Statistical Analysis Summary

of

Ferox 230
Fuel Economy Test

conducted at

Savage Industries, American Fork, UT Terminal

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DATA
WORKS

Code: 2.3.2.-1

Title: Savage Industries/AF

Date: 1 Oct. 1989 through 30 April 1990

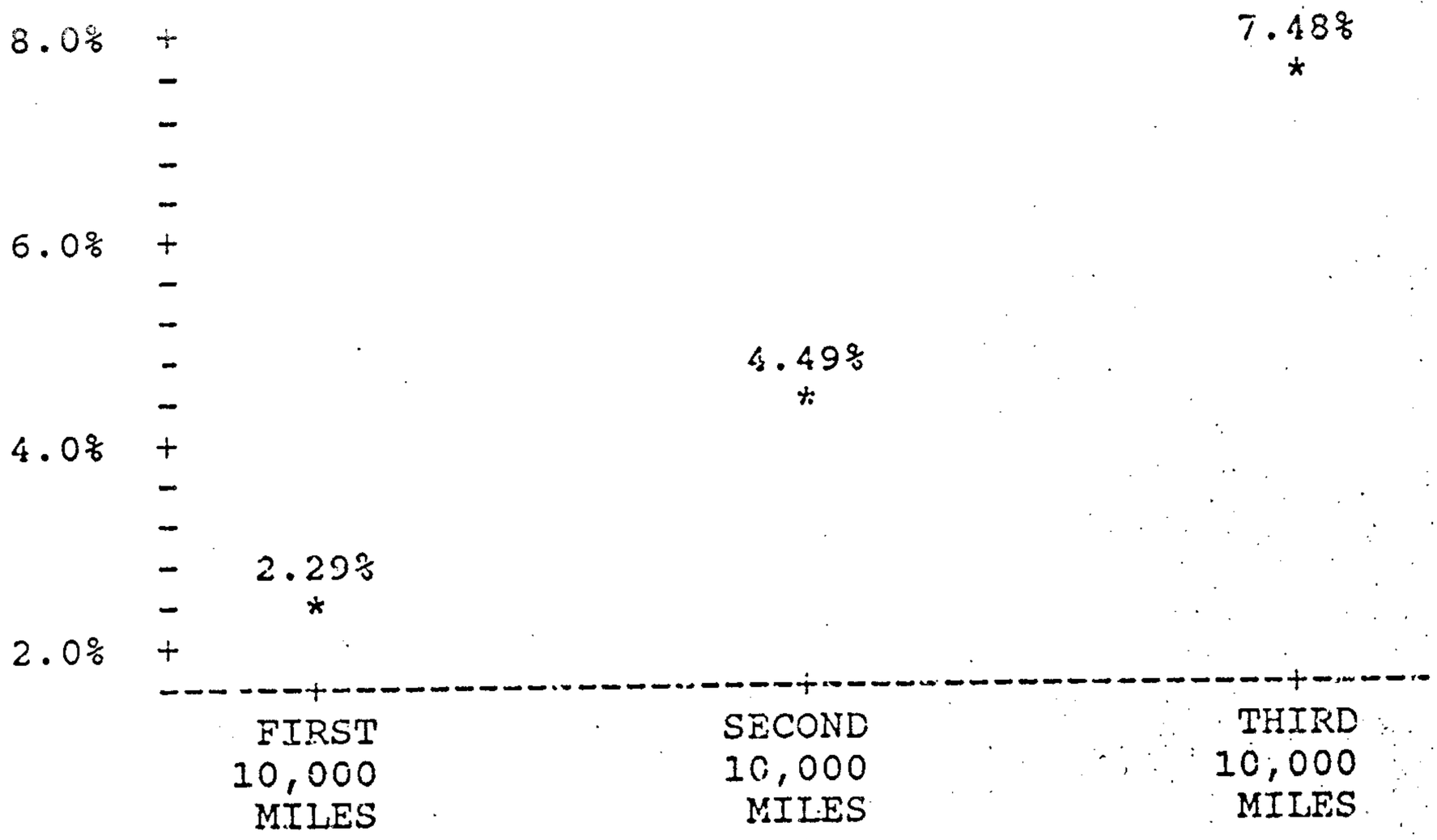
Task: To discover whether or not treating diesel fuel with Ferox 230 will significantly improve fuel and maintenance economy of over-the-road tractor and trailer vehicles.

