

TECHNICAL REPORT

SENSITIVITY OF TEST CYCLE AND FUEL TYPE
ON A CRUSADER 350 INBOARD MARINE ENGINE
TEST RESULTS - 1992

by

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Office of Air and Radiation
U.S. Environmental Protection Agency

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1. Executive Summary

This report contains emission test results from a Crusader 350 marine inboard engine. Emission testing included EPA Heavy-Duty Federal Test Procedure (HD-FTP) transient emission tests, International Council of Marine Industry Associations (ICOMIA) 5-mode steady-state tests, and Bodensee Schifffahrts Ordngug (BSO) 8(9)-mode steady-state tests. This gasoline engine was tested while operating on on-highway certification fuel (Indolene) and Clean Air Act Baseline (CAAB) fuel, as well as on a 12% MTBE blend and several ethanol blends ranging from 10% to 40%. Diluted sampling was used to test for emissions of HC, CO, and NO_x. In addition, some work was done on the emission effects of adding transience to the ICOMIA test cycle.

This test program gives some insight into the characterization of baseline emissions for a new marine inboard engine as well as potential emission reductions through the use of oxygenated fuels. As the percentage of alcohol in the fuel increased, HC and CO decreased and NO_x increased without a significant change in power. Fuel consumption also increased slightly.

Some effort was put into observing the ability of carburetor calibrations to reduce emissions. There seemed to be some tradeoff between HC and NO_x.

Finally, adding transience to the ICOMIA cycle increased HC, CO, and BSFC and decreased NO_x results. Only HC seemed to be affected by the amount of transience added. An increase in HC was expected with an increase in transience due to rich fuel-air ratios typical during accelerations.

2. Introduction

The Clean Air Act mandates that EPA determine the significance of the contribution of nonroad engines and vehicles to pollution in ozone and CO nonattainment areas by November 15, 1992. Marine engines and vessels are categorized as part of nonroad, but little is known about their emission levels.

A team has been assembled, within EPA, to characterize the market structure for the marine industry as well as the operation characteristics of marine engines and vessels. One role of this marine team is to gather emission data for all types of marine engines. Therefore, EPA is planning to develop testing facilities for the testing of a wide range of engines. Currently, EPA has the capabilities to test large, inboard marine engines. Through cooperation with Crusader Marine Engines, an inboard marine engine has been tested by both industry and EPA.

At EPA's National Vehicle and Fuel Emissions Laboratory (NVFEL), the Crusader engine was tested over the on-highway transient test procedure, a 5-mode marine steady-state test procedure and an 8(9)-mode marine steady-state test procedure. In addition, fuel effects of a methyl tertiary-butyl ether (MTBE) blend and several ethanol blends were studied. Test results for the marine inboard engine are presented in this report.

3. Engine

Table 3.1 summarizes the specifications for the Crusader marine inboard engine which was used in this program. The marine prototype was a naturally aspirated, V-configuration, 8-cylinder, 350 in³ displacement heavy-duty otto-cycle engine. Rated and peak torque speeds for this carburetted engine were 4400 and 2600 RPM, respectively. Rated horsepower for this marine engine was 220 hp.

Marinization is the term used to describe the process used to adapt an automobile engine for marine applications. The major change that Crusader makes to the GM small block engine is additional cooling to make up for the lack of air flow around the engine due to the enclosed engine compartments in boats. Other adaptations include a change in cam-timing to optimize power and fuel consumption, increased oil pan size, and an enrichment of the fuel-air ratio.

Table 3.1
Engine Specifications

Manufacturer (Marinizer)	Crusader Engines
Base Engine Manufacturer	GM--Chevy small block
Manufacturer's Rated Power (HP)	227
Manufacturer's Rated Speed (RPM)	4400
EPA Measured Rated Power (HP)	222
EPA Measured Rated Speed (RPM)	4263
Cylinder Configuration	V
Number of Cylinders	8
Displacement (cubic inches)	350
Fuel System	Quadrajete carburetor

4. Fuels

Part of the scope of work for this test program was to compare the effects of operating a marine inboard engine on various alternative fuel blends. The engine was operated using on-highway certification fuel (Indolene®), Clean Air Act Baseline fuel (CAAB), low T-90 (12% MTBE blend), gasohol (10% ethanol blend), as well as 20%, 30%, 40% ethanol blends. Ethanol was blended with CAAB fuel in NVFEL's laboratory to create the higher ethanol blends.

The certification, CAAB, low T-90, and gasohol fuels were introduced to the engine by transferring the fuel from the barrel in which it was shipped to the normal laboratory fuel delivery system by an auxiliary lift pump. Ethanol blends that were mixed in-house were pumped directly from the barrel to the engine. All fuels was delivered to the engine at a pressure of 0 to 0.5 psi and at a temperature of less than 100° F.

Fuel specifications are included in the appendix for each of the fuels.

5. Test Procedures

5.1 Steady-State Checkout

The Crusader marine inboard engine was set up in National Vehicle and Fuel Emissions Laboratory (NVFEL) test cell #1 and run at both measured rated speed and peak torque speed with the throttle wide open. At each of these conditions, the speed, torque, and fuel flow were measured after stabilization occurred. Each condition was considered stable when the engine oil temperature stayed within $\pm 2^{\circ}$ F for two minutes. These values were compared to the manufacturer's data to ensure that the engine was set-up and running correctly.

With the installation complete, the engine was run at steady-state conditions while speeds, torques, and fuel flows were recorded. These values were compared to the engine manufacturer's values (Table 5.1) and were found to be similar.

Table 5.1
Crusader Marine Inboard Engine
Steady-State Performance Data

LAB	Torque, ft-lb		Fuel Flow, lbs/hr	
	2600 rpm	4400 rpm	2600 rpm	4400 rpm
Crusader (McLaren)	132	288	33	126
EPA/NVFEL	133	268	36	122

5.2 Transient Testing

Following a torque map of the engine, two EPA on-highway HD-FTP transient test sequences were performed on the engine. A test sequence consisted of one cold-start (ambient temperature) transient test plus two consecutive hot-start (steady-state operating temperature) transient tests (sequence = 1 cold-start + 2 hot-start). All gaseous (HC, CO, and NO_x) emissions were collected for each transient test. The cold-start and first hot-start were used in determining the composite result. The HD-FTP transient emissions tests were performed following procedures given in CFR 40 Part 86 Subpart N for heavy-duty gasoline emissions measurement.

When using fuels with high ethanol percentages, there is a risk of corrosion damage to the carburetor and fuel pump if the fuel is left in the engine over night. For this reason, forced cool-downs were used for cold starts that were run using the high ethanol fuels.

5.3 Steady-State (8-Mode) Testing

A 8(9)-mode steady-state cycle was used that combined all of the modes from the ICOMIA and the BSO marine test cycles. By weighting the modes appropriately, emission values were determined for both the ICOMIA and the BSO cycle. The 5-mode ICOMIA cycle was run as described in SAE papers 901596 and 901597. The additional 3(4) modes were taken from Article 13.11a of the BSO written by the International Bodensee Shipping Commission. One mode in the BSO procedure is only necessary if the full power at rated speed deviates more than 5% from maximum power. This mode was not necessary for the Crusader engine.

Gaseous emissions (HC, CO, and NO_x) and brake specific fuel consumption (BSFC) were measured for each mode, then composites were computed using assigned weighting factors for the ICOMIA and BSO procedures. All emissions measurements used dilute full-flow

CVS sampling techniques.

Two steady-state emission tests were performed on the engine using Indolene, gasohol, and 30% ethanol blend, three were performed using low T-90 fuel and 40% ethanol blend, and five were performed using CAAB fuel. The third tests run on the low T-90, 40% blend, and the CAAB fuel were run due to the inconsistencies observed between the first and second tests. Test numbers 4 and 5 on the CAAB fuel were used as part of a correlation program with McLaren Engines. In these two tests, EPA used the rated speed used by McLaren rather than the rated speed observed in NVFEL.

The steady-state cycles are believed to be more appropriate than the HD-FTP transient test for characterization of this engine and for comparison of the effects of the different oxygenated fuels on this engine. This is because the transient test was developed based on data from on-highway trucks while the steady-state tests were based on data from marine pleasure craft.

5.4 Emission Sampling

The engine was mounted on the test stand, and its flywheel was connected to the dynamometer through a drive shaft torquemeter. The exhaust systems for marinized engines differ from most other systems. Coolant water and exhaust gasses are mixed before being ejected from the engine in order to cool the gasses in order to comply with Coast Guard safety regulations. The cooling water is also used to reduce noise in the exhaust system (in place of a muffler). For this reason, it was necessary to block the water before it mixed with the exhaust and route the water back to the cooling tower through tapped holes in the exhaust manifold. An exhaust tube was fabricated which blocked the cooling water while allowing the exhaust gasses to be transferred to the CVS dilution tunnel for sampling.

6. Certification Fuel (Indolene) Testing/Results

6.1 HD-FTP Transient Testing/Results

After the engine was torque mapped on Indolene, two HD-FTP transient tests were run in order to have data that could be used for comparison between a marine engine and a regulated on highway engine. Each test consisted of one cold and two hot starts, with the composite results computed from the cold start and first hot start. A second hot start was run as an easy way to check variability. The HD-FTP test results for the engine run on Indolene are presented in Table 6.1. There were only small differences (3.4% for HC and CO, 0.8% for NO_x and BSFC) between the emissions from the Crusader engine when it was run on Indolene as compared to Clean Air Act Baseline fuel. These differences were within the test-to-test variability of the engine.

Table 6.1:
Certification Fuel
Heavy-Duty Gasoline Transient Test Results

	HC (g/hp-hr)	CO (g/hp-hr)	NO _x (g/hp-hr)	BSFC (lb/hp-hr)
First Sequence				
Cold Start	9.984	185.5	3.435	0.606
Hot Start #1	10.060	184.0	3.118	0.597
Hot Start #2	9.596	181.7	3.132	0.594
Composite*	10.049	184.2	3.163	0.598
Second Sequence				
Cold Start	9.963	186.6	3.354	0.605
Hot Start #1	9.665	184.3	3.276	0.594
Hot Start #2	9.580	182.0	3.120	0.591
Composite*	9.707	184.6	3.287	0.596
Composite Average	9.878	184.4	3.225	0.597

*Composite = 1/7(Cold Start) + 6/7(Hot Start #1)

6.2 Steady-State (ICOMIA and BSO) Testing/Results

The steady-state test was performed twice on this engine. The results for both tests were within 5 percent of each other for all constituents. By weighting the modes appropriately, both the ICOMIA and BSO test results were determined. For the ICOMIA test procedure, composite HC, CO, and NO_x levels were determined to be 5.955, 129.0, and 4.255 g/hp-hr respectively. For the BSO test procedure, composite HC, CO, and NO_x levels were 4.181, 122.5, and 4.472 g/hp-hr. Both steady-state procedures showed lower HC and CO and higher NO_x than the transient test. This was probably due to rich operation during accelerations. Because the ICOMIA procedure puts more emphasis on the modes with lower speed and torque than the BSO procedure, the ICOMIA procedure showed higher HC and CO and lower NO_x than the BSO procedure.

The non-reduced ICOMIA and BSO steady-state test results are presented in Tables 6.2 and 6.3. These tables are broken down into four groups with the first grouping of data identifying the actual test modes, and mode weighting factor used in computing the mode-weighted composite brake specific emissions, for both steady-state procedures, at the bottom of each table. The other groupings of data include a mass emission rate in grams/hour for each mode, a fuel specific emission result at each mode in grams/pound of fuel consumed, and finally the brake specific emission rate at each mode is given in grams/horsepower-hour.

Table 6.2:
Certification Fuel
ICOMIA and BSO Steady-State Test #1 Results

8-Mode Test Points							
Mode	Speed % of Rated	Torque % of WOT	Weighting Factor		Speed rpm	Torque ft-lb	HP
			ICOMIA	BSO			
1	100	100	6%	10%	4263	274.1	222.5
2	80	71.6	14%	5%	3410	196.3	127.5
3	60	46.5	15%	10%	2558	127.5	62.1
4	40	25.3	25%	10%	1705	69.3	22.5
5	idle	0	40%	30%	700	0.0	0.0
6	50	35.4	--	10%	2132	97.0	39.4
7	70	58.6	--	20%	2984	160.6	91.2
8	90	85.3	--	5%	3837	210.5	153.8

Mode g/hr results						
Mode	HP	Fuel lb/hr	HC g/hr	CO g/hr	NO _x g/hr	CO ₂ g/hr
1	224.6	122.80	567.1	45,183	557.6	102,054
2	127.7	65.12	277.7	9,174	746.6	68,566
3	62.8	33.49	141.4	2,504	374.3	37,899
4	23.0	16.74	97.2	3,008	28.4	14,809
5	0.1	3.72	384.0	1,952	1.5	4,179
6	40.0	22.31	118.6	2,851	146.8	27,455
7	91.4	40.91	185.5	3,161	668.0	54,678
8	152.4	83.68	391.0	24,220	468.3	77,291

Mode g/lb fuel						
Mode	HP	Fuel lb/lb	HC g/lb	CO g/lb	NO _x g/lb	CO ₂ g/lb
1	224.6	NA	4.618	367.94	4.541	831.1
2	127.7	NA	4.264	140.88	11.465	1052.9
3	62.8	NA	4.222	74.77	11.176	1131.7
4	23.0	NA	5.806	179.69	1.697	884.6
5	0.1	NA	103.2	524.73	0.403	1123.4
6	40.0	NA	5.316	127.79	6.580	1230.6
7	91.4	NA	4.534	77.27	16.329	1336.5
8	152.4	NA	4.673	289.44	5.596	923.6

Mode g/hp-hr						
Mode	HP	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
1	224.6	0.547	2.525	201.20	2.483	454.4
2	127.7	0.510	2.174	71.81	5.844	536.7
3	62.8	0.533	2.252	39.89	5.962	603.7
4	23.0	0.727	4.221	130.59	1.232	642.9
5	0.1	NA	NA	NA	NA	NA
6	40.0	0.558	2.966	71.30	3.672	686.6
7	91.4	0.448	2.030	34.58	7.308	598.2
8	152.4	0.549	2.565	158.91	3.072	507.1

Weighted Results	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
ICOMIA	0.584	5.841	126.79	4.335	575.14
BSO	0.539	4.131	122.41	4.538	560.00

Table 6.3:
Certification Fuel
ICOMIA and BSO Steady-State Test #2 Results

8-Mode Test Points							
Mode	Speed % of Rated	Torque % of WOT	Weighting Factor		Speed rpm	Torque ft-lb	HP
			ICOMIA	BSO			
1	100	100	6%	10%	4263	274.1	222.5
2	80	71.6	14%	5%	3410	196.3	127.5
3	60	46.5	15%	10%	2558	127.5	62.1
4	40	25.3	25%	10%	1705	69.3	22.5
5	idle	0	40%	30%	700	0.0	0.0
6	50	35.4	--	10%	2132	97.0	39.4
7	70	58.6	--	20%	2984	160.6	91.2
8	90	85.3	--	5%	3837	210.5	153.8

Mode g/hr results						
Mode	HP	Fuel lb/hr	HC g/hr	CO g/hr	NO _x g/hr	CO ₂ g/hr
1	223.6	120.87	525.5	43,079	585.8	103,425
2	128.3	65.08	286.0	10,542	687.6	67,981
3	62.5	31.61	140.5	2,434	379.7	39,190
4	23.4	16.74	108.1	3,526	25.4	17,468
5	0.1	3.72	408.5	2,023	0.0	4,272
6	40.0	24.16	122.8	2,917	137.8	28,404
7	91.4	44.63	189.8	3,070	646.2	54,028
8	153.4	81.82	408.0	26,224	404.2	76,589

Mode g/lb fuel						
Mode	HP	Fuel lb/lb	HC g/lb	CO g/lb	NO _x g/lb	CO ₂ g/lb
1	223.6	NA	4.348	356.41	4.847	855.7
2	128.3	NA	4.395	161.99	10.565	1044.6
3	62.5	NA	4.445	77.00	12.012	1239.8
4	23.4	NA	6.458	210.63	1.517	1043.5
5	0.1	NA	109.8	543.82	0.000	1148.4
6	40.0	NA	5.083	120.74	5.704	1175.7
7	91.4	NA	4.253	68.79	14.479	1210.6
8	153.4	NA	4.987	320.51	4.940	936.1

Mode g/hp-hr						
Mode	HP	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
1	223.6	0.540	2.350	192.61	2.619	462.4
2	128.3	0.507	2.229	82.15	5.358	529.8
3	62.5	0.506	2.248	38.96	6.076	627.2
4	23.4	0.716	4.629	150.93	1.087	747.8
5	0.1	NA	NA	NA	NA	NA
6	40.0	0.604	3.071	72.95	3.447	710.4
7	91.4	0.489	2.077	33.61	7.074	591.4
8	153.4	0.533	2.659	170.93	2.635	499.2

Weighted Results	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
ICOMIA	0.574	6.069	131.13	4.175	593.38
BSO	0.545	4.231	122.57	4.406	566.70

7. Clean Air Act Baseline Fuel Testing/Results

7.1 HD-FTP Transient Testing/Results

After the Crusader engine was torque mapped on this fuel, two HD-FTP transient tests were run. No significant difference was seen in between the power maps on Indolene and CAAB. Composite HC, CO, and NO_x levels were determined to be 10.232, 177.8, and 3.200 g/hp-hr respectively. These results were only slightly different than those determined for the engine while operating on certification fuel. The ethanol blends that will be discussed later in this document were made from the CAAB fuel. For this reason, all of the alternative fuels will be compared to this fuel rather than to the certification fuel. The HD-FTP transient test results for the CAAB fuel are presented in Table 7.1.

Table 7.1:
Clean Air Act Baseline Fuel
Heavy-Duty Gasoline Transient Test Results

	HC (g/hp-hr)	CO (g/hp-hr)	NO _x (g/hp-hr)	BSFC (lb/hp-hr)
First Sequence				
Cold Start	9.872	176.0	3.206	0.599
Hot Start #1	10.110	174.7	3.140	0.598
Hot Start #2	10.495	176.8	3.141	0.597
Composite*	10.076	174.9	3.149	0.598
Second Sequence				
Cold Start	9.956	180.7	3.392	0.610
Hot Start #1	10.459	180.6	3.227	0.605
Hot Start #2	10.622	179.8	3.246	0.598
Composite*	10.387	180.6	3.251	0.606
Composite Average	10.232	177.8	3.200	0.602

*Composite = 1/7(Cold Start) + 6/7(Hot Start #1)

7.2 Steady-State (ICOMIA and BSO) Testing/Results

The steady-state procedure was run five times with this fuel. The third test was due to a 7% inconsistency between the NO_x results for the first two runs. The fourth and fifth tests are discussed in Section 7.3. Composite HC, CO, and NO_x results for the first three tests were 5.917, 128.3, and 4.767 g/hp-hr respectively for the ICOMIA, and composite HC, CO, and NO_x results were 4.065, 118.5, and 5.010 g/hp-hr for the BSO procedure. Again, the steady-state results did not agree with the HD-FTP transient results; HC and CO were much lower, and NO_x was much higher. This is not surprising since the transient test was developed for on-highway vehicles while the two steady-state tests were developed for marine vessels. The ICOMIA and BSO test results are presented in Tables 7.4 to 7.6.

7.3 Sensitivity of Carburetor Calibration on Emissions

Before the marine engine was set-up at NVFEL, Crusader had hired McLaren Engines to perform steady-state emission testing over the ICOMIA and BSO steady-state marine test procedures. This test program originated from the idea of a correlation program with McLaren. However, based on the results from BSO testing at McLaren, Crusader calibrated the carburetor for performance and emissions. Therefore, the data obtained do not represent a difference in the facilities, but the data do show the sensitivity of carburetor calibration on emissions. In order to make an appropriate comparison between McLaren and EPA facilities, the steady-state modes were calculated using the manufacturer's rated speed of 4400 RPM (as McLaren used) rather than the rated speed of 4263 RPM measured at NVFEL. These emission results are presented in the following table:

**Table 7.2:
Emission Results due to Carburetor Calibration**

Test Facility	Test Procedure	HC (g/hp-hr)	CO (g/hp-hr)	NO _x (g/hp-hr)
McLaren (before carburetor calibration)	ICOMIA	3.791	79.2	9.461
	BSO	4.539	85.0	8.368
EPA (after carburetor calibration)	ICOMIA	5.354	130.9	4.595
	BSO	3.686	128.5	4.542

By adjusting the fuel-air mixture, Crusader (based on the BSO

cycle) reduced HC by 19% and NO_x by 46% while increasing CO by 51%. Over the ICOMIA cycle HC was seen to increase by 41%. This was due to the 160% increase in HC at idle which the ICOMIA weights as 40% of the emissions. For each of the other modes, a decrease in HC was observed. Because the BSO only weights idle as 30% of the total and because of the dramatic reduction in mode 7, a decrease in HC was seen due to the carburetor adjustment for this test procedure. Modal data is presented in Table 7.3. EPA non-reduced steady-state data for these tests are presented in Tables 7.7 and 7.8.

Table 7.3:
McLaren and EPA Modal Results for Crusader Engine

Mode	Speed RPM	Torque ft-lb	HC g/hr		CO g/hr		NO _x g/hr	
			McLaren	EPA	McLaren	EPA	McLaren	EPA
1*	750	0.0	150	392	1490	2304	0.0003	0.75
2*	1760	73.4	116	94	2019	3201	121	43
3	2200	102.4	147	120	1226	2629	407	215
4*	2640	132.7	187	137	1248	2244	746	510
5	3080	169.7	224	199	1322	6300	1240	692
6*	3520	207.2	285	279	4384	13510	1812	738
7	3960	247.2	2615	380	28887	33222	427	317
8*	4400	289.6	544	411	34314	41991	1287	605

* The eight modes are presented in the order specified by the BSO test procedure. The five modes marked with stars are the modes specified in the ICOMIA test procedure.

Table 7.4:
Clean Air Act Baseline Fuel
ICOMIA and BSO Steady-State Test #1 Results

8-Mode Test Points							
Mode	Speed % of Rated	Torque % of WOT	Weighting Factor		Speed rpm	Torque ft-lb	HP
			ICOMIA	BSO			
1	100	100	6%	10%	4263	274.1	222.5
2	80	71.6	14%	5%	3410	196.3	127.5
3	60	46.5	15%	10%	2558	127.5	62.1
4	40	25.3	25%	10%	1705	69.3	22.5
5	idle	0	40%	30%	700	0.0	0.0
6	50	35.4	--	10%	2132	97.0	39.4
7	70	58.6	--	20%	2984	160.6	91.2
8	90	85.3	--	5%	3837	210.5	153.8

Mode g/hr results						
Mode	HP	Fuel lb/hr	HC g/hr	CO g/hr	NO _x g/hr	CO ₂ g/hr
1	220.5	119.58	449.8	38,958	684.3	102,760
2	127.0	63.57	259.1	10,748	722.4	67,959
3	62.3	31.76	136.1	2,615	442.0	42,268
4	23.2	16.83	95.6	3,447	33.1	16,547
5	0.5	5.61	446.4	2,040	3.9	3,624
6	40.0	22.42	119.7	3,024	150.9	27,394
7	91.1	42.98	193.8	4,118	705.7	57,419
8	153.0	80.30	336.1	19,327	607.9	77,004

Mode g/lb fuel						
Mode	HP	Fuel lb/lb	HC g/lb	CO g/lb	NO _x g/lb	CO ₂ g/lb
1	220.5	NA	3.761	325.79	5.723	859.3
2	127.0	NA	4.076	169.07	11.364	1069.0
3	62.3	NA	4.285	82.34	13.917	1330.9
4	23.2	NA	5.680	204.81	1.967	983.2
5	0.5	NA	79.57	363.64	0.695	646.0
6	40.0	NA	5.339	134.88	6.731	1221.9
7	91.1	NA	4.509	95.81	16.419	1335.9
8	153.0	NA	4.186	240.68	7.570	959.0

Mode g/hp-hr						
Mode	HP	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
1	220.5	0.542	2.040	176.67	3.103	466.0
2	127.0	0.500	2.040	84.61	5.687	535.0
3	62.3	0.510	2.184	41.98	7.095	678.5
4	23.2	0.725	4.119	148.59	1.427	713.3
5	0.5	NA	NA	NA	NA	NA
6	40.0	0.561	2.995	75.64	3.774	685.1
7	91.1	0.472	2.128	45.22	7.749	630.5
8	153.0	0.525	2.196	126.31	3.973	503.3

Weighted Results	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
ICOMIA	0.589	6.179	127.67	4.715	596.12
BSO	0.545	4.219	115.63	5.075	578.11

Table 7.5:
Clean Air Act Baseline Fuel
ICOMIA and BSO Steady-State Test #2 Results

8-Mode Test Points							
Mode	Speed % of Rated	Torque % of WOT	Weighting Factor		Speed rpm	Torque ft-lb	HP
			ICOMIA	BSO			
1	100	100	6%	10%	4263	274.1	222.5
2	80	71.6	14%	5%	3410	196.3	127.5
3	60	46.5	15%	10%	2558	127.5	62.1
4	40	25.3	25%	10%	1705	69.3	22.5
5	idle	0	40%	30%	700	0.0	0.0
6	50	35.4	--	10%	2132	97.0	39.4
7	70	58.6	--	20%	2984	160.6	91.2
8	90	85.3	--	5%	3837	210.5	153.8

Mode g/hr results						
Mode	HP	Fuel lb/hr	HC g/hr	CO g/hr	NO _x g/hr	CO ₂ g/hr
1	222.6	121.45	414.0	37,383	774.9	103,129
2	127.5	67.22	271.0	11,586	763.6	70,837
3	63.1	33.63	139.2	2,517	468.6	42,180
4	23.2	16.82	104.2	3,633	41.9	18,351
5	0.4	5.61	419.6	2,409	4.8	4,585
6	39.6	24.29	124.7	2,945	181.3	29,504
7	91.7	44.84	196.1	4,222	733.8	57,899
8	153.5	97.04	397.2	28,872	371.6	74,989

Mode g/lb fuel						
Mode	HP	Fuel lb/lb	HC g/lb	CO g/lb	NO _x g/lb	CO ₂ g/lb
1	222.6	NA	3.409	307.81	6.380	849.1
2	127.5	NA	4.032	172.36	11.360	1053.8
3	63.1	NA	4.139	74.84	13.934	1254.2
4	23.2	NA	6.195	215.99	2.491	1091.0
5	0.4	NA	74.80	429.41	0.856	817.3
6	39.6	NA	5.134	121.24	7.464	1214.7
7	91.7	NA	4.373	94.16	16.365	1291.2
8	153.5	NA	4.093	297.53	3.829	772.8

Mode g/hp-hr						
Mode	HP	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
1	222.6	0.545	1.860	167.90	3.480	463.19
2	127.5	0.527	2.125	90.87	5.988	555.6
3	63.1	0.533	2.207	39.91	7.430	668.8
4	23.2	0.724	4.488	156.42	1.805	790.1
5	0.4	NA	NA	NA	NA	NA
6	39.6	0.614	3.151	74.40	4.581	745.5
7	91.7	0.489	2.139	46.05	8.003	631.4
8	153.5	0.632	2.588	188.09	2.421	488.5

Weighted Results	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
ICOMIA	0.604	5.952	131.12	5.063	618.77
BSO	0.575	4.132	123.01	5.251	590.76

Table 7.6:
Clean Air Act Baseline Fuel
ICOMIA and BSO Steady-State Test #3 Results

8-Mode Test Points							
Mode	Speed % of Rated	Torque % of WOT	Weighting Factor		Speed rpm	Torque ft-lb	HP
			ICOMIA	BSO			
1	100	100	6%	10%	4263	274.1	222.5
2	80	71.6	14%	5%	3410	196.3	127.5
3	60	46.5	15%	10%	2558	127.5	62.1
4	40	25.3	25%	10%	1705	69.3	22.5
5	idle	0	40%	30%	700	0.0	0.0
6	50	35.4	--	10%	2132	97.0	39.4
7	70	58.6	--	20%	2984	160.6	91.2
8	90	85.3	--	5%	3837	210.5	153.8

Mode g/hr results						
Mode	HP	Fuel lb/hr	HC g/hr	CO g/hr	NO _x g/hr	CO ₂ g/hr
1	221.6	121.83	409.5	41,128	584.4	98,039
2	127.3	63.80	255.3	10,352	737.0	68,801
3	63.0	31.92	127.6	2,327	419.6	40,303
4	23.2	15.01	98.6	3,294	32.3	16,546
5	0.5	5.63	394.1	1,948	3.3	4,359
6	39.8	24.38	119.9	2,827	152.5	28,042
7	91.0	44.98	177.6	3,966	654.2	54,844
8	154.4	80.49	324.9	19,961	570.5	77,027

Mode g/lb fuel						
Mode	HP	Fuel lb/lb	HC g/lb	CO g/lb	NO _x g/lb	CO ₂ g/lb
1	221.6	NA	3.361	337.58	4.797	804.7
2	127.3	NA	4.002	162.25	11.552	1078.4
3	63.0	NA	3.998	72.89	13.145	1262.6
4	23.2	NA	6.566	219.47	2.149	1102.3
5	0.5	NA	69.99	345.97	0.586	774.2
6	39.8	NA	4.916	115.96	6.253	1150.2
7	91.0	NA	3.949	88.18	14.544	1219.3
8	154.4	NA	4.036	248.00	7.088	957.0

Mode g/hp-hr						
Mode	HP	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
1	221.6	0.550	1.848	185.65	2.638	442.5
2	127.3	0.501	2.005	81.28	5.787	540.2
3	63.0	0.507	2.027	36.95	6.663	640.0
4	23.2	0.647	4.249	142.01	1.391	713.2
5	0.5	NA	NA	NA	NA	NA
6	39.8	0.613	3.013	71.06	3.832	704.8
7	91.0	0.494	1.951	43.56	7.184	602.3
8	154.4	0.521	2.104	129.29	3.695	498.9

