,655	5,988	5.29	
4998	52,208	10,313	5.06	4998	33,623	6,067	5.54	
4999	54,879	10,294	5.33	4999	33,568	6,282	5.34	
4900 Series Only:	589,847 ÷	116,320 =	5.07		307,917 ÷	55,431 =	5.55	+9.47%
Avg. Miles Per Month:	73,730				34,213 (-54%)			
Pool 23, 6600 Series								
6685	55,017	10,695	5.14	6685	34,309	6,330	5.42	
6686	51,030	9,449	5.40	6686	33,670	6,457	5.21	
6687	68,239	12,472	5.47	6687	36,236	6,215	5.83	
6688	60,452	10,263	5.89	6688	33,447	6,132	5.45	
6689	42,205	7,111	5.94	6689	26,454	5,241	5.05	
6600 Series Only	276,943 ÷	49,990 =	5.54		164,116 ÷	30,375 =	5.40	–2.59%
Avg. Miles Per Month:	34,618				18,235 (-47%)			
Totals, All Pool 23 Buses	866,790 ÷	166,310 =	5.21		472,033 ÷	85,806 =	5.50	+5.57%
Avg. Miles Per Month	108,349				52,448 (-52%)			

Notes: 1. Bus 4990 was eliminated from the Treated data. (See Phase II - Carbon Mass Balance, Page 6, and Phase III - MPG Comparison, Page 8, and Harmful Emissions, Pages 11 and 12 for complete explanation).

Notes 2. All Treated data totals shown exclude October and November, 1984. (See Phase III - MPG Comparison, Page 9 for explanation).

Exhibit J

Greyhound Lines, Inc.

Fuel Cost Savings Analysis

	4900 Series Only		Pool 23	
	MPG Comparison	Carbon Mass Balance	MPG Comparison	Carbon Mass Balance
Average Gallons of Diesel Fuel Consumed Per Year	53,000,000	53,000,000	53,000,000	53,000,000
Average Cost Per Gallon	$.96	$.96	$.96	$.96
Average Yearly Cost of Fuel	$50,880,000	$50,880,000	$50,880,000	$50,880,000
Percentage Increase in Fuel Economy	9.47 (Table I)	9.74 (Exhibit C)	5.57 (Table I)	11.24 (Exhibit E)
Gross Fuel Cost Savings	$ 4,818,336	$ 4,955,712	$ 2,834,016	$ 5,718,912
Less Cost of FPC-1 To Treat 53,000,000 Gallons Per Year (53,000,000 Gals. ÷ 88,000 Gals./Drum = 602.27 Drums x $1320/Drum)	$ 794,996	$ 794,996	$ 794,996	$ 794,996
Net Fuel Cost Savings Per Year	$ 4,023,340	$ 4,160,716	$ 2,039,020	$ 4,923,916
Return on Investment	506%	523%	256%	619%

ENGINE WATER TEMP. 190

11:54 A.M.
12:04 P.M.

Exhaust Gas Analysis Form

Company: Greyhound

Date: 12-1-88 Baseline: ✓ Treated:

Equipment Tested: MC

Engine Type: 6V92TA #6VF119933 Mileage: 482485

Fuel Type: 2 Fuel Temp.: 99 / 105

Unit ID No.: 9012

Exhaust Gas Readings

	CO2	O2	CO	HC	EX.Temp.	AIR Flow	RPM
1.	2.15	17.1	.01	2	330	1865	
2.	2.15	17.0	.01	2	333	1994	
3.	2.15	16.9	.01	2	334	1878	
4.	2.14	17.4	.01	5	335		
5.	2.14	17.2	.01	5	336		
6.	2.14	17.2	.01	4	336		
7.	2.13	17.3	.01	5	336		
8.	2.12	17.2	.01	3	336		
AVE 9.	2.14	17.16	.01	3.5	334.5	1912.33	
10.							
11.							
12.							
13.							
14.							

Signature of Technicians [signature]

CHRIS PETERSON -GLI

ENGINE WATER TEMP. 180°

61°
9:14 A.M.
9:19 A.M.

Exhaust Gas Analysis Form

Company: GREYHOUND

Date: 12-1-88 Baseline: X Treated: ____

Equipment Tested: MIC

Engine Type: 6V92TA # 6VF146683 Mileage: 221483

Fuel Type: 2 Fuel Temp.: 69 / 77

Unit ID No.: 7010

Exhaust Gas Readings

	CO2	O2	CO	HC	EX.Temp.	Flow	RPM
1.	2.50	16.9	.01	3	301	1500	
2.	2.40	16.7	.01	3	303	1345	
3.	? 2.37	17.2	.01	3	304		
4.	2.36	17.1	.01	4	306		
5.	2.52	17.2	.01	4	309		
6.	2.50	17.1	.01	4	309		
7.	2.49	17.1	.01	4	309		
8.	2.51	17.4	.01	4	310		
AVE 9.	2.46	17.1	.01	3.63	306.38	1422.5	
10.						⇒ 462	
11.							
12.							
13.							
14.							

Signature of Technicians Pat [illegible] / [illegible]

Chris Peterson - GLI

ENGINE WATER TEMP 180

65°

Exhaust Gas Analysis Form

Company: GREYHOUND

Date: 11-30-88 Baseline: X Treated: ______

Equipment Tested: MCI [illegible]

Engine Type: 6V92 [illegible] Mileage: [illegible] FUEL CARD

Fuel Type: 2 Fuel Temp.: 76 / 79

Unit ID No.: 7007

AIR OFF

Exhaust Gas Readings

CLOSED SHUTTERS

	CO2	O2	CO	HC	EX.Temp.	Flow	RPM
1.	2.15	17.2	.01	4	319		F.T.
2.	2.14	17.1	.01	2			
3.	2.11	17.4	.01	5			
4.	2.10	17.5	.01	5	328		
5.	2.15	17.6	.01	3			
AVE: 6.	2.13	17.36	.01	3.8	323.5	—	GOV.
7.							
8.							
9.							
10.							
11.							
12.							
13.							
14.							