Statistical Analysis Summary

This summary describes and displays the most important data from an exhaustive statistical analysis of test data supplied, over a seven month period of time, 9 Oct. 89 through 30 Apr. 90, by Savage Industries' American Fork, Utah bulk hauling terminal. The test compared the fuel economy of matched truck and trailer vehicles. The test vehicles (S246, S251) burned diesel fuel treated with Ferox 230 and traveled a combined total of 241,079 miles; the control vehicles (S245, S248) burned untreated diesel fuel and traveled a combined total of 246,836 miles. The fuel was treated by the drivers of the vehicles. The data analyzed was collected by terminal personel and supplied to Data Works for analysis via Parish Chemical.

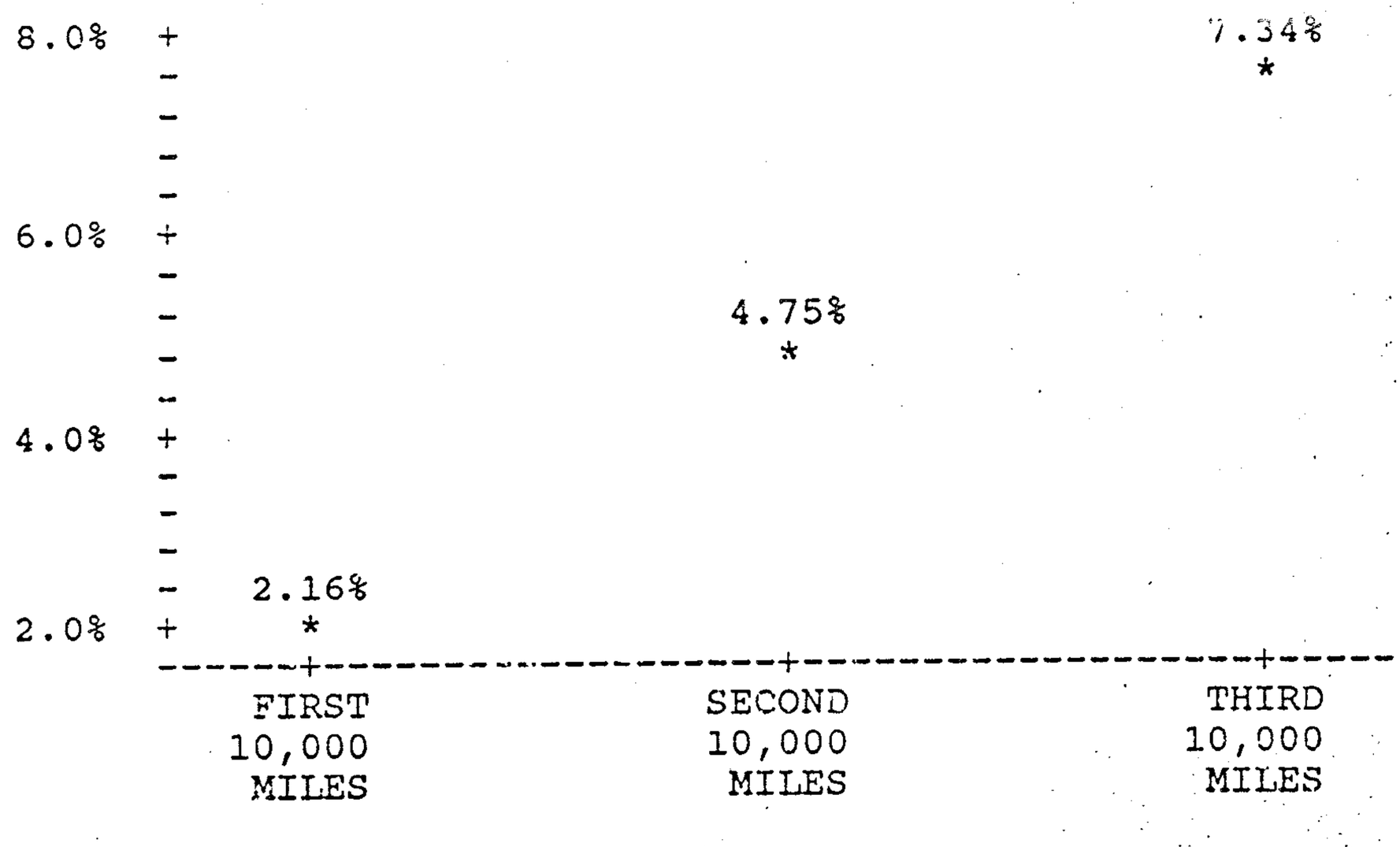
Over the first 10,000 miles driven, the average mpg of vehicles burning treated fuel was 2.29% better than that of vehicles burning untreated fuel; 4.49% better over the second 10,000 miles; and 7.48% better over the third 10,000 miles (see Figure 1).