Weighted Results	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
ICOMIA	0.581	5.620	126.02	4.522	589.24
BSO	0.554	3.844	116.84	4.704	563.45

Table 7.7:
Clean Air Act Baseline Fuel
ICOMIA and BSO Steady-State (McLaren Modes) Test #4 Results

8-Mode Test Points							
Mode	Speed % of Rated	Torque % of WOT	Weighting Factor		Speed rpm	Torque ft-lb	HP
			ICOMIA	BSO			
1	100	100	6%	10%	4400	289.6	242.6
2	80	71.6	14%	5%	3520	207.2	138.9
3	60	46.5	15%	10%	2640	132.7	66.7
4	40	25.3	25%	10%	1760	73.4	24.6
5	idle	0	40%	30%	750	0.0	0.0
6	50	35.4	--	10%	2200	102.4	42.9
7	70	58.6	--	20%	3080	169.7	99.5
8	90	85.3	--	5%	3960	247.2	186.4

Mode g/hr results						
Mode	HP	Fuel lb/hr	HC g/hr	CO g/hr	NO _x g/hr	CO ₂ g/hr
1	224.2	127.14	423.5	42,023	605.3	99,884
2	138.3	69.35	278.9	13,576	729.1	71,176
3	67.1	35.61	139.3	2,297	511.0	44,147
4	25.5	16.86	99.0	3,140	43.3	17,213
5	0.9	5.62	386.3	2,310	0.0	4,587
6	43.1	24.34	120.2	2,611	220.1	30,279
7	99.9	48.64	185.9	5,110	738.1	56,645
8	185.1	104.64	369.7	31,895	336.8	73,015

Mode g/lb fuel						
Mode	HP	Fuel lb/lb	HC g/lb	CO g/lb	NO _x g/lb	CO ₂ g/lb
1	224.2	NA	3.331	330.53	4.761	785.6
2	138.3	NA	4.021	195.76	10.514	1026.3
3	67.1	NA	3.911	64.51	14.351	1239.7
4	25.5	NA	5.869	186.25	2.567	1020.9
5	0.9	NA	68.74	410.96	0.000	816.2
6	43.1	NA	4.940	107.25	9.043	1244.0
7	99.9	NA	3.821	105.06	15.174	1164.6
8	185.1	NA	3.533	304.81	3.219	697.8

Mode g/hp-hr						
Mode	HP	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
1	224.2	0.567	1.889	187.43	2.700	445.5
2	138.3	0.502	2.017	98.21	5.274	514.9
3	67.1	0.531	2.077	34.26	7.621	658.4
4	25.5	0.662	3.885	123.30	1.700	675.9
5	0.9	NA	NA	NA	NA	NA
6	43.1	0.564	2.787	60.51	5.101	701.8
7	99.9	0.487	1.860	51.14	7.386	566.9
8	185.1	0.565	1.997	172.31	1.820	394.5

Weighted Results	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
ICOMIA	0.587	5.333	130.52	4.553	578.82
BSO	0.559	3.642	124.23	4.680	539.52

Table 7.8:
Clean Air Act Baseline Fuel
ICOMIA and BSO Steady-State (McLaren Modes) Test #5 Results

8-Mode Test Points							
Mode	Speed % of Rated	Torque % of WOT	Weighting Factor		Speed rpm	Torque ft-lb	HP
			ICOMIA	BSO			
1	100	100	6%	10%	4400	289.6	289.6
2	80	71.6	14%	5%	3520	207.2	207.2
3	60	46.5	15%	10%	2640	132.7	66.7
4	40	25.3	25%	10%	1760	73.4	24.6
5	idle	0	40%	30%	750	0.0	0.0
6	50	35.4	--	10%	2200	102.4	42.9
7	70	58.6	--	20%	3080	169.7	99.5
8	90	85.3	--	5%	3960	247.2	186.4

Mode g/hr results						
Mode	HP	Fuel lb/hr	HC g/hr	CO g/hr	NO _x g/hr	CO ₂ g/hr
1	224.0	125.19	398.2	41,958	604.9	102,983
2	138.4	69.13	279.7	13,443	747.3	73,612
3	66.8	37.39	133.7	2,191	509.0	43,922
4	25.0	16.83	89.6	3,261	41.9	17,063
5	0.4	5.61	398.0	2,298	1.5	4,746
6	44.0	24.31	120.4	2,646	209.8	31,314
7	99.9	50.48	212.6	7,489	645.5	58,356
8	186.0	103.02	389.6	34,548	297.1	75,755

Mode g/lb fuel						
Mode	HP	Fuel lb/lb	HC g/lb	CO g/lb	NO _x g/lb	CO ₂ g/lb
1	224.0	NA	3.181	335.15	4.832	822.6
2	138.4	NA	4.046	194.46	10.811	1064.8
3	66.8	NA	3.576	58.60	13.613	1174.7
4	25.0	NA	5.322	193.76	2.491	1013.8
5	0.4	NA	70.94	409.60	0.271	845.9
6	44.0	NA	4.954	108.83	8.631	1288.1
7	99.9	NA	4.212	148.33	12.787	1156.0
8	186.0	NA	3.781	335.35	2.884	735.3

Mode g/hp-hr						
Mode	HP	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
1	224.0	0.559	1.778	187.32	2.701	459.8
2	138.4	0.500	2.021	97.14	5.400	531.9
3	66.8	0.559	2.000	32.78	7.614	657.0
4	25.0	0.674	3.588	130.62	1.680	683.5
5	0.4	NA	NA	NA	NA	NA
6	44.0	0.553	2.738	60.16	4.771	712.0
7	99.9	0.506	2.129	74.99	6.464	584.4
8	186.0	0.554	2.094	185.70	1.597	407.2

Weighted Results	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
ICOMIA	0.594	5.375	131.23	4.637	593.69
BSO	0.564	3.729	132.67	4.403	554.51

8. Low T-90 Fuel Testing/Results

8.1 HD-FTP Transient Testing/Results

Low T-90 fuel was blended from the CAAB fuel by adding 12% MTBE. Composite transient test HC, CO, and NO_x levels, for this fuel, were determined to be 6.743, 162.3, and 3.163 g/hp-hr respectively. This translates to reductions of 37% HC and 9% CO and an increase of 23% NO_x relative to CAAB. However, it is important to stress here that the HD-FTP transient test was designed for on-highway trucks. The marine cycles are probably more representative of the actual use of this engine. For this reason, reductions due to the oxygenated fuels are probably better characterized by the steady-state marine cycles. Transient test results are presented in Table 8.1.

Table 8.1:
Low T-90 Fuel
Heavy-Duty Gasoline Transient Test Results

	HC (g/hp-hr)	CO (g/hp-hr)	NO _x (g/hp-hr)	BSFC (lb/hp-hr)
First Sequence				
Cold Start	7.617	166.0	3.252	0.599
Hot Start #1	6.742	163.3	3.143	0.566
Hot Start #2	6.822	164.3	3.142	0.572
Composite*	6.867	163.7	3.159	0.571
Second Sequence				
Cold Start	7.320	156.8	3.460	0.577
Hot Start #1	6.501	161.5	3.117	0.566
Hot Start #2	6.710	163.0	3.179	0.573
Composite*	6.618	160.8	3.166	0.568
Composite Average	6.743	162.3	3.163	0.569

*Composite = 1/7(Cold Start) + 6/7(Hot Start #1)

8.2 Steady-State (ICOMIA and BSO) Testing/Results

Due to the 15 % inconsistencies in both CO and NO_x results between the first and second steady-state tests, a third test was run. All three tests were averaged to calculate the composite results. The composite HC, CO, and NO_x results for low T-90 fuel over the ICOMIA cycle were 4.884, 112.7, and 4.966 g/hp-hr respectively. As compared to the CAAB fuel, reductions of 17% HC and 12% CO and an increase of 4% NO_x were observed. Over the BSO cycle, HC, CO, and NO_x results were 3.431, 102.6, and 5.131 g/hp-hr. The BSO showed reductions of 16% HC and 13% CO and a 2% increase in NO_x. No significant change in fuel consumption or power was seen for this fuel. Differences between the ICOMIA and BSO cycles were largely due to the different weighting factors for the idle mode. These test results are shown in Tables 8.2-8.4.

Table 8.2:
Low T-90 Fuel
ICOMIA and BSO Steady-State Test #1 Results

8-Mode Test Points							
Mode	Speed % of Rated	Torque % of WOT	Weighting Factor		Speed rpm	Torque ft-lb	HP
			ICOMIA	BSO			
1	100	100	6%	10%	4263	274.1	222.5
2	80	71.6	14%	5%	3410	196.3	127.5
3	60	46.5	15%	10%	2558	127.5	62.1
4	40	25.3	25%	10%	1705	69.3	22.5
5	idle	0	40%	30%	700	0.0	0.0
6	50	35.4	--	10%	2132	97.0	39.4
7	70	58.6	--	20%	2984	160.6	91.2
8	90	85.3	--	5%	3837	210.5	153.8

Mode g/hr results						
Mode	HP	Fuel lb/hr	HC g/hr	CO g/hr	NO _x g/hr	CO ₂ g/hr
1	241.0	119.89	492.9	41,607	579.9	100,436
2	127.1	63.69	285.2	11,161	710.0	68,340
3	62.4	31.85	136.4	1,911	420.2	39,088
4	23.0	14.98	108.3	3,252	37.1	17,602
5	0.1	5.61	318.2	1,817	5.4	4,707
6	40.1	24.32	121.8	2,221	167.0	28,951
7	90.8	43.03	168.8	2,179	727.7	55,065
8	152.9	84.20	380.7	24,031	487.5	78,954

Mode g/lb fuel						
Mode	HP	Fuel lb/lb	HC g/lb	CO g/lb	NO _x g/lb	CO ₂ g/lb
1	241.0	NA	4.111	347.04	4.837	837.7
2	127.1	NA	4.480	175.24	11.148	1073.0
3	62.4	NA	4.286	60.00	13.193	1227.3
4	23.0	NA	7.230	217.09	2.477	1175.0
5	0.1	NA	56.72	323.89	0.963	839.0
6	40.1	NA	5.008	91.32	6.867	1190.4
7	90.8	NA	3.923	50.64	16.911	1279.7
8	152.9	NA	4.521	285.40	5.790	937.7

Mode g/hp-hr						
Mode	HP	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
1	241.0	0.497	2.045	172.61	2.406	416.7
2	127.1	0.501	2.244	87.81	5.585	537.7
3	62.4	0.510	2.185	30.63	6.735	626.5
4	23.0	0.650	4.700	141.19	1.611	764.1
5	0.1	NA	NA	NA	NA	NA
6	40.1	0.606	3.036	55.38	4.164	721.8
7	90.8	0.474	1.859	23.99	8.010	606.2
8	152.9	0.551	2.489	157.14	3.187	516.3

Weighted Results	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
ICOMIA	0.567	5.154	124.15	4.402	585.19
BSO	0.534	3.609	110.98	4.757	557.78

Table 8.3:
Low T-90 Fuel
ICOMIA and BSO Steady-State Test #2 Results

8-Mode Test Points							
Mode	Speed % of Rated	Torque % of WOT	Weighting Factor		Speed rpm	Torque ft-lb	HP
			ICOMIA	BSO			
1	100	100	6%	10%	4263	274.1	222.5
2	80	71.6	14%	5%	3410	196.3	127.5
3	60	46.5	15%	10%	2558	127.5	62.1
4	40	25.3	25%	10%	1705	69.3	22.5
5	idle	0	40%	30%	700	0.0	0.0
6	50	35.4	--	10%	2132	97.0	39.4
7	70	58.6	--	20%	2984	160.6	91.2
8	90	85.3	--	5%	3837	210.5	153.8

Mode g/hr results						
Mode	HP	Fuel lb/hr	HC g/hr	CO g/hr	NO _x g/hr	CO ₂ g/hr
1	221.5	121.69	450.5	34,322	744.6	101,138
2	128.2	65.57	237.8	8,087	836.6	70,538
3	62.4	33.72	100.9	1,342	439.0	39,765
4	23.1	17.80	96.4	2,930	38.8	18,481
5	0.1	3.74	299.0	1,888	3.3	4,732
6	40.5	24.35	102.3	2,001	175.4	29,041
7	91.9	43.09	154.4	2,737	683.9	54,140
8	153.9	89.87	333.7	19,989	618.9	82,213

Mode g/lb fuel						
Mode	HP	Fuel lb/lb	HC g/lb	CO g/lb	NO _x g/lb	CO ₂ g/lb
1	221.5	NA	3.702	282.04	6.119	831.1
2	128.2	NA	3.627	123.33	12.759	1075.8
3	62.4	NA	2.992	39.80	13.019	1179.3
4	23.1	NA	5.416	164.61	2.180	1038.3
5	0.1	NA	79.95	504.81	0.882	1265.2
6	40.5	NA	4.201	82.18	7.203	1192.6
7	91.9	NA	3.583	63.52	15.871	1256.4
8	153.9	NA	3.713	222.42	6.887	914.8

Mode g/hp-hr						
Mode	HP	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
1	221.5	0.549	2.034	154.93	3.361	456.5
2	128.2	0.512	1.855	63.10	6.528	550.4
3	62.4	0.541	1.618	21.52	7.040	637.6
4	23.1	0.771	4.179	126.98	1.683	800.9
5	0.1	NA	NA	NA	NA	NA
6	40.5	0.602	2.529	49.46	4.336	718.0
7	91.9	0.469	1.680	29.78	7.439	589.0
8	153.9	0.584	2.168	129.87	4.021	534.1

Weighted Results	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
ICOMIA	0.592	4.721	105.15	5.142	612.36
BSO	0.554	3.333	97.78	5.208	575.75

Table 8.4:
Low T-90 Fuel
ICOMIA and BSO Steady-State Test #3 Results

8-Mode Test Points							
Mode	Speed % of Rated	Torque % of WOT	Weighting Factor		Speed rpm	Torque ft-lb	HP
			ICOMIA	BSO			
1	100	100	6%	10%	4263	274.1	222.3
2	80	71.6	14%	5%	3410	196.3	127.5
3	60	46.5	15%	10%	2558	127.5	62.1
4	40	25.3	25%	10%	1705	69.3	23.2
5	idle	0	40%	30%	700	0.0	0.0
6	50	35.4	--	10%	2132	97.0	39.4
7	70	58.6	--	20%	2984	160.6	91.2
8	90	85.3	--	5%	3837	210.5	153.8

Mode g/hr results						
Mode	HP	Fuel lb/hr	HC g/hr	CO g/hr	NO _x g/hr	CO ₂ g/hr
1	221.6	123.49	446.3	35,612	799.3	103,900
2	127.3	65.53	244.9	8,999	835.6	69,462
3	62.8	35.57	110.1	1,506	482.9	43,988
4	23.2	16.84	85.3	2,812	40.5	16,074
5	0.6	5.61	309.1	1,866	4.6	4,507
6	40.2	24.32	101.2	1,985	183.8	28,710
7	90.9	48.65	163.1	3,422	699.5	54,467
8	153.3	84.20	266.0	15,184	618.9	69,483

Mode g/lb fuel						
Mode	HP	Fuel lb/lb	HC g/lb	CO g/lb	NO _x g/lb	CO ₂ g/lb
1	221.6	NA	3.614	288.38	6.472	841.4
2	127.3	NA	3.737	137.33	12.751	1060.0
3	62.8	NA	3.096	42.33	13.576	1236.7
4	23.2	NA	5.065	166.97	2.046	954.5
5	0.6	NA	55.10	332.59	0.815	803.3
6	40.2	NA	4.161	81.64	7.558	1180.5
7	90.9	NA	3.352	70.33	14.379	1119.6
8	153.3	NA	3.159	180.33	7.351	825.2

Mode g/hp-hr						
Mode	HP	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
1	221.6	0.557	2.014	160.69	3.607	468.8
2	127.3	0.515	1.924	70.72	6.566	545.9
3	62.8	0.566	1.753	23.96	7.686	700.1
4	23.2	0.725	3.673	121.07	1.745	692.1
5	0.6	NA	NA	NA	NA	NA
6	40.2	0.605	2.516	49.36	4.570	713.8
7	90.9	0.535	1.794	37.64	7.695	599.2
8	153.3	0.549	1.735	99.05	4.038	453.2

Weighted Results	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
ICOMIA	0.609	4.778	108.88	5.353	609.26
BSO	0.579	3.352	98.92	5.429	572.58

9. Gasohol Fuel Testing/Results

9.1 HD-FTP Transient Testing/Results

Gasohol is a 10% ethanol blend using CAAB fuel as the base fuel. HD-FTP transient test results for HC, CO, and NO_x were determined to be 7.725, 139.1, and 3.926 g/hp-hr. This translates to reductions of 25% HC and 22% CO and an increase of 23% NO_x over the CAAB fuel. For both the low T-90 fuel and the gasohol fuel, a 5% reduction in fuel consumption was observed on the transient test. However, this effect on fuel consumption was not supported by the steady-state tests specifically designed for marine applications. Non-reduced transient test data on this fuel are presented in Table 9.1.

**Table 9.1:
Gasohol Fuel
Heavy-Duty Gasoline Transient Test Results**

	HC (g/hp-hr)	CO (g/hp-hr)	NO _x (g/hp-hr)	BSFC (lb/hp-hr)
First Sequence				
Cold Start	8.941	151.2	3.851	0.590
Hot Start #1	7.718	138.9	4.084	0.572
Hot Start #2	7.635	138.8	3.714	0.568
Composite*	7.893	140.7	4.051	0.575
Second Sequence				
Cold Start	8.735	147.1	3.640	0.588
Hot Start #1	7.363	135.9	3.827	0.562
Hot Start #2	7.395	138.8	3.795	0.566
Composite*	7.559	137.5	3.800	0.566
Composite Average	7.725	139.1	3.926	0.570

*Composite = 1/7(Cold Start) + 6/7(Hot Start #1)

9.2 Steady-State (ICOMIA and BSO) Testing/Results

The steady-state test procedure was run twice on this fuel. For the ICOMIA test procedure, composite HC, CO, and NO_x levels were determined to be 5.226, 97.9, and 4.679 g/hp-hr respectively. According to the ICOMIA cycle, HC, CO, and NO_x were reduced 12%, 24%, and 2% respectively. A NO_x reduction was unexpected due to the added oxygen in the fuel; however, it should be noted that the 2% increase is within the test to test variability. For the BSO test procedure, composite HC, CO, and NO_x levels were 3.561, 89.0, and 4.818 g/hp-hr. The BSO showed reductions of 12% HC, 25% CO, and 4% NO_x. This was the only oxygenated fuel that did not show a NO_x increase over the Clean Air Act Baseline fuel. These results are presented in Tables 9.2 and 9.3.

**Table 9.2:
Gasohol Fuel
ICOMIA and BSO Steady-State Test #1 Results**

8-Mode Test Points							
Mode	Speed % of Rated	Torque % of WOT	Weighting Factor		Speed rpm	Torque ft-lb	HP
			ICOMIA	BSO			
1	100	100	6%	10%	4263	274.1	222.5
2	80	71.6	14%	5%	3410	196.3	127.5
3	60	46.5	15%	10%	2558	127.5	62.1
4	40	25.3	25%	10%	1705	69.3	22.5
5	idle	0	40%	30%	700	0.0	0.0
6	50	35.4	--	10%	2132	97.0	39.4
7	70	58.6	--	20%	2984	160.6	91.2
8	90	85.3	--	5%	3837	210.5	153.8

Mode g/hr results						
Mode	HP	Fuel lb/hr	HC g/hr	CO g/hr	NO _x g/hr	CO ₂ g/hr
1	222.2	121.03	436.0	30,879	705.7	97,321
2	126.6	67.07	262.0	9,138	731.6	73,154
3	62.6	33.54	111.0	1,163	379.1	43,124
4	22.8	16.76	99.4	2,263	32.0	18,441
5	0.7	5.58	383.6	1,756	3.6	4,898
6	39.4	24.19	106.4	1,519	146.1	30,955
7	90.9	46.52	154.0	2,105	618.4	58,217
8	153.2	85.60	321.1	19,599	525.7	80,709

Mode g/lb fuel						
Mode	HP	Fuel lb/lb	HC g/lb	CO g/lb	NO _x g/lb	CO ₂ g/lb
1	222.2	NA	3.602	255.14	5.831	804.1
2	126.6	NA	3.906	136.25	10.908	1090.7
3	62.6	NA	3.309	34.68	11.302	1285.7
4	22.8	NA	5.932	135.03	1.909	1100.3
5	0.7	NA	68.74	314.80	0.647	877.8
6	39.4	NA	4.398	62.81	6.041	1279.7
7	90.9	NA	3.310	45.25	13.294	1251.4
8	153.2	NA	3.751	228.96	6.141	942.9

Mode g/hp-hr						
Mode	HP	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
1	222.2	0.545	1.962	138.95	3.175	437.9
2	126.6	0.530	2.070	72.22	5.782	578.2
3	62.6	0.536	1.773	18.59	6.057	689.1
4	22.8	0.736	4.368	99.41	1.406	810.1
5	0.7	NA	NA	NA	NA	NA
6	39.4	0.614	2.702	38.59	3.711	786.2
7	90.9	0.512	1.695	23.17	6.808	640.9
8	153.2	0.559	2.096	127.91	3.431	526.8

Weighted Results	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
ICOMIA	0.606	5.556	98.61	4.549	627.60
BSO	0.569	3.733	88.99	4.682	593.42

Table 9.3:
Gasohol Fuel
ICOMIA and BSO Steady-State Test #2 Results

8-Mode Test Points							
Mode	Speed % of Rated	Torque % of WOT	Weighting Factor		Speed rpm	Torque ft-lb	HP
			ICOMIA	BSO			
1	100	100	6%	10%	4263	274.1	222.5
2	80	71.6	14%	5%	3410	196.3	127.5
3	60	46.5	15%	10%	2558	127.5	62.1
4	40	25.3	25%	10%	1705	69.3	22.5
5	idle	0	40%	30%	700	0.0	0.0
6	50	35.4	--	10%	2132	97.0	39.4
7	70	58.6	--	20%	2984	160.6	91.2
8	90	85.3	--	5%	3837	210.5	153.8

Mode g/hr results						
Mode	HP	Fuel lb/hr	HC g/hr	CO g/hr	NO _x g/hr	CO ₂ g/hr
1	224.1	122.89	439.4	33,614	792.2	106,111
2	127.1	65.25	252.0	8,643	766.4	73,592
3	62.1	33.54	103.2	1,075	389.1	42,081
4	23.1	16.76	94.9	2,326	34.1	18,916
5	0.6	1.86	317.7	1,388	5.4	4,120
6	39.8	24.21	104.5	1,275	147.0	30,500
7	91.4	46.55	150.7	1,829	652.0	59,275
8	153.8	85.65	323.8	19,058	547.7	81,606

Mode g/lb fuel						
Mode	HP	Fuel lb/lb	HC g/lb	CO g/lb	NO _x g/lb	CO ₂ g/lb
1	224.1	NA	3.576	273.53	6.446	863.5
2	127.1	NA	3.861	132.47	11.745	1127.9
3	62.1	NA	3.077	32.06	11.600	1254.6
4	23.1	NA	5.661	138.77	2.038	1128.6
5	0.6	NA	170.8	745.98	2.881	2215.2
6	39.8	NA	4.317	52.66	6.073	1259.8
7	91.4	NA	3.236	39.29	14.006	1273.4
8	153.8	NA	3.781	222.51	6.395	952.8

Mode g/hp-hr						
Mode	HP	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
1	224.1	0.548	1.961	150.01	3.535	473.5
2	127.1	0.513	1.982	68.00	6.029	579.0
3	62.1	0.540	1.663	17.33	6.270	678.2
4	23.1	0.727	4.114	100.85	1.481	820.2
5	0.6	NA	NA	NA	NA	NA
6	39.8	0.608	2.627	32.05	3.696	766.7
7	91.4	0.509	1.648	20.01	7.133	648.4
8	153.8	0.557	2.106	123.96	3.563	530.8

Weighted Results	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
ICOMIA	0.569	4.895	97.19	4.809	630.61
BSO	0.551	3.389	88.95	4.954	602.47

10. Higher Ethanol Blends--Transient Tests

The engine was operated on fuels with increasing amounts of ethanol in order to observe the effects of higher ethanol blends on engine operation and emissions. Increasing increments of 10% ethanol were used to determine the engine's potential for operating on ethanol blends. For each of these blends, two hot starts were run. Even at 40% ethanol (the highest blend that was run), no significant change in power was observed.

Cold starts were not initially run on the Crusader engine due to concerns that leaving the ethanol fuel in the engine over night may cause some corrosion damage to the carburetor and fuel pump. The cold start had little effect on the emission results for the Indolene, CAAB, low T-90, and gasohol runs. Therefore, it was assumed that hot starts only would be enough to characterize transient operation. Using a forced cool method, a cold start was run with the 30% blend. No significant changes in the composite results were seen.

Increased ethanol in the fuel tended to decrease HC and CO and increase NO_x from the Crusader engine over the transient cycle. However, HC increased slightly and NO_x decreased slightly when the blend was moved from 30% to 40% ethanol. The steady-state tests are probably more appropriate for observing the effects of ethanol on the operation of a marine engine.

Steady-state tests were run for the 30% and 40% blends. The 20% blend did not seem interesting because of the engine's ability to operate on much higher blends. The transient testing results for these three ethanol blends are shown in Tables 10.1-10.3.

**Table 10.1: 20% Ethanol Blend
Heavy-Duty Gasoline Transient Test Results**

	HC (g/hp-hr)	CO (g/hp-hr)	NO _x (g/hp-hr)	BSFC (lb/hp-hr)
Hot Start #1	7.476	133.5	4.199	0.558
Hot Start #2	7.598	136.9	4.381	0.567
Average	7.537	135.2	4.290	0.563

**Table 10.2: 30% Ethanol Blend
Heavy-Duty Gasoline Transient Test Results**

	HC (g/hp-hr)	CO (g/hp-hr)	NO _x (g/hp-hr)	BSFC (lb/hp-hr)
Cold Start	5.346	73.7	6.155	0.535
Hot Start #1	6.008	81.1	5.998	0.530
Hot Start #2	6.176	81.8	6.071	0.533
Composite Average*	5.913	80.0	6.020	0.531

*Composite = 1/7(Cold Start) + 6/7(Hot Start #1)

**Table 10.3: 40% Ethanol Blend
Heavy-Duty Gasoline Transient Test Results**

	HC (g/hp-hr)	CO (g/hp-hr)	NO _x (g/hp-hr)	BSFC (lb/hp-hr)
Hot Start #1	6.082	64.9	6.019	0.512
Hot Start #2	6.575	63.4	5.882	0.505
Average	6.323	64.2	5.951	0.509

11. 30% Ethanol Blend Testing/Results

11.1 HD-FTP Transient Testing/Results

This fuel was blended from the CAAB fuel by adding 30% ethanol. For this transient test, a choke mechanism was hooked up to the engine. As recommended by Crusader, the choke was wired open for all of the other tests. Composite transient test HC, CO, and NO_x levels, for this fuel, were determined to be 5.164, 76.0, and 5.814 g/hp-hr. Compared to operating the engine with the choke wired open on the 30% ethanol blend, reductions in HC, CO, NO_x, and BSFC were 13%, 5%, 3%, and 3% respectively. These changes were mostly due to reductions in the hot start results. This was unusual since the choke mechanism was not expected to affect hot start performance. Emissions increased during the cold starts as a result of the choke mechanism. Transient test results are presented in Table 11.1.

Table 11.1:
30% Ethanol Blend (with Choke Mechanism)
Heavy-Duty Gasoline Transient Test Results

	HC (g/hp-hr)	CO (g/hp-hr)	NO _x (g/hp-hr)	BSFC (lb/hp-hr)
First Sequence				
Cold Start	5.698	79.0	5.895	0.533
Hot Start #1	5.050	77.7	5.905	0.520
Hot Start #2	4.990	75.6	5.676	0.514
Composite*	5.142	77.9	5.904	0.522
Second Sequence				
Cold Start	6.451	78.1	5.530	0.528
Hot Start #1	4.974	73.3	5.756	0.505
Hot Start #2	5.030	75.0	5.780	0.519
Composite*	5.185	74.0	5.724	0.508
Composite Average	5.164	76.0	5.814	0.515

*Composite = 1/7(Cold Start) + 6/7(Hot Start #1)

11.2 Steady-State (ICOMIA and BSO) Testing/Results

Two steady-state tests (with the choke wired open) were run using the 30% blend. The composite HC, CO, and NO_x results for this fuel over the ICOMIA cycle were 3.201, 34.4, and 6.847 g/hp-hr respectively. As compared to the CAAB fuel, reductions of 46% HC and 73% CO and an increase of 44% NO_x were observed. Over the BSO cycle, HC, CO, and NO_x results were 2.109, 35.3, and 6.787 g/hp-hr. The BSO showed reductions of 45% HC and 79% CO and a 46% increase in NO_x. No significant change in power was seen for this fuel. Fuel consumption increased slightly (2% for ICOMIA, 4% for BSO). These test results are shown in Tables 11.2 and 11.3.