Signature of Technicians Pat Gower - Craig [illegible]

BILL WIMMER - GLI

TIME 9:55

10:05

ENGINE WATER TEMP. 170

5
10:
10:

Exhaust Gas Analysis Form

Company: Greyhounds

Date: 12-1-88 **Baseline:** ✓ **Treated:**

Equipment Tested: MIC

Engine Type: 6V92D # 6VF151332 **Mileage:** 133194

Fuel Type: 2 **Fuel Temp.:** 83 / 89

Unit ID No.: 7031

Exhaust Gas Readings

	CO2	O2	CO	HC	EX.Temp.	Air Flow	RPM
1.	2.73	16.9	.01	4	316	1247	
2.	2.70	16.2	.01	4	320	1185	
3.	2.70	16.1	.01	4	321	1530	
4.	2.65	16.6	.01	5	321	1300	
5.	2.66	16.6	.01	5	321		
6.	2.68	16.5	.01	5	320		
7.	2.62	16.7	.01	5	320		
8.	2.63	16.6	.01	5	321		
AVE 9.	2.67	16.53	.01	4.63	320	1320.67	GOV.
10.						⇓ 428.84	
11.							
12.							
13.							
14.							

Signature of Technicians [illegible signature]

Chris Tomlin - GLI

ENGINE WA[illegible] TEMP. 170°

71°
10:40 A.M.
10:52 A.M.

Exhaust Gas Analysis Form

Company: Greyhound

Date: [illegible] Baseline: V Treated:

Equipment Tested: MC

Engine Type: 6V92DE #6VF14667 Mileage: [illegible]

Fuel Type: 2 Fuel Temp.: 88 / 91

Unit ID No.: 7012

Exhaust Gas Readings

OPEN SHUTTERS

	CO2	O2	CO	HC	EX.Temp.	Flow	RPM
1.	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~7~~	~~[illegible]~~		
2.	2.48	16.8	.01	6	320		
3.	2.51	17.2	.01	5	322		
4.	2.51	17.1	.01	5	322		
5.	2.51	17.0	.01	9	322		
6.	2.46	17.3	.01	5	322		
AVE: 7.	2.49	17.18	.01	7.2	321.6	–	–
8.							
9.							
10.							
11.							
12.							
13.							
14.							

Signature of Technicians Pat Gower, Craig Flinders

[illegible] -GLI

71
12:19 P.M
12:24 P.M.

ENGINE WATER TEMP. - 150

Exhaust Gas Analysis Form

Company: GREYHOUND

Date: 11-30-88 Baseline: X Treated:

Equipment Tested: MIC

Engine Type: 6V92 Det. #6VF 112535 Mileage: 514744

Fuel Type: 2 Fuel Temp.: 71 / 76

Unit ID No.: 8985

Exhaust Gas Readings

OPEN SHUTTERS

	CO2	O2	CO	HC	EX.Temp.	Flow	RPM
1.	1.98	17.8	.01	4	331		
2.	1.97	17.6	.01	4	334		
3.	1.96	17.5	.01	4	334		
4.	1.92	17.8	.01	4	335		
5.	1.92	17.7	.01	4	336		
AVE 6.	1.95	17.68	.01	4	334		
7.							
8.							
9.							
10.							
11.							
12.							
13.							
14.							

Signature of Technicians: Pat Sauer, Craig Flinders

CHRIS PETERSON - GLI

ENGINE WATER TEMP. 180

10:38 A.M.
10:39 A.M.

Exhaust Gas Analysis Form

Company: GREYHOUND

Date: 2-30-88 Baseline: ✓ Treated: ______

Equipment Tested: MCI

#DGVF0848

Engine Type: 6V92DDT. Mileage: [illegible]

Fuel Type: 2 Fuel Temp.: 74 / 78

Unit ID No.: 8940

Engine Miles 9080

Exhaust Gas Readings

CLOSED SHUTTERS

	CO2	O2	CO	HC	EX.Temp.	Flow	RPM
1.	1.75	18.0	.01	3	308		
2.	1.74	18.0	.01	3	[illegible]		
3.	1.73	18.6	.01	5	31[illegible]		
4.	1.72	18.0	.01	4	319		
5.	1.76	17.9	.01	5	320		
6.	1.76	18.0	.01	3	321		
AVE: 7.	1.74	18.08	.01	3.83	316.17		
8.							
9.							
10.							
11.							
12.							
13.							
14.							

Signature of Technicians Pat Glover - Craig Slinders

WIMMER - PARKER - GLI
BILL TIM

ENGINE WATE TEMP 180°

74°
1:22 A.M.
1:31 P.M.

Exhaust Gas Analysis Form

Company: GREYHOUND

Date: 11-30-88 Baseline: X Treated:

Equipment Tested: MIC

Engine Type: 6V92DET. #1 6VF 11118 Mileage: 492705

Fuel Type: 2 Fuel Temp.: 79 / 84

Unit ID No.: 8981

Exhaust Gas Readings

	CO2	O2	CO	HC	EX.Temp.	Flow	RPM
1.	2.12	17.5	.01	3	335		
2.	2.11	17.4	.01	3	337		
3.	2.11	17.3	.01	3	338		
4.	2.08	17.5	.01	4	342		
5.	2.08	17.5	.01	4	343		
AVE 6.	2.10	17.5	.01	3.4	339		
7.							
8.							
9.							
10.							
11.							
12.							
13.							
14.							

Signature of Technicians Pat Homer, Craig L. Andrus

CHRIS PETERSON – GLI

ENGINE WATER TEMP 180

74°

1:02 P.M.

1:08 P.M.

Exhaust Gas Analysis Form

Company: GREYHOUND

Date: 11-30-88 Baseline: X Treated:

Equipment Tested: MIC

Engine Type: 6V92DST. #6VF112141 Mileage: 515001

Fuel Type: 2 Fuel Temp.: 85 / 88

Unit ID No.: 8975

Exhaust Gas Readings

	CO2	O2	CO	HC	EX.Temp.	Flow	RPM
1.	2.29	17.3	.01	5	340		
2.	2.28	17.2	.01	5	342		
3.	2.27	17.2	.01	5	344		
4.	2.27	17.4	.02	5	346		
5.	2.26	17.3	.02	5	347		
AVE 6.	2.27	17.28	.01	5	343.8		
7.							
8.							
9.							
10.							
11.							
12.							
13.							
14.							

Signature of Technicians: Pat Sauer, Craig Flinders

CHRIS PETERSON - GLI

ENGINE WAT ? TEMP 185

68°
1105 P.M

Exhaust Gas Analysis Form

Company: GREYHOUND

Date: 12-1-88 Baseline: X Treated:

Equipment Tested: MIC

Engine Type: 6V92D #6VF112379 Mileage: 578098

Fuel Type: Fuel Temp.: 78 / 81

Unit ID No.: 8990

Exhaust Gas Readings

	CO2	O2	CO	HC	EX.Temp.	Flow	RPM
1.	2.16	17.0	.01	4	330	2360	
2.	2.16	16.8	.01	4	345	2434	
3.	2.16	16.9	.01	4	347	2352	
4.	2.20	16.8	.01	5	348		
5.	2.20	16.8	.01	5	349		
6.	2.21	16.8	.01	4	348		
7.	2.26	16.9	.01	6	342		
8.	2.27	16.8	.01	5	344		
9.	2.27	16.8	.01	6	344		
AVE 10.	2.21	16.82	.01	4.78	344.11	2382	
11.						773	
12.							
13.							
14.							

