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16. Abstracts An evaluation was conducted of the Stargas fuel additive to verify its influence on reduction of emissions and to establish the adequacy of the Federal Emission Test Procedure to measure the relatively small effects of a fuel modification of this sort. The Stargas additive was formulated to be used with unleaded gasolines. It was mixed in approximate proportions of eight ounces to fifty gallons of fuel. This modified fuel was used both for testing and for mileage accumulation. The vehicles used in the test program were a 1971 Ford Galaxie with a 351 CID engine and automatic transmission, and a 1970 Plymouth Valiant with a 225 CID engine and automatic transmission. Both vehicles were tested in the baseline condition on fuel without Stargas; then the vehicles were tested with no mileage accumulation with Stargas. The testing employed on both vehicles was the 1972 Federal Emission Test Procedure. Emission data from both vehicles became erratic after mileage accumulation on fuel containing Stargas. It was, therefore, not possible to accurately quantify emission changes attributable to the additive. However, the fact that the emissions were generally worse with the additive than without discourages any further evaluation of Stargas.				
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## Background

The Test and Evaluation Branch has received many requests to evaluate fuel additives or treatments. One such request was originated by the Stargas Corporation of Phoenix, Arizona. Preliminary data supplied by the manufacturer indicated substantial decreases in hydrocarbon, carbon monoxide and oxides of nitrogen. The effect appeared to increase with mileages up to 1000 miles, with a substantial immediate reduction. It was decided to conduct an evaluation to verify these effects and to establish the adequacy of the Federal Emission Test Procedure to measure the relatively small effects of a fuel modification of this sort.

## Control Technique

Stargas is formulated to be used with unleaded gasolines. Its qualitative analysis was not revealed by the developers. It was mixed in approximate proportions of eight ounces to fifty gallons of fuel. This modified fuel was used both for testing and for mileage accumulation. The developers of Stargas predicted an immediate effect with the treatment.

## Test Program

Two vehicles were selected for use in the evaluation program; a 1971 Ford Galaxie with a 351 CID engine and automatic transmission and a 1970 Plymouth Valiant with a 225 CID engine and automatic transmission. Both of these vehicles were predominantly run on unleaded fuels prior to the evaluation, the base fuel for the 1971 Ford was American Oil's 97 octane Indolene Clear HO III. This fuel is identical to the fuel specified for Federal emission tests with the exception that there is no lead in the fuel. The base fuel for the 1970 Valiant was American Oil's 91 octane unleaded pump fuel available at stations in the area.

Both vehicles were tested in the baseline condition on fuel without Stargas. Then the vehicles were tested with no mileage accumulation with Stargas. The Ford was subsequently tested after 440 miles of Stargas useage. The Valiant was tested after 500 miles and 1000 miles of driving with Stargas.

The testing employed on both vehicles was the 1972 Federal Emission Test Procedure as specified in the November 10, 1970, Federal Register. This is a cold start constant volume sampling procedure using the LA4-S4 driving cycle. Bag samples were

analyzed using a flame ionization detector for hydrocarbons, non-dispersive infrared analysis for carbon monoxide and carbon dioxide, and chemiluminescence for oxides of nitrogen.

The 1971 Ford was also tested using a continuous steady-state analysis of tailpipe concentrations. The instrumentation for this analysis consisted of non-dispersive infrared analysis for hydrocarbon, carbon monoxide, carbon dioxide and nitric oxide.

### Results

Tables of all emission results are presented in the Appendix of this report. Table I, below, indicates the results measured on the Ford Galaxie.

Table I

% Reduction from Baseline  
1972 Federal Emission Test

440 miles accumulated

<u>HC</u>	<u>CO</u>	<u>CO<sub>2</sub></u>	<u>NOx</u>
-47% inc.	42%	-5% inc.	-13% inc.

% Reduction from Baseline  
Continuous Tailpipe Analysis

Idle

0 miles accumulated

<u>HC</u>	<u>CO</u>	<u>NOx</u>
-27% inc.	-5% inc.	-47% inc.

440 miles accumulated

-166% inc.	36%	-65% inc.
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30 MPH Cruise

0 miles accumulated

<u>HC</u>	<u>CO</u>	<u>NOx</u>
-8% inc.	-6% inc.	-15% inc.