Table 11.2:
30% Ethanol Blend Fuel
ICOMIA and BSO Steady-State Test #1 Results

8-Mode Test Points							
Mode	Speed % of Rated	Torque % of WOT	Weighting Factor		Speed rpm	Torque ft-lb	HP
			ICOMIA	BSO			
1	100	100	6%	10%	4263	274.1	222.5
2	80	71.6	14%	5%	3410	196.3	127.5
3	60	46.5	15%	10%	2558	127.5	62.1
4	40	25.3	25%	10%	1705	69.3	22.5
5	idle	0	40%	30%	700	0.0	0.0
6	50	35.4	--	10%	2132	97.0	39.4
7	70	58.6	--	20%	2984	160.6	91.2
8	90	85.3	--	5%	3837	210.5	153.8

Mode g/hr results						
Mode	HP	Fuel lb/hr	HC g/hr	CO g/hr	NO _x g/hr	CO ₂ g/hr
1	221.3	118.57	235.4	12700	1721.8	113,614
2	127.1	64.84	82.1	807	1165.9	75,423
3	61.8	33.35	51.0	173	308.2	41,628
4	23.1	16.66	44.5	186	57.4	18,853
5	0.4	7.42	230.0	916	11.1	6,549
6	40.4	25.97	48.4	97	143.0	31,541
7	91.4	51.91	59.6	209	653.6	59,756
8	153.2	81.62	162.5	4048	1281.3	89,329

Mode g/lb fuel						
Mode	HP	Fuel lb/lb	HC g/lb	CO g/lb	NO _x g/lb	CO ₂ g/lb
1	221.3	NA	1.985	107.11	14.521	958.2
2	127.1	NA	1.265	12.45	17.981	1163.2
3	61.8	NA	1.529	5.18	9.240	1248.2
4	23.1	NA	2.668	11.16	3.447	1131.6
5	0.4	NA	31.00	123.45	1.501	882.7
6	40.4	NA	1.863	3.75	5.507	1214.5
7	91.4	NA	1.147	4.03	12.591	1151.1
8	153.2	NA	1.990	49.60	15.698	1094.4

Mode g/hp-hr						
Mode	HP	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
1	221.3	0.536	1.064	57.38	7.779	513.3
2	127.1	0.510	0.646	6.35	9.172	593.4
3	61.8	0.540	0.825	2.79	4.986	673.5
4	23.1	0.723	1.927	8.06	2.490	817.5
5	0.4	NA	NA	NA	NA	NA
6	40.4	0.643	1.198	2.41	3.541	780.9
7	91.4	0.568	0.652	2.29	7.150	653.7
8	153.2	0.533	1.060	26.42	8.363	583.0

Weighted Results	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
ICOMIA	0.612	2.947	28.39	7.166	668.94
BSO	0.587	1.954	27.95	7.148	636.83

Table 11.3:
30% Ethanol Blend Fuel
ICOMIA and BSO Steady-State Test #2 Results

8-Mode Test Points							
Mode	Speed % of Rated	Torque % of WOT	Weighting Factor		Speed rpm	Torque ft-lb	HP
			ICOMIA	BSO			
1	100	100	6%	10%	4263	274.1	222.5
2	80	71.6	14%	5%	3410	196.3	127.5
3	60	46.5	15%	10%	2558	127.5	62.1
4	40	25.3	25%	10%	1705	69.3	22.5
5	idle	0	40%	30%	700	0.0	0.0
6	50	35.4	--	10%	2132	97.0	39.4
7	70	58.6	--	20%	2984	160.6	91.2
8	90	85.3	--	5%	3837	210.5	153.8

Mode g/hr results						
Mode	HP	Fuel lb/hr	HC g/hr	CO g/hr	NO _x g/hr	CO ₂ g/hr
1	219.7	122.50	290.8	20487	1464.0	111,209
2	127.8	64.96	100.2	1057	1077.0	73,895
3	62.5	35.27	47.4	139	315.7	40,421
4	23.4	16.70	43.4	243	46.1	17,274
5	0.5	3.71	277.9	1058	14.7	5,161
6	39.7	24.11	47.1	124	143.2	31,804
7	90.8	48.23	54.9	210	640.4	57,081
8	153.0	83.37	181.9	6922	930.2	77,867

Mode g/lb fuel						
Mode	HP	Fuel lb/lb	HC g/lb	CO g/lb	NO _x g/lb	CO ₂ g/lb
1	219.7	NA	2.374	167.24	11.951	907.8
2	127.8	NA	1.542	16.28	16.579	1137.5
3	62.5	NA	1.343	3.93	8.951	1146.1
4	23.4	NA	2.600	14.53	2.762	1034.4
5	0.5	NA	74.91	285.10	3.960	1391.0
6	39.7	NA	1.954	5.14	5.940	1319.1
7	90.8	NA	1.138	4.35	13.278	1183.5
8	153.0	NA	2.182	83.03	11.157	934.0

Mode g/hp-hr						
Mode	HP	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
1	219.7	0.558	1.324	93.25	6.663	506.2
2	127.8	0.509	0.784	8.28	8.430	578.4
3	62.5	0.564	0.757	2.22	5.048	646.4
4	23.4	0.715	1.859	10.39	1.974	739.5
5	0.5	NA	NA	NA	NA	NA
6	39.7	0.607	1.185	3.12	3.603	800.2
7	90.8	0.531	0.605	2.31	7.054	628.8
8	153.0	0.545	1.189	45.24	6.078	508.9

Weighted Results	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
ICOMIA	0.589	3.455	40.49	6.527	633.95
BSO	0.569	2.262	42.73	6.427	607.50

12. 40% Ethanol Blend Testing/Results

12.1 HD-FTP Transient Testing/Results

No on-highway transient tests were run using the 40% ethanol blend. HD-FTP testing was performed on the more common fuels only so that the emissions from marine engines could be compared to the emissions automotive engines on an identical test cycle. The marine steady-state cycles are believed to be more appropriate for determining potential reductions from oxygenated fuel being used in a marine engine.

12.2 Steady-State (ICOMIA and BSO) Testing/Results

The steady-state test procedure was run three times on this fuel. For the ICOMIA test procedure, composite HC, CO, and NO_x levels were determined to be 3.226, 26.8, and 6.974 g/hp-hr respectively. According to the ICOMIA cycle, HC and CO were reduced 46% and 79% while NO_x was increased 46%. For the BSO test procedure, composite HC, CO, and NO_x levels were 2.050, 25.1, and 6.250 g/hp-hr. The BSO showed reductions of 50% HC, and 79% CO, and an increase of 25% NO_x. According to the BSO procedure, the 40% blend showed less NO_x than the 30% blend. This may have been due to lower combustion temperatures because of significantly less combustion material in modes 6 of all three tests and mode 7 of the second and third tests. The steady-state results for the 40% ethanol blend are presented in Tables 12.1-12.3.

Table 12.1:
40% Ethanol Blend Fuel
ICOMIA and BSO Steady-State Test #1 Results

8-Mode Test Points							
Mode	Speed % of Rated	Torque % of WOT	Weighting Factor		Speed rpm	Torque ft-lb	HP
			ICOMIA	BSO			
1	100	100	6%	10%	4263	274.1	222.5
2	80	71.6	14%	5%	3410	196.3	127.5
3	60	46.5	15%	10%	2558	127.5	62.1
4	40	25.3	25%	10%	1705	69.3	22.5
5	idle	0	40%	30%	700	0.0	0.0
6	50	35.4	--	10%	2132	97.0	39.4
7	70	58.6	--	20%	2984	160.6	91.2
8	90	85.3	--	5%	3837	210.5	153.8

Mode g/hr results						
Mode	HP	Fuel lb/hr	HC g/hr	CO g/hr	NO _x g/hr	CO ₂ g/hr
1	220.6	117.15	221.1	9452	1626.4	109,462
2	127.3	70.70	80.1	878	1083.7	74,013
3	61.6	33.51	49.6	182	253.9	41,511
4	23.2	16.75	66.3	342	67.2	21,394
5	0.4	9.3	472.3	1439	6.9	3,548
6	40.2	37.19	61.4	159	112.9	30,301
7	91.9	55.79	52.9	263	563.5	59,339
8	153.4	83.52	173.7	4319	1285.4	93,035

Mode g/lb fuel						
Mode	HP	Fuel lb/lb	HC g/lb	CO g/lb	NO _x g/lb	CO ₂ g/lb
1	220.6	NA	1.887	80.68	13.883	934.4
2	127.3	NA	1.133	12.41	15.328	1046.9
3	61.6	NA	1.481	5.44	7.578	1238.8
4	23.2	NA	3.956	20.41	4.011	1277.2
5	0.4	NA	50.78	154.75	0.740	381.5
6	40.2	NA	1.652	4.27	3.036	814.8
7	91.9	NA	0.948	4.72	10.100	1063.6
8	153.4	NA	2.079	51.72	15.391	1113.9

Mode g/hp-hr						
Mode	HP	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
1	220.6	0.531	1.002	42.82	7.368	495.9
2	127.3	0.556	0.629	6.90	8.516	581.6
3	61.6	0.544	0.805	2.96	4.122	673.8
4	23.2	0.721	2.853	14.71	2.893	921.1
5	0.4	NA	NA	NA	NA	NA
6	40.2	0.925	1.529	3.96	2.810	754.0
7	91.9	0.607	0.575	2.86	6.131	645.6
8	153.4	0.545	1.132	28.16	8.381	606.6

Weighted Results	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
ICOMIA	0.646	5.132	29.80	6.635	646.89
BSO	0.628	3.052	26.20	6.547	619.29

Table 12.2:
40% Ethanol Blend Fuel
ICOMIA and BSO Steady-State Test #2 Results

8-Mode Test Points							
Mode	Speed % of Rated	Torque % of WOT	Weighting Factor		Speed rpm	Torque ft-lb	HP
			ICOMIA	BSO			
1	100	100	6%	10%	4263	274.1	222.5
2	80	71.6	14%	5%	3410	196.3	127.5
3	60	46.5	15%	10%	2558	127.5	62.1
4	40	25.3	25%	10%	1705	69.3	22.5
5	idle	0	40%	30%	700	0.0	0.0
6	50	35.4	--	10%	2132	97.0	39.4
7	70	58.6	--	20%	2984	160.6	91.2
8	90	85.3	--	5%	3837	210.5	153.8

Mode g/hr results						
Mode	HP	Fuel lb/hr	HC g/hr	CO g/hr	NO _x g/hr	CO ₂ g/hr
1	220.2	120.72	199.3	10143	1748.0	112,950
2	127.0	66.86	58.9	727	1163.6	77,965
3	62.0	35.29	54.1	158	220.3	36,471
4	23.0	20.43	45.4	222	77.6	21,668
5	0.4	7.42	152.9	1038	9.5	4,721
6	39.1	31.55	46.5	142	116.6	31,287
7	91.3	55.65	45.2	244	496.0	56,813
8	153.0	85.28	170.6	4834	1249.5	90,867

Mode g/lb fuel						
Mode	HP	Fuel lb/lb	HC g/lb	CO g/lb	NO _x g/lb	CO ₂ g/lb
1	220.2	NA	1.651	84.02	14.480	935.6
2	127.0	NA	0.881	10.87	17.404	1166.1
3	62.0	NA	1.532	4.47	6.243	1033.5
4	23.0	NA	2.224	10.87	3.798	1061.6
5	0.4	NA	20.61	139.92	1.280	575.6
6	39.1	NA	1.474	4.50	3.696	991.7
7	91.3	NA	0.812	4.38	8.913	1020.9
8	153.0	NA	2.000	56.68	14.652	1065.5

Mode g/hp-hr						
Mode	HP	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
1	220.2	0.548	0.905	46.08	7.942	513.2
2	127.0	0.526	0.464	5.72	9.160	613.7
3	62.0	0.569	0.872	2.55	3.554	588.2
4	23.0	0.887	1.973	9.64	3.370	941.5
5	0.4	NA	NA	NA	NA	NA
6	39.1	0.806	1.188	3.63	2.979	799.5
7	91.3	0.610	0.495	2.67	1.437	622.8
8	153.0	0.557	1.115	31.59	8.166	593.9

Weighted Results	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
ICOMIA	0.491	2.183	26.08	7.013	655.67
BSO	0.625	1.510	25.52	6.570	618.55

Table 12.3:
40% Ethanol Blend Fuel
ICOMIA and BSO Steady-State Test #3 Results

8-Mode Test Points							
Mode	Speed % of Rated	Torque % of WOT	Weighting Factor		Speed rpm	Torque ft-lb	HP
			ICOMIA	BSO			
1	100	100	6%	10%	4263	274.1	222.5
2	80	71.6	14%	5%	3410	196.3	127.5
3	60	46.5	15%	10%	2558	127.5	62.1
4	40	25.3	25%	10%	1705	69.3	22.5
5	idle	0	40%	30%	700	0.0	0.0
6	50	35.4	--	10%	2132	97.0	39.4
7	70	58.6	--	20%	2984	160.6	91.2
8	90	85.3	--	5%	3837	210.5	153.8

Mode g/hr results						
Mode	HP	Fuel lb/hr	HC g/hr	CO g/hr	NO _x g/hr	CO ₂ g/hr
1	221.9	115.29	194.0	9376	1900.4	124,408
2	126.5	66.98	67.4	620	1182.6	79,229
3	62.6	35.37	56.4	180	230.9	39,955
4	23.1	16.75	43.3	213	71.9	21,185
5	0.4	7.44	173.0	1004	12.1	4,414
6	39.6	33.49	43.2	139	101.6	30,170
7	90.8	53.93	48.0	251	104.6	24,484
8	153.4	89.09	158.0	3927	1264.8	89,094

Mode g/lb fuel						
Mode	HP	Fuel lb/lb	HC g/lb	CO g/lb	NO _x g/lb	CO ₂ g/lb
1	221.9	NA	1.682	81.32	16.483	1079.1
2	126.5	NA	1.006	9.25	17.656	1182.9
3	62.6	NA	1.596	5.09	6.529	1129.6
4	23.1	NA	2.586	12.73	4.294	1264.8
5	0.4	NA	23.25	134.91	1.625	593.3
6	39.6	NA	1.288	4.16	3.034	900.9
7	90.8	NA	0.889	4.65	1.939	454.0
8	153.4	NA	1.773	44.08	14.197	1000.0

Mode g/hp-hr						
Mode	HP	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
1	221.9	0.519	0.874	42.24	8.563	560.6
2	126.5	0.529	0.533	4.90	9.346	626.2
3	62.6	0.565	0.902	2.88	3.690	638.4
4	23.1	0.726	1.878	9.25	3.119	918.6
5	0.4	NA	NA	NA	NA	NA
6	39.6	0.846	1.090	3.52	2.568	762.3
7	90.8	0.594	0.528	2.76	1.152	269.7
8	153.4	0.581	1.030	25.61	8.246	580.9

Weighted Results	BSFC lb/hp-hr	HC g/hp-hr	CO g/hp-hr	NO _x g/hp-hr	CO ₂ g/hp-hr
ICOMIA	0.621	2.364	24.41	7.273	682.13
BSO	0.611	1.589	23.42	5.634	540.53

13. Effects of Transience on Emissions from Marine Engine

13.1 Transient ICOMIA Cycles

In order to observe the effects of transience on emissions from this marine engine, three transient duty cycles were created from the ICOMIA 5-mode steady-state cycle. These test cycles were similar to those presented at the July 30, 1992 Marine Workshop by the National Marine Manufacturers Association (NMMA) in which Michigan Automotive Research Corporation (MARCO) ran the modes of the ICOMIA together in correct order, then in reverse order, over different time intervals. The engine spend the same percentage of its time in each operation mode as is defined by the ICOMIA weighting factors for calculating composite emissions. Three different speeds were used in this test program in order to simulate different levels of transience. The "low transience ICOMIA" is shown in Figure 13.1.

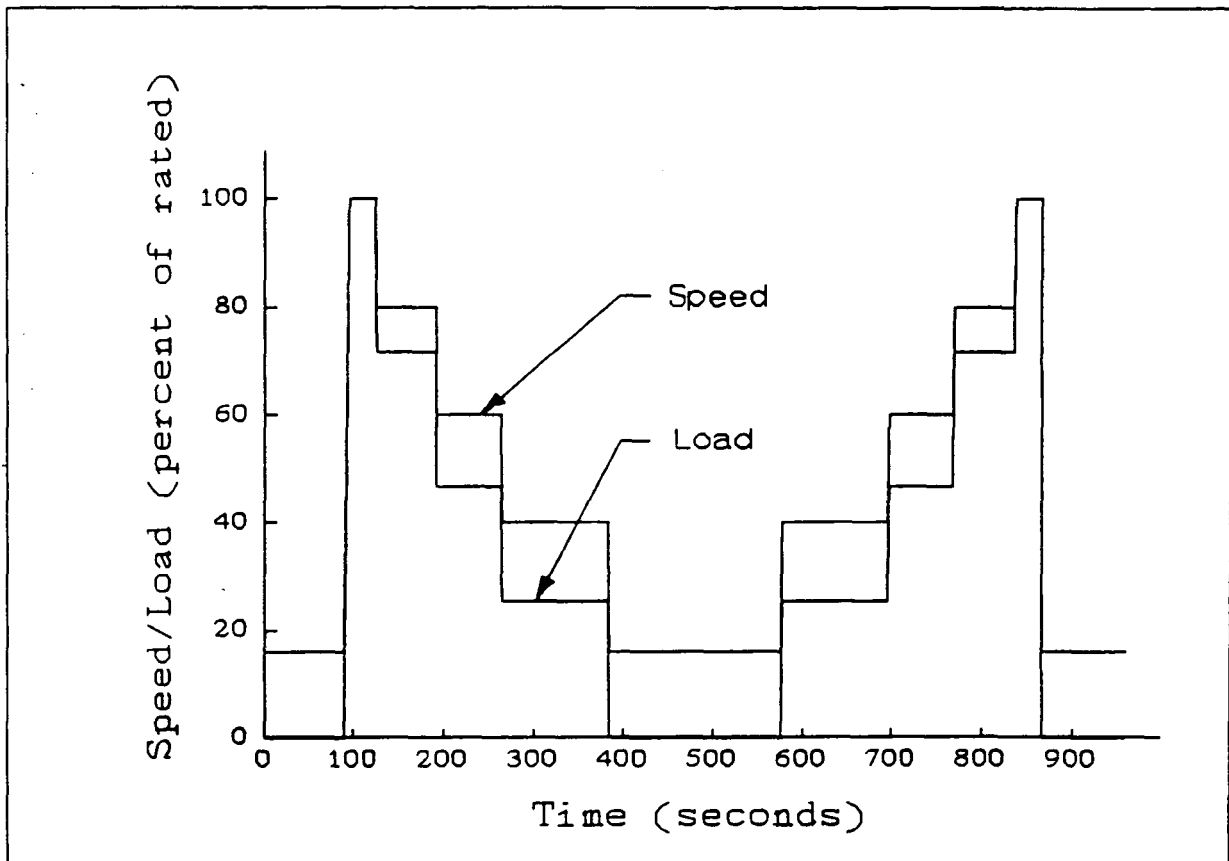


Figure 13.1: Low Transience ICOMIA Test Cycle (One 16-Minute Series)

For the medium transience ICOMIA, this step cycle is repeated 4 times in the 16 minutes. The high transience cycle repeats 16 times in 16 minutes. As the transience increased, both the engine

and the dynamometer had increasing difficulty in following the cycle. One bag per test was used to sample the emissions over each cycle.

13.2 Transient ICOMIA Test Results

As the amount of transience in the duty cycle increased, the engine showed some interesting results. For HC, CO, and BSFC, the highest results were when transience was maximized and the lowest results were during the steady-state test. However, for NO_x, the highest emissions were from the steady-state ICOMIA and the lowest emissions were from the low transience ICOMIA. As was expected, HC increased as transience increased, however CO and BSFC were measured to be lower (and NO_x higher) over the medium than the low transience ICOMIA.

These tests show that, for this engine, adding transience to the ICOMIA has a large effect on HC, CO, and NO_x, and some effect on BSFC. There was no evidence that the amount of transience added to the cycle affects CO, NO_x, or BSFC. The results of these tests are presented in Tables 13.1-13.3.

**Table 13.1: CAAB Fuel
No Transience ICOMIA (Steady-State) Test Results**

	HC (g/hp-hr)	CO (g/hp-hr)	NO _x (g/hp-hr)	BSFC (lb/hp-hr)
Steady-State #1	6.179	127.7	4.715	0.589
Steady-State #2	5.952	131.1	5.063	0.604
Steady-State #3	5.620	126.0	4.522	0.581
Average	5.917	128.3	4.767	0.591

**Table 13.2: CAAB Fuel
Low Transience ICOMIA (One 16-Min. Series) Test Results**

	HC (g/hp-hr)	CO (g/hp-hr)	NO _x (g/hp-hr)	BSFC (lb/hp-hr)
Hot Start #1	7.689	183.1	3.151	0.603
Hot Start #2	7.906	185.8	3.108	0.607
Average	7.798	184.5	3.130	0.605

**Table 13.3: CAAB Fuel
Medium Transience ICOMIA (Four 4-Min. Series) Test Results**

	HC (g/hp-hr)	CO (g/hp-hr)	NO _x (g/hp-hr)	BSFC (lb/hp-hr)
Hot Start #1	8.254	171.1	3.395	0.595
Hot Start #2	8.347	172.2	3.661	0.597
Average	8.301	171.7	3.528	0.596

**Table 13.4: CAAB Fuel
High Transience ICOMIA (Sixteen 1-Min. Series) Test Results**

	HC (g/hp-hr)	CO (g/hp-hr)	NO _x (g/hp-hr)	BSFC (lb/hp-hr)
Hot Start #1	9.025	188.9	3.343	0.614
Hot Start #2	9.310	200.0	3.653	0.648
Average	9.168	194.5	3.498	0.631

14. Effects of Alcohols on FID Measurements of HC

A flame ionization detector (FID) was used to measure hydrocarbons in the exhaust from the Crusader engine. Unburned oxygenates may cause the FID to underestimate HC in the exhaust; however, no correction in the calibration of the FID was made for this test program. The underestimation of HC is small for the low T-90 fuel and the gasohol fuel (about 3%), but becomes larger for the higher ethanol blends.

In Table 14.1, the second column presents the percent of alcohol in the exhaust and is based on other in-house testing of oxygenated fuels. Carbon atoms are underestimated by the FID, for this part of the exhaust, due to its oxygen content. According to tests run on automobile engines, this underestimation is about 22% for MTBE and 27% for ethanol¹. By taking this into effect and by accounting for the oxygen molecules which are not detected by the FID, the third column in Table 14.1 was generated. These correction factors can be used to multiply to the HC measurements for the alternative fuels in order to approximate the adjustment that should have been made for the oxygenated fuels.

Because these correction factors were not derived using the FID used in this test program, they are not applied to any of the hydrocarbon emission data in this report. However, if the were applied, the qualitative results would not change significantly. For example, the reduction in HC due to 40% ethanol being blended into CAAB fuel would be 39% with the correction factor rather than 45% as reported in this paper. In either case, a large reduction in HC is seen.

Table 14.1: Approximate Effects of Alcohols on HC Results

Fuel	Alcohol in Exhaust	HC Correction Factor
Low T-90 (12% MTBE)	3.0%	1.03
Gasohol (10% Eth.)	2.8%	1.03
20% Ethanol Blend	5.6%	1.06
30% Ethanol Blend	8.4%	1.09
40% Ethanol Blend	11.2%	1.12

¹ Smith, Lawrence R., Characterization of Exhaust Emissions from Alcohol-Fueled Vehicles, Southwest Research Institute, May 1985.

15. Analysis and Conclusions

Emission data were collected from a Crusader 350 marine inboard engine, prototype, heavy-duty gasoline engine. This engine was operated over the HD-FTP on-highway transient test, the ICOMIA 5-mode marine steady-state test, and the BSO marine steady-state test using several fuels. These fuels included Indolene, CAAB, low T-90, gasohol, and several ethanol blends up to 40% ethanol. The transient test was only run to compare marine technology with on-highway technology; there is no implication that the HD-FTP test procedure can accurately represent marine engine usage or the emissions from a marine engine.

The Crusader engine was first operated on two baseline fuels: certification fuel (Indolene) and Clean Air Act Baseline fuel (CAAB). The marine engine seemed to operate about the same on both fuels. Over the transient cycles, less than a 4% difference was seen for HC and CO, and no significant difference was seen for NO_x and fuel consumption. For the marine steady-state cycles, HC, CO, and BSFC were within a 3% difference; however NO_x had a difference of more than 10%. All of the oxygenated fuels were mixed from the CAAB fuel.

Emission standards for heavy-duty gasoline engines for 1991 (based on the HD-FTP transient test procedure) are 1.1 g/hp-hr HC, 14.4 g/hp-hr CO, and 5.0 g/hp-hr NO_x. This marine engine would only be able to meet the NO_x requirement. However, it should be noted that the emission standards are based on after-catalyst exhaust while the results presented in this report are engine-out.

Emissions data for the Indolene and CAAB fuel are presented in Table 15.1 and Table 15.2.

Table 15.1
Emissions Summary for Crusader 350 Marine Inboard Engine
Certification Fuel

	HC (g/hp-hr)	CO (g/hp-hr)	NO _x (g/hp-hr)	BSFC (lb/hp-hr)
HD-FTP, Transient	9.878	184.4	3.225	0.597
ICOMIA, Steady-State	5.955	129.0	4.255	0.579
BSO, Steady-State	4.181	122.5	4.472	0.542

Table 15.2
Emissions Summary for Crusader 350 Marine Inboard Engine
Clean Air Act Baseline Fuel

	HC (g/hp-hr)	CO (g/hp-hr)	NO _x (g/hp-hr)	BSFC (lb/hp-hr)
HD-FTP, Transient	10.232	177.8	3.200	0.602
ICOMIA, Steady-State	5.917	128.3	4.767	0.591
BSO, Steady-State	4.065	118.5	5.010	0.558

In order to observe the sensitivity of the emissions to carburetor calibration, the steady-state modes were adjusted to match those used when the Crusader engine was tested by McLaren Engines. Crusader used the data from McLaren to calibrate its carburetor for performance and emissions before sending it to EPA. The rated speed was measured at EPA to be 4243 RPM while McLaren used the manufacturer's rated speed of 4400 RPM. Based on the ICOMIA, Crusader was able to reduce NO_x while paying a penalty in HC and CO. However, Crusader reduced HC by an order of magnitude at 90% of rated speed which is not seen in the ICOMIA procedure. Therefore, the BSO procedure shows a reduction in HC and NO_x with a penalty in CO only. The effects of the calibration changes are presented in Table 15.3.

Table 15.3
Changes in Emissions due to Carburetor Calibration
(Using McLaren Modes for Correlation)
Clean Air Act Baseline Fuel

	HC (g/hp-hr)	CO (g/hp-hr)	NO _x (g/hp-hr)
ICOMIA, Steady-State	41.2%	65.3%	-51.4%
BSO, Steady-State	-18.8%	51.2%	-45.7%

The Crusader marine engine was tested with one methyl tertiary-butyl ether (MTBE) blend and several ethanol blends of fuel. HC and CO were reduced with the MTBE (low T-90) fuel with only a small increase in NO_x and no change in BSFC. The results indicated that as the percentage of ethanol was increased from 0% to 40%, HC and CO decreased and NO_x increased. This was expected because of known effects of leaning out the fuel-air mixtures. Fuel consumption also increased slightly. The engine seemed to run well on the 40% ethanol blend and showed no significant change in

power as compared to the baseline fuel. Although the engine ran well on 40% ethanol blend, there is some concern that durability problems may arise in the long term due to materials compatibility problems.

Non-reduced data for the oxygenated fuel tests are presented in Tables 15.4 to 15.7. Table 15.8 shows the reductions over CAAB fuel for the various alcohol blends when tested on the ICOMIA cycle.

Table 15.4
Emissions Summary for Crusader 350 Marine Inboard Engine
Low T-90 Fuel

	HC (g/hp-hr)	CO (g/hp-hr)	NO _x (g/hp-hr)	BSFC (lb/hp-hr)
HD-FTP, Transient	6.743	162.3	3.163	0.569
ICOMIA, Steady-State	4.884	112.7	4.966	0.589
BSO, Steady-State	3.431	102.6	5.131	0.556

Table 15.5
Emissions Summary for Crusader 350 Marine Inboard Engine
Gasohol Fuel

	HC (g/hp-hr)	CO (g/hp-hr)	NO _x (g/hp-hr)	BSFC (lb/hp-hr)
HD-FTP, Transient	7.725	139.1	3.926	0.570
ICOMIA, Steady-State	5.226	97.9	4.679	0.588
BSO, Steady-State	3.561	89.0	4.818	0.560

Table 15.6
Emissions Summary for Crusader 350 Marine Inboard Engine
30% Ethanol Blend

	HC (g/hp-hr)	CO (g/hp-hr)	NO _x (g/hp-hr)	BSFC (lb/hp-hr)
HD-FTP, Transient	5.913	80.0	6.020	0.531
ICOMIA, Steady-State	3.201	34.4	6.847	0.601
BSO, Steady-State	2.109	35.3	6.787	0.578

Table 15.7
Emissions Summary for Crusader 350 Marine Inboard Engine
40% Ethanol Blend

	HC (g/hp-hr)	CO (g/hp-hr)	NO _x (g/hp-hr)	BSFC (lb/hp-hr)
HD-FTP, Transient*	6.323	64.2	5.951	0.509
ICOMIA, Steady-State	3.226	26.8	6.974	0.639
BSO, Steady-State	2.050	25.1	6.250	0.621

Hot Starts Only

Table 15.8
Emissions Summary for Crusader 350 Marine Inboard Engine
Alcohol Blends on ICOMIA Test Procedure

	HC (g/hp-hr)	CO (g/hp-hr)	NO _x (g/hp-hr)	BSFC (lb/hp-hr)
CAAB (0% alcohol)	5.917	128.3	4.767	0.591
Low T-90 (12.5% MTBE)	4.884 (-17%)	113 (-12%)	5.0 (+4%)	0.591 (0%)
Gasohol (9.5% ethanol)	5.226 (-12%)	97.9 (-24%)	4.679 (-2%)	0.588 (-1%)
30% Ethanol Blend	3.201 (-46%)	34.4 (-73%)	6.847 (+44%)	0.601 (+2%)
40% Ethanol Blend	3.226 (-45%)	26.8 (-79%)	6.974 (+46%)	0.639 (+8%)

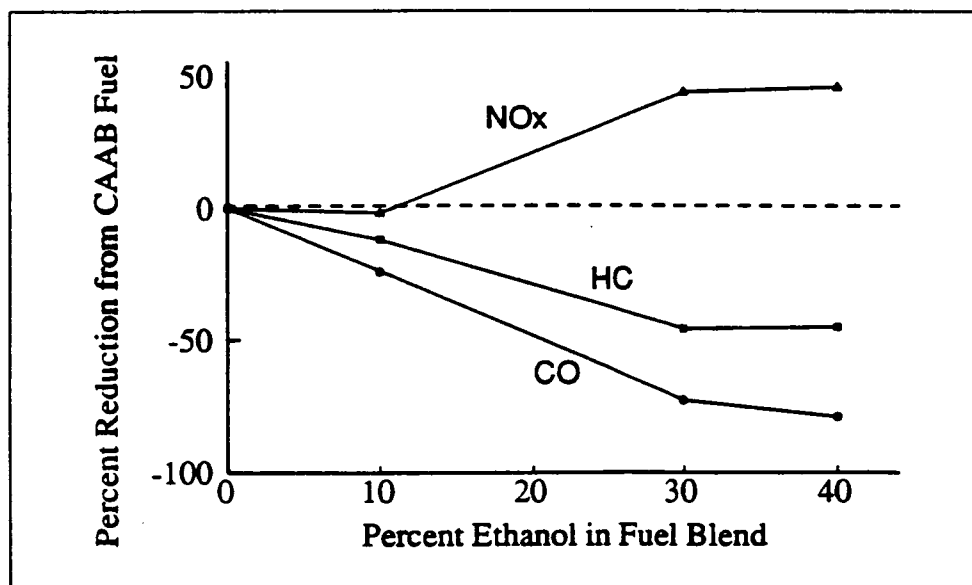


Figure 15.1: Effects of Ethanol in Fuel

Three transient marine tests were developed from the ICOMIA cycle by running the modes together at three different frequencies. These tests show that, for this engine, adding transience to the ICOMIA has a large effect on HC, CO, and NO_x, and some effect on BSFC. Although HC increased with increased transience, there was no evidence that the amount of transience added to the cycle affects CO, NO_x, or BSFC. The results of these tests are presented in Table 15.9.