Signature of Technicians R. Lower / Craig Flanders

CHRIS PETERSON / GRI

ENGINE WATER TEMP. 180

71°
12:56 P.M.
1:03 P.M.

Exhaust Gas Analysis Form

Company: Greyhound

Date: 12-1-88 Baseline: ✓ Treated: ____

Equipment Tested: MIC

Engine Type: 6V92TD #6VF117934 Mileage: 433901

Fuel Type: 2 Fuel Temp.: 71 / 78

Unit ID No.: 9055

Exhaust Gas Readings

	CO2	O2	CO	HC	EX.Temp.	Flow	RPM
1.	2.55	16.1	.01	5	364	1300	
2.	2.55	16.1	.01	5	370	1710	
3.	2.55	16.0	.01	4	370	1865	
4.	2.54	16.4	.01	4	372		
5.	2.53	16.3	.01	4	373		
6.	2.53	16.3	.01	4	373		
7.	2.47	16.4	.01	3	372		
8.	2.47?	16.4	.01	3	373		
9.	2.47	16.4	.01	3	373		
10.			.01	3.89	371.11	1625	
11.							
12.							
13.							
14.							

Signature of Technicians Pat Gower / Craig Flinders

Chris Peterson - GLI

ENGIN WATER TEM 170

68°
1:41 P.M.
1:47 P.M.

Exhaust Gas Analysis Form

Company: GREYHOUND

Date: 11-30-88 Baseline: X Treated: ______

Equipment Tested: MIC

Engine Type: 6V92 DET. 6VF118367 Mileage: 426550

Fuel Type: 2 Fuel Temp.: 70 / 73

Unit ID No.: 9015

Exhaust Gas Readings

	CO_2	O_2	CO	HC	EX.Temp.	Flow	RPM
1.	2.12	17.3	.01	6	348		
2.	2.12	17.2	.01	5	349		
3.	2.12	17.2	.01	5	349		
4.	2.15	17.4	.01	3	350		
5.	2.14	17.4	.01	4	350		
AVE 6.	2.13	17.3	.01	4.6	349.2		
7.							
8.							
9.							
10.							
11.							
12.							
13.							
14.							

Signature of Technicians Pat Sower, Craig Flinders

CHRIS PETERSON - GLI

ENGINE WATER TEMP 170

"71"
12:30 P.M.
12:39 P.M.

Exhaust Gas Analysis Form

Company: GREYHOUND

Date: 12-1-88 Baseline: X Treated:

Equipment Tested: BUS

Engine Type: 6V92D #6VF085738C Mileage: 429101

Fuel Type: 2 Fuel Temp.: 79 / 86

Unit ID No.: 9034

Exhaust Gas Readings

	CO2	O2	CO	HC	EX.Temp.	Flow	RPM
1.	2.05	17.2	.01	6	300	2152	
2.	2.05	17.1	.01	5	302	1970	
3.	2.05	17.0	.01	4	309	2274	
4.	1.99	17.4	.01	5	306		
5.	1.99	17.3	.01	5	306		
6.	1.99	17.3	.01	5	306		
7.	1.96	17.6	.01	6	308		
8.	1.96	17.4	.01	6	308		
9.	1.96	17.3	.01	6	308		
AVE 10.	2.00	17.29	.01	5.33	305.78	2132.00	
11.						692	
12.							
13.							
14.							

Signature of Technicians Pat ... Ray Flinders

John Colia - GLI

ENGINE WATER TEMP. 170°

82°
12:08 P.M.
12:13 P.M.

Exhaust Gas Analysis Form

Company: GREYHOUND

Date: 11-30-88 Baseline: X Treated:

Equipment Tested: MC #6VF117827

Engine Type: 6V92 DET. Mileage: 424868

Fuel Type: 2 Fuel Temp.: 96 / 97

Unit ID No.: 9058

Exhaust Gas Readings

	CO2	O2	CO	HC	EX.Temp.	Flow	RPM
1.	2.20	17.3	.100	2	312		
2.	2.20	17.2	.100	2	319		
3.	2.20	17.2	.100	2	322		
4.	2.19	17.4	.101	3	325		
5.	2.19	17.4	.101	3	327		
AVE 6.	2.20	17.3	.1004	2.4	321		
7.							
8.							
9.							
10.							
11.							
12.							
13.							
14.							

Signature of Technicians Pat Stover, Craig Slinders

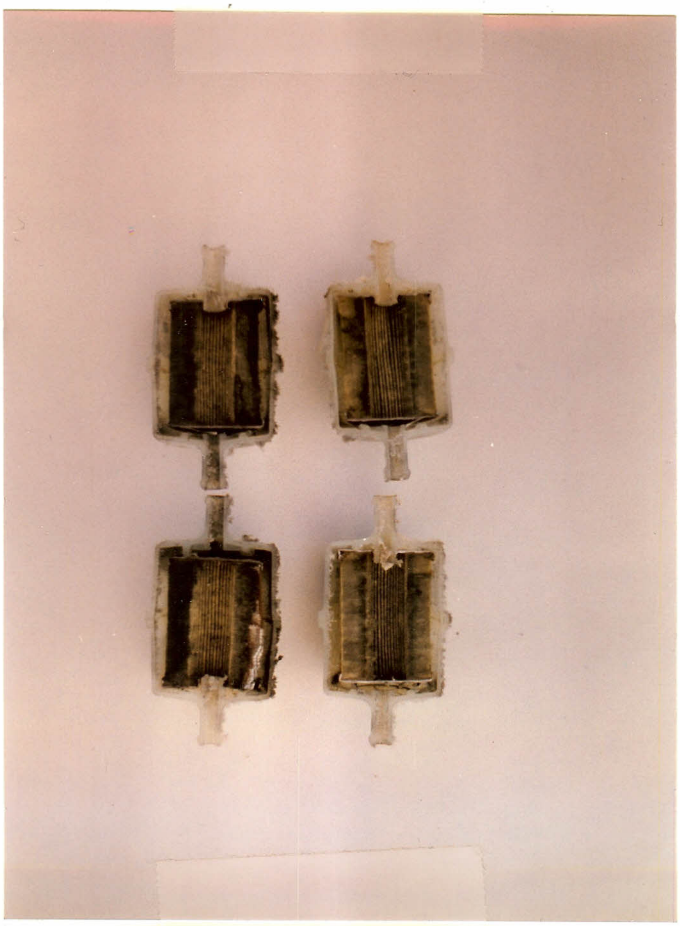
PETERSON, CHRIS - GLI

Greyhound Lines, Inc.

