State of California

MEMORANDUM

To : Rod Summerfield
Assistant Division Chief

Date : March 1, 1990

Subject : Omstar Statistical Analysis

Thu Vo, Assoc. ARE TV
Advanced Engineering Section
From : Air Resources Board

At your request I have performed statistical analysis of the "official" Omstar data provided by Robert Kou of the After Market Parts Section. An analysis of variance method was used to determine whether the effect of the additive is statistically significant. The model adjusts the emissions for various factors, variation between vehicles, variation due to mileage accumulation and variation due to the additive. To test the statistical significance of the additive effect, the probability of random variation is calculated. If the variation due to the additive is significantly greater than random variation, the probability of that variation being random would be low. Consequently, the additive effect is concluded to be significant at a high confidence level. Two separate analyses were performed for the two fuel types: certification and commercial, and one analysis was performed on the whole data set in which there was no distinction made between the two fuels. The results are shown below.

Results of ANOVA for Effect of Additive
(Probability of random variation)

	Certification	Commercial	No Distinction Between Fuels
FTP_HC	0.0023**	0.0570*	0.0003**
FTP_CO	0.2938	0.4865	0.2672
FTP_NOx	0.8601	0.1491	0.3158
FTP_FE	0.0790*	0.7159	0.0797*
FTP_PART	0.3447	0.4825	0.2668
HFET_HC	0.0448**	0.0038**	0.0012**
HFET_CO	0.0512*	0.4586	0.0946*
HFET_NOx	0.5416	0.4440	0.3498
HFET_FE	0.3819	0.8252	0.6848

** Significant at 95% confidence level
* Significant at 90% confidence level

The significant results at the 95% confidence level are in boldface. The additive had significant effect on FTP_HC and HFET_HC emissions when tested with certification fuel. When tested with commercial fuel, only HFET_HC emissions were significantly affected by the additive. In addition, the additive appears to affect FTP_FE and HFET_CO emissions when tested with certification fuel, and FTP_HC and FTP_NOx emissions when tested with commercial fuel, though the effect does not reach the 95% confidence level.

The magnitudes of the additive effect were also estimated for the high confidence level results. The estimated means of various emissions are shown below.

Emission Means (grams per mile)

	Certification (No Add./Add.)	Commercial (No Add./Add.)	No Distinction Between Fuels (No Add./Add.)
FTP_HC	0.20/0.10	0.20/0.16	0.20/0.13
FTP_NOx	--	3.74/3.90	
FTP_FE	14.5/15.1	--	14.7/15.1
HFET_HC	0.21/0.15	0.16/0.11	0.19/0.13
HFET_CO	0.99/0.89	--	0.94/0.87

The statistical conclusions presented above were based on the results of a particular analysis method. Other approaches such as the one used by Mr. McAdams, Sierra's statistical consultant, may also be used to perform the analysis. However, one must keep in mind the assumptions associated with each approach. Mr. McAdams' method appears to be more "powerful" in that the baseline emissions were normalized so all the test data, both certification and commercial fuel data, can be included in the analysis. Including more data in the analysis would reduce the estimated random error, thus increase the power of the statistical test. However, in Mr. McAdam's method the variation between vehicles was treated as random error. If that variation was large, it could confound other effects. The approaches used by ARB staff and Mr. McAdam are similar in principle. The conclusions generated by the two methods are probably very similar. The important issue is the scope of the test program that would ensure at a reasonable probability that the effect of the additive would be detected.