Table 15.9
Emissions Summary for Crusader 350 Marine Inboard Engine
Effects of Added Transience to ICOMIA Cycle (CAAB Fuel)

Test Cycle (versions of ICOMIA)	HC (g/hp-hr)	CO (g/hp-hr)	NO _x (g/hp-hr)	BSFC (lb/hp-hr)
No Transience	5.917	128.3	4.767	0.591
Low Transience	7.798	184.5	3.130	0.605
Medium Transience	8.301	171.7	3.528	0.596
High Transience	9.168	194.5	3.498	0.631

This test program gives some insight into the characterization of baseline emissions for a new marine inboard engine as well as potential emission reductions through the use of oxygenated fuels. As the percentage of alcohol in the fuel increased, HC and CO decreased and NO_x increased. This was expected due to known effects of leaning out the fuel-air mixtures. There was no significant change in power, but fuel consumption increased slightly.

EPA compared its results with the data from McLaren that Crusader used to calibrate its carburetor. NO_x was reduced but CO increased. HC was observed to increase on the ICOMIA procedure and decrease on the BSO procedure.

Finally, adding transience to the ICOMIA cycle increased HC, CO, and BSFC and decreased NO_x results. Only HC seemed to be affected by the amount of transience added.

Appendices

- A Non-Reduced Transient Test Data
- B Non-Reduced Steady-State Test Data
- C Fuel Specifications

A. Non-Reduced Transient Test Data

HD920129
999 CRUSADER350MAR92 0
1B CS1F

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 07/21/92 TIME: 13:34:46 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920129
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 7-21-92 9:15
Processing Time: 07/21/92 13:34:43

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D103
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 13923 TIM DAVIS

TEST CONDITIONS:

Barometer: 29.28 "HG
Dew Point Temperature: 59.0 F
Dry Bulb Temperature: 74.6 F
Humidity (Abs.): 76.39 grains H2O/lbs. dry air
Humidity (Rel.): 58.30 %
NOx Corr. Factor: 1.0066

TEST OPTIONS:

Cold Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 6 IND UNLEADED, 91 OCT
Alpha(H/C Ratio): 1.8500
Fuel Specific Gravity: .7416
Lbs Fuel/Gals Fuel: 6.1770

COMMENTS:

COLD START # 1 FULL E/M

VALIDATION CHECKS:

CONGRATULATIONS!

THIS TEST PASSED CYCLE PERFORMANCE (GAS REGULATIONS)!

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.421	1.363	4.26
02	243	3.666	3.635	.85
03	302	10.008	9.937	.71
04	316	1.391	1.367	1.76
TOT	315	16.486	16.302	1.13

Remark: COLD START # 1 FULL E/M

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	28.775	1.01406	-5.925	.99823	248	.8
	02	34.771	1.01073	-3.861	.99875	243	.8
	03	24.576	1.00805	-1.842	.99892	302	.8
	04	27.295	1.01342	-5.403	.99777	316	.8
	TOT	29.292	1.00868	-.929	.99928	315	.8

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	8.518%	.95684	1.003	.91009	243	.8
	02	6.658%	.94357	1.825	.95624	307	.8
	03	4.974%	.96074	2.446	.97695	302	.8
	04	4.889%	.95548	.934	.96722	315	.8
	TOT	6.374%	.96484	1.326	.96779	273	.8

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	3.858%	1.03101	.111	.95154	243	.8
	02	3.990%	.98816	.486	.97725	243	.8
	03	4.111%	.97305	1.888	.98182	302	.8
	04	2.257%	.99150	.238	.97973	315	.8
	TOT	3.699%	.99310	.498	.98463	273	.8

A.1 Certification Fuel Cold Start #1

HD920129
999 CRUSADER350MAR92 0
1B CS1F

HEAVY DUTY GASOLINE TRANSIENT TEST
BAG EMISSIONS REPORT

DATE: 07/21/92 TIME: 13:34:47 PAGE: 2

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams
Bag 1 NLLN CS	9.984	13.389	164.600	185.485	248.739	3057.910	548.94	736.14	9049.86	3.435	4.606	56.630

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/ Bhp-hr
Bag 1 NLLN CS	1.616	9.983	.606
Measured Fuel Flow: CS	1.730 Gals	10.686 Lbs	

BAG DETAIL REPORT

Bag # 1	NLLN CS											
Length	: 1167.	SEC.	SITE EMISSION	RNG DEFL.	CONC.	RNG DEFL.	CONC.	CORRECTED				
Bhp-Hr	: 16.486		A202 MEAS HC	19	.1	3.17	19	9.0	282.35	279.37	PPMC	164.60
Dilut. Factor:	16.608		A202 MEAS CO	22	.2	13.87	22	33.3	2583.66	2570.63	PPM	3057.91
Bag Fill Time:	1174.0	Sec.	A009 MEAS CO2	23	2.1	.038	23	26.3	.520	.484	%	9049.86
Exh. Volume	: 36080.	Cu.Ft.	A009 MEAS NOX	17	.0	.00	17	11.6	28.79	28.79	PPM	56.63
Fuel Consump.:	1.616	Gal.										
"	: 9.98	Lb.										
BSFC	: .606	Lb/Bhp-Hr										
"	: 368.62	Gm/Kw-Hr										

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
CS	9.983	10.686	-6.58%

HD920130
999 CRUSADER350MAR92 0
1B HS1F

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 07/21/92 TIME: 13:53:43 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920130
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 7-21-92 9:54
Processing Time: 07/21/92 13:53:40

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 13923 TIM DAVIS

TEST CONDITIONS:

Barometer: 29.28 "HG
Dew Point Temperature: 52.8 F
Dry Bulb Temperature: 75.7 F
Humidity (Abs.): 60.79 grains H2O/lbs. dry air
Humidity (Rel.): 44.90 %
NOx Corr. Factor: .9374

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 6 IND UNLEADED, 91 OCT
Alpha (H/C Ratio): 1.8500
Fuel Specific Gravity: .7416
Lbs Fuel/Gals Fuel: 6.1770

COMMENTS:

HOT START # 1 FULL E/M

VALIDATION CHECKS:

CONGRATULATIONS!
THIS TEST PASSED CYCLE PERFORMANCE (GAS REGULATIONS)!

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.388	1.363	1.83
02	242	3.662	3.635	.74
03	301	10.003	9.937	.66
04	316	1.380	1.367	.95
TOT	315	16.434	16.302	.81

"Remark: HOT START # 1 FULL E/M"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	28.302	1.01237	-5.238	.99828	248	.8
	02	34.612	1.00965	-3.897	.99876	242	.8
	03	24.104	1.00687	-1.595	.99896	301	.8
	04	26.981	1.01254	-5.586	.99782	316	.8
	TOT	28.931	1.00753	-.830	.99930	315	.8

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	5.167%	.95570	.962	.96591	242	.8
	02	6.635%	.94476	1.774	.95661	307	.8
	03	4.632%	.95831	2.672	.97985	301	.8
	04	4.859%	.95010	.977	.96728	315	.8
	TOT	5.452%	.96434	1.336	.97623	273	.8

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	2.526%	.98715	.293	.97745	242	.8
	02	3.908%	.98853	.460	.97819	242	.8
	03	3.863%	.97041	2.026	.98383	301	.8
	04	2.215%	.98780	.241	.98036	315	.8
	TOT	3.322%	.99001	.517	.98751	273	.8

A.2 Certification Fuel Hot Start #1

HD920130
999 CRUSADER350MAR92 0
1B HS1F

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 07/21/92 TIME: 13:53:44 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams
Bag 1 NLLN HS	10.060	13.491	165.320	184.037	246.798	3024.460	538.04	721.53	8842.19	3.118	4.181	51.240

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/ Bhp-hr
Bag 1 NLLN HS	1.587	9.804	.597

Measured Fuel Flow: HS 1.670 Gals 10.316 Lbs

BAG DETAIL REPORT

			----BACKGROUND----			-----EXHAUST-----			CORRECTED		GMS/	
			RNG	DEFL.	CONC.	RNG	DEFL.	CONC.	CONCENTRATION	GRAMS	BHP-HR	
Bag # 1	NLLN HS											
Length	: 1167.	SEC.										
Bhp-Hr	: 16.434		A009 MEAS HC	16	2.6	7.83	16	96.2	288.66	281.30	PPMC	165.32
Dilut. Factor:	16.802		A202 MEAS CO	22	.0	.00	22	32.9	2548.87	2548.87	PPM	3024.46
Bag Fill Time:	1172.0	Sec.	A009 MEAS CO2	23	2.3	.042	23	26.0	.514	.474	%	8842.19
Exh. Volume	: 35990.	Cu.Ft.	A009 MEAS NOX	17	.0	.00	17	11.3	28.04	28.04	PPM	51.24
Fuel Consump.:	1.587	Gal.										3.118
"	: 9.80	Lb.										
BSFC	: .597	Lb/Bhp-Hr										
"	: 363.14	Gm/Kw-Hr										

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	9.804	10.316	-4.96%

HD920131
999 CRUSADER350MAR92 0
1B HS2F

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 07/21/92 TIME: 14:12:26 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920131
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 7-21-92 10:33
Processing Time: 07/21/92 14:12:24

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 13923 TIM DAVIS

TEST CONDITIONS:

Barometer: 29.27 "HG
Dew Point Temperature: 54.5 F
Dry Bulb Temperature: 76.0 F
Humidity (Abs.): 64.78 grains H2O/lbs. dry air
Humidity (Rel.): 47.30 %
NOx Corr. Factor: .9541

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 6 IND UNLEADED, 91 OCT
Alpha(H/C Ratio): 1.8500
Fuel Specific Gravity: .7416
Lbs Fuel/Gals Fuel: 6.1770

COMMENTS:

HOT START # 2 FULL E/M

VALIDATION CHECKS:

CONGRATULATIONS!

THIS TEST PASSED CYCLE PERFORMANCE (GAS REGULATIONS)!

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.379	1.363	1.17
02	240	3.660	3.635	.69
03	300	9.979	9.937	.42
04	316	1.379	1.367	.88
TOT	315	16.397	16.302	.58

Remark: HOT START # 2 FULL E/M

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	28.443	1.01138	-5.057	.99826	248	.8
	02	34.641	1.00848	-3.500	.99875	240	.8
	03	24.536	1.00604	-1.930	.99892	300	.8
	04	27.313	1.01127	-5.087	.99776	316	.8
	TOT	29.172	1.00650	-.608	.99929	315	.8

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	5.203%	.94919	1.080	.96507	240	.8
	02	6.715%	.94379	1.816	.95549	307	.8
	03	4.785%	.96143	2.363	.97866	300	.8
	04	4.933%	.95185	.923	.96643	315	.8
	TOT	5.534%	.96353	1.328	.97548	273	.8

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	2.575%	.98275	.298	.97650	240	.8
	02	3.982%	.98699	.484	.97734	240	.8
	03	3.976%	.97182	1.822	.98293	300	.8
	04	2.273%	.98756	.228	.97933	315	.8
	TOT	3.394%	.98882	.496	.98694	273	.8

A.3 Certification Fuel Hot Start #2

HD920131
999 CRUSADER350MAR92 0
1B HS2F

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 07/21/92 TIME: 14:12:28 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams
Bag 1 NLLN HS	9.596	12.868	157.350	181.719	243.689	2979.640	539.02	722.84	8838.30	3.132	4.200	51.350

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/Bhphr
Bag 1 NLLN HS	1.576	9.734	.594
Measured Fuel Flow: HS	1.650 Gals	10.192 Lbs	

BAG DETAIL REPORT

Bag # 1 NLLN HS			SITE EMISSION			CORRECTED CONCENTRATION			GRAMS		GMS/BHP-HR		
Length	: 1167.	SEC.	A009 MEAS HC	RNG DEFL.	CONC.	16	91.4	273.66	267.14	PPMC	157.35	9.596	
Bhp-Hr	: 16.397		A202 MEAS CO	22	.0	.00	22	32.4	2505.52	2505.52	PPM	2979.64	181.719
Dilut. Factor:	17.064		A009 MEAS CO2	23	2.0	.037	23	25.7	.507	.473	%	8838.30	539.019
Bag Fill Time:	1173.0	Sec.	A009 MEAS NOX	17	.0	.00	17	11.1	27.55	27.55	PPM	51.35	3.132
Exh. Volume	: 36070.	Cu.Ft.											
Fuel Consump.:	1.576	Gal.											
"	: 9.73	Lb.											
BSFC	: .594	Lb/Bhp-Hr											
"	: 361.32	Gm/Kw-Hr											

Certification Fuel Hot Start #2

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	9.735	10.192	-4.49%

HD920132
999 CRUSADER350MAR92 0
1B CS2F

HEAVY DUTY GASOLINE TRANSIENT TEST
ADMINISTRATIVE REPORT

DATE: 07/22/92 TIME: 13:03:13 PAGE: 1

ADMINISTRATIVE INFORMATION:

Test No.: HD-920132
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 7-22-92 8:50
Processing Time: 07/22/92 13:03:10

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D103
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 13923 TIM DAVIS

TEST CONDITIONS:

Barometer: 29.31 "HG
Dew Point Temperature: 58.0 F
Dry Bulb Temperature: 74.3 F
Humidity (Abs.): 73.58 grains H2O/lbs. dry air
Humidity (Rel.): 56.80 %
NOx Corr. Factor: .9933

TEST OPTIONS:

Cold Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 6 IND UNLEADED, 91 OCT
Alpha (H/C Ratio): 1.8500
Fuel Specific Gravity: .7416
Lbs Fuel/Gals Fuel: 6.1770

COMMENTS:

COLD START # 2 FULL E/M

VALIDATION CHECKS:

CONGRATULATIONS!

THIS TEST PASSED CYCLE PERFORMANCE (GAS REGULATIONS)!

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.423	1.363	4.40
02	243	3.674	3.635	1.07
03	302	9.997	9.937	.60
04	316	1.388	1.367	1.54
TOT	315	16.483	16.302	1.11

"Remark: COLD START # 2 FULL E/M"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	28.792	-1.01442	-6.416	.99823	248	.8
	02	34.814	1.01153	-4.486	.99875	243	.8
	03	24.617	1.00877	-2.197	.99892	302	.8
	04	27.477	1.01363	-5.122	.99775	316	.8
	TOT	29.326	1.00941	-1.462	.99928	315	.8

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	7.834%	.95332	1.136	.92236	243	.8
	02	6.714%	.94309	1.848	.95548	307	.8
	03	4.841%	.95601	2.681	.97793	302	.8
	04	5.071%	.95132	.914	.96452	315	.8
	TOT	6.205%	.96227	1.392	.96926	273	.8

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	3.685%	1.02381	.190	.95499	243	.8
	02	3.980%	.98912	.487	.97740	243	.8
	03	3.959%	.96895	2.075	.98298	302	.8
	04	2.311%	.98874	.233	.97864	315	.8
	TOT	3.620%	.99124	.537	.98521	273	.8

A.4 Certification Fuel Cold Start #2

HD920132
999 CRUSADER350MAR92 0
1B CS2F

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 07/22/92 TIME: 13:03:14 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams
Bag 1 NLLN CS	9.963	13.361	164.220	186.570	250.194	3075.230	547.05	733.60	9016.96	3.354	4.498	55.280

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/ Bhp-hr
Bag 1 NLLN CS	1.615	9.978	.605

Measured Fuel Flow: CS 1.710 Gals 10.563 Lbs

BAG DETAIL REPORT

Bag # 1 NLLN CS											
Length	: 1167.	SEC.		SITE EMISSION	---- <td>---- <td></td> <td>CORRECTED</td> <td></td> <td></td> <td>GMS/ BHP-HR</td> </td>	---- <td></td> <td>CORRECTED</td> <td></td> <td></td> <td>GMS/ BHP-HR</td>		CORRECTED			GMS/ BHP-HR
Bhp-Hr	: 16.483			A202 MEAS HC	RNG DEFL. CONC.	RNG DEFL. CONC.		CONCENTRATION	GRAMS		
Dilut. Factor:	16.628			A202 MEAS CO	22 .0 .00	22 33.4 2592.38		279.50 PPMC	164.22		9.963
Bag Fill Time:	1170.0	Sec.		A009 MEAS CO2	23 2.0 .037	23 26.2 .518		2592.38 PPM	3075.23		186.570
Exh. Volume	:35980.	Cu.Ft.		A009 MEAS NOX	17 .1 .25	17 11.6 28.79		.484 %	9016.96		547.046
Fuel Consump.:	1.615	Gal.	6.10 L.					28.56 PPM	55.28		3.354
"	: 9.98	Lb.	4525.9 Gm								
BSFC	: .605	Lb/Bhp-Hr									
"	: 368.01	Gm/Kw-Hr									

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
CS	9.978	10.563	-5.54%

HD920133
999 CRUSADER350MAR92 0
1B HS3F

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 07/22/92 TIME: 14:11:05 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920133
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 7-22-92 9:28
Processing Time: 07/22/92 14:11:03

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D103
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 13923 TIM DAVIS

TEST CONDITIONS:

Barometer: 29.31 "HG
Dew Point Temperature: 57.9 F
Dry Bulb Temperature: 77.8 F
Humidity (Abs.): 73.31 grains H2O/lbs. dry air
Humidity (Rel.): 50.40 %
NOx Corr. Factor: .9921

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 6 IND UNLEADED, 91 OCT
Alpha (H/C Ratio): 1.8500
Fuel Specific Gravity: .7416
Lbs Fuel/Gals Fuel: 6.1770

COMMENTS:

HOT START # 3 FULL E/M

VALIDATION CHECKS:

CONGRATULATIONS!

THIS TEST PASSED CYCLE PERFORMANCE (GAS REGULATIONS)!

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.388	1.363	1.83
02	242	3.669	3.635	.94
03	300	9.994	9.937	.57
04	316	1.386	1.367	1.39
TOT	315	16.437	16.302	.83

"Remark: HOT START # 3 FULL E/M"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	18.868	1.01349	-5.791	.99924	248	.8
	02	23.281	1.01052	-4.595	.99944	242	.8
	03	21.471	1.00746	-1.936	.99917	300	.8
	04	17.861	1.01386	-6.596	.99905	316	.8
	TOT	20.881	1.00820	-1.143	.99964	315	.8

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	2.952%	.96906	.704	.98892	242	.8
	02	3.958%	.96203	1.281	.98466	307	.8
	03	3.041%	.96712	2.059	.99137	300	.8
	04	2.545%	.96724	.747	.99111	315	.8
	TOT	3.232%	.97401	1.003	.99169	273	.8

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	1.354%	.99489	.201	.99352	242	.8
	02	2.393%	.99726	.297	.99186	242	.8
	03	2.554%	.97909	1.530	.99299	300	.8
	04	1.169%	.99814	.170	.99455	315	.8
	TOT	2.050%	.99525	.379	.99526	273	.8

A.5 Certification Fuel Hot Start #3

HD920133
999 CRUSADER350MAR92 0
1B HS3F

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 07/22/92 TIME: 14:11:06 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams
Bag 1 NLLN HS	9.665	12.961	158.860	184.310	247.164	3029.510	535.55	718.19	8802.87	3.276	4.393	53.840

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/ Bhp-hr
Bag 1 NLLN HS	1.581	9.768	.594

Measured Fuel Flow: HS 1.670 Gals 10.316 Lbs

BAG DETAIL REPORT

			---BACKGROUND---			-----EXHAUST-----			CORRECTED		GMS/ BHP-HR		
			RNG	DEFL.	CONC.	RNG	DEFL.	CONC.	CONCENTRATION	GRAMS			
Bag # 1	NLLN HS												
Length	: 1167.	SEC.	A009 MEAS HC	16	1.6	4.88	16	91.5	274.44	269.85	PPMC	158.86	9.665
Bhp-Hr	: 16.437		A202 MEAS CO	22	.0	.00	22	32.9	2548.87	2548.87	PPM	3029.51	184.310
Dilut. Factor:	17.154		A009 MEAS CO2	23	1.6	.029	23	25.3	.499	.471	%	8802.87	535.552
Bag Fill Time:	1172.0	Sec.	A009 MEAS NOX	17	.0	.00	17	11.2	27.80	27.80	PPM	53.84	3.276
Exh. Volume	: 36050.	Cu.Ft.											
Fuel Consump.:	1.581	Gal.											
"	: 9.77	Lb.											
BSFC	: .594	Lb/Bhp-Hr											
"	: 361.32	Gm/Kw-Hr											

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	9.768	10.316	-5.31%

HD920134
999 CRUSADER350MAR92 0
1B HS4F

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 07/22/92 TIME: 13:21:03 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920134
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 7-22-92 10: 7
Processing Time: 07/22/92 13:21:00

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D103
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 13923 TIM DAVIS

TEST CONDITIONS:

Barometer: 29.31 *HG
Dew Point Temperature: 53.5 F
Dry Bulb Temperature: 77.9 F
Humidity (Abs.): 62.33 grains H2O/lbs. dry air
Humidity (Rel.): 42.80 %
NOx Corr. Factor: .9438

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 6 IND UNLEADED, 91 OCT
Alpha(H/C Ratio): 1.8500
Fuel Specific Gravity: .7416
Lbs Fuel/Gals Fuel: 6.1770

COMMENTS:

HOT START # 4 FULL E/M

VALIDATION CHECKS:

CONGRATULATIONS!

THIS TEST PASSED CYCLE PERFORMANCE (GAS REGULATIONS)!

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.386	1.363	1.69
02	242	3.667	3.635	.88
03	300	9.992	9.937	.55
04	316	1.388	1.367	1.54
TOT	315	16.433	16.302	.80

Remark: HOT START # 4 FULL E/M

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	18.655	1.01289	-5.838	.99925	248	.8
	02	23.324	1.01003	-4.718	.99944	242	.8
	03	21.424	1.00722	-2.585	.99918	300	.8
	04	17.861	1.01360	-6.709	.99905	316	.8
	TOT	20.857	1.00778	-1.280	.99964	315	.8

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	2.881%	.96749	.835	.98941	242	.8
	02	4.053%	.96181	1.323	.98393	307	.8
	03	3.030%	.97735	1.392	.99161	300	.8
	04	2.688%	.97127	.681	.99018	315	.8
	TOT	3.265%	.97618	.952	.99155	273	.8

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	1.400%	.99439	.231	.99306	242	.8
	02	2.475%	.99607	.308	.99128	242	.8
	03	2.484%	.98804	1.021	.99349	300	.8
	04	1.233%	1.00186	.157	.99399	315	.8
	TOT	2.050%	.99728	.322	.99528	273	.8

A.6 Certification Fuel Hot Start #4

HD920134
999 CRUSADER350MAR92 0
1B HS4F

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 07/22/92 TIME: 13:21:04 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams
Bag 1 NLLN HS	9.580	12.847	157.420	181.997	244.062	2990.760	534.15	716.31	8777.73	3.120	4.184	51.260

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/ Bhp-hr
Bag 1 NLLN HS	1.571	9.705	.591
Measured Fuel Flow: HS	1.650 Gals	10.192 Lbs	

BAG DETAIL REPORT

Bag # 1	NLLN HS			-----BACKGROUND-----		-----EXHAUST-----		CORRECTED		GMS/ BHP-HR
				RNG	DEFL.	CONC.	RNG	DEFL.	CONC.	
Length	: 1167.	SEC.	SITE EMISSION	16	2.0	6.10	16	91.0	272.93	267.18 PPMC
Bhp-Hr	: 16.433		A009 MEAS HC	22	.0	.00	22	32.5	2514.18	157.42
Dilut. Factor:	17.234		A202 MEAS CO	23	1.7	.031	23	25.3	.499	2990.76
Bag Fill Time:	1173.0	Sec.	A009 MEAS CO2	17	.0	.00	17	11.2	27.80	8777.73
Exh. Volume	: 36080.	Cu.Ft.	A009 MEAS NOX							51.26
Fuel Consump.:	1.571	Gal.								3.120
"	: 9.70	Lb.								
BSFC	: .591	Lb/Bhp-Hr								
"	: 359.49	Gm/Kw-Hr								

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	9.705	10.192	-4.78%

HD920149
999 CRUSADER350MAR92 0
1B CS1F

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 08/05/92 TIME: 10:24:28 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920149
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 8- 5-92 7:58
Processing Time: 08/05/92 10:24:25

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D103
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 11165 MIKE MATTHEWS

TEST CONDITIONS:

Barometer: 29.27 "HG
Dew Point Temperature: 43.7 F
Dry Bulb Temperature: 76.4 F
Humidity (Abs.): 43.05 grains H2O/lbs. dry air
Humidity (Rel.): 31.20 %
NOx Corr. Factor: .8694

TEST OPTIONS:

Cold Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 16 COMMERCIAL UNLEADED
Alpha (H/C Ratio): 1.8500
Fuel Specific Gravity: .0000
Lbs Fuel/Gals Fuel: .0000

COMMENTS:

THIS TEST WAS PROCESSED USING #16 COMMERCIAL UNLEADED CAAB.
1ST COLD START FULL /EM CAAB FUEL

VALIDATION CHECKS:

CONGRATULATIONS!
THIS TEST PASSED CYCLE PERFORMANCE (GAS REGULATIONS)!

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.379	1.376	.22
02	244	3.620	3.677	-1.55
03	302	9.900	10.097	-1.95
04	316	1.362	1.381	-1.38
TOT	315	16.262	16.532	-1.63

*Remark: 1ST COLD START/EMISSIONS/CAAB FUEL"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	13.491	1.01078	-23.743	.99961	248	.6
	02	15.652	1.00782	-22.409	.99974	244	.6
	03	20.833	1.00456	-19.535	.99922	302	.6
	04	11.619	1.01104	-23.994	.99960	316	.6
	TOT	16.401	1.00533	-18.720	.99977	315	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	5.565%	.99769	-.541	.96248	244	.6
	02	3.904%	.99463	-.686	.98601	307	.6
	03	3.381%	1.00211	-1.418	.99016	302	.6
	04	3.043%	.99840	-.820	.98809	315	.6
	TOT	4.028%	.99534	-.763	.98771	273	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	2.725%	1.01746	-.244	.97399	244	.6
	02	2.206%	1.00023	-.375	.99294	244	.6
	03	2.762%	1.00023	-1.104	.99207	302	.6
	04	1.301%	.99955	-.210	.99314	315	.6
	TOT	2.363%	.99335	-.325	.99358	273	.6

A.7 Clean Air Act Baseline Fuel Cold Start #1

HD920149
999 CRUSADER350MAR92 0
1B CS1F

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 08/05/92 TIME: 10:24:29 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC -----			CO -----			CO2 -----			NOx -----		
	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams
Bag 1 NLLN CS	9.871	13.237	160.520	175.956	235.961	2861.400	554.75	743.93	9021.37	3.206	4.299	52.130

FUEL CONSUMPTION:

	----- Fuel -----		
	Gals	Lbs	Lbs/ Bhp-hr
Bag 1 NLLN CS	.000	9.740	.599
Measured Fuel Flow: CS	1.700 Gals	.000 Lbs	

BAG DETAIL REPORT

Bag # 1 NLLN CS	-----BACKGROUND-----			-----EXHAUST-----			CORRECTED	GRAMS	GMS/ BHP-HR			
	RNG	DEFL.	CONC.	RNG	DEFL.	CONC.	CONCENTRATION					
Length : 1167. SEC.	A202	MEAS	HC	19	.2	6.33	19	8.9	279.24	273.28 PPMC	160.52	9.871
Bhp-Hr : 16.262	A202	MEAS	CO	22	.1	6.93	22	31.4	2419.31	2412.79 PPM	2861.40	175.956
Dilut. Factor: 16.960	A009	MEAS	CO2	23	2.1	.038	23	26.3	.520	.484 %	9021.37	554.752
Bag Fill Time: 1172.0 Sec.	A009	MEAS	NOK	17	.0	.00	17	12.4	30.78	30.78 PPM	52.13	3.206
Exh. Volume : 35970. Cu.Ft.												
Fuel Consump.: .000 Gal. .00 L.												
" : 9.74 Lb. 4417.8 Gm												
BSFC : .599 Lb/Bhp-Hr												
" : 364.36 Gm/Kw-Hr												

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
CS	9.740	.000	.00%

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams
Bag 1 NLLN HS	10.110	13.558	164.070	174.735	234.323	2835.590	554.84	744.05	9003.94	3.140	4.211	50.950

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/Bhphr
Bag 1 NLLN HS	.000	9.707	.598

Measured Fuel Flow: HS 1.640 Gals .000 Lbs

BAG DETAIL REPORT

Bag # 1 NLLN HS			SITE EMISSION	----BACKGROUND----		-----EXHAUST-----		CORRECTED CONCENTRATION	GRAMS	GMS/BHP-HR
				RNG	DEFL.	RNG	DEFL.			
Length	: 1167.	SEC.	A009 MEAS HC	16	1.0	3.05	16 93.9	278.85 PPMC	164.07	10.110
Bhp-Hr	: 16.228		A202 MEAS CO	22	.1	6.93	22 31.1	2387.05 PPM	2835.59	174.735
Dilut. Factor:	17.010		A009 MEAS CO2	23	2.2	.040	23 26.3	.482 %	9003.94	554.840
Bag Fill Time:	1172.0	Sec.	A009 MEAS NOX	17	.0	.00	17 12.1	30.03 PPM	50.95	3.140
Exh. Volume	:36030.	Cu.Ft.								
Fuel Consump.:	.000	Gal.								
"	: 9.71	Lb.								
BSFC	: .598	Lb/Bhp-Hr								
"	: 363.75	Gm/Kw-Hr								

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	9.707	.000	.00%

Clean Air Act Baseline Fuel Hot Start #1

HD920150
999 CRUSADER350MAR92 0
1B HSIF

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 08/06/92 TIME: 15:35:46 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920150
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 8- 5-92 8:36
Processing Time: 08/06/92 15:33:28

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D103
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 11165 MIKE MATTHEWS

TEST CONDITIONS:

Barometer: 29.27 "HG
Dew Point Temperature: 43.7 F
Dry Bulb Temperature: 77.5 F
Humidity (Abs.): 43.05 grains H2O/lbs. dry air
Humidity (Rel.): 30.00 %
NOx Corr. Factor: .8694

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 16 COMMERCIAL UNLEADED
Alpha(H/C Ratio): 1.8500
Fuel Specific Gravity: .0000
lbs Fuel/Gals Fuel: .0000

COMMENTS:

THIS TEST WAS PROCESSED USING # 16 COMMERCIAL UNLEADED FUEL.
1ST HOT START FULL /EM CAAB FUEL

VALIDATION CHECKS:

CONGRATULATIONS!