Carbon Mass Balance Filter Comparison

Pool 23, (Buses 4990 – 4999 & 6685 – 6689)

Baseline Test Filter Utilized
July 21, 22, 23 & 24, 1984.



Treated Test Filter Utilized
October 5, 6, 7 & 8, 1984.

Note: See Harmful Emissions, Page 12 for complete explanation.

Table 2

EXHAUST GAS, AIR FLOW AND TEMPERATURE SUMMARY FROM THE GREYHOUND TRANSIT TEST FLEET, SAN FRANCISCO, CA.

Unit No. 9514

	CO2%	O2%	CO%	HCppm	Exh. Temp.	Amb. Temp.	Fuel Temp.	Air Flow
Base	2.52	16.26	.07	13.0	351.3 °F	71 °F	N/A	1223 cfm
Treated	2.39	17.02	.01	2.0	290.2 °F	62 °F	N/A	898 cfm

Unit No. 9507

	CO2%	O2%	CO%	HCppm	Exh. Temp.	Amb. Temp.	Fuel Temp.	Air Flow
Base	2.06	17.15	.01	4.0	298.9 °F	71 °F	N/A	1090 cfm
Treated	2.42	16.65	.01	3.5	296.4 °F	70 °F	N/A	764 cfm

Unit No. 9649

	CO2%	O2%	CO%	HCppm	Exh. Temp.	Amb. Temp.	Fuel Temp.	Air Flow
Base	2.46	16.44	.01	7.3	413.5 °F	69 °F	N/A	937 cfm
Treated	1.70	18.00	.04	11.5	416.0 °F	72 °F	N/A	820 cfm

Unit No. 9645

	CO2%	O2%	CO%	HCppm	Exh. Temp.	Amb. Temp.	Fuel Temp.	Air Flow
Base	2.39	16.50	.01	8.3	425.5 °F	72 °F	N/A	824 cfm
Treated	1.80	17.68	.01	6.0	416.3 °F	72 °F	N/A	703 cfm

Table 3

EXHAUST TEMPERATURE AND AIRFLOW COMPARISON
MAINLINER FLEET

UNIT NO.	BASE TEMP.	TREATED TEMP.*	BASE A.F.	TREATED A.F.
8975	343.8° F	339.4° F	-	-
8990	344.1° F	348.2° F	774 CFM	658 CFM
8981	339.0° F	332.6° F	-	-
8940	316.2° F	322.2° F	-	723 CFM
8985	334.0° F	336.5° F	-	731 CFM
AVE. FOR 8900 SERIES BUSES	**335.4° F**	**335.7° F**	**774 CFM**	**704 CFM**
9034	305.8° F	326.5° F	692 CFM	762 CFM
9012	334.5° F	355.8° F	621 CFM	587 CFM
9015	349.2° F	356.9° F	-	-
9058	321.0° F	349.5° F	-	-
AVE. FOR 9000 SERIES BUSES	**325.4° F**	**346.7° F**	**657 CFM**	**674 CFM**
7010	306.4° F	322.0° F	462 CFM	433 CFM
7012	321.6° F	323.0° F	-	-
7031	320.0° F	326.2° F	429 CFM	563 CFM
7007	323.5° F	331.2° F	-	-
7000	307.5° F	353.4° F+	473 CFM	509 CFM
7003	320.0° F	320.0° F	462 CFM	515 CFM
AVE. FOR 7000 SERIES BUSES	**316.5° F**	**329.3° F**	**456 CFM**	**505 CFM**

* Corrected for changes in ambient temperature

+ No ambient temperature correction

Table 4

EXHAUST TEMPERATURE AND AIRFLOW COMPARISON
TRANSIT FLEET

UNIT NO.	BASE TEMP.	TREATED TEMP.*	BASE A.F.	TREATED A.F.
9514	351.8° F	290.2° F	1223 CFM	898 CFM
9507	298.9° F	296.4° F	1090 CFM	764 CFM
9649	413.5° F	416.0° F	937 CFM	820 CFM
9645	425.5° F	416.3° F	824 CFM	703 CFM
AVE. FOR TRANSIT BUSES	**372.4° F**	**354.7° F**	**1019 CFM**	**796 CFM**

* Corrected for changes in ambient temperature

Table 5

FUEL TEMPERATURE COMPARISON

UNIT NUMBER	AVERAGE BASE FUEL TEMP.	AVERAGE TREATED FUEL TEMP.
9034	82.5° F	91.0° F
9015	71.5° F	90.5° F
9058	95.5° F	85.0° F
9012	102.0° F	94.0° F
AVE. FOR 9000 SERIES	**87.9° F**	**90.1° F**
8975	86.6° F	85.5° F
8990	79.5° F	92.0° F
8981	81.5° F	85.0° F
8940	76.0° F	77.0° F
8985	73.5° F	84.5° F
AVE. FOR 8900 SERIES	**79.4° F**	**84.8° F**
7040	91.5° F	103.0° F
7010	73.0° F	93.0° F
7012	90.5° F	96.0° F
7031	86.0° F	100.0° F
7007	77.5° F	95.0° F
7000	80.5° F	110.0° F
7003	83.0° F	99.0° F
AVE. FOR 7000 SERIES	**83.1° F**	**99.5° F**
AVERAGE FOR FLEET	**83.2° F**	**92.5° F**

Table 6

MOLECULAR WEIGHT OF EXHAUST GASES, ENGINE PERFORMANCE FACTORS AND FUEL ECONOMY IMPROVEMENTS FOR MAINLINER FLEET

Unit No. 9034

Mwt1	29.0119	Mwt2	29.0226
pf1	306,285.2202	pf2	308,149.1814
PF1	338,949.7422	PF2	318,056.8656

% Change F.E. = [(318,056.8656 - 338,949.7422)/338,949.7422](100)

% Change F.E. = - 6.16%

Unit No. 9015

Mwt1	29.0331	Mwt2	29.0138
pf1	287,978.3038	pf2	325,213.0666
PF1	354,691.0858	PF2	386,443.8353