Figure 1: The graph below shows the actaul percentage of improvement (in mpg) that took place over the first 30,000 miles driven by the vehicles from the Savage Trucking terminal in American Fork.



Using actual results in a linear regression analysis, it can be-predicted with 90% confidence that the improvement in mpg will be between -0.56% and 4.97% over the first 10,000 miles; between 2.35% and 7.16% over the second 10,000 miles; and between 4.53% and 10.16% over the third 10,000 miles. Figure 2 shows the actual predicted values based on the test results.

Figure 2: The graph below shows the statistically expected percentage of improvement (in mpg) for the first 30,000 miles the vehicles are driven burning Ferox 230 treated



After 30,000 miles have been driven burning Ferox 230 treated fuel, the rate of improvement stabilizes and does not continue to increase. One set of data showed a decrease after 30,000 miles. Test results show that, at a 99% confidence level, the percent improvement in mpg is between 4.54% and 5.75%.

The oil test results are based on ten samples taken May 3, 1990 and May 23, 1990, from six vehicles. Vehicles S244, S246, and S251 burned fuel treated with Ferox 230, while vehicles S245, S248, and S252 burned untreated fuel. Statistical anyslysis of the data from these samples confirms a significant difference between the oil of vehicles which burned treated fuel and the oil of those which burned untreated fuel. Due to the small sample size, these results are preliminary; further testing must be done to improve confidence

levels. At this point, it can concluded with 90% confidence that the rate at which soot, silicon, chrome, and copper build up in the oil of vehicles burning Ferox 230 treated fuel is significantly less than the rate of substance build up in the oil of vehicles which burned untreated fuel.

Effect of FEROX on Fuel Economy

Statistical Analysis

by Russell D. Henry

August 26, 1992

Report for Parish Chemical

Orem, Utah

Effect of FEROX on Fuel Economy

Introduction

Four matched vehicles were tested to determine the effect of adding FEROX on the fuel economy of matched tractor/trailer vehicles. The vehicles were 1990 International tractors powered by 400 hp 3406B Caterpillar diesel engines. Beall bottom-dump trailers were used. Each vehicle traveled a similar route and carried a similar load (24 hours a day, five days a week). The vehicles were given identical maintenance routines.

From 9 October 1989 to 31 May 1990 two of the vehicles used FEROX and two of the vehicles used a placebo. The drivers were responsible for adding the FEROX or placebo in a double-blind test.

This report shows that the trucks that used FEROX had a significant increase in MPG, with increases up to five percent.

Results

The improvement in MPG is calculated by comparing the average MPG each month for the FEROX trucks and the control group. The results are shown below:

Month	Improvement
September	-1.4%
October	1.4%
November	2.8%
December	2.7%
January	2.6%
February	5.4%
March	4.7%
April	0.5%
May	4.7%

The percentage shown is the percent improvement in MPG of the FEROX trucks. For example, in November the trucks that were using FEROX had an average MPG 2.8 percent higher than the trucks that used a placebo.

September is included to show the status of the trucks at the beginning of the experiment. As shown, the trucks that later got FEROX were averaging 1.4 percent less MPG before the experiment.

For the first and second months, the confidence interval has a negative lower limit and a positive upper limit. Because the value "zero" is between the two limits, it would not be a surprising result. Therefore, in the first two months of using FEROX, there may be no significant improvement in average MPG.

However, from the third to the eighth months, we expect higher MPG for the FEROX group. After eight months, we expect an average improvement in MPG of 4.5 percent. (The improvement may actually be between 1.7% and 7.3%.)

The confidence intervals are imprecise due to the small sample size in the study. The predictions and confidence intervals can be improved in further experiments that include more trucks and reduce the variation due to routes and loads.

Analysis

The results shown above were analyzed over time using regression, which allows us to predict improvement after a given number of months, and shows a 95% confidence interval for those predictions. For example, after five months, the average improvement in MPG from using FEROX should be 3 percent, although it could be anywhere between 1.5 percent and 4.7 percent (See table below).