THIS TEST PASSED CYCLE PERFORMANCE (GAS REGULATIONS)!

<COMMENT>: Torque & BHP standard errors are validated by the Digalog

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.369	1.376	-.51
02	242	3.616	3.677	-1.66
03	301	9.890	10.097	-2.05
04	316	1.353	1.381	-2.03
TOT	315	16.228	16.532	-1.84

"Remark: 1ST HOT START/EMISSIONS/CAAB FUEL"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	13.267	1.00951	-23.081	.99962	248	.6
	02	15.588	1.00641	-21.903	.99975	242	.6
	03	20.050	1.00325	-19.283	.99927	301	.6
	04	11.790	1.01003	-24.058	.99958	316	.6
	TOT	16.093	1.00396	-18.229	.99978	315	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	3.124%	.99782	-.441	.98827	242	.6
	02	3.821%	.99244	-.589	.98653	307	.6
	03	3.388%	1.00412	-1.545	.99016	301	.6
	04	3.114%	.99636	-.846	.98750	315	.6
	TOT	3.407%	.99496	-.734	.99119	273	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	1.439%	.99563	-.105	.99255	242	.6
	02	2.190%	.99715	-.311	.99301	242	.6
	03	2.816%	1.00106	-1.200	.99177	301	.6
	04	1.301%	.99714	-.230	.99314	315	.6
	TOT	2.111%	.99120	-.309	.99485	273	.6

A.8 Clean Air Act Baseline Fuel Hot Start #1

HD920151
999 CRUSADER350MAR92 0
1B HS2F

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 08/10/92 TIME: 14:20:15 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920151
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 8- 5-92 9:16
Processing Time: 08/06/92 15:30:58

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D103
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 11165 MIKE MATTHEWS

TEST CONDITIONS:

Barometer: 29.29 "HG
Dew Point Temperature: 44.8 F
Dry Bulb Temperature: 77.5 F
Humidity (Abs.): 44.88 grains H2O/lbs. dry air
Humidity (Rel.): 31.30 %
NOx Corr. Factor: .8760

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 16 COMMERCIAL UNLEADED
Alpha (H/C Ratio): 1.8500
Fuel Specific Gravity: .0000
Lbs Fuel/Gals Fuel: .0000

COMMENTS:

THIS TEST PROCESSED USING # 16 COMMERCIAL UNLEADED
2ND HOT START FULL/EM CAAB FUEL

VALIDATION CHECKS:

CONGRATULATIONS!
THIS TEST PASSED CYCLE PERFORMANCE (GAS REGULATIONS)!

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.373	1.376	-.22
02	241	3.621	3.677	-1.52
03	302	9.878	10.097	-2.17
04	316	1.360	1.381	-1.52
TOT	315	16.232	16.532	-1.81

"Remark: 2ND HOT START/EMISSIONS/CAAB FUEL"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	17.059	1.00818	-22.672	.99937	248	.6
	02	18.601	1.00511	-21.327	.99964	241	.6
	03	23.238	1.00197	-18.429	.99902	302	.6
	04	14.000	1.00878	-23.741	.99941	316	.6
	TOT	19.026	1.00281	-17.932	.99969	315	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	4.001%	.99637	-.238	.98086	241	.6
	02	4.890%	.99212	-.381	.97811	307	.6
	03	3.804%	1.00930	-1.899	.98775	302	.6
	04	3.633%	.99678	-.712	.98308	315	.6
	TOT	4.148%	.99475	-.614	.98699	273	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	1.969%	.99167	-.018	.98605	241	.6
	02	2.887%	.99320	-.192	.98781	241	.6
	03	3.028%	1.00481	-1.466	.99057	302	.6
	04	1.689%	.99613	-.170	.98845	315	.6
	TOT	2.543%	.99007	-.269	.99253	273	.6

A.9 Clean Air Act Baseline Fuel Hot Start #2

HD920151
999 CRUSADER350MAR92 0
1B HS2F

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 08/10/92 TIME: 14:20:17 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/Bhp-hr	Gms/Kw-Hr	Grams	Gms/Bhp-hr	Gms/Kw-Hr	Grams	Gms/Bhp-hr	Gms/Kw-Hr	Grams	Gms/Bhp-hr	Gms/Kw-Hr	Grams
Bag 1 NLLN HS	10.495	14.074	170.350	176.820	237.119	2870.150	548.05	734.95	8895.98	3.141	4.212	50.980

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/Bhp-hr
Bag 1 NLLN HS	.000	9.684	.597
Measured Fuel Flow: HS	1.640 Gals	.000 Lbs	

BAG DETAIL REPORT

Bag # 1 NLLN HS	Length : 1167. SEC.	Bhp-Hr : 16.232	Dilut. Factor: 17.074	Bag Fill Time: 1173.0 Sec.	Exh. Volume : 36080. Cu.Ft.	Fuel Consump.: .000 Gal. .00 L.	" : 9.68 Lb. 4392.5 Gm	BSFC : .597 Lb/Bhp-Hr	" : 363.14 Gm/Kw-Hr	---BACKGROUND---		-----EXHAUST-----		CORRECTED		GRAMS	GMS/BHP-HR	
										SITE EMISSION	RNG DEFL.	CONC.	RNG DEFL.	CONC.	CONCENTRATION			PPMC
A009 MEAS HC										16	.7	2.13	16	97.0	291.14	289.13	170.35	10.495
A202 MEAS CO										22	.1	6.93	22	31.4	2419.31	2412.78	2870.15	176.820
A009 MEAS CO2										23	2.2	.040	23	26.0	.514	.476	8895.98	548.052
A009 MEAS NOX										17	.0	.00	17	12.0	29.78	29.78	50.98	3.141

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	9.684	.000	.00%

HD920152
999 CRUSADER350MAR92 0
1B CS2C

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 08/06/92 TIME: 15:12:21 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920152
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 8- 6-92 10:45
Processing Time: 08/06/92 15:12:18

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 11165 MIKE MATTHEWS

TEST CONDITIONS:

Barometer: 29.35 "HG
Dew Point Temperature: 47.4 F
Dry Bulb Temperature: 77.1 F
Humidity (Abs.): 49.48 grains H2O/lbs. dry air
Humidity (Rel.): 35.00 %
NOx Corr. Factor: .8929

TEST OPTIONS:

Cold Start Only One Bag Only
Manual Zero and Span
Digalog Dyno Controller

FUEL PROPERTIES:

Fuel Type: 16 COMMERCIAL UNLEADED
Alpha(H/C Ratio): 1.8500
Fuel Specific Gravity: .0000
Lbs Fuel/Gals Fuel: .0000

COMMENTS:

COLD START # 2 FULL E/M CAAB FUEL
THIS TEST WAS PROCESSED USING # CAAB # 16 COMMERCIAL FUEL

VALIDATION CHECKS:

CONGRATULATIONS!

THIS TEST PASSED CYCLE PERFORMANCE (GAS REGULATIONS)!

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.402	1.376	1.89
02	243	3.652	3.677	-.68
03	302	9.933	10.097	-1.62
04	316	1.381	1.381	.00
TOT	316	16.368	16.532	-.99

"Remark: COLD START # 2 FULL EM CAAB FUEL"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	17.407	1.00836	-5.430	.99935	248	.6
	02	18.276	1.00515	-3.934	.99965	243	.6
	03	23.516	1.00182	-.807	.99900	302	.6
	04	13.748	1.00855	-6.207	.99943	316	.6
	TOT	19.105	1.00274	-.477	.99969	316	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	6.803%	.99618	-.266	.94304	243	.6
	02	5.025%	.99834	-.647	.97720	307	.6
	03	3.798%	1.00917	-1.857	.98790	302	.6
	04	3.568%	1.00260	-.769	.98379	316	.6
	TOT	4.892%	.99712	-.704	.98201	273	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	3.516%	1.02509	-.141	.95634	243	.6
	02	2.930%	1.00401	-.296	.98771	243	.6
	03	2.950%	1.00936	-1.426	.99118	302	.6
	04	1.673%	1.00727	-.181	.98882	316	.6
	TOT	2.878%	.99794	-.296	.99058	273	.6

A.10 Clean Air Act Baseline Fuel Cold Start #2

HD920152
999 CRUSADER350MAR92 0
1B CS2C

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 08/06/92 TIME: 15:12:22 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams
Bag 1 NLLN CS	9.956	13.351	162.970	180.660	242.269	2957.050	563.67	755.90	9226.22	3.392	4.549	55.530

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/Bhphr
Bag 1 NLLN CS	.000	9.992	.610
Measured Fuel Flow: CS	1.730 Gals	.000 Lbs	

BAG DETAIL REPORT

Bag # 1	NLLN CS			---BACKGROUND---			---EXHAUST---			CORRECTED			GMS/BHP-HR			
				RNG	DEFL.	CONC.	RNG	DEFL.	CONC.	CONCENTRATION	GRAMS					
Length	: 1167.	SEC.		A202	MEAS	HC	19	.0	.00	19	8.8	276.13	276.13	PPMC	162.97	9.956
Bhp-Hr	: 16.368			A202	MEAS	CO	22	.1	6.93	22	32.2	2488.23	2481.71	PPM	2957.05	180.660
Dilut. Factor:	16.820			A009	MEAS	CO2	23	1.6	.029	23	26.3	.520	.493	%	9226.22	563.674
Bag Fill Time:	1172.0	Sec.		A009	MEAS	NOX	17	.0	.00	17	12.8	31.77	31.77	PPM	55.53	3.392
Exh. Volume	: 36140.	Cu.Ft.														
Fuel Consump.:	.000	Gal.	.00 L.													
"	: 9.99	Lb.	4532.1 Gm													
BSFC	: .610	Lb/Bhp-Hr														
"	: 371.05	Gm/Kw-Hr														

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
CS	9.992	.000	.00%

HD920153
999 CRUSADER350MAR92 0
1B HS3C

HEAVY DUTY GASOLINE TRANSIENT TEST
ADMINISTRATIVE REPORT

DATE: 08/06/92 TIME: 15:09:11 PAGE: 1

ADMINISTRATIVE INFORMATION:

Test No.: HD-920153
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 8- 6-92 11:23
Processing Time: 08/06/92 15:09:08

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D103
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 56432 JOE HURLEY

TEST CONDITIONS:

Barometer: 29.39 "HG
Dew Point Temperature: 47.7 F
Dry Bulb Temperature: 78.2 F
Humidity (Abs.): 49.98 grains H2O/lbs. dry air
Humidity (Rel.): 34.20 %
NOx Corr. Factor: .8948

TEST OPTIONS:

Hot Start Only One Bag Only
Manual Zero and Span
Digalog Dyno Controller

FUEL PROPERTIES:

Fuel Type: 16 COMMERCIAL UNLEADED
Alpha(H/C Ratio): 1.8500
Fuel Specific Gravity: .0000
Lbs Fuel/Gals Fuel: .0000

COMMENTS:

HOT START # 3 FULL E/M CAAB FUEL
THIS TEST WAS PROCESSED USING # 16 CAAB COMMERCIAL FUEL

VALIDATION CHECKS:

CONGRATULATIONS!

THIS TEST PASSED CYCLE PERFORMANCE (GAS REGULATIONS)!

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.382	1.376	.44
02	242	3.630	3.677	-1.28
03	302	9.934	10.097	-1.61
04	316	1.369	1.381	-.87
TOT	315	16.315	16.532	-1.31

"Remark: HOT START # 3 FULL E/M CAAB FUEL"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	12.961	1.00701	-5.382	.99964	248	.6
	02	15.780	1.00397	-4.309	.99974	242	.6
	03	19.570	1.00079	-1.490	.99930	302	.6
	04	11.747	1.00748	-6.331	.99958	316	.6
	TOT	15.906	1.00154	-.620	.99979	315	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	3.148%	.99998	-.483	.98814	242	.6
	02	3.749%	.99519	-.694	.98710	307	.6
	03	3.273%	1.00458	-1.499	.99082	302	.6
	04	2.951%	.99964	-.876	.98883	315	.6
	TOT	3.322%	.99686	-.778	.99165	273	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	1.432%	1.00338	-.122	.99274	242	.6
	02	2.129%	1.00106	-.345	.99344	242	.6
	03	2.667%	1.00423	-1.148	.99266	302	.6
	04	1.289%	1.00541	-.240	.99336	315	.6
	TOT	2.036%	.99546	-.312	.99525	273	.6

A.11 Clean Air Act Baseline Fuel Hot Start #3

HD920153
999 CRUSADER350MAR92 0
1B HS3C

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 08/06/92 TIME: 15:09:12 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams
Bag 1 NLLN HS	10.459	14.026	170.630	180.612	242.205	2946.680	554.12	743.08	9040.42	3.227	4.327	52.640

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/Bhphr
Bag 1 NLLN HS	.000	9.868	.605
Measured Fuel Flow: HS	1.660 Gals	.000 Lbs	

BAG DETAIL REPORT

Bag # 1 NLLN HS	Length : 1167. SEC.	Bhp-Hr : 16.315	Dilut. Factor: 17.007	Bag Fill Time: 1173.0 Sec.	Exh. Volume :36170. Cu.Ft.	Fuel Consump.: .000 Gal. .00 L.	BSFC : .605 Lb/Bhp-Hr	" : 368.01 Gm/Kw-Hr	SITE EMISSION			----BACKGROUND----			-----EXHAUST-----			CORRECTED		GRAMS	GMS/BHP-HR
									A009 MEAS HC	A202 MEAS CO	A009 MEAS CO2	A009 MEAS NOX	RNG DEFL.	CONC.	RNG DEFL.	CONC.	CONCENTRATION	PPMC			
									16	1.0	3.05	16	97.2	291.75	288.88	PPMC	170.63	10.459			
									22	.0	.00	22	32.0	2470.96	2470.96	PPM	2946.68	180.612			
									23	1.7	.031	23	25.9	.512	.482	%	9040.42	554.117			
									17	.0	.00	17	12.1	30.03	30.03	PPM	52.64	3.227			

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	9.868	.000	.00%

HD920154
999 CRUSADER350MAR92 0
1B HS4C

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 08/06/92 TIME: 15:19:18 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920154
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 8- 6-92 12: 2
Processing Time: 08/06/92 15:19:16

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D103
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 11165 MIKE MATTHEWS

TEST CONDITIONS:

Barometer: 29.39 "HG
Dew Point Temperature: 47.3 F
Dry Bulb Temperature: 78.2 F
Humidity (Abs.): 49.22 grains H2O/lbs. dry air
Humidity (Rel.): 33.70 %
NOx Corr. Factor: .8919

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 16 COMMERCIAL UNLEADED
Alpha(H/C Ratio): 1.8500
Fuel Specific Gravity: .0000
Lbs Fuel/Gals Fuel: .0000

COMMENTS:

HOT START # 4 FULL E/M CAAB FUEL
THIS TEST WAS PROCESSED USING # 16 COMMERCIAL UNLEADED FUEL.

VALIDATION CHECKS:

CONGRATULATIONS!
THIS TEST PASSED CYCLE PERFORMANCE (GAS REGULATIONS)!

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.375	1.376	-.07
02	243	3.632	3.677	-1.22
03	301	9.918	10.097	-1.77
04	316	1.365	1.381	-1.16
TOT	315	16.289	16.532	-1.47

"Remark: HOT START # 4 FULL E/M CAAB FUEL"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	12.609	1.00568	-4.891	.99965	248	.6
	02	15.588	1.00309	-4.219	.99974	243	.6
	03	19.519	.99995	-1.279	.99931	301	.6
	04	11.662	1.00686	-6.448	.99959	316	.6
	TOT	15.716	1.00071	-.583	.99979	315	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	3.082%	.99741	-.489	.98855	243	.6
	02	3.708%	.99786	-.766	.98744	307	.6
	03	3.412%	1.00695	-1.695	.99008	301	.6
	04	3.018%	.99831	-.878	.98828	315	.6
	TOT	3.350%	.99735	-.823	.99152	273	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	1.392%	1.00037	-.130	.99308	243	.6
	02	2.070%	1.00296	-.375	.99383	243	.6
	03	2.736%	1.00471	-1.268	.99229	301	.6
	04	1.346%	1.00392	-.241	.99273	315	.6
	TOT	2.053%	.99501	-.338	.99517	273	.6

A.12 Clean Air Act Baseline Fuel Hot Start #4

HD920154
999 CRUSADER350MAR92 0
1B HS4C

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 08/06/92 TIME: 15:19:20 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams
Bag 1 NLLN HS	10.623	14.246	173.030	179.844	241.175	2929.490	544.36	730 00	8867.12	3.246	4.353	52.880

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/ Bhp-hr
Bag 1 NLLN HS	.000	9.734	.598
Measured Fuel Flow: HS	1.650 Gals	.000 Lbs	

BAG DETAIL REPORT

Bag # 1 NLLN HS			SITE EMISSION			CORRECTED			GMS/ BHP-HR			
Length	: 1167.	SEC.	RNG	DEFL.	CONC.	CONCENTRATION	GRAMS					
Bhp-Hr	: 16.289		A009	MEAS	HC	16	98.4	295.41	293.11	PPMC	173.03	10.623
Dilut. Factor:	: 17.233		A202	MEAS	CO	22	.2	13.87	2457.90	PPM	2929.49	179.844
Bag Fill Time:	: 1171.0	Sec.	A009	MEAS	CO2	23	1.6	.029	.473	%	8867.12	544.362
Exh. Volume	: 36150.	Cu.Ft.	A009	MEAS	NOX	17	.0	.00	30.28	PPM	52.88	3.246
Fuel Consump.:	: .000	Gal.										
"	: 9.73	Lb.										
BSFC	: .598	Lb/Bhp-Hr										
"	: 363.75	Gm/Kw-Hr										

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	9.734	.000	.00%

HD920140
999 CRUSADER350MAR92 0
1B

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 07/30/92 TIME: 10:22:44 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920140
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 7-29-92 14:25
Processing Time: 07/29/92 15:13:14

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 11165 MIKE MATTHEWS

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 13923 TIM DAVIS
Analyzer Operator: 11165 MIKE MATTHEWS

TEST CONDITIONS:

Barometer: 29.00 "HG
Dew Point Temperature: 47.0 F
Dry Bulb Temperature: 76.8 F
Humidity (Abs.): 49.32 grains H2O/lbs. dry air
Humidity (Rel.): 34.90 %
NOx Corr. Factor: .8923

TEST OPTIONS:

Cold Start Only One Bag Only
Manual Zero and Span
Digalog Dyno Controller

FUEL PROPERTIES:

Fuel Type: 6 IND UNLEADED, 91 OCT
Alpha(H/C Ratio): 1.8500
Fuel Specific Gravity: .7416
Lbs Fuel/Gals Fuel: 6.1770

COMMENTS:

C/S #1 T-90 LOW FUEL NATURAL COOL DOWN AFTER RUNNING FOR 10 MIN ONLY
IN THE A.M. NO F/C/D USED

VALIDATION CHECKS:

CONGRATULATIONS!

THIS TEST PASSED CYCLE PERFORMANCE (GAS REGULATIONS)!

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.418	1.393	1.79
02	245	3.726	3.731	-.13
03	304	10.145	10.219	-.72
04	316	1.407	1.396	.79
TOT	313	16.696	16.738	-.25

"Remark: C/S T90 LOW FUEL #1"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	16.703	1.00639	-6.416	.99939	248	.6
	02	18.574	1.00394	-5.378	.99964	245	.6
	03	24.839	1.00069	-2.149	.99888	304	.6
	04	13.379	1.00682	-6.712	.99946	316	.6
	TOT	19.391	1.00155	-1.876	.99968	313	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	3.824%	.94913	1.519	.98092	245	.6
	02	4.675%	.93769	2.219	.97810	307	.6
	03	4.446%	.93220	3.950	.98097	304	.6
	04	3.440%	.94736	1.399	.98333	313	.6
	TOT	4.226%	.95078	1.931	.98538	273	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	2.098%	.96093	.543	.98309	245	.6
	02	3.392%	.96710	.824	.98272	245	.6
	03	3.729%	.93999	2.909	.98407	304	.6
	04	1.853%	.96450	.418	.98517	313	.6
	TOT	3.024%	.96732	.849	.98901	273	.6

A.13 LOW T-90 Fuel Cold Start #1

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/Bhp-hr	Gms/Kw-Hr	Grams	Gms/Bhp-hr	Gms/Kw-Hr	Grams	Gms/Bhp-hr	Gms/Kw-Hr	Grams	Gms/Bhp-hr	Gms/Kw-Hr	Grams
Bag 1 NLLN CS	7.617	10.215	127.180	166.048	222.674	2772.340	577.45	774.37	9641.10	3.252	4.361	54.300

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/Bhp-hr
Bag 1 NLLN CS	1.619	9.999	.599
Measured Fuel Flow: CS	1.690 Gals	10.439 Lbs	

BAG DETAIL REPORT

Bag # 1 NLLN CS	Length : 1167. SEC.	Bhp-Hr : 16.696	Dilut. Factor: 16.489	Bag Fill Time: 1173.0 Sec.	Exh. Volume : 35640. Cu.Ft.	Fuel Consump.: 1.619 Gal. 6.12 L.	BSFC : .599 Lb/Bhp-Hr	SITE EMISSION	---BACKGROUND---		-----EXHAUST-----		CORRECTED CONCENTRATION	GRAMS	GMS/BHP-HR		
									RNG DEFL.	CONC.	RNG DEFL.	CONC.					
								A009 MEAS HC	16	.5	1.52	16	73.4	219.95	218.51 PPMC	127.18	7.617
								A202 MEAS CO	22	.0	.00	22	30.7	2359.34	2359.34 PPM	2772.34	166.048
								A009 MEAS CO2	23	1.9	.035	23	27.9	.555	.522 %	9641.10	577.449
								A009 MEAS NOX	17	.0	.00	17	12.7	31.52	31.52 PPM	54.30	3.252

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
CS	9.999	10.439	-4.21%

HD920141
999 CRUSADER350MAR92 0
1B

HEAVY DUTY GASOLINE TRANSIENT TEST

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BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams
Bag 1 NLLN HS	6.742	9.041	112.510	163.272	218.951	2724.520	537.51	720.82	8969.47	3.143	4.215	52.450

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/ Bhp-hr
Bag 1 NLLN HS	1.530	9.448	.566
Measured Fuel Flow: HS	1.660 Gals	10.254 Lbs	

BAG DETAIL REPORT

Bag # 1 NLLN HS											
Length	: 1167.	SEC.		SITE EMISSION	RNG	DEFL.	CONC.	-----EXHAUST-----		CORRECTED	
Bhp-Hr	: 16.687			A009 MEAS HC	16	1.0	3.05	16 65.4	196.03	193.15	PPMC
Dilut. Factor:	17.417			A202 MEAS CO	22	.0	.00	22 30.2	2316.69	2316.69	PPM
Bag Fill Time:	1172.0	Sec.		A009 MEAS CO2	23	1.9	.035	23 26.2	.518	.485	%
Exh. Volume	: 35670.	Cu.Ft.		A009 MEAS NOX	17	.0	.00	17 12.2	30.28	30.28	PPM
Fuel Consump.:	1.530 Gal.	5.78 L.								52.45	
"	: 9.45 Lb.	4285.7 Gm									
BSFC	: .566 Lb/Bhp-Hr										
"	: 344.28 Gm/Kw-Hr										

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	9.448	10.254	-7.86%

HD920141
999 CRUSADER350MAR92 0
1B

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 07/30/92 TIME: 10:15:15 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920141
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 7-29-92 15: 4
Processing Time: 07/30/92 10:15:12

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 11165 MIKE MATTHEWS

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 11165 MIKE MATTHEWS
Analyzer Operator: 11165 MIKE MATTHEWS

TEST CONDITIONS:

Barometer: 29.00 "HG
Dew Point Temperature: 47.6 F
Dry Bulb Temperature: 77.8 F
Humidity (Abs.): 50.46 grains H2O/lbs. dry air
Humidity (Rel.): 34.50 %
NOx Corr. Factor: .8966

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 6 IND UNLEADED, 91 OCT
Alpha (H/C Ratio): 1.8500
Fuel Specific Gravity: .7416
Lbs Fuel/Gals Fuel: 6.1770

COMMENTS:

H/S 1 T90 FUEL

VALIDATION CHECKS:

CONGRATULATIONS!
THIS TEST PASSED CYCLE PERFORMANCE (GAS REGULATIONS)!

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.417	1.393	1.72
02	242	3.721	3.731	-.27
03	302	10.144	10.219	-.73
04	316	1.405	1.396	.64
TOT	316	16.687	16.738	-.30

"Remark: H/S T90 LOW FUEL #1"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	17.000	1.00553	-5.743	.99937	248	.6
	02	18.520	1.00270	-4.813	.99964	242	.6
	03	25.000	.99972	-2.225	.99886	302	.6
	04	14.036	1.00632	-6.922	.99941	316	.6
	TOT	19.596	1.00040	-1.279	.99967	316	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	3.892%	.94806	1.651	.98027	242	.6
	02	4.535%	.93356	2.350	.97916	307	.6
	03	4.280%	.93714	3.691	.98256	302	.6
	04	3.462%	.94415	1.475	.98300	316	.6
	TOT	4.153%	.95038	1.991	.98594	273	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	2.119%	.95881	.608	.98281	242	.6
	02	3.329%	.96416	.864	.98329	242	.6
	03	3.568%	.94417	2.691	.98560	302	.6
	04	1.852%	.96318	.417	.98514	316	.6
	TOT	2.946%	.96749	.846	.98969	273	.6

A.14 Low T-90 Fuel Hot Start #1

HD920142
999 CRUSADER350MAR92 0
1B

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 01/30/92 TIME: 10:20:04 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams
Bag 1 NLLN HS	6.822	9.148	113.630	164.315	220.350	2736.840	543.28	728.55	9048.90	3.142	4.213	52.330

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/ Bhp-hr
Bag 1 NLLN HS	1.541	9.519	.572

Measured Fuel Flow: HS 1.650 Gals 10.192 Lbs

BAG DETAIL REPORT

			---BACKGROUND---			---EXHAUST---			CORRECTED		GMS/	
			RNG	DEFL.	CONC.	RNG	DEFL.	CONC.	CONCENTRATION	GRAMS	BHP-HR	
Bag # 1	NLLN HS											
Length	:	1167. SEC.										
Bhp-Hr	:	16.656	A009 MEAS HC	16	.7	2.13	16	65.7	196.92	194.91 PPMC	113.63	6.822
Dilut. Factor:	:	17.348	A202 MEAS CO	22	.0	.00	22	30.3	2325.21	2325.21 PPM	2736.84	164.315
Bag Fill Time:	:	1173.0 Sec.	A009 MEAS CO2	23	1.8	.033	23	26.3	.520	.489 %	9048.90	543.282
Exh. Volume	:	35700. Cu.Ft.	A009 MEAS NOX	17	.0	.00	17	12.2	30.28	30.28 PPM	52.33	3.142
Fuel Consump.:	:	1.541 Gal. 5.82 L.										
"	:	9.52 Lb. 4317.9 Gm										
BSFC	:	.572 Lb/Bhp-Hr										
"	:	347.93 Gm/Kw-Hr										

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	9.519	10.192	-6.60%

HD920142
999 CRUSADER350MAR92 0
1B

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 07/30/92 TIME: 10:20:02 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920142
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 7-29-92 15:45
Processing Time: 07/30/92 10:11:39

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 11165 MIKE MATTHEWS

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 11165 MIKE MATTHEWS
Analyzer Operator: 11165 MIKE MATTHEWS

TEST CONDITIONS:

Barometer: 28.98 "HG
Dew Point Temperature: 47.2 F
Dry Bulb Temperature: 77.5 F
Humidity (Abs.): 49.74 grains H2O/lbs. dry air
Humidity (Rel.): 34.30 %
NOx Corr. Factor: .8939

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 6 IND UNLEADED, 91 OCT
Alpha(H/C Ratio): 1.8500
Fuel Specific Gravity: .7416
Lbs Fuel/Gals Fuel: 6.1770

COMMENTS:

H/S 2 T90

VALIDATION CHECKS:

CONGRATULATIONS!
THIS TEST PASSED CYCLE PERFORMANCE (GAS REGULATIONS)!