% Change F.E. = [(386,443.8353 - 354,691.0858)/354,691.0858](100)

% Change F.E. = + 8.95%

Unit No. 9058

Mwt1	29.0441	Mwt2	29.0618
pf1	279,906.1577	pf2	286,293.1087
PF1	332,734.7172	PF2	343,849.0675

% Change F.E. = [(343,849.0675 - 332,734.7172)/332,849.0675](100)

% Change F.E. = + 3.34%

Unit No. 9012

Mwt1	29.0290	Mwt2	29.0314
pf1	286,691.2167	pf2	278,961.6849
PF1	367,380.9221	PF2	382,467.4003

% Change F.E. = [(382,467.4003 - 367,380.9221)/367,380.9221](100)

% Change F.E. = + 4.11%

Unit No. 8975

Mwt1	29.0547	Mwt2	29.0422
pf1	270,489.4687	pf2	281,611.7012

% Change F.E. = [(281,611.7012 - 270,489.4687)/270,489.4687](100)

% Change F.E. = + 4.11%

Unit No. 8981

Mwt1	29.0362	Mwt2	29.0118
pf1	292,201.5063	pf2	324,186.966

% Change F.E. = [(324,186.9661 - 292,201.5063)/292,201.5063](100)

% Change F.E. = + 10.95%

Unit No. 8940

Mwt1	29.0018	Mwt2	28.9670
pf1	351,768.8527	pf2	399,236.6401

% Change F.E. = [(399,236.6401 - 351,768.8527)/351,768.8527](100)

% Change F.E. = + 13.49%

Unit No. 8985

Mwt1	29.0194	Mwt2	29.0082
pf1	314,298.7552	pf2	314,246.4125

% Change F.E. = [(314,246.4125 - 314,298.7552)/314,298.7552](100)

% Change F.E. = -.017%

Unit No. 7040

Mwt1	29.0919	Mwt2	29.0875
pf1	236,638.8672	pf2	223,769.2376
PF1	336,741.9018	PF2	340,389.9431

% Change F.E. = [(340,389.9431 - 336,741.9018)/336,741.9018](100)

% Change F.E. = + 1.08%

Unit No. 7010

Mwt1	29.0778	Mwt2	29.1202
pf1	249,993.0839	pf2	223,266.5349
PF1	414,707.1418	PF2	403,220.3939

% Change F.E. = [(403,220.3939 - 414,707.1418)/414,707.1418](100)

% Change F.E. = - 2.80%

Unit No. 7031

Mwt1	29.0887	Mwt2	29.9890
pf1	230,453.3333	pf2	347,625.3536
PF1	419,006.0606	PF2	485,440.5915

% Change F.E. = [(485,440.5915 - 419,006.0606)/419,006.0606](100)

% Change F.E. = + 15.86%

Unit No. 7007

Mwt1	29.0354	Mwt2	28.9970
pf1	288,068.2362	pf2	334,491.5458
PF1	494,959.3489	PF2	520,084.8768

% Change F.E. = [(520,084.8768 - 494,959.3489)/494,959.3489](100)

% Change F.E. = + 5.08%

Unit No. 7000

Mwt1	29.0899	Mwt2	29.1307
pf1	244,104.0784	pf2	196,355.5373
PF1	396,927.7123	PF2	313,783.0923

% Change F.E. = [(313,783.0923 - 396,927.7123)/396,927.7123](100)

% Change F.E. = - 20.95%

Unit No. 7003

Mwt1	29.1058	Mwt2	29.0361
pf1	223,161.0688	pf2	286,857.3888
PF1	376,765.4409	PF2	434,463.6181

% Change F.E. = [(434,463.6181 - 376,765.4409)/376,765.4409](100)

% Change F.E. = + 15.31%

Unit No. 7012

Mwt1	29.0860	Mwt2	28.9670
pf1	246,847.5213	pf2	418,219.9241
PF1	423,105.3127	PF2	640,994.4976

% Change F.E. = [(640,994.4976 - 423,105.3127)/423,105.3127](100)

% Change F.E. = + 51.5%

Table 7

SUMMARY OF FUEL SAVINGS FOR MAINLINER FLEET

UNIT NUMBER	%FUEL SAVINGS
7000	- 20.95%*
9034	- 6.16%
7010	- 2.80%
8985	- 0.017%
7040	+ 1.08%
9058	+ 3.34%
9012	+ 4.11%
8975	+ 4.11%
7007	+ 5.08%
9015	+ 8.95%
8981	+ 10.95%
8940	+ 13.49%
7003	+ 15.31%
7031	+ 15.86%
7012	+ 51.50%*

AVERAGE FUEL SAVINGS (all data)

103.85% / 15 = 6.92%

AVERAGE FUEL SAVINGS (excluding outliers)

73.30% / 13 = 5.64%

* Outliers

Table 8

MOLECULAR WEIGHT OF EXHAUST GASES, ENGINE PERFORMANCE FACTORS AND FUEL ECONOMY IMPROVEMENTS FOR TRANSIT FLEET

Unit No. 9514

Mwt1	29.0744	Mwt2	29.0793
pf1	237,859.7644	pf2	247,108.3139
PF1	157,788.7383	PF2	208,744.3511

% Change F.E. = [(208,744.3511 - 157,788.7383)/157,788.7383](100)

% Change F.E. = + 32.29%

Unit No. 9507

Mwt1	29.0158	Mwt2	29.0574
pf1	297,579.9269	pf2	253,934.4604
PF1	207,186.6115	PF2	251,076.0359

% Change F.E. = [(251,076.0359 - 207,186.6115)/207,186.6115](100)

% Change F.E. = + 21.18%

Unit No. 9649

Mwt1	29.0516	Mwt2	28.9827
pf1	249,541.6851	pf2	352,714.7452
PF1	232,630.3756	PF2	375,512.1617

% Change F.E. = [(375,512.1617 - 232,630.3756)/232,630.3756](100)

% Change F.E. = + 61.42%

Unit No. 9645

Mwt1	29.0429	Mwt2	28.9955
pf1	256,663.0303	pf2	339,797.7825
PF1	275,819.3123	PF2	423,563.0111

% Change F.E. = [(423,563.0111 - 275,819.3123)/275,819.3123](100)

% Change F.E. = + 53.57%

Table 9

SUMMARY OF FUEL SAVINGS FOR TRANSIT FLEET

UNIT NUMBER	%FUEL SAVINGS
9514	+ 32.29%
9507	+ 21.18%
9649	+ 61.42%
9645	+ 53.57%

AVERAGE FUEL SAVINGS

168.46% / 4 = 42.11%

Carbon Mass Balance Formula

ASSUMPTIONS: C_8H_{15} and SG = 0.78
Time is constant
Load is constant
RPM is constant