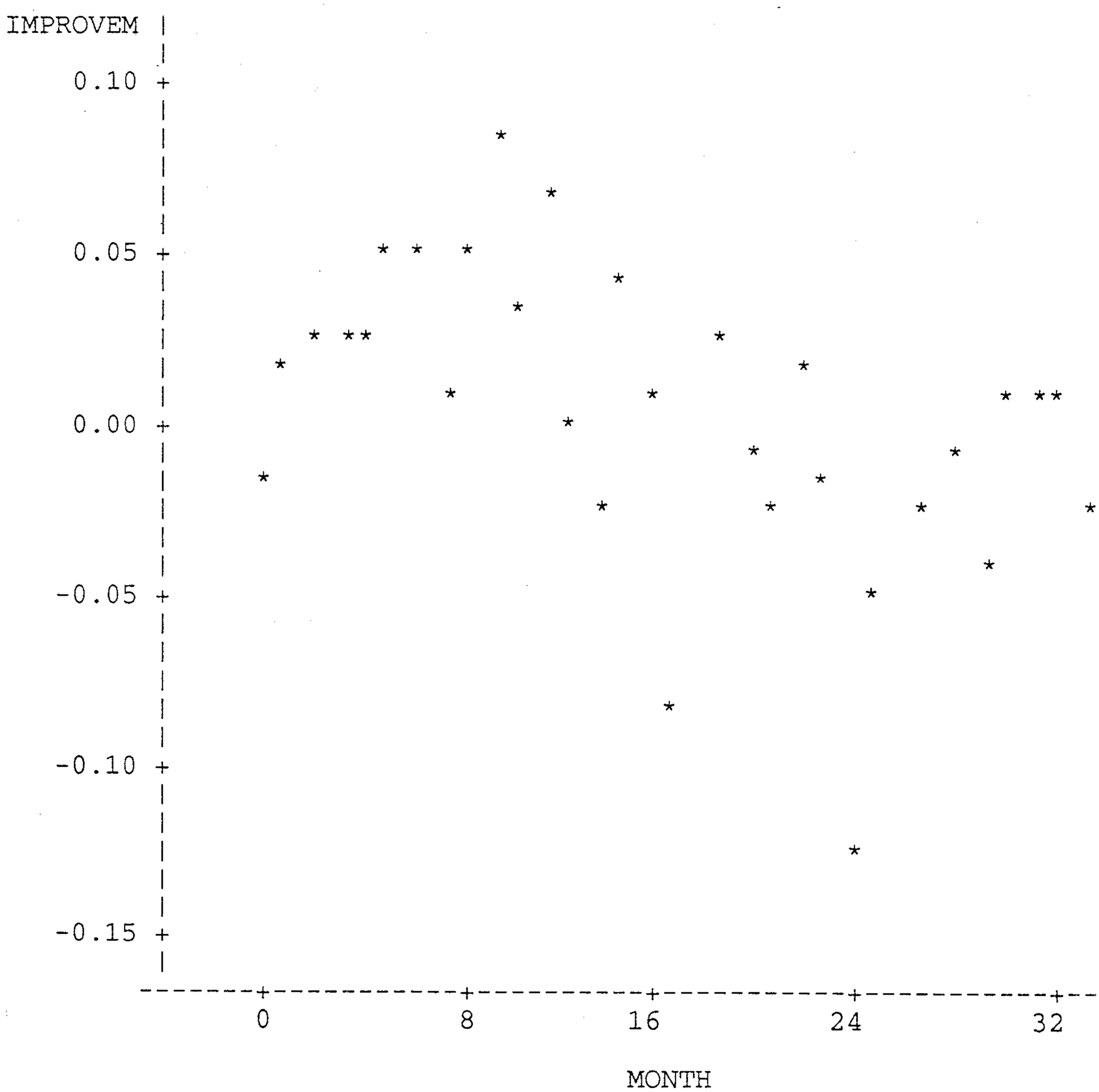
Month	Average Improvement	Lower Limit	Upper Limit
First	1.2%	-1.0%	3.5%
Second	1.7%	-0.2%	3.6%
Third	2.1%	0.5%	3.7%
Fourth	2.6%	1.1%	4.1%
Fifth	3.1%	1.5%	4.7%
Sixth	3.5%	1.6%	5.4%
Seventh	4.1%	1.7%	6.3%
Eighth	4.5%	1.7%	7.3%

APPENDIX

In June 1990 all trucks in the study began using FEROX, and the next page shows a plot of the results. The x-axis is Month and the y-axis is Improvement. As before, the average MPG for each group is compared, and the "improvement" score is how much better the treatment group did than the control group. Of course, after month 8, both groups used FEROX. A negative percentage means that the control group did better.

The experiment covers the time span from month zero to month eight. Notice the upward trend, as the FEROX trucks did better and better.

After month eight, we compare the results of the two groups as both received FEROX. There is a clear downward trend from that point. This means that the control group caught up with the treatment group once it began using FEROX.


IMPROVEM
0.10
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-0.05
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-0.15
0
8
16
24
32
MONTH