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.401	1.393	.57
02	242	3.710	3.731	-.56
03	303	10.141	10.219	-.76
04	316	1.404	1.396	.57
TOT	316	16.656	16.738	-.49

"Remark: H/S T90 LOW FUEL #2"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	13.267	1.00529	-6.396	.99962	248	.6
	02	15.620	1.00242	-5.445	.99974	242	.6
	03	20.904	.99934	-2.861	.99920	303	.6
	04	11.832	1.00619	-7.501	.99958	316	.6
	TOT	16.401	.99999	-1.713	.99977	316	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	3.220%	.94436	1.479	.98631	242	.6
	02	4.127%	.93494	2.161	.98274	307	.6
	03	3.912%	.93582	3.818	.98535	303	.6
	04	3.044%	.94163	1.554	.98674	316	.6
	TOT	3.723%	.95039	1.923	.98867	273	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	1.608%	.96091	.479	.99007	242	.6
	02	2.903%	.96590	.759	.98728	242	.6
	03	3.286%	.94205	2.822	.98771	303	.6
	04	1.546%	.96501	.406	.98964	316	.6
	TOT	2.611%	.96813	.796	.99189	273	.6

A.15 Low T-90 Fuel Hot Start #2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams
Bag 1 NLLN CS	7.320	9.816	122.880	156.830	210.312	2632.540	561.41	752.87	9423.90	3.460	4.640	58.070

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/Bhphr
Bag 1 NLLN CS	1.568	9.686	.577
Measured Fuel Flow: CS	1.710 Gals	10.563 Lbs	

BAG DETAIL REPORT

Bag # 1 NLLN CS			---BACKGROUND---			---EXHAUST---			CORRECTED		GMS/BHP-HR
			RNG	DEFL.	CONC.	RNG	DEFL.	CONC.	CONCENTRATION	GRAMS	
Length	: 1167.	SEC.	SITE EMISSION								
Bhp-Hr	: 16.786		A009	MEAS	HC	16	.4	1.22	211.31	PPMC	122.88
Dilut. Factor:	17.196		A202	MEAS	CO	22	.1	6.93	2242.25	PPM	2632.54
Bag Fill Time:	1173.0	Sec.	A009	MEAS	CO2	23	1.3	.024	.511		9423.90
Exh. Volume	: 35610.	Cu.Ft.	A009	MEAS	NOX	17	.0	.00	33.76	PPM	58.07
Fuel Consump.:	1.568	Gal.									
"	: 9.69	Lb.									
BSFC	: .577	Lb/Bhp-Hr									
"	: 350.98	Gm/Kw-Hr									

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
CS	9.686	10.563	-8.30%

Low T-90 Fuel Cold Start #2

HD920143
999 CRUSADER350MAR92 0
1B

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 07/31/92 TIME: 09:44:09 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920143
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 7-31-92 8:18
Processing Time: 07/31/92 09:44:06

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 11165 MIKE MATTHEWS

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 13923 TIM DAVIS
Analyzer Operator: 11165 MIKE MATTHEWS

TEST CONDITIONS:

Barometer: 28.95 "HG
Dew Point Temperature: 46.9 F
Dry Bulb Temperature: 77.8 F
Humidity (Abs.): 49.22 grains H2O/lbs. dry air
Humidity (Rel.): 33.60 %
NOx Corr. Factor: .8919

TEST OPTIONS:

Cold Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only
12 Hour Soak.

FUEL PROPERTIES:

Fuel Type: 6 IND UNLEADED, 91 OCT
Alpha (H/C Ratio): 1.8500
Fuel Specific Gravity: .7416
Lbs Fuel/Gals Fuel: 6.1770

COMMENTS:

C/S #2 T90 FUEL

VALIDATION CHECKS:

CONGRATULATIONS!

THIS TEST PASSED CYCLE PERFORMANCE (GAS REGULATIONS)!

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.426	1.393	2.37
02	245	3.746	3.731	.40
03	305	10.196	10.219	-.23
04	316	1.418	1.396	1.58
TOT	316	16.786	16.738	.29

"Remark: C/S #2 T90"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	17.234	1.01026	-5.665	.99936	248	.6
	02	18.868	1.00748	-4.734	.99963	245	.6
	03	25.100	1.00428	-1.999	.99886	305	.6
	04	14.071	1.01046	-6.412	.99941	316	.6
	TOT	19.799	1.00501	-1.119	.99967	316	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	4.058%	.94910	1.513	.97857	245	.6
	02	4.742%	.93529	2.337	.97735	307	.6
	03	4.369%	.94368	3.291	.98208	305	.6
	04	3.589%	.95102	1.409	.98198	316	.6
	TOT	4.289%	.95359	1.882	.98513	273	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	2.264%	.96587	.561	.98055	245	.6
	02	3.495%	.96979	.871	.98175	245	.6
	03	3.674%	.95439	2.431	.98507	305	.6
	04	1.946%	.97066	.435	.98380	316	.6
	TOT	3.056%	.97451	.807	.98905	273	.6

A.16 Low T-90 Fuel Cold Start #2

HD920144
999 CRUSADER350MAR92 0
1B

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 07/31/92 TIME: 09:54:55 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams
Bag 1 NLLN HS	6.501	8.718	108.940	161.479	216.547	2706.070	540.29	724.54	9054.23	3.117	4.180	52.230

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/ Bhp-hr
Bag 1 NLLN HS	1.535	9.479	.566

Measured Fuel Flow: HS 1.620 Gals 10.007 Lbs

BAG DETAIL REPORT

Bag # 1 NLLN HS			SITE EMISSION			CORRECTED			GMS/	
Length	: 1167.	SEC.	A009 MEAS HC	16	2.6	187.07	PPMC	108.94	BHP-HR	
Bhp-Hr	: 16.758		A202 MEAS CO	22	.1	2301.65	PPM	2706.07	161.479	
Dilut. Factor	: 17.295		A009 MEAS CO2	23	2.0	.490	%	9054.23	540.293	
Bag Fill Time	: 1173.0	Sec.	A009 MEAS NOX	17	.0	30.78	PPM	52.23	3.117	
Exh. Volume	: 35660.	Cu.Ft.								
Fuel Consump.	: 1.535 Gal.	5.80 L.								
"	: 9.48 Lb.	4299.7 Gm								
BSFC	: .566 Lb/Bhp-Hr									
"	: 344.28 Gm/Kw-Hr									

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	9.479	10.007	-5.27%

HD920144
999 CRUSADER350MAR92 0
1B

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 07/31/92 TIME: 09:54:54 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920144
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 7-31-92 8:57
Processing Time: 07/31/92 09:54:51

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 11165 MIKE MATTHEWS

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 13923 TIM DAVIS
Analyzer Operator: 13923 TIM DAVIS

TEST CONDITIONS:

Barometer: 28.93 "HG
Dew Point Temperature: 44.9 F
Dry Bulb Temperature: 77.8 F
Humidity (Abs.): 45.62 grains H2O/lbs. dry air
Humidity (Rel.): 31.10 %
NOx Corr. Factor: .8787

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 6 IND UNLEADED, 91 OCT
Alpha(H/C Ratio): 1.8500
Fuel Specific Gravity: .7416
Lbs Fuel/Gals Fuel: 6.1770

COMMENTS:

H/S #3 T90 FUEL

VALIDATION CHECKS:

CONGRATULATIONS!

THIS TEST PASSED CYCLE PERFORMANCE (GAS REGULATIONS)!

<COMMENT>: Torque & BHP standard errors are validated by the test.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.420	1.393	1.94
02	244	3.741	3.731	.27
03	304	10.184	10.219	-.34
04	316	1.412	1.396	1.15
TOT	316	16.758	16.738	.12

"Remark: H/S #3 T90"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	17.493	1.00882	-5.366	.99934	248	.6
	02	18.841	1.00609	-4.537	.99963	244	.6
	03	24.617	1.00299	-1.882	.99890	304	.6
	04	14.107	1.00937	-6.506	.99940	316	.6
	TOT	19.672	1.00370	-.980	.99967	316	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	3.806%	.94589	1.658	.98099	244	.6
	02	4.669%	.93590	2.361	.97807	307	.6
	03	4.454%	.93438	3.918	.98103	304	.6
	04	3.514%	.94835	1.385	.98263	316	.6
	TOT	4.241%	.95095	1.998	.98538	273	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	2.137%	.96089	.592	.98252	244	.6
	02	3.357%	.97040	.869	.98318	241	.6
	03	3.732%	.94590	2.828	.98433	304	.6
	04	1.900%	.96897	.410	.98452	316	.6
	TOT	3.025%	.97150	.859	.98920	273	.6

A.17 Low T-90 Fuel Hot Start #3

HD920145
999 CRUSADER350MAR92 0
1B

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 07/31/92 TIME: 10:54:38 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920145
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 7-31-92 9:34
Processing Time: 07/31/92 10:54:35

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 11165 MIKE MATTHEWS

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 13923 TIM DAVIS
Analyzer Operator: 11165 MIKE MATTHEWS

TEST CONDITIONS:

Barometer: 28.93 "HG
Dew Point Temperature: 45.1 F
Dry Bulb Temperature: 77.1 F
Humidity (Abs.): 45.97 grains H2O/lbs. dry air
Humidity (Rel.): 32.10 %
NOx Corr. Factor: .8800

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 6 IND UNLEADED, 91 OCT
Alpha(H/C Ratio): 1.8500
Fuel Specific Gravity: .7416
Lbs Fuel/Gals Fuel: 6.1770

COMMENTS:

H/S #4 T90 FUEL

VALIDATION CHECKS:

CONGRATULATIONS!

THIS TEST PASSED CYCLE PERFORMANCE (GAS REGULATIONS)!

<COMMENT>: Torque & BHP standard errors are validated by the Digalog

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.417	1.393	1.72
02	244	3.736	3.731	.13
03	304	10.165	10.219	-.53
04	316	1.415	1.396	1.36
TOT	316	16.734	16.738	-.02

*Remark: H/S #4 T90"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	17.550	1.00791	-5.504	.99933	248	.6
	02	18.947	1.00534	-4.813	.99962	244	.6
	03	24.310	1.00221	-1.997	.99893	304	.6
	04	14.248	1.00901	-6.880	.99939	316	.6
	TOT	19.621	1.00293	-1.141	.99967	316	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	3.764%	.94534	1.635	.98138	244	.6
	02	4.706%	.93480	2.391	.97768	307	.6
	03	4.196%	.93850	3.605	.98327	304	.6
	04	3.670%	.94306	1.583	.98087	316	.6
	TOT	4.192%	.95029	2.021	.98569	273	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	2.093%	.96066	.580	.98320	244	.6
	02	3.432%	.96895	.869	.98239	244	.6
	03	3.493%	.94876	2.584	.98633	304	.6
	04	1.936%	.96627	.443	.98386	316	.6
	TOT	2.955%	.97106	.833	.98969	273	.6

A.18 Low T-90 Fuel Hot Start #4

HD920145
999 CRUSADER350MAR92 0
1B

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 07/31/92 TIME: 10:54:39 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams
Bag 1 NLLN HS	6.710	8.998	112.280	163.045	218.647	2728.390	547.74	734.53	9165.87	3.179	4.263	53.200

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/Bhphr
Bag 1 NLLN HS	1.552	9.588	.573
Measured Fuel Flow: HS	1.670 Gals	10.316 Lbs	

BAG DETAIL REPORT

Bag # 1 NLLN HS	Length : 1167. SEC.	Bhp-Hr : 16.734	Dilut. Factor: 17.202	Bag Fill Time: 1173.0 Sec.	Exh. Volume : 35690. Cu.Ft.	Fuel Consump.: 1.552 Gal. 5.86 L.	BSFC : .573 Lb/Bhp-Hr	SITE EMISSION	----BACKGROUND----			-----EXHAUST-----			CORRECTED		GRAMS	GMS/BHP-HR
									RNG	DEFL.	CONC.	RNG	DEFL.	CONC.	CONCENTRATION	PPMC		
								A009 MEAS HC	16	1.8	5.49	16	66.0	197.82	192.65	PPMC	112.28	6.710
								A202 MEAS CO	22	.1	6.93	22	30.3	2325.21	2318.68	PPM	2728.39	163.045
								A009 MEAS CO2	23	1.8	.033	23	26.6	.527	.496	%	9165.87	547.739
								A009 MEAS NOX	17	.0	.00	17	12.6	31.27	31.27	PPM	53.20	3.179

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	9.588	10.316	-7.05%

HD920157
999 CRUSADER350MAR92 0
1B CS1G

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 08/25/92 TIME: 07:37:42 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920157
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 8-24-92 12:58
Processing Time: 08/25/92 07:37:39

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 13923 TIM DAVIS

TEST CONDITIONS:

Barometer: 29.30 "HG
Dew Point Temperature: 58.4 F
Dry Bulb Temperature: 76.4 F
Humidity (Abs.): 74.68 grains H2O/lbs. dry air
Humidity (Rel.): 53.70 %
NOx Corr. Factor: .9985

TEST OPTIONS:

Cold Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 19 GASOHOL
Alpha(H/C Ratio): 2.0859
Fuel Specific Gravity: .8239
Lbs Fuel/Gals Fuel: 6.8620

COMMENTS:

1ST COLD START GASAHOL FULL E/M

VALIDATION CHECKS:

<COMMENT>: This test passed cycle performance (Gasoline Regulations)

<COMMENT>: Torque & BHP standard errors are validated by the Digalog

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.456	1.400	4.00
02	245	3.670	3.697	-.73
03	307	10.027	10.097	-.69
04	316	1.418	1.407	.78
TOT	316	16.570	16.601	-.19

Remark: 1ST COLD START FULL E/M GASOHOL

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	16.309	1.00558	-4.677	.99942	248	.6
	02	17.833	1.00284	-3.855	.99967	245	.6
	03	25.923	.99979	-.916	.99878	307	.6
	04	13.115	1.00527	-4.791	.99948	316	.6
	TOT	19.468	1.00051	-.277	.99968	316	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	8.875%	.92758	2.408	.89240	245	.6
	02	5.606%	.89394	3.533	.96466	307	.6
	03	5.480%	.90310	5.748	.96836	307	.6
	04	4.468%	.91406	2.376	.97007	316	.6
	TOT	6.305%	.92443	3.034	.96534	273	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	4.374%	.98364	.713	.93109	245	.6
	02	4.323%	.93487	1.416	.97037	245	.6
	03	4.935%	.91273	4.431	.97090	307	.6
	04	2.353%	.92857	.782	.97556	316	.6
	TOT	4.277%	.95100	1.344	.97792	273	.6

A.19 Gasohol Fuel Cold Start #1

HD920157
999 CRUSADER350MAR92 0
1B CSIG

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 08/25/92 TIME: 07:37:43 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams
Bag 1 NLLN CS	8.941	11.990	148.160	151.155	202.702	2504.640	570.72	765.35	9456.84	3.851	5.164	63.810

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/Bhphr
Bag 1 NLLN CS	1.426	9.784	.590
Measured Fuel Flow: CS	1.710 Gals	11.734 Lbs	

BAG DETAIL REPORT

Bag # 1 NLLN CS	Length : 1167. SEC.	Bhp-Hr : 16.570	Dilut. Factor: 17.076	Bag Fill Time: 1173.0 Sec.	Exh. Volume : 36010. Cu.Ft.	Fuel Consump.: 1.426 Gal. 5.39 L.	BSFC : .590 Lb/Bhp-Hr	"	"	SITE EMISSION	---BACKGROUND---			-----EXHAUST-----			CORRECTED		GRAMS	GMS/BHP-HR
											RNG	DEFL.	CONC.	RNG	DEFL.	CONC.	CONCENTRATION	PPMC		
										A009 MEAS HC	16	1.2	3.66	16	85.2	255.40	251.95	PPMC	148.16	8.941
										A009 MEAS CO	22	.0	.00	22	26.2	2109.62	2109.62	PPM	2504.64	151.155
										A009 MEAS CO2	23	2.4	.044	23	27.6	.548	.507	"	9456.84	570.720
										A009 MEAS NOX	17	.0	.00	17	13.2	32.76	32.76	PPM	63.81	3.851

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
CS	9.784	11.734	-16.62%

HD920158
999 CRUSADER350MAR92 0
1B H51G

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 08/25/92 TIME: 07:42:59 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920158
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 8-24-92 13:36
Processing Time: 08/25/92 07:42:56

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 13923 TIM DAVIS

TEST CONDITIONS:

Barometer: 29.29 "HG
Dew Point Temperature: 57.1 F
Dry Bulb Temperature: 77.8 F
Humidity (Abs.): 71.24 grains H2O/lbs. dry air
Humidity (Rel.): 48.90 %
NOx Corr. Factor: .9826

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 19 GASOHOL
Alpha (H/C Ratio): 2.0859
Fuel Specific Gravity: .8239
Lbs Fuel/Gals Fuel: 6.8620

COMMENTS:

HOT START # 1 GASOHOL FULL E/M

VALIDATION CHECKS:

<COMMENT>: This test passed cycle performance (Gasoline Regulations).

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.419	1.400	1.36
02	246	3.683	3.697	-.38
03	307	10.018	10.097	-.78
04	316	1.417	1.407	.71
TOT	316	16.537	16.601	-.39

Remark: 1ST HOT START FULL E/M GASOHOL

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	15.906	1.00382	-3.922	.99945	248	.6
	02	18.083	1.00153	-3.597	.99966	246	.6
	03	26.458	.99864	-.962	.99872	307	.6
	04	12.689	1.00400	-4.543	.99951	316	.6
	TOT	19.570	.99923	-.046	.99967	316	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	4.690%	.90684	2.679	.96888	246	.6
	02	5.557%	.89208	3.792	.96512	307	.6
	03	5.657%	.90479	5.658	.96648	307	.6
	04	4.594%	.91364	2.344	.96842	316	.6
	TOT	5.319%	.92153	3.161	.97507	273	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	2.665%	.91684	1.028	.97185	246	.6
	02	4.256%	.93503	1.498	.97127	246	.6
	03	5.033%	.91200	4.419	.96972	307	.6
	04	2.380%	.92717	.778	.97501	316	.6
	TOT	3.985%	.94655	1.397	.98062	273	.6

A.20 Gasohol Fuel Hot Start #1

HD920158
999 CRUSADER350MAR92 0
1B HS1G

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 08/25/92 TIME: 07:43:00 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	----- HC -----			----- CO -----			----- CO2 -----			----- NOx -----		
	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams
Bag 1 NLLN HS	7.718	10.350	127.640	138.895	186.261	2296.910	568.05	761.77	9393.86	4.084	5.477	67.540

FUEL CONSUMPTION:

	----- Fuel -----		
	Gals	Lbs	Lbs/ Bhp-hr
Bag 1 NLLN HS	1.379	9.463	.572
Measured Fuel Flow: HS	1.650 Gals	11.322 Lbs	

BAG DETAIL REPORT

Bag # 1	NLLN HS											
Length	: 1167.	SEC.	SITE EMISSION	RNG	DEFL.	CONC.	RNG	DEFL.	CONC.	CORRECTED	GRAMS	GMS/ BHP-HR
Bhp-Hr	: 16.537		A009 MEAS HC	16	1.9	5.79	16	74.3	222.64	217.18	PPMC	7.718
Dilut. Factor:	17.672		A009 MEAS CO	22	.1	7.02	22	24.3	1942.34	1935.72	PPM	138.895
Bag Fill Time:	1173.0	Sec.	A009 MEAS CO2	23	2.2	.040	23	27.3	.542	.504		568.051
Exh. Volume	: 35990.	Cu.Ft.	A009 MEAS NOX	17	.1	.25	17	14.3	35.50	35.26	PPM	4.084
Fuel Consump.:	1.379	Gal.										
"	: 9.46	Lb.										
BSFC	: .572	Lb/Bhp-Hr										
"	: 347.93	Gm/Kw-Hr										

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	9.464	11.322	-16.42%

HD920159
999 CRUSADER350MAR92 0
1B HS2G

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 08/25/92 TIME: 07:48:21 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920159
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 8-24-92 14:14
Processing Time: 08/25/92 07:48:18

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 13923 TIM DAVIS

TEST CONDITIONS:

Barometer: 29.28 "HG
Dew Point Temperature: 51.2 F
Dry Bulb Temperature: 78.2 F
Humidity (Abs.): 57.26 grains H2O/lbs. dry air
Humidity (Rel.): 38.90 %
NOx Corr. Factor: .9230

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 19 GASOHOL
Alpha (H/C Ratio): 2.0859
Fuel Specific Gravity: .8239
Lbs Fuel/Gals Fuel: 6.8620

COMMENTS:

HOT START # 2 GASOHOL FULL E/M

VALIDATION CHECKS:

<COMMENT>: This test passed cycle performance (Gasoline Regulations).

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.415	1.400	1.07
02	246	3.669	3.697	-.76
03	307	9.997	10.097	-.99
04	316	1.408	1.407	.07
TOT	316	16.489	16.601	-.67

"Remark: 2ND HOT START FULL E/M GASOHOL"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	12.288	1.00356	-4.615	.99967	248	.6
	02	15.460	1.00112	-4.270	.99975	246	.6
	03	23.216	.99819	-1.605	.99901	307	.6
	04	10.909	1.00416	-5.538	.99964	316	.6
	TOT	16.852	.99878	-.534	.99976	316	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	4.152%	.90652	2.599	.97542	246	.6
	02	5.238%	.89308	3.597	.96895	307	.6
	03	5.171%	.90573	5.556	.97189	307	.6
	04	4.240%	.91168	2.282	.97287	316	.6
	TOT	4.915%	.92200	3.048	.97865	273	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	2.290%	.92208	.962	.97930	246	.6
	02	3.909%	.93599	1.406	.97570	246	.6
	03	4.593%	.91280	4.297	.97469	307	.6
	04	2.111%	.92825	.745	.98027	316	.6
	TOT	3.631%	.94699	1.335	.98388	273	.6

A.21 Gasohol Fuel Hot Start #2

HD920159
999 CRUSADER350MAR92 0
1B HS2G

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 08/25/92 TIME: 07:48:22 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams
Bag 1 NLLN HS	7.635	10.239	125.890	138.822	186.163	2289.030	561.88	753.49	9264.86	3.714	4.981	61.240

FUEL CONSUMPTION:

	Gals	Lbs	Lbs/ Bhp-hr
Bag 1 NLLN HS	1.364	9.360	.568
Measured Fuel Flow: HS	1.640 Gals	11.254 Lbs	

BAG DETAIL REPORT

Bag # 1 NLLN HS										
Length : 1167.	SEC.	SITE EMISSION	---- <td>---- <td>CORRECTED</td> <td></td> <td>GMS/ BHP-HR</td> <td></td> <td></td> <td></td> </td>	---- <td>CORRECTED</td> <td></td> <td>GMS/ BHP-HR</td> <td></td> <td></td> <td></td>	CORRECTED		GMS/ BHP-HR			
Bhp-Hr : 16.489		A009 MEAS HC	RNG DEFL. CONC.	RNG DEFL. CONC.	CONCENTRATION	GRAMS				
Dilut. Factor: 17.881		A009 MEAS CO	16 2.1 6.40	16 73.5 220.25	214.20 PPMC	125.89	7.635			
Bag Fill Time: 1173.0	Sec.	A009 MEAS CO2	22 .2 14.05	22 24.3 1942.34	1929.08 PPM	2289.03	138.822			
Exh. Volume : 35990.	Cu.Ft.	A009 MEAS NOX	23 2.1 .038	23 26.9 .533	.497 %	9264.86	561.881			
Fuel Consump.: 1.364 Gal.	5.15 L.		17 .2 .50	17 13.9 34.50	34.04 PPM	61.24	3.714			
" : 9.36 Lb.	4245.5 Gm									
BSFC : .568 Lb/Bhp-Hr										
" : 345.50 Gm/Kw-Hr										

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	9.360	11.254	-16.83%

HD920160
999 CRUSADER350MAR92 0
1B CS2G

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 08/25/92 TIME: 10:53:07 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920160
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 8-25-92 8:36
Processing Time: 08/25/92 10:53:04

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 13923 TIM DAVIS

TEST CONDITIONS:

Barometer: 29.29 "HG
Dew Point Temperature: 52.3 F
Dry Bulb Temperature: 78.2 F
Humidity (Abs.): 59.65 grains H2O/lbs. dry air
Humidity (Rel.): 40.50 %
NOx Corr. Factor: .9327

TEST OPTIONS:

Cold Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 19 GASOHOL
Alpha (H/C Ratio): 2.0859
Fuel Specific Gravity: .8239
Lbs Fuel/Gals Fuel: 6.8620

COMMENTS:

COLD START # 2 FULL E/M GASOHOL

VALIDATION CHECKS:

<COMMENT>: This test passed cycle performance (Gasoline Regulations).

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.457	1.400	4.07
02	246	3.674	3.697	-.62
03	307	10.026	10.097	-.70
04	316	1.415	1.407	.57
TOT	316	16.572	16.601	-.17

Remark: COLD START # 2 FULL E/M GASOHOL.

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	13.342	1.00639	-5.522	.99961	248	.6
	02	15.780	1.00319	-4.328	.99974	246	.6
	03	24.021	1.00023	-1.868	.99895	307	.6
	04	11.000	1.00610	-5.735	.99963	316	.6
	TOT	17.436	1.00085	-.726	.99974	316	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	6.269%	.92744	2.473	.94470	246	.6
	02	5.312%	.89500	3.473	.96824	307	.6
	03	5.127%	.90276	5.792	.97218	307	.6
	04	4.155%	.91649	2.205	.97417	316	.6
	TOT	5.365%	.92526	2.989	.97474	273	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	3.319%	.97510	.731	.95898	246	.6
	02	3.900%	.93853	1.366	.97593	246	.6
	03	4.573%	.91167	4.504	.97485	307	.6
	04	2.123%	.93319	.736	.98026	316	.6
	TOT	3.795%	.95157	1.329	.98255	273	.6

A.22 Gasohol Fuel Cold Start #2

HD920160
999 CRUSADER350MAR92 0
1B CS2G

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 08/25/92 TIME: 10:53:08 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams
Bag 1 NLLN CS	8.735	11.714	144.760	147.135	197.311	2438.320	574.47	770.38	9520.12	3.640	4.881	60.330

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/Bhphr
Bag 1 NLLN CS	1.420	9.747	.588
Measured Fuel Flow: CS	1.690 Gals	11.597 Lbs	

BAG DETAIL REPORT

Bag # 1 NLLN CS			----BACKGROUND----			-----EXHAUST-----			CORRECTED		
Length	: 1167.	SEC.	SITE EMISSION	RNG DEFL.	CONC.	RNG DEFL.	CONC.	CONCENTRATION	GRAMS	GMS/BHP-HR	
Bhp-Hr	: 16.572		A009 MEAS HC	16	1.1	3.35	16	83.3	249.67	246.51 PPMC	144.76
Dilut. Factor:	17.172		A009 MEAS CO	22	.0	.00	22	25.6	2056.61	2056.61 PPM	2438.32
Bag Fill Time:	1171.0	Sec.	A009 MEAS CO2	22	4.7	.041	22	58.3	.550	.511	9520.12
Exh. Volume	:35960.	Cu.Ft.	A009 MEAS NOX	15	.1	.05	15	66.8	33.26	33.21 PPM	60.33
Fuel Consump.:	1.420 Gal.	5.37 L.									
"	: 9.75 Lb.	4421.3 Gm									
BSFC	: .588 Lb/Bhp-Hr										
"	: 357.67 Gm/Kw-Hr										

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
CS	9.747	11.597	-15.95%

HD920170
999 CRUSADER350MAR92 0
1B HS3G

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 08/25/92 TIME: 10:58:37 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920170
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 8-25-92 9:15
Processing Time: 08/25/92 10:58:34

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 13923 TIM DAVIS

TEST CONDITIONS:

Barometer: 29.29 "HG
Dew Point Temperature: 55.7 F
Dry Bulb Temperature: 78.2 F
Humidity (Abs.): 67.67 grains H2O/lbs. dry air
Humidity (Rel.): 45.90 %
NOx Corr. Factor: .9667

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 19 GASOHOL
Alpha(H/C Ratio): 2.0859
Fuel Specific Gravity: .8239
Lbs Fuel/Gals Fuel: 6.8620

COMMENTS:

HOT START # 3 FULL E/M GASOHOL

VALIDATION CHECKS:

<COMMENT>: This test passed cycle performance (Gasoline Regulations).