DATA:

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)
T = Temperature (F^o)
F = Flow (exhaust CFM)
SG = Specific Gravity
VF = Volume Fraction
$VFCO_2$ = "reading" ÷ 100
VFO_2 = "reading" ÷ 100
VFHC = "reading" ÷ 1,000,000
VFCO = "reading" ÷ 100

EQUATIONS:

$$1wt=(VFHC)(86)+(VFCO)(28)+(VFCO_2)(44)+(VFO_2)(32)+[(1\text{-}VFHC\text{-}VFCO\text{-}VFO_2\text{-}VFCO_2)(28)]$$

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

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

PERCENT INCREASE (OR DECREASE) IN FUEL ECONOMY $\left(\frac{PF_2 - PF_1}{PF_1}\right) \times 100$

Greyhound Lines, Inc.

Carbon Mass Balance

4900 Series Only

(Buses 4991 - 4999)

	Baseline	Treated	Increase or Decrease
CO_2	5.17	4.70	−9.09%
O_2	13.01	13.74	+5.31%
HC	9.67	.75	−92.24%
CO	.007	0	−100%
Temp.	517.52°F	527.43°F	
Flow	803 CFM	819 CFM	

Volume Fractions

VFHC	0.0000097	0.0000008
VFCO	0.00017	0
$VFCO_2$	0.0517	0.04699
VFO_2	0.1301	0.1374

Molecular Weight and Performance Factors

Mwt_1	29.347717	Mwt_2	29.301555
pf_1	120622.87	pf_2	133578.12
PF_1	146884.64	PF_2	161193.16

$$161193.16 - 146884.64 = \frac{14308.52}{146884.64} \times 100 = 9.74\%$$

Note: Bus 4990 was eliminated from this Treated data. (See Phase II - Carbon Mass Balance, Page 6, and Phase III - MPG Comparison, Page 8, and Harmful Emissions, Pages 11 and 12 for complete explanation).

Exhibit D

Greyhound Lines, Inc.

Carbon Mass Balance

6600 Series Only

(Buses 6685 - 6689)

	Baseline	Treated	Increase or Decrease
CO_2	5.3	4.79	−9.62%
O_2	12.89	13.61	+5.29%
HC	9.67	1.08	−88.83%
CO	.009	0	−100%
Temp.	549.38°F	521.68°F	
Flow	853 CFM	810 CFM	

Volume Fractions

VFHC	0.0000097	0.0000011
VFCO	0.000086	0
$VFCO_2$	0.053	0.0479
VFO_2	0.1289	0.1361

Molecular Weight and Performance Factors

Mwt_1	29.364002	Mwt_2	29.310625
pf_1	117490.59	pf_2	130864.95
PF_1	139133.35	PF_2	158741.61

$$158741.61 - 139133.35 = \frac{19608.26}{139133.35} \times 100 = 14.09\%$$

Exhibit E

Greyhound Lines, Inc.

Carbon Mass Balance

(Buses 4991 - 4999 and 6685 - 6689)

	Baseline	Treated	Increase or Decrease
CO_2	5.21	4.73	−9.21%
O_2	12.97	13.70	+5.33%
HC	9.67	.87	−91%
CO	.008	0	−100%
Temp.	528.9°F	525.38°F	
Flow	821 CFM	816 CFM	

Volume Fractions

VFHC	0.0000097	0.0000009
VFCO	0.00014	0
$VFCO_2$	0.0521	0.0473
VFO_2	0.1297	0.1370

Molecular Weight and Performance Factors

Mwt_1	29.353532	Mwt_2	29.30479
pf_1	119504.20	pf_2	132609.13
PF_1	144116.32	PF_2	160317.61

$$160317.16 - 144116.32 = \frac{16201.29}{144116.32} \times 100 = 11.24\%$$

Note: Bus 4990 was eliminated from this Treated data. (See Phase II - Carbon Mass Balance, Page 6, and Phase III - MPG Comparison, Page 8, and Harmful Emissions, Pages 11 and 12 for complete explanation).

Evaluation

of

FPC-1

Fuel Performance Catalyst

at

Greyhound Lines, Inc.
Eastern Division
Florida Operation

Report Prepared For

Greyhound Lines, Inc.

Phoenix, Arizona

by

JRC Enterprises, Inc.

Tempe, Arizona

Data Herein Provided by

Greyhound Lines, Inc.
Phoenix, Arizona

Greyhound Fleet Maintenance Management
Eastern Division
Miami, Orlando, St. Petersburg & Jacksonville, Florida

and

UHI Corporation
Provo, Utah

TABLE OF CONTENTS

I. INTRODUCTION

FPC-1 Fuel Performance Catalyst is the designation of a ferrous picrate catalyst developed to enhance the combustion of all liquid hydrocarbon fuels. The catalyst has undergone extensive testing at independent and university affiliated laboratories in light duty gasoline and diesel powered vehicles. These test procedures have included the EPA standardized, Federal Test Procedures (FTP), hot and cold cycles, the Highway Fuel Economy Test (HFET), (both use carbon mass balance procedures), the SAE J-1082 Interstate and Suburban Fuel Economy Tests, the Coordinated Research Council Cold Start Driveability Test and steady-state engine dynamometer testing.

These tests have provided documentation which show the FPC-1 catalyst creates the following benefits:

1) Increased fuel efficiency (or improved fuel economy).

2) Reduced emissions of harmful pollutants and smoke.

3) Improved driveability (engine performance).

This report will discuss the results of an extensive three phase engine performance evaluation using this unique fuel combustion catalyst. The test was conducted by Greyhound Lines, Inc., Phoenix, Arizona, at their Eastern Division, Florida Operation, in cooperation with J.R.C. Enterprises Inc., Tempe, Arizona, and UHI Corporation, Provo, Utah, the FPC-1 manufacturer. An explanation of the test procedures used to determine the effect of the catalyst on fuel economy, harmful emissions and engine performance characteristics will be documented and the results summarized.

II. TESTS

The tests were conducted in three phases. First, a preliminary fuel economy test; second, a carbon mass balance and harmful emissions analysis; and finally, a long term mileage comparison.