440 miles accumulated

<u>HC</u>	<u>CO</u>	<u>NOx</u>
-71% inc.	31%	-

50 MPH Cruise

0 miles accumulated

<u>HC</u>	<u>CO</u>	<u>NOx</u>
2%	-26% inc.	-

440 miles accumulated

-23% inc.	21%	7%
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During mileage accumulation the Ford developed a cold starting problem requiring frequent restarts. As the results indicate a substantial decrease in carbon monoxide was measured accompanied by an increase in hydrocarbon and oxides of nitrogen emissions. The extremely lean operation apparently resulted in some misfire.

Because of the inexplicable effects detected on the Ford it was decided to initiate testing on the 1970 Valiant. Table II, below, indicates the results obtained on the Valiant.

Table II

% Reduction from Baseline  
1972 Federal Emission Test

0 miles accumulated

<u>HC</u>	<u>CO</u>	<u>CO<sub>2</sub></u>
-7% inc.	-2% inc.	-1% inc.

500 miles accumulated

1%	-4% inc.	-3% inc.
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1000 miles accumulated

-14% inc.	-44% inc.	-9% inc.
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4.

No NOx data is reported on this testing due to a chemiluminescence analyzer problem. This car also developed false start tendencies during mileage accumulation. In addition, severe detonation was detected during mileage accumulation and testing with Stargas possibly due to the lower octane base fuel used. No beneficial emission effects were measured during this testing phase.

One additional observation was made during the evaluation program. On several occasions fuel containing Stargas was spilled on the hands of laboratory personnel resulting in at least two cases in mild stinging and whitening of the skin. This condition was relieved by flushing the hands with water.

### Conclusions

1. Emission data from both vehicles became somewhat erratic after mileage accumulation on fuel containing Stargas. It was, therefore, not possible to accurately quantify emission changes attributable to the additive.
2. Reductions in carbon monoxide emissions were measured on one vehicle accompanied by increases in hydrocarbon and oxides of nitrogen. All through emission increased on the other vehicle.
3. Both vehicles suffered deterioration of driveability during mileage accumulation but direct effect of Stargas was ascertained as the cause of this phenomenon.
4. Although the data cannot accurately predict the effect of the additive on emissions, the fact that emissions were generally worse with the additive than without discourages any further evaluation of Stargas.

5.

APPENDIX

6.

Stargas Evaluation  
1971 Ford Galaxie

Hot Steady-State Evaluation

<u>Idle</u>	<u>HC</u>	<u>CO</u>	<u>NO</u>
Baseline	187 ppm	.22%	247 ppm
Stargas 0 miles	238	.23	364
Stargas 440 miles	498	.14	407
<u>30 MPH</u>			
Baseline	49 ppm	.16%	523 ppm
Stargas 0 miles	53	.17	604
Stargas 440 miles	84	.11	537
<u>50 MPH</u>			
Baseline	55 ppm	.19%	2220 ppm
Stargas 0 miles	54	.24	2220
Stargas 440 miles	68	.15	2060

Stargas Evaluation

1972 Federal Emission Test (cold start)

All Results in Grams Per Mile

	<u>HC</u>	<u>CO</u>	<u>CO<sub>2</sub></u>	<u>NO<sub>x</sub></u>
Baseline	2.00	24.2	600	2.80
Stargas 440 miles	3.34	19.2	651	3.15
	2.53	14.9	613	3.15
Average with Stargas	2.94	17.1	632	3.15

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Stargas Evaluation  
1970 Valiant 225 CID

1972 Federal Emission Tests  
(all results in grams per mile)

Baseline	91 Octane American Lead Free			
<u>Test #</u>	<u>Date</u>	<u>HC</u>	<u>CO</u>	<u>CO2</u>
18-0039	11/8	2.9	41.2	347
18-0040	11/9	3.0	38.7	345
18-0043	11/10	2.6	40.2	352
Average		2.8	40.0	348
Stargas	w/91 Octane no mileage accumulation			
18-0044	11/11	3.0	41.6	355
18-0045	11/12	3.0	40.1	350
Average		3.0	40.9	352
Stargas	w/91 Octane 500 miles accumulated:			
18-0070	11/30	3.1	50.3	351
18-0080	12/1	2.1	32.7	367
Average		2.6	41.5	359
Stargas	w/91 Octane 1000 miles accumulated			
18-0089	12/8	3.5	69.8	382
18-0090	12/9	3.6	68.8	381
18-0092	12/10	2.6	46.6	385
18-0094	12/13	3.1	45.4	385
Average		3.2	57.7	383