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.457	1.400	4.07
02	246	3.674	3.697	-.62
03	307	10.026	10.097	-.70
04	316	1.415	1.407	.57
TOT	316	16.572	16.601	-.17

Remark: HOT START # 3 FULL E/M GASOHOL

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	13.342	1.00639	-5.522	.99961	248	.6
	02	15.780	1.00319	-4.328	.99974	246	.6
	03	24.021	1.00023	-1.868	.99895	307	.6
	04	11.000	1.00610	-5.735	.99963	316	.6
	TOT	17.436	1.00085	-.726	.99974	316	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	6.269%	.92744	2.473	.94470	246	.6
	02	5.312%	.89500	3.473	.96824	307	.6
	03	5.127%	.90276	5.792	.97218	307	.6
	04	4.155%	.91649	2.205	.97417	316	.6
	TOT	5.365%	.92526	2.989	.97474	273	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	3.319%	.97510	.731	.95898	246	.6
	02	3.900%	.93853	1.366	.97593	246	.6
	03	4.573%	.91167	4.504	.97485	307	.6
	04	2.123%	.93319	.736	.98026	316	.6
	TOT	3.795%	.95157	1.329	.98255	273	.6

A.23 Gasohol Fuel Hot Start #3

HD920170
999 CRUSADER350MAR92 0
1B HS3G

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 08/25/92 TIME: 10:58:38 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/Bhp-hr	Gms/Kw-Hr	Grams	Gms/Bhp-hr	Gms/Kw-Hr	Grams	Gms/Bhp-hr	Gms/Kw-Hr	Grams	Gms/Bhp-hr	Gms/Kw-Hr	Grams
Bag 1 NLLN HS	7.363	9.874	122.030	135.945	182.305	2252.870	559.65	750.50	9274.49	3.827	5.132	63.430

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/Bhp-hr
Bag 1 NLLN HS	1.358	9.318	.562
Measured Fuel Flow: HS	1.630 Gals	11.185 Lbs	

BAG DETAIL REPORT

Bag # 1 NLLN HS	Length : 1167. SEC.	Bhp-Hr : 16.572	Dilut. Factor: 17.947	Bag Fill Time: 1172.0 Sec.	Exh. Volume : 35990. Cu.Ft.	Fuel Consump.: 1.358 Gal. 5.13 L.	BSFC : .562 Lb/Bhp-Hr	"	"	---BACKGROUND---		-----EXHAUST-----		CORRECTED		GRAMS	GMS/BHP-HR
										SITE EMISSION	RNG DEFL.	CONC.	RNG DEFL.	CONC.	CONCENTRATION		
A009 MEAS HC	16	2.2	6.71	16	71.4	213.96	207.63	PPMC	122.03	7.363							
A009 MEAS CO	22	.0	.00	22	23.8	1898.61	1898.61	PPM	2252.87	135.945							
A009 MEAS CO2	22	4.6	.040	22	56.9	.535	.497	%	9274.49	559.648							
A009 MEAS NOX	15	.0	.00	15	67.6	33.66	33.66	PPM	63.43	3.827							

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	9.318	11.185	-16.69%

HD920171
999 CRUSADER350MAR92 0
1B HS4G

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 08/25/92 TIME: 11:04:27 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920171
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 8-25-92 9:54
Processing Time: 08/25/92 11:04:24

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 13923 TIM DAVIS

TEST CONDITIONS:

Barometer: 29.28 "HG
Dew Point Temperature: 55.9 F
Dry Bulb Temperature: 78.5 F
Humidity (Abs.): 68.19 grains H2O/lbs. dry air
Humidity (Rel.): 45.80 %
NOx Corr. Factor: .9690

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 19 GASOHOL
Alpha (H/C Ratio): 2.0859
Fuel Specific Gravity: .8239
Lbs Fuel/Gals Fuel: 6.8620

COMMENTS:

HOT START # 4 FULL E/M GASOHOL

VALIDATION CHECKS:

<COMMENT>: This test passed cycle performance (Gasoline Regulations).

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.403	1.400	.21
02	246	3.674	3.697	-.62
03	307	10.012	10.097	-.84
04	316	1.411	1.407	.28
TOT	316	16.500	16.601	-.61

"Remark: HOT START # 4 FULL E/M GASOHOL"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	13.038	1.00412	-5.512	.99963	248	.6
	02	15.166	1.00117	-4.383	.99976	246	.6
	03	22.605	.99817	-1.783	.99907	307	.6
	04	11.180	1.00456	-6.254	.99962	316	.6
	TOT	16.703	.99886	-.864	.99976	316	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	4.184%	.90531	2.452	.97498	246	.6
	02	5.165%	.89546	3.623	.96994	307	.6
	03	5.165%	.91028	5.356	.97223	307	.6
	04	4.295%	.91750	2.141	.97252	316	.6
	TOT	4.913%	.92517	2.946	.97881	273	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	2.302%	.92028	.883	.97900	246	.6
	02	3.815%	.93880	1.387	.97696	246	.6
	03	4.514%	.91764	4.116	.97579	307	.6
	04	2.112%	.93307	.702	.98044	316	.6
	TOT	3.573%	.95009	1.269	.98448	273	.6

A.24 Gasohol Fuel Hot Start #4

HD920171
999 CRUSADER350MAR92 0
1B HS4G

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 08/25/92 TIME: 11:04:28 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams
Bag 1 NLLN HS	7.395	9.917	122.020	138.769	186.092	2289.690	561.00	752.32	9256.53	3.795	5.089	62.610

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/Bhphr
Bag 1 NLLN HS	1.362	9.346	.566
Measured Fuel Flow: HS	1.630 Gals	11.185 Lbs	

BAG DETAIL REPORT

Bag # 1 NLLN HS	Length : 1167. SEC.	Bhp-Hr : 16.500	Dilut. Factor: 17.864	Bag Fill Time: 1172.0 Sec.	Exh. Volume : 36040. Cu.Ft.	Fuel Consump.: 1.362 Gal. 5.15 L.	" : 9.35 Lb. 4239.3 Gm	BSFC : .566 Lb/Bhp-Hr	" : 344.28 Gm/Kw-Hr	---BACKGROUND---			-----EXHAUST-----			CORRECTED		GRAMS	GMS/BHP-HR
										SITE EMISSION	RNG DEFL.	CONC.	RNG DEFL.	CONC.	CONCENTRATION	PPMC			
A009 MEAS HC										16	2.2	6.71	16	71.3	213.66	207.33	PPMC	122.02	7.395
A009 MEAS CO										22	.1	7.02	22	24.2	1933.59	1926.96	PPM	2289.69	138.769
A009 MEAS CO2										22	4.8	.042	22	56.9	.535	.496	%	9256.53	561.002
A009 MEAS NOX										15	.0	.00	15	66.5	33.10	33.10	PPM	62.61	3.795

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	9.346	11.185	-16.44%

HD920181
999 CRUSADER350MAR92 0
1B HS1B

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 09/03/92 TIME: 11:01:12 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920181
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 9- 3-92 9:17
Processing Time: 09/03/92 11:01:09

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requester: 56432 JOE HURLEY
Analyzer Operator: 13923 TIM DAVIS

TEST CONDITIONS:

Barometer: 28.95 "HG
Dew Point Temperature: 47.7 F
Dry Bulb Temperature: 78.9 F
Humidity (Abs.): 50.74 grains H2O/lbs. dry air
Humidity (Rel.): 33.40 %
NOx Corr. Factor: .8977

TEST OPTIONS:

Hot Start Only One Bag Only
Manual Zero and Span
Digalog Dyno Controller

FUEL PROPERTIES:

Fuel Type: 5 IND UNLEADED, 96 OCT
Alpha(H/C Ratio): 1.8655
Fuel Specific Gravity: .7432
Lbs Fuel/Gals Fuel: 6.1900

COMMENTS:

HOT START # 1 (20 % BLEND FOR DAVE G)

VALIDATION CHECKS:

<COMMENT>: This test passed cycle performance (Gasoline) evaluation.

<COMMENT>: Torque & BHP standard errors are validated by 10 Dispers.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.429	1.427	.14
02	245	3.774	3.773	.03
03	305	10.264	10.305	-.40
04	316	1.463	1.431	2.24
TOT	307	16.930	16.936	-.04

"Remark: 1ST HOT START 20 % BLEND FOR DAVE (G)"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	18.547	1.00879	-5.123	.99926	248	.8
	02	22.738	1.00609	-4.140	.99946	245	.8
	03	21.260	1.00343	-2.134	.99918	305	.8
	04	17.464	1.00967	-6.029	.99908	316	.8
	TOT	20.494	1.00393	-.758	.99965	307	.8

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	3.796%	.93766	1.407	.98084	245	.8
	02	4.576%	.93332	2.102	.97836	307	.8
	03	4.194%	.93034	4.071	.98244	305	.8
	04	3.630%	.94783	1.563	.98153	307	.8
	TOT	4.173%	.94838	1.922	.98525	273	.8

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	1.963%	.96342	.401	.98593	245	.8
	02	3.007%	.97267	.694	.98662	245	.8
	03	3.455%	.93951	3.164	.98613	305	.8
	04	1.561%	.97373	.456	.99006	307	.8
	TOT	2.764%	.97128	.814	.99078	273	.8

A.25 20% Ethanol Blend Fuel Hot Start #1

HD920181
999 CRUSADER350MAR92 0
1B HS1B

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 09/03/92 TIME: 11:01:13 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams
Bag 1 NLLN HS	7.476	10.025	126.570	133.483	179.004	2259.870	569.83	764.15	9647.20	4.199	5.631	71.100

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/Bhphr
Bag 1 NLLN HS	1.527	9.453	.558

Measured Fuel Flow: HS 1.740 Gals 10.771 Lbs

BAG DETAIL REPORT

Bag # 1	NLLN HS			---BACKGROUND---			-----EXHAUST-----			CORRECTED		GMS/
Length	: 1167.	SEC.	SITE EMISSION	RNG	DEFL.	CONC.	RNG	DEFL.	CONC.	CONCENTRATION	GRAMS	BHP-HR
Bhp-Hr	: 16.930		A009 MEAS HC	16	.9	2.75	16	73.5	220.25	217.66 PPMC	126.57	7.476
Dilut. Factor:	17.322		A009 MEAS CO	22	.0	.00	22	24.1	1924.83	1924.83 PPM	2259.87	133.483
Bag Fill Time:	1172.0	Sec.	A009 MEAS CO2	23	2.1	.038	23	28.1	.559	.523 %	9647.20	569.829
Exh. Volume	: 35610.	Cu.Ft.	A009 MEAS NOX	15	.1	.05	15	82.3	41.11	41.07 PPM	71.10	4.199
Fuel Consump.:	1.527	Gal.										
"	: 9.45	Lb.										
BSFC	: .558	Lb/Bhp-Hr										
"	: 339.42	Gm/Kw-Hr										

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	9.453	10.771	-12.23%

20% Ethanol Blend Fuel Hot Start #1

HD920182
999 CRUSADER350MAR92 0
1B HS2B

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 09/03/92 TIME: 13:30:51 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920182
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 9- 3-92 9:56
Processing Time: 09/03/92 13:30:48

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 13923 TIM DAVIS

TEST CONDITIONS:

Barometer: 28.95 "HG
Dew Point Temperature: 52.1 F
Dry Bulb Temperature: 78.5 F
Humidity (Abs.): 59.90 grains H2O/lbs. dry air
Humidity (Rel.): 39.90 %
NOx Corr. Factor: .9337

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 5 IND UNLEADED, 96 OCT
Alpha(H/C Ratio): 1.8655
Fuel Specific Gravity: .7432
Lbs Fuel/Gals Fuel: 6.1900

COMMENTS:

HOT START # 2 (20 % BLEND FOR DAVE G)

VALIDATION CHECKS:

<COMMENT>: This test passed cycle performance (Gasoline Regulations).

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.445	1.427	1.26
02	245	3.778	3.773	.13
03	305	10.245	10.305	-.58
04	316	1.467	1.431	2.52
TOT	304	16.935	16.936	-.01

"Remark: 2ND HOT START 20 % BLEND FOR DAVE (G)"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	12.961	1.00888	-5.524	.99964	248	.8
	02	15.620	1.00611	-4.524	.99974	245	.8
	03	21.633	1.00325	-2.165	.99915	305	.8
	04	11.576	1.00976	-6.349	.99960	316	.8
	TOT	16.523	1.00383	-.947	.99977	304	.8

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	3.345%	.94753	1.477	.98537	245	.8
	02	3.875%	.94549	1.848	.98478	307	.8
	03	4.142%	.93600	3.598	.98304	305	.8
	04	3.458%	.95611	1.503	.98349	304	.8
	TOT	3.791%	.95344	1.814	.98784	273	.8

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	1.774%	.96582	.474	.98853	245	.8
	02	2.774%	.97629	.639	.98867	245	.8
	03	3.483%	.94232	2.870	.98589	305	.8
	04	1.544%	.97666	.436	.99035	304	.8
	TOT	2.650%	.97175	.788	.99143	273	.8

HD920182
999 CRUSADER350MAR92 0
1B HS2B

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 09/03/92 TIME: 13:30:52 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC -----			CO -----			CO2 -----			NOx -----		
	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams
Bag 1 NLLN HS	7.598	10.189	128.670	136.896	183.581	2318.340	576.80	773.50	9768.14	4.381	5.875	74.190

FUEL CONSUMPTION:

	Fuel -----		
	Gals	Lbs	Lbs/ Bhp-hr
Bag 1 NLLN HS	1.552	9.606	.567
Measured Fuel Flow: HS	1.750 Gals	10.833 Lbs	

BAG DETAIL REPORT

Bag # 1	NLLN HS										
Length	: 1167.	SEC.	SITE EMISSION	RNG	DEFL.	CONC.	RNG	DEFL.	CONC.	CORRECTED	
Bhp-Hr	: 16.935		A009 MEAS HC	16	1.9	5.79	16	75.6	226.54	221.09	PPMC
Dilut. Factor:	17.077		A009 MEAS CO	22	.2	14.05	22	24.8	1986.19	1972.97	PPM
Bag Fill Time:	1173.0	Sec.	A009 MEAS CO2	23	2.0	.037	23	28.3	.563	.529	%
Exh. Volume	: 35640.	Cu.Ft.	A009 MEAS NOX	15	.0	.00	15	82.4	41.16	41.16	PPM
Fuel Consump.:	1.552 Gal.	5.86 L.									
"	: 9.61	Lb.									
BSFC	: .567	Lb/Bhp-Hr									
"	: 344.89	Gm/Kw-Hr									

20% Ethanol Blend Fuel Hot Start #2

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	9.606	10.833	-11.32%

HD920193
999 CRUSADER350MAR92 0
1B CA30

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 09/23/92 TIME: 16:53:16 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920193
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 9-23-92 15:49
Processing Time: 09/23/92 16:53:13

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36c
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 13923 TIM DAVIS

TEST CONDITIONS:

Barometer: 29.39 "HG
Dew Point Temperature: 51.0 F
Dry Bulb Temperature: 76.4 F
Humidity (Abs.): 56.62 grains H2O/lbs. dry air
Humidity (Rel.): 41.00 %
NOx Corr. Factor: .9205

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 5 IND UNLEADED, 96 OCT
Alpha (H/C Ratio): 1.8655
Fuel Specific Gravity: .7432
Lbs Fuel/Gals Fuel: 6.1900

COMMENTS:

COLD START A 30 % BLEND ETHANOL

VALIDATION CHECKS:

<COMMENT>: This test passed cycle performance (Gasoline Regulations).

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.425	1.445	-1.38
02	242	3.724	3.818	-2.46
03	303	10.189	10.385	-1.89
04	316	1.416	1.449	-2.28
TOT	309	16.754	17.096	-2.00

"Remark: 1ST COLD START 30 % BLEND ETHANOL FULL/EM"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	13.454	1.01515	-24.071	.99961	248	.6
	02	15.556	1.01239	-22.946	.99975	242	.6
	03	22.181	1.00911	-19.694	.99912	303	.6
	04	11.269	1.01544	-24.221	.99962	316	.6
	TOT	16.733	1.00994	-19.231	.99977	309	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	6.818%	.94495	.593	.93558	242	.6
	02	4.298%	.93109	1.174	.98055	307	.6
	03	4.082%	.94245	2.342	.98353	303	.6
	04	3.350%	.93661	.713	.98373	309	.6
	TOT	4.777%	.94962	.948	.98045	273	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	4.024%	.97367	.183	.93725	242	.6
	02	2.999%	.96387	.374	.98643	242	.6
	03	3.502%	.95078	1.766	.98581	303	.6
	04	1.620%	.95376	.215	.98886	309	.6
	TOT	3.184%	.96761	.414	.98759	273	.6

A.27 30% Ethanol Blend Fuel Cold Start #1

HD920193
999 CRUSADER350MAR92 0
1B CA30

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 09/23/92 TIME: 16:53:17 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams
Bag 1 NLLN HS	5.346	7.169	89.570	73.683	98.811	1234.480	637.11	854.38	10674.17	6.155	8.254	103.130

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/ Bhp-hr
Bag 1 NLLN HS	1.448	8.966	.535
Measured Fuel Flow: HS	1.760 Gals	10.894 Lbs	

BAG DETAIL REPORT

Bag # 1	NLLN HS											
Length	: 1167.	SEC.	SITE EMISSION	RNG DEFL.	CONC.	RNG DEFL.	CONC.	CORRECTED		GRAMS	GMS/ BHP-HR	
Bhp-Hr	: 16.754		A009 MEAS HC	16	.8	2.44	16	51.9	155.78	153.47 PPMC	89.57	5.346
Dilut. Factor:	18.410		A009 MEAS CO	22	.0	.00	22	14.2	1047.64	1047.64 PPM	1234.48	73.683
Bag Fill Time:	1173.0	Sec.	A009 MEAS CO2	22	3.9	.033	22	64.0	.608	.576 %	10674.17	637.112
Exh. Volume	: 35740.	Cu.Ft.	A009 MEAS NOX	17	.0	.00	17	23.3	57.88	57.88 PPM	103.13	6.155
Fuel Consump.:	1.448	Gal.										
"	: 8.97	Lb.										
BSFC	: .535	Lb/Bhp-Hr										
"	: 325.43	Gm/Kw-Hr										

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	8.966	10.894	-17.70%

HD920191
999 CRUSADER350MAR92 0
1B HA30

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 09/23/92 TIME: 12:58:26 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920191
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 9-23-92 9:50
Processing Time: 09/23/92 12:58:24

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 13923 TIM DAVIS

TEST CONDITIONS:

Barometer: 29.42 "HG
Dew Point Temperature: 33.3 F
Dry Bulb Temperature: 78.5 F
Humidity (Abs.): 28.40 grains H2O/lbs. dry air
Humidity (Rel.): 19.30 %
NOx Corr. Factor: .8203

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 5 IND UNLEADED, 96 OCT
Alpha (H/C Ratio): 1.8655
Fuel Specific Gravity: .7432
Lbs Fuel/Gals Fuel: 6.1900

COMMENTS:

HOT START A 30 % BLEND ETHANOL

VALIDATION CHECKS:

<COMMENT>: This test passed cycle performance (Gasoline Regulations).

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.418	1.445	-1.87
02	242	3.724	3.818	-2.46
03	304	10.173	10.385	-2.04
04	316	1.423	1.449	-1.79
TOT	315	16.738	17.096	-2.09

*Remark: 1ST HOT START FULL E/M"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	12.728	1.01311	-23.144	.99965	248	.6
	02	15.297	1.01022	-22.096	.99976	242	.6
	03	22.383	1.00706	-19.145	.99910	304	.6
	04	11.135	1.01344	-23.864	.99963	316	.6
	TOT	16.613	1.00785	-18.517	.99977	315	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	3.322%	.94732	.473	.98547	242	.6
	02	3.854%	.93615	1.112	.98448	307	.6
	03	4.069%	.94981	1.849	.98385	304	.6
	04	2.982%	.95344	.345	.98751	315	.6
	TOT	3.672%	.95534	.736	.98868	273	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	1.784%	.95521	.238	.98815	242	.6
	02	2.755%	.96442	.353	.98853	242	.6
	03	3.456%	.95652	1.363	.98665	304	.6
	04	1.497%	.96168	.154	.99062	315	.6
	TOT	2.594%	.96799	.348	.99198	273	.6

A.28 30% Ethanol Blend Fuel Hot Start #1

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams
Bag 1 NLLN HS	6.008	8.057	100.560	81.099	108.756	1357.430	615.57	825.49	10303.42	5.998	8.043	100.400

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/ Bhp-hr
Bag 1 NLLN HS	1.432	8.866	.530
Measured Fuel Flow: HS	1.730 Gals	10.709 Lbs	

BAG DETAIL REPORT

Bag # 1 NLLN HS			SITE EMISSION	---BACKGROUND---		-----EXHAUST-----		CORRECTED		GRAMS	GMS/ BHP-HR
				RNG	DEFL.	RNG	DEFL.	CONCENTRATION			
Length	: 1167.	SEC.	A009 MEAS HC	16	.9	16	58.2	171.96	PPMC	100.56	6.008
Bhp-Hr	: 16.738		A009 MEAS CO	22	.1	22	15.6	1149.73	PPM	1357.43	81.099
Dilut. Factor:	18.541		A009 MEAS CO2	22	4.3	22	62.3	.555	%	10303.42	615.571
Bag Fill Time:	1341.0	Sec.	A009 MEAS NOX	17	.0	17	25.4	63.11	PPM	100.40	5.998
Exh. Volume	: 35810.	Cu.Ft.									
Fuel Consump.:	1.432 Gal.	5.41 L.									
"	: 8.87 Lb.	4021.7 Gm									
BSFC	: .530 Lb/Bhp-Hr										
"	: 322.39 Gm/Kw-Hr										

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	8.866	10.709	-17.20%

30% Ethanol Blend Fuel Hot Start #1

HD920192
999 CRUSADER350MAR92 0
1B HB30

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 09/23/92 TIME: 13:06:35 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920192
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 9-23-92 10:30
Processing Time: 09/23/92 13:06:32

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 13923 TIM DAVIS

TEST CONDITIONS:

Barometer: 29.42 "HG
Dew Point Temperature: 49.9 F
Dry Bulb Temperature: 78.9 F
Humidity (Abs.): 54.27 grains H2O/lbs. dry air
Humidity (Rel.): 36.30 %
NOx Corr. Factor: .9112

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 5 IND UNLEADED, 96 OCT
Alpha(H/C Ratio): 1.8655
Fuel Specific Gravity: .7432
Lbs Fuel/Gals Fuel: 6.1900

COMMENTS:

HOT START B 30 % BLEND ETHANOL

VALIDATION CHECKS:

<COMMENT>: This test passed cycle performance (Gasoline Regulations).

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.429	1.445	-1.11
02	244	3.735	3.818	-2.17
03	304	10.155	10.385	-2.21
04	316	1.409	1.449	-2.76
TOT	316	16.727	17.096	-2.16

"Remark: 2ND HOT START FULL E/M"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	25.846	1.01069	-21.218	.99856	248	.6
	02	28.320	1.00860	-20.750	.99917	244	.6
	03	31.337	1.00568	-17.580	.99823	304	.6
	04	21.909	1.01136	-22.586	.99856	316	.6
	TOT	27.423	1.00656	-17.752	.99937	316	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	4.407%	.94170	.774	.97436	244	.6
	02	4.934%	.93618	1.233	.97481	307	.6
	03	4.833%	.94257	2.259	.97703	304	.6
	04	4.081%	.93347	.636	.97584	316	.6
	TOT	4.652%	.94938	.987	.98177	273	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	2.629%	.94392	.403	.97391	244	.6
	02	3.696%	.96002	.500	.97935	244	.6
	03	4.149%	.94745	1.731	.98056	304	.6
	04	2.198%	.94481	.235	.97924	316	.6
	TOT	3.366%	.96153	.489	.98643	273	.6

A.29 30% Ethanol Blend Fuel Hot Start #2

HD920192
999 CRUSADER350MAR92 0
1B HB30

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 09/23/92 TIME: 13:06:36 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams
Bag 1 NLLN HS	6.176	8.282	103.310	81.795	109.689	1368.180	618.73	829.73	10349.50	6.071	8.141	101.550

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/Bhphr
Bag 1 NLLN HS	1.440	8.916	.533
Measured Fuel Flow: HS	1.740 Gals	10.771 Lbs	

BAG DETAIL REPORT

Bag # 1 NLLN HS	Length : 1167. SEC.	Bhp-Hr : 16.727	Dilut. Factor: 18.479	Bag Fill Time: 1173.0 Sec.	Exh. Volume : 35850. Cu.Ft.	Fuel Consump.: 1.440 Gal. 5.44 L.	BSFC : .533 Lb/Bhp-Hr	: 324.21 Gm/Kw-Hr	---BACKGROUND---			---EXHAUST---			CORRECTED		GMS/BHP-HR	
									SITE EMISSION	RNG DEFL.	CONC.	RNG DEFL.	CONC.	CONCENTRATION	GRAMS			
A009 MEAS HC									16	1.4	4.27	16	60.2	180.51	176.48	PPMC	103.31	6.176
A009 MEAS CO									22	.1	7.04	22	15.7	1164.19	1157.53	PPM	1368.18	81.795
A009 MEAS CO2									22	4.2	.035	22	62.4	.591	.557	%	10349.50	618.730
A009 MEAS NOX									17	.1	.25	17	23.2	57.63	57.40	PPM	101.55	6.071

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	8.916	10.771	-17.22%

30% Ethanol Blend Fuel Hot Start #2

HD920186
999 CRUSADER350MAR92 0
1B H140

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 09/11/92 TIME: 07:31:09 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams
Bag 1 NLLN HS	6.082	8.156	102.360	64.890	87.019	1092.040	615.63	825.57	10360.37	6.019	8.072	101.290

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/ Bhp-hr
Bag 1 NLLN HS	1.393	8.620	.512
Measured Fuel Flow: HS	1.700 Gals	10.523 Lbs	

BAG DETAIL REPORT

Bag # 1 NLLN HS		SITE EMISSION			----BACKGROUND----		-----EXHAUST-----		CORRECTED		GMS/ BHP-HR	
Length	: 1167. SEC.	A009 MEAS HC	RNG	DEFL.	CONC.	RNG	DEFL.	CONC.	CONCENTRATION	GRAMS		
Bhp-Hr	: 16.829	16	1.4	4.27	16	60.1	180.22	176.17	PPMC	102.36	6.082	
Dilut. Factor:	18.973	A009 MEAS CO	22	.0	.00	22	12.3	930.92	930.92	PPM	1092.04	64.890
Bag Fill Time:	1173.0 Sec.	A009 MEAS CO2	22	4.0	.035	22	62.7	.595	.562	%	10360.37	615.626
Exh. Volume	:35580. Cu.Ft.	A009 MEAS NOX	17	.0	.00	17	24.3	60.37	60.37	PPM	101.29	6.019
Fuel Consump.:	1.393 Gal. 5.26 L.											
"	: 8.62 Lb. 3910.0 Gm											
BSFC	: .512 Lb/Bhp-Hr											
"	: 311.44 Gm/Kw-Hr											

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	8.620	10.523	-18.08%

HD920186
999 CRUSADER350MAR92 0
1B H140

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 09/11/92 TIME: 07:31:07 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920186
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 9-10-92 15:22
Processing Time: 09/11/92 07:31:04

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 11165 MIKE MATTHEWS

TEST CONDITIONS:

Barometer: 29.03 "HG
Dew Point Temperature: 43.7 F
Dry Bulb Temperature: 81.3 F
Humidity (Abs.): 43.41 grains H2O/lbs. dry air
Humidity (Rel.): 26.50 %
NOx Corr. Factor: .8707

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 5 IND UNLEADED, 96 OCT
Alpha(H/C Ratio): 1.8655
Fuel Specific Gravity: .7432
Lbs Fuel/Gals Fuel: 6.1900

COMMENTS:

HOT START # 1 40 % BLEND ETHANOL FUEL

VALIDATION CHECKS:

<COMMENT>: This test passed cycle performance (Gasoline Regulations).

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.440	1.429	.77
02	241	3.743	3.755	-.32
03	300	10.176	10.238	-.61
04	316	1.470	1.433	2.58
TOT	314	16.829	16.855	-.15

"Remark: 1ST H/START 40 % BLEND ETHANOL FUEL"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	12.450	1.00426	-4.935	.99966	248	.6
	02	15.264	1.00176	-4.164	.99976	241	.6
	03	21.401	.99889	-1.643	.99916	300	.6
	04	11.269	1.00512	-5.989	.99962	316	.6
	TOT	16.186	.99953	-.754	.99978	314	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	3.565%	.94040	1.784	.98323	241	.6
	02	3.962%	.93399	2.292	.98345	307	.6
	03	4.071%	.95603	2.560	.98392	300	.6
	04	3.082%	.93285	2.432	.98621	314	.6
	TOT	3.773%	.95030	2.167	.98795	273	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	2.049%	.96193	.515	.98514	241	.6
	02	2.880%	.96989	.744	.98779	241	.6
	03	3.525%	.96328	1.791	.98644	300	.6
	04	1.576%	.96211	.606	.98997	314	.6
	TOT	2.712%	.97468	.718	.99153	273	.6

A.30 40% Ethanol Blend Fuel Hot Start #1

HD920187
999 CRUSADER350MAR92 0
1B H240

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 09/11/92 TIME: 09:06:42 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams
Bag 1 NLLN HS	6.575	8.817	110.490	63.401	85.022	1065.520	605.84	812.45	10181.81	5.882	7.888	98.860

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/ Bhp-hr
Bag 1 NLLN HS	1.371	8.485	.505
Measured Fuel Flow: HS	1.660 Gals	10.275 Lbs	

BAG DETAIL REPORT

Bag # 1 NLLN HS			---BACKGROUND---		---EXHAUST---		CORRECTED			
Length : 1167.	SEC.	SITE EMISSION	RNG	DEFL.	CONC.	RNG	DEFL.	CONC.	CONCENTRATION	GRAMS
Bhp-Hr : 16.806		A009 MEAS HC	16	1.0	3.05	16	64.3	192.74	189.85 PPMC	110.49
Dilut. Factor: 19.317		A009 MEAS CO	22	.0	.00	22	12.0	906.78	906.78 PPM	1065.52
Bag Fill Time: 1173.0	Sec.	A009 MEAS CO2	22	3.9	.034	22	61.6	.584	.551 %	10181.81
Exh. Volume : 35640.	Cu.Ft.	A009 MEAS NOX	17	.0	.00	17	23.9	59.37	59.37 PPM	98.86
Fuel Consump.: 1.371	Gal.									
" : 8.48	Lb.									
BSFC : .505	Lb/Bhp-Hr									
" : 307.18	Gm/Kw-Hr									

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	8.485	10.275	-17.42%

HD920187
999 CRUSADER350MAR92 0
1B H240

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 09/11/92 TIME: 09:06:40 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920187
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 9-10-92 16: 1
Processing Time: 09/11/92 07:38:44

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 11165 MIKE MATTHEWS

TEST CONDITIONS:

Barometer: 29.03 "HG
Dew Point Temperature: 42.3 F
Dry Bulb Temperature: 78.5 F
Humidity (Abs.): 41.11 grains H2O/lbs. dry air
Humidity (Rel.): 27.50 %
NOx Corr. Factor: .8626

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 5 IND UNLEADED, 96 OCT
Alpha(H/C Ratio): 1.8655
Fuel Specific Gravity: .7432
Lbs Fuel/Gals Fuel: 6.1900

COMMENTS:

HOT START # 2 40 % BLEND ETHANOL FUEL

VALIDATION CHECKS:

<COMMENT>: This test passed cycle performance (Gasoline Regulations).