Phase I - Preliminary Single Engine Test

In meetings held between Mr. J.A. Malcomb, Senior Vice President, Maintenance/Engineering, Greyhound Lines Inc., J.R. Challis, President, J.R.C. Enterprises Inc., and S. Craig Flinders, Sales Manager, UHI Corporation, a trial test was established to verify the economic benefit provided by the FPC-1 catalyst. The study was conducted on an 8V-71 D.D.A. powered inter-branch transport operating out of the Chicago area. The truck was monitored for approximately eight months, from January 1983 to August of the same year.

Although the data from this study was not published, Mr. Malcomb reported the test truck demonstrated a significant improvement in fuel economy with the catalyst treated fuel. The success of this single engine trial provided the impetus for a more conclusive, wider range test using a larger test fleet.

Long Term Testing

A group of fifteen (15) Greyhound buses was selected by Mr. Malcomb as the test fleet for the next two phases of testing. These buses (designated Pool 23) operating primarily out of Miami, Florida, were selected as the test fleet for the following reasons;

a) All Pool 23 buses were restricted to operate within the state of Florida (serving the Walt Disney World service routes) allowing a specific geographic area for controlled fueling, thereby, assuring the use of FPC-1 treated fuel in the test fleet.

b) The Pool 23 buses provided a good cross section of the Greyhound Lines fleet.

c) Because the Pool 23 fleet had a designated service schedule (Walt Disney Route), it was felt that consistency in routing and loads could best be achieved for baseline and treated comparisons.

d) The Greyhound Lines, Eastern Division, Florida Operation, offered a most reliable personnel team to implement the test procedures and oversee the test program.

A Baseline MPG average was established from the Greyhound monthly mpg reports for an seven (7) month period beginning December, 1983 through June 1984. This baseline was then compared to a FPC-1 treated fuel period beginning August 1984, and ending April 1985.

In conjunction with the extended fuel consumption comparison, a carbon mass balance method of determining fuel economy was also conducted on the Pool 23 buses. The carbon mass balance test is covered in Phase II; the MPG comparison in Phase III.

Phase II - Carbon Mass Balance

History and Development

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."

It is from this concept that UHI Corporation derived the exhaust gas analysis technique of determining fuel consumption changes used by J.R.C. Enterprises, Inc. and UHI personnel in this test with Greyhound Lines, Inc.

Although not as controlled a test as obtainable in a laboratory using a chassis dynamometer, the method used has consistently proven to be far more accurate than monthly mpg fleet records.

The technique uses state-of-the-art NDIR instruments that measure carbon doxide (CO_2), carbon monoxide (CO), oxygen (O_2), and unburned hydrocarbons (HC).

Test Procedure

During a four (4) day period from July 21 through July 24, 1984, all Pool 23 buses were brought to the Miami Maintenance Center for baseline "carbon mass exhaust gas testing". Each bus engine was operated at a fixed RPM and load that could be easily reproduced. Numerous exhaust gas readings were taken on each bus with a Sun Electric MGA-90 Multiple Gas Analyzer and the mean percentage of the carbon dioxide (CO_2), carbon monoxide (CO), and oxygen (O_2), and the mean parts per million hydrocarbons (HC) determined.

Exhaust airflow rate and exhaust temperature were also recorded using a Davis high speed anemometer and an IMC digital thermocouple. All readings were taken and resultant averages calculated under the supervision of Mr. Lee Hopkins, Manager of Maintenance Center and/or Greyhound personnel designated by Mr. Hopkins.

Copies of all data were submitted to Mr. Hopkins upon test completion each day. Fuel treatment with FPC-1 Fuel Performance Catalyst was then accomplished as will be detailed in the PHASE III - MPG comparison section later.

During a second four (4) day period from October 5 through October 8, 1984, after all Pool 23 buses had exceeded the 150 hour or 6000 mile recommended break-in period, carbon mass test procedures were duplicated as in baseline testing.

Again, all readings were taken and the resultant averages calculated under the supervision of Mr. Hopkins.

The carbon balance data is compiled and compared in the following exhibits;

EXHIBIT B - illustrates the actual Carbon Balance Formula.

EXHIBIT C - depicts the Carbon Mass Balance test results on the 4900 series buses only.

EXHIBIT D - the 6600 series buses only, and

EXHIBIT E - the cumulative (all Pool 23 buses) results.

The results of the PHASE II - Carbon Mass Balance study confirm fuel economy improvements with FPC-1 treated fuel in excess of 10% over baseline cumulatively (EXHIBIT C), 14.09% for the 6600 series buses only (EXHIBIT D), and 9.74% for the 4900 series only (EXHIBIT E).

It might also be noted that potential engine failures can oftentimes be identified by this method of exhaust analysis. For example, during both baseline and treated testing, bus 4990 showed unusually high exhaust temperature and exhaust emission levels when compared to the other fourteen (14) test buses. The high emission levels of bus 4990 corresponded with its then high fuel consumption trend. The bus subsequently required repair for turbo charger and aftercooler problems and, as a result, was dropped from the test data used in all comparisons.

How FPC-1 Affects Exhaust Emissions

In order to fully understand the correlation between emission levels and internal combustion engine operation, and the effect of the FPC-1 catalyst on these parameters, it must be understood how the different exhaust gases react to the combustion cycle in terms of time and mechanical efficiency.

Excessive hydrocarbons (HC) levels are a result of inefficient combustion which takes place when the fuel is burned without enough air to allow complete combustion.

Oxygen (O2) and carbon dioxide (CO2) levels are an excellent indicator of a lean running engine. If O2 levels are high, and CO2 levels are low, the engine is running lean. Conversely, if the O2 levels are low, and the CO2 levels are high, then the engine is running rich.

In most cases, HC and CO levels can be altered by increasing or decreasing the amount of time the engine configuration allows for combustion to take place. For instance, modern slow speed diesel engines run more efficiently than do modern high speed diesel engines. The slow speed diesel engine has considerably more time to burn the fuel.

SAE Technical Paper #831204, entitled "The Effects of an Iron Based Fuel Catalyst Upon Diesel Fleet Operation", explains that the FPC-1 active ingredient decreases the amount of time necessary for combustion to take place. As a result, "pressure is higher and more work can be accomplished for the same energy supplied." Further, HC and CO levels will be reduced. In the case of Greyhound Lines, Inc., there was a 94% reduction in CO and a 92% reduction in HC.

These results qualitatively demonstrate an improvement in fuel combustion under the operating conditions outlined. Regarding O2 and CO2 levels, the Greyhound test fleet showed a definite leaning out. The baseline fleet average showed levels of CO2 to be 5.2% with O2 levels of 12.97%. This compares to the leaning affect of the treated period in which the CO2 levels were 4.73% with O2 levels of 13.70%.

The actual fuel usage records correlate directly with the above mentioned emissions data. Bus #4990 has had a significantly lower mpg performance than any other bus in the test fleet. With the mechanical problems that #4990 experienced, it is not surprising that the HC and CO levels were significantly higher than the fleet average. These "mechanical inefficiencies" caused emission level increases in bus #4990 with baseline CO levels of

0.513% as compared to the fleet average of 0.008%, and HC levels of 13 ppm as compared to the fleet average of 9.7 ppm. All of the above data was taken under identical loads and engine temperatures.

Additional evidence to indicate improved combustion was demonstrated when smoke and solid particulate levels were monitored. A letter from Lee Hopkins with accompanying photos provide visual documentation into the reduction of solid particulates. Further, Messrs. Lee Hopkins and H.B. Swann acknowledge the elimination of complaints of heavy smoke during the treated portion of the test.

Phase III - Fifteen Month Road Test / MPG Comparison

Based upon Greyhound Lines monthly fuel consumption records from December, 1983, through July, 1984, Baseline MPG averages were established for the entire Pool 23 fleet. The fuel tanks at the fueling facilities in Miami, Orlando, St. Petersburg, and Jacksonville were treated by J.R. Challis, J.R.C. Enterprises, on July 25, 26, and 27, 1984, at a one part FPC-1 to 1600 parts diesel fuel ratio.

The Greyhound personnel at each location were instructed in the treatment ratios and procedures for future treatments during the ongoing test period. A reporting system was also established to provide a record of all fuel deliveries and the FPC-1 used for each fuel delivery. Fuel consumption data was collected in the usual manner throughout the test period and submitted on a monthly basis to Mr. Malcomb and subsequently to Mr. Challis.

It became apparent early in the treated segment of the Greyhound test that, although fuel consumption had improved, the monthly mpg data was far more erratic than during the baseline period. Total mileage accumulated by the fleet also decreased by an average of 30,000 miles per month or 2,000 miles per bus.

Consequently, in May of 1985, Mr. Craig Flinders and Mr. Kim LeBaron, representatives of UHI Corporation, met with Mr. Lee Hopkins, Manager of the Greyhound Maintenance Center in Miami, to investigate the possible cause of the change in the data.

After investigation, Mr. Hopkins records revealed that the

Pool 23 fleet had experienced a significant change in routing shortly after the treated test period began. The greatest change occurred with the 6600 series portion of the test fleet which, during the baseline period of mpg recording, had run exclusively the Walt Disney World route from Miami to Orlando and back. These 6600 series buses were taken off this route in October of 1984 and put into charter service. Mr. Hopkins reported that since the routing change, the 6600 fleet had experienced major increases in stop-and-go driving and idle time over that of the baseline period.

The same was confirmed by Mr. T.J. Shelby at the Orlando facility. Mr. Shelby added that the 6600 buses were carrying heavier loads on charter service than while running to and from Disney World. For these reasons, Mr. Hopkins recommended the 6600 fleet be dropped from the test.

It was also discovered that the 4900 fleet had also experienced operation changes as indicated again by the reduction in miles driven. However, Mr. Hopkins' records showed these changes far less significant and having only minimal impact on the fuel consumption figures. The 4900 fleet experienced enough common factors in both baseline and treated segments to provide an accurate comparison.

Mr Hopkins also reported that the buses maintained good mechanically working order except unit 4990 which suffered turbo charger and aftercooler problems throughout the test program. Mr. Hopkins recommended unit 4990 also be dropped from the test fleet.

In early October, UHI discovered a container compatibility problem in one batch of FPC-1 which resulted in product contamination. UHI recalled the entire batch, five drums of which had been shipped to Greyhound locations. Although replacement product was provided, shipping problems prevented the arrival of the replacement product in time to treat fuel shipments delivered to the Miami Maintence Center (the facility that predominantly fuels and maintains the Pool 23 fleet) in mid and late October.

Although it is impossible to determine the exact affect of this break in regular treatment, experience has confirmed that fuel economy will drop off and that the "breakin" period required to bring about the full effects of FPC-1 must be repeated.

However, this does provide the opportunity to do an A-B-A (treated-return to baseline-treated analysis) comparison. Such a comparison shows large reductions in fuel economy during October (4.70 mpg) and November (4.90 mpg) when the fleet was operating on untreated and diluted fuel, and substantial gains in fuel economy after the fuel was again fully treated with FPC-1 and breakin completed (5.43 mpg in December). Therefore, Mr. Hopkins has recommended that the October and November data be dropped from the test.

The mileage and fuel consumption figures for the Pool 23 fleet are compiled on the table in Exhibit I of this report. The table demonstrates the data for both baseline and treated fuel periods under three separate headings. These include; 4900 series buses only, 6600 series buses only, and All Pool 23 buses. The ten 4900 series buses experienced a 9.47% improvement in fuel economy with FPC-1 treated fuel. The five 6600 series buses experienced a 2.59% decrease in fuel economy and the entire Pool 23 fleet averaged a 5.57% improvement in fuel economy while using FPC-1 treated fuel.

IV. Summary

In even the most controlled field evaluations it is impossible to control all the variables. This test was no exception. However, the test was monitored over a significant period of time (15 months), and enough data has been accumulated on 15 buses to provide a meaningful fuel economy comparison between the baseline and treated segments of the evaluation.

The following list summarizes the adjustments recommended by Greyhound managers that would add to the reliability of the test results and conclusions:

1) <u>6600 Fleet</u>: The entire 6600 fleet be eliminated from the data base due to dramatic route and load changes.

2) <u>Bus #4990</u>: Bus #4990 be eliminated from the data base because of mechanical problems during the treated fuel segment of the test.

3) <u>October/November</u>: The months of October and November be eliminated from the data base because the fuel was not fully treated.

None of these adjustments have been made in the final analysis of the data and all data is shown on the exhibits contained in the report and in Exhibit J, the Fuel Cost Savings Analysis. However, if the above recommendations were carried out, the test would show that Greyhound experienced a 9.5% improvement in fuel economy with FPC-1 treated fuel. This percentage improvement agrees with the carbon mass balance calculations on the 4900 series fleet of +9.74% and the total fleet carbon mass calculation of +11.24%.

V. Conclusion

Fuel economy derived from monthly fuel usage reports shows a minimum improvement in fuel economy with FPC-1 treated fuel of 5.57%. Carbon balance testing reveals a minimum improvement of 9.74% . Based upon the results of the Greyhound evaluation, it is estimated that annual net fuel savings could be between 2.04 million and 4.9 million dollars.