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.441	1.429	.84
02	241	3.747	3.755	-.21
03	300	10.158	10.238	-.78
04	316	1.460	1.433	1.88
TOT	314	16.806	16.855	-.29

"Remark: 2ND H/START 40 % BLEND ETHANOL FUEL"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	16.186	1.00368	-4.674	.99943	248	.6
	02	17.804	1.00128	-3.987	.99967	241	.6
	03	24.290	.99838	-1.347	.99892	300	.6
	04	12.689	1.00418	-5.464	.99951	316	.6
	TOT	18.762	.99905	-.611	.99970	314	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	4.213%	.93920	1.861	.97668	241	.6
	02	4.535%	.93565	2.284	.97851	307	.6
	03	4.626%	.95252	2.713	.97917	300	.6
	04	3.417%	.93239	2.266	.98309	314	.6
	TOT	4.294%	.94957	2.156	.98442	273	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	2.615%	.95582	.587	.97571	241	.6
	02	3.393%	.96930	.783	.98310	241	.6
	03	3.995%	.95829	1.964	.98247	300	.6
	04	1.848%	.95959	.563	.98617	314	.6
	TOT	3.167%	.97191	.756	.98842	273	.6

A.31 40% Ethanol Blend Fuel Hot Start #2

HD920207
999 CRUSADER350MAR92 0
1B CIWC

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 10/14/92 TIME: 12:47:06 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams
Bag 1 NLLN CS	5.698	7.641	95.840	78.991	105.929	1328.550	624.57	837.56	10504.58	5.895	7.905	99.140

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/Bhphr
Bag 1 NLLN CS	1.448	8.964	.533

Measured Fuel Flow: CS 1.780 Gals 11.018 Lbs

BAG DETAIL REPORT

Bag # 1 NLLN CS	Length : 1167. SEC.	Bhp-Hr : 16.819	Dilut. Factor: 18.471	Bag Fill Time: 1178.0 Sec.	Exh. Volume : 35740. Cu.Ft.	Fuel Consump.: 1.448 Gal. 5.47 L.	" : 8.96 Lb. 4066.1 Gm	BSFC : .533 Lb/Bhp-Hr	" : 324.21 Gm/Kw-Hr	---BACKGROUND---		-----EXHAUST-----		CORRECTED		GRAMS	GMS/BHP-HR	
										SITE EMISSION	RNG DEFL.	CONC.	RNG DEFL.	CONC.	CONCENTRATION			PPMC
A009 MEAS HC										16	1.0	3.05	16	55.7	167.10	164.22	95.84	5.698
A009 MEAS CO										22	.2	14.09	22	15.4	1140.79	1127.47	1328.55	78.991
A009 MEAS CO2										23	1.6	.029	23	29.9	.595	.561	10504.58	624.566
A009 MEAS NOX										17	.0	.00	17	23.0	57.13	57.13	99.14	5.895

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
CS	8.964	11.018	-18.64%

HD920207
999 CRUSADER350MAR92 0
1B CIWC

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 10/14/92 TIME: 12:47:05 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920207
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 10-14-92 12: 8
Processing Time: 10/14/92 12:47:02

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 13923 TIM DAVIS

TEST CONDITIONS:

Barometer: 28.91 "HG
Dew Point Temperature: 47.5 F
Dry Bulb Temperature: 76.0 F
Humidity (Abs.): 50.43 grains H2O/lbs. dry air
Humidity (Rel.): 36.50 %
NOx Corr. Factor: .8965

TEST OPTIONS:

Cold Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 5 IND UNLEADED, 96 OCT
Alpha(H/C Ratio): 1.8655
Fuel Specific Gravity: .7432
Lbs Fuel/Gals Fuel: 6.1900

COMMENTS:

COLD START # 1 30 % BLEND ETHANOL W/CHOKE

VALIDATION CHECKS:

<COMMENT>: This test passed cycle performance (Gasoline Regulations).

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.616	1.376	17.44
02	245	3.704	3.677	.73
03	305	10.098	10.097	.01
04	316	1.402	1.381	1.52
TOT	313	16.819	16.532	1.74

"Remark: 1ST COLD START 30 % BLEND ETHANOL W/CHOKE"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	90.510	1.00824	8.219	.98255	248	.4
	02	29.715	1.00950	-3.420	.99908	245	.4
	03	32.125	1.00650	-.069	.99815	305	.4
	04	22.271	1.01186	-4.863	.99851	316	.4
	TOT	49.366	1.00620	3.610	.99796	313	.4

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	6.482%	.96007	1.473	.94747	245	.4
	02	4.802%	.94726	2.036	.97689	307	.4
	03	4.720%	.96680	1.804	.97961	305	.4
	04	3.741%	.95905	1.238	.98062	313	.4
	TOT	5.000%	.96369	1.566	.97994	273	.4

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	3.724%	.99020	.501	.95125	245	.4
	02	3.476%	.98728	.565	.98215	245	.4
	03	4.071%	.97354	1.518	.98190	305	.4
	04	1.990%	.97882	.342	.98339	313	.4
	TOT	3.449%	.98638	.583	.98610	273	.4

A.32 30% Ethanol (with Choke Mechanism) Cold Start #1

HD920205
999 CRUSADER350MAR92 0
1B HIWC

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 10/14/92 TIME: 10:41:09 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams
Bag 1 NLLN HS	5.050	6.772	83.820	77.662	104.146	1288.960	610.45	818.63	10131.65	5.905	7.919	98.000

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/ Bhp-hr
Bag 1 NLLN HS	1.395	8.635	.520

Measured Fuel Flow: HS 1.670 Gals 10.337 Lbs

BAG DETAIL REPORT

Bag # 1 NLLN HS			SITE EMISSION			CORRECTED			GMS/		
Length	: 1167.	SEC.	RNG DEFL.	CONC.		RNG DEFL.	CONC.		CONCENTRATION	GRAMS	BHP-HR
Bhp-Hr	: 16.597		16	2.2	6.71	16	50.3	151.02	144.67	PPMC	5.050
Dilut. Factor:	18.899		22	.0	.00	22	14.9	1101.89	1101.89	PPM	77.662
Bag Fill Time:	1173.0	Sec.	23	1.9	.034	23	29.4	.584	.551	%	610.450
Exh. Volume	: 35480.	Cu.Ft.	17	.0	.00	17	22.0	54.65	54.65	PPM	98.00
Fuel Consump.:	1.395	Gal.									
"	: 8.64	Lb.									
BSFC	: .520	Lb/Bhp-Hr									
"	: 316.30	Gm/Kw-Hr									

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	8.635	10.337	-16.46%

HD920205
999 CRUSADER350MAR92 0
18 H1WC

HEAVY DUTY GASOLINE TRANSIENT TEST
ADMINISTRATIVE REPORT

DATE: 10/14/92 TIME: 10:41:08 PAGE: 1

ADMINISTRATIVE INFORMATION:

Test No.: HD-920205
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 10-14-92 8:57
Processing Time: 10/14/92 10:41:05

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 11165 MIKE MATTHEWS

TEST CONDITIONS:

Barometer: 28.90 "HG
Dew Point Temperature: 52.0 F
Dry Bulb Temperature: 78.5 F ✓
Humidity (Abs.): 59.78 grains H2O/lbs. dry air
Humidity (Rel.): 39.70 %
NOx Corr. Factor: .9333

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller
One Bag Only

FUEL PROPERTIES:

Fuel Type: 5 IND UNLEADED, 96 OCT
Alpha(H/C Ratio): 1.8655
Fuel Specific Gravity: .7432
Lbs Fuel/Gals Fuel: 6.1900

COMMENTS:

HOT START # 1 WITH CHOKE 30 % BLEND ETHANOL FUEL

VALIDATION CHECKS:

<COMMENT>: This test passed cycle performance (Gasoline Regulations).

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.413	1.376	2.69
02	243	3.693	3.677	.44
03	301	10.090	10.097	-.07
04	316	1.401	1.381	1.45
TOT	314	16.597	16.532	.39

"Remark: 1ST H/START 30 % BLEND ETHANOL W/ CHOKE"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	27.129	1.00967	-3.827	.99841	248	.4
	02	28.653	1.00719	-2.710	.99914	243	.4
	03	31.048	1.00450	.255	.99826	301	.4
	04	21.702	1.00969	-4.283	.99858	316	.4
	TOT	27.659	1.00535	-.006	.99936	314	.4

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	3.614%	.96747	1.383	.98336	243	.4
	02	4.361%	.94705	2.048	.98084	307	.4
	03	4.251%	.96284	2.081	.98326	301	.4
	04	3.690%	.95614	1.369	.98102	314	.4
	TOT	4.046%	.96328	1.616	.98678	273	.4

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	2.162%	.97953	.469	.98275	243	.4
	02	3.278%	.98125	.624	.98398	243	.4
	03	3.673%	.96948	1.651	.98513	301	.4
	04	1.923%	.97614	.363	.98440	314	.4
	TOT	2.941%	.98283	.603	.98984	273	.4

A.33 30% Ethanol (with Choke Mechanism) Hot Start #1

HD920206
999 CRUSADER350MAR92 0
1B H2WC

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 10/14/92 TIME: 10:47:26 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams
Bag 1 NLLN HS	4.990	6.692	82.820	75.582	101.357	1254.430	605.44	811.90	10048.45	5.676	7.612	94.200

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/ Bhp-hr
Bag 1 NLLN HS	1.379	8.538	.514

Measured Fuel Flow: HS 1.670 Gals 10.337 Lbs

BAG DETAIL REPORT

Bag # 1 NLLN HS		SITE EMISSION	----BACKGROUND----	-----EXHAUST-----	CORRECTED		GMS/ BHP-HR
Length	: 1167. SEC.		RNG DEFL.	CONC.	RNG DEFL.	CONC.	
Bhp-Hr	: 16.597	A009 MEAS HC	16 .8	2.44	16 48.3	145.06	142.75 PPMC 82.82 4.990
Dilut. Factor	: 19.236	A009 MEAS CO	22 .0	.00	22 14.5	1070.86	1070.86 PPM 1254.43 75.582
Bag Fill Time	: 1173.0 Sec.	A009 MEAS CO2	23 1.7	.031	23 29.0	.575	.546 10048.45 605.437
Exh. Volume	: 35530. Cu.Ft.	A009 MEAS NOX	17 .0	.00	17 22.0	54.65	54.65 PPM 94.20 5.676
Fuel Consump.	: 1.379 Gal. 5.21 L.						
"	: 8.54 Lb. 3872.6 Gm						
BSFC	: .514 Lb/Bhp-Hr						
"	: 312.65 Gm/Kw-Hr						

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	8.538	10.337	-17.41%

HD920206
999 CRUSADER350MAR92 0
1B H2WC

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 10/14/92 TIME: 10:47:24 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920206
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 10-14-92 8:57
Processing Time: 10/14/92 10:47:22

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 11165 MIKE MATTHEWS

TEST CONDITIONS:

Barometer: 28.90 "HG
Dew Point Temperature: 47.4 F
Dry Bulb Temperature: 79.2 F
Humidity (Abs.): 50.26 grains H2O/lbs. dry air
Humidity (Rel.): 32.70 %
NOx Corr. Factor: .8958

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 5 IND UNLEADED, 96 OCT
Alpha(H/C Ratio): 1.8655
Fuel Specific Gravity: .7432
Lbs Fuel/Gals Fuel: 6.1900

COMMENTS:

HOT START # 2 30 % BLEND ETHANOL WITH CHOKE

VALIDATION CHECKS:

<COMMENT>: This test passed cycle performance (Gasoline regulations).

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.413	1.376	2.69
02	243	3.693	3.677	.44
03	301	10.090	10.097	-.07
04	316	1.401	1.381	1.45
TOT	314	16.597	16.532	.39

"Remark: 1ST H/START 30 % BLEND ETHANOL W/ CHOKE"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	27.129	1.00967	-3.827	.99841	248	.4
	02	28.653	1.00719	-2.710	.99914	243	.4
	03	31.048	1.00450	.255	.99826	301	.4
	04	21.702	1.00969	-4.283	.99858	316	.4
	TOT	27.659	1.00535	-.006	.99936	314	.4

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	3.614%	.96747	1.383	.98336	243	.4
	02	4.361%	.94705	2.048	.98084	307	.4
	03	4.251%	.96284	2.081	.98326	301	.4
	04	3.690%	.95614	1.369	.98102	314	.4
	TOT	4.046%	.96328	1.616	.98678	273	.4

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	2.162%	.97953	.469	.98275	243	.4
	02	3.278%	.98125	.624	.98398	243	.4
	03	3.673%	.96948	1.651	.98513	301	.4
	04	1.923%	.97614	.363	.98440	314	.4
	TOT	2.941%	.98283	.603	.98984	273	.4

A.34 30% Ethanol (with Choke Mechanism) Hot Start #2

HD920210
999 CRUSADER350MAR92 0
1B C2WC

HEAVY DUTY ENGINE TRANSIENT TEST

DATE: 10/15/92 TIME: 14:42:44 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/Bhp-hr	Gms/Kw-Hr	Grams	Gms/Bhp-hr	Gms/Kw-Hr	Grams	Gms/Bhp-hr	Gms/Kw-Hr	Grams	Gms/Bhp-hr	Gms/Kw-Hr	Grams
Bag 1 NLIN CS	6.451	8.651	107.740	78.053	104.671	1303.49	615.97	826.03	10286.71	5.530	7.416	92.350

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/Bhp-hr
Bag 1 NLIN CS	1.424	8.812	.528

Measured Fuel Flow: CS 1.740 Gals 10.771 Lbs

BAG DETAIL REPORT

Bag # 1 NLIN CS			SITE EMISSIONS			EXHAUST			CORRECTED			GRAMS		GMS/BHP-HR		
Length	: 1167.	SEC.	REL. DEFIL.	CONC.	REL. DEFIL.	CONC.	REL. DEFIL.	CONC.	REL. DEFIL.	CONC.	REL. DEFIL.	CONC.	REL. DEFIL.	CONC.	REL. DEFIL.	CONC.
Bhp-Hr	: 16.700		A009 MEAS HC	16	2.75	A009 MEAS CO	22	14.5	A009 MEAS CO2	23	29.5	A009 MEAS NOx	17	21.3		
Dilut. Factor:	18.748		A009 MEAS CO	22	14.5	A009 MEAS CO2	23	29.5	A009 MEAS NOx	17	21.3					
Bag Fill Time:	1176.0	Sec.	A009 MEAS CO	22	14.5	A009 MEAS CO2	23	29.5	A009 MEAS NOx	17	21.3					
Exh. Volume	: 35880.	Cu.Ft.	A009 MEAS CO	22	14.5	A009 MEAS CO2	23	29.5	A009 MEAS NOx	17	21.3					
Fuel Consump.:	1.424	Gal.	A009 MEAS CO	22	14.5	A009 MEAS CO2	23	29.5	A009 MEAS NOx	17	21.3					
"	: 8.81	Lb.	A009 MEAS CO	22	14.5	A009 MEAS CO2	23	29.5	A009 MEAS NOx	17	21.3					
BSFC	: .528	Lb/Bhp-Hr	A009 MEAS CO	22	14.5	A009 MEAS CO2	23	29.5	A009 MEAS NOx	17	21.3					
"	: 321.17	Gm/Kw-Hr	A009 MEAS CO	22	14.5	A009 MEAS CO2	23	29.5	A009 MEAS NOx	17	21.3					

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
CS	8.812	10.771	-18.19%

30% Ethanol (with Choke Mechanism) Cold Start #2

HD920210
999 CRUSADER350MAR92 0
1B C2WC

HEAVY DUTY ENGINE TRANSIENT TEST

DATE: 10/15/92 TIME: 14:42:43 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920210
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 999 TECHNOLOGY ASSESSMENT -
Test Date/Time: 10-15-92 12:36
Processing Time: 10/15/92 14:42:40

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 300
CVS Type: CIV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 13923 TIM DAVIS

TEST CONDITIONS:

Barometer: 29.07 "HG
Dew Point Temperature: 47.9 F
Dry Bulb Temperature: 71.8 F
Humidity (Abs.): 50.92 grains H2O/lbs. dry air
Humidity (Rel.): 42.60 %
NOx Corr. Factor: .8983

TEST OPTIONS:

Cold Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 5 IND UNLEADED, 96 OCT
Alpha(H/C Ratio): 1.8655
Fuel Specific Gravity: .7432
Lbs Fuel/Gals Fuel: 6.1900

COMMENTS:

COLD START # 2 / 30 % BLEND ETHANOL WITH CHOKE

VALIDATION CHECKS:

<COMMENT>: This test passed cycle performance (calculated separation).

<COMMENT>: Torque & BHP standard errors are validly calculated.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.462	1.376	6.25
02	245	3.702	3.677	.68
03	301	10.126	10.097	.29
04	316	1.469	1.381	6.33
TOT	313	16.700	16.532	1.02

"REMARK: COLD START # 2 / 30 % BLEND FUEL W/ CHOKE"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	27.713	1.01138	-1.801	.99835	248	.4
	02	29.326	1.00977	-2.177	.99911	245	.4
	03	31.177	1.00671	1.425	.99825	301	.4
	04	22.249	1.01244	-3.943	.99852	316	.4
	TOT	28.142	1.00763	1.033	.99934	313	.4

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	6.135%	.96562	1.424	.95319	245	.4
	02	4.704%	.94763	2.001	.97780	307	.4
	03	4.427%	.96973	1.752	.98212	301	.4
	04	3.635%	.95350	1.523	.98147	313	.4
	TOT	4.784%	.96465	1.677	.98163	273	.4

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	3.534%	.99037	1.442	.95590	245	.4
	02	3.454%	.98517	1.606	.98239	245	.4
	03	3.788%	.98048	1.295	.98451	301	.4
	04	1.886%	.98013	1.375	.98511	313	.4
	TOT	3.289%	.98924	1.550	.98743	273	.4

A.35 30% Ethanol (with Choke Mechanism) Cold Start #2

HD920208
999 CRUSADER350MAR92 1
1B H3WC

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 10/16/92 TIME: 09:08:07 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920208
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 1

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 10-15-92 8:11
Processing Time: 10/16/92 09:08:04

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 13923 TIM DAVIS

TEST CONDITIONS:

Barometer: 29.04 "HG
Dew Point Temperature: 48.3 F
Dry Bulb Temperature: 76.0 F
Humidity (Abs.): 51.75 grains H2O/lbs. dry air
Humidity (Rel.): 37.60 %
NOx Corr. Factor: .9015

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 5 IND UNLEADED, 96 OCT
Alpha (H/C Ratio): 1.8655
Fuel Specific Gravity: .7432
Lbs Fuel/Gals Fuel: 6.1900

COMMENTS:

HOT START # 3 / 30 % BLEND ETHANOL WITH CHOKE

VALIDATION CHECKS:

<COMMENT>: This test passed cycle performance (Gasoline Regulations).

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.414	1.376	2.76
02	243	3.686	3.617	.24
03	303	10.109	10.097	.12
04	316	1.403	1.381	1.59
TOT	315	16.613	16.532	.49

"Remark: HOT START # 3 30 % BLEND ETHANOL WITH CHOKE"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	37.121	1.00793	-.442	.99702	248	.4
	02	41.279	1.00662	-.522	.99822	243	.4
	03	37.736	1.00422	2.433	.99743	303	.4
	04	32.264	1.00897	-2.156	.99686	316	.4
	TOT	37.443	1.00501	1.883	.99882	315	.4

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	3.983%	.95803	1.605	.97946	243	.4
	02	4.797%	.93918	2.245	.97654	307	.4
	03	4.942%	.95557	2.679	.97738	303	.4
	04	4.044%	.94998	1.472	.97700	315	.4
	TOT	4.541%	.95841	1.827	.98324	273	.4

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	2.547%	.97236	.539	.97586	243	.4
	02	3.737%	.97489	.739	.97896	243	.4
	03	4.372%	.96318	2.124	.97891	303	.4
	04	2.307%	.97040	.431	.97744	315	.4
	TOT	3.461%	.97993	.720	.98589	273	.4

A.36 30% Ethanol (with Choke Mechanism) Hot Start #3

HD920209
999 CRUSADER350MAR92 1
1B H4WC

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 10/16/92 TIME: 09:15:37 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920209
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 1

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 10-15-92 8:50
Processing Time: 10/16/92 09:15:34

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 13923 TIM DAVIS

TEST CONDITIONS:

Barometer: 29.04 "HG
Dew Point Temperature: 48.0 F
Dry Bulb Temperature: 76.6 F
Humidity (Abs.): 51.17 grains H2O/lbs. dry air
Humidity (Rel.): 36.40 %
NOx Corr. Factor: .8993

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 5 IND UNLEADED, 96 OCT
Alpha(H/C Ratio): 1.8655
Fuel Specific Gravity: .7432
Lbs Fuel/Gals Fuel: 6.1900

COMMENTS:

HOT START # 4 / 30 % BLEND ETHANOL WITH CHOKE

VALIDATION CHECKS:

<COMMENT>: This test passed cycle performance (Gasoline Regulations).

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	248	1.415	1.376	2.83
02	244	3.699	3.677	.60
03	303	10.098	10.097	.01
04	316	1.403	1.381	1.59
TOT	315	16.615	16.532	.50

"Remark: HOT START # 4 / 30 % BLEND ETHANOL WITH CHOKE"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	37.789	1.00784	-1.052	.99691	248	.4
	02	41.207	1.00623	-.570	.99823	244	.4
	03	37.121	1.00366	2.917	.99751	303	.4
	04	31.670	1.00800	-1.473	.99697	316	.4
	TOT	37.269	1.00460	1.849	.99883	315	.4

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	4.193%	.96287	1.475	.97749	244	.4
	02	4.993%	.93961	2.333	.97466	307	.4
	03	4.923%	.95173	2.869	.97737	303	.4
	04	3.992%	.95402	1.375	.97776	315	.4
	TOT	4.620%	.95867	1.815	.98267	273	.4

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	2.632%	.97450	.532	.97430	244	.4
	02	3.838%	.97736	.758	.97795	244	.4
	03	4.367%	.95777	2.335	.97872	303	.4
	04	2.290%	.97275	.396	.97787	315	.4
	TOT	3.503%	.97854	.751	.98551	273	.4

A.37 30% Ethanol (with Choke Mechanism) Hot Start #4

HD920208
999 CRUSADER350MAR92 1
1B H3WC

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 10/16/92 TIME: 09:08:08 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams
Bag 1 NLLN HS	4.974	6.670	82.640	73.291	98.285	1217.580	595.62	798.74	9895.05	5.756	7.719	95.630

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/ Bhp-hr
Bag 1 NLLN HS	1.355	8.390	.505
Measured Fuel Flow: HS	1.670 Gals	10.337 Lbs	

BAG DETAIL REPORT

Bag # 1 NLLN HS	--- BACKGROUND ---			----- EXHAUST -----			CORRECTED	GRAMS	GMS/
	RMG	DEFLL	CONC.	RMG	DEFLL	CONC.	CONCENTRATION		BHP-HR
Length : 1167. SEC.	16	1.0	3.05	16	48.2	144.76	141.87 PPMC	82.64	4.974
Bhp-Hr : 16.613	22	.3	21.14	22	14.3	1055.37	1035.32 PPM	1217.58	73.291
Dilut. Factor: 19.524	23	1.8	.033	23	28.6	.566	.535 %	9895.05	595.621
Bag Fill Time: 1172.0 Sec.	17	.1	.25	17	22.2	55.14	54.91 PPM	95.63	5.756
Exh. Volume : 35670. Cu.Ft.									
Fuel Consump.: 1.355 Gal. 5.12 L.									
" : 8.39 Lb. 3805.8 Gm									
BSFC : .505 Lb/Bhp-Hr									
" : 307.18 Gm/Kw-Hr									

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	8.390	10.337	-18.83%

HD920199
999 CRUSADER350MAR92 0
1B ACB5

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 10/08/92 TIME: 15:45:06 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920199
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 10- 8-92 13:42
Processing Time: 10/08/92 15:45:03

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36c
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 13923 TIM DAVIS

TEST CONDITIONS:

Barometer: 29.03 "HG
Dew Point Temperature: 52.3 F
Dry Bulb Temperature: 77.5 F
Humidity (Abs.): 60.18 grains H2O/lbs. dry air
Humidity (Rel.): 41.50 %
NOx Corr. Factor: .9349

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 15 CLEAN AIR ACT BASELINE
Alpha (H/C Ratio): 1.8382
Fuel Specific Gravity: .8670
Lbs Fuel/Gals Fuel: 7.2210

COMMENTS:

ALT CYCLE BOAT ICOMIA CYCLE # 3 TEST RUN 1

VALIDATION CHECKS:

<COMMENT>: This test passed cycle performance (Gasoline Regulations).

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	273	6.487	6.597	-1.67
02	268	.777	.777	.00
03	300	6.753	6.921	-2.43
04	305	.003	.000	.00
TOT	301	14.020	14.295	-1.92

"Remark: 3RD ICOMIA CYCLE RUN # A"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	66.302	1.00458	-12.406	.99717	273	.6
	02	30.397	1.00092	-10.567	.99631	268	.6
	03	123.004	.99236	26.021	.98648	300	.6
	04	.000	.00000	688.689	.00000	305	.6
	TOT	81.111	1.00277	-7.144	.99534	301	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	4.379%	.96122	.953	.97655	268	.6
	02	.886%	.98263	.173	.99379	300	.6
	03	3.795%	.92497	2.364	.97375	300	.6
	04	.597%	.00000	.295	.00000	301	.6
	TOT	3.294%	.95880	.761	.98494	58	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	4.696%	.96444	.716	.97679	268	.6
	02	.269%	.98092	.031	.99744	268	.6
	03	3.528%	.93489	1.386	.98411	300	.6
	04	.086%	.00000	.051	.00000	301	.6
	TOT	3.276%	.95859	.497	.98607	58	.6

A.38 Low Transience ICOMIA (CAAB Fuel) Hot Start #1

HD920209
999 CRUSADER350MAR92 1
1B H4WC

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 10/16/92 TIME: 09:15:38 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams
Bag 1 NLLN HS	5.030	6.745	83.570	75.041	100.632	1246.810	612.15	820.91	10170.93	5.780	7.751	96.040

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/ Bhp-hr
Bag 1 NLLN HS	1.392	8.616	.519
Measured Fuel Flow: HS	1.670 Gals	10.337 Lbs	

BAG DETAIL REPORT

			---BACKGROUND---			---EXHAUST---			CORRECTED	GRAMS	GMS/ BHP-HR
			RNG	DEFL.	CONC.	RNG	DEFL.	CONC.	CONCENTRATION		
Bag # 1	NLLN HS										
Length	: 1167.	SEC.							143.11	PPMC	83.57
Bhp-Hr	: 16.615		A009	MEAS	HC	16	49.1	147.44			5.030
Dilut. Factor:	19.051		A009	MEAS	CO	22	14.5	1070.86	1057.51	PPM	1246.81
Bag Fill Time:	1173.0	Sec.	A009	MEAS	CO2	23	29.3	.582	.549	%	10170.93
Exh. Volume	: 35760.	Cu.Ft.	A009	MEAS	NOX	17	22.2	55.14	55.14	PPM	96.04
Fuel Consump.:	1.392 Gal.	5.26 L.									
"	: 8.62 Lb.	3908.2 Gm									
BSFC	: .519 Lb/Bhp-Hr										
"	: 315.70 Gm/Kw-Hr										

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	8.616	10.337	-16.65%

HD920200
999 CRUSADER350MAR92 0
1B ACB6

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 10/13/92 TIME: 15:43:44 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920200
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 10- 8-92 14:17
Processing Time: 10/08/92 15:55:30

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 13923 TIM DAVIS

TEST CONDITIONS:

Barometer: 29.03 "HG
Dew Point Temperature: 52.5 F
Dry Bulb Temperature: 77.8 F
Humidity (Abs.): 60.64 grains H2O/lbs. dry air
Humidity (Rel.): 41.40 %
NOx Corr. Factor: .9368

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 15 CLEAN AIR ACT BASELINE
Alpha (H/C Ratio): 1.8382
Fuel Specific Gravity: .8670
Lbs Fuel/Gals Fuel: 7.2210

COMMENTS:

ALT CYCLE BOAT ICOMIA CYCLE # 3 RUN B

VALIDATION CHECKS:

<COMMENT>: This test passed cycle performance (Gasoline Regulations).

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	273	6.488	6.597	-1.65
02	269	.773	.777	-.51
03	300	6.747	6.921	-2.51
04	305	.002	.000	.00
TOT	303	14.009	14.295	-2.00

"Remark: 3RD ICOMIA CYCLE RUN # B"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	65.658	1.00394	-12.032	.99722	273	.6
	02	30.414	1.00002	-10.154	.99630	269	.6
	03	122.849	.99176	26.295	.98650	300	.6
	04	.000	.00000	688.206	.00000	305	.6
	TOT	80.889	1.00220	-6.996	.99536	303	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	4.304%	.96108	.979	.97740	269	.6
	02	.899%	.98032	.143	.99359	300	.6
	03	3.638%	.92819	2.208	.97627	300	.6
	04	.539%	.00000	.065	.00000	303	.6
	TOT	3.208%	.96023	.687	.98589	58	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	4.618%	.96368	.739	.97775	269	.6
	02	.279%	.97767	.026	.99722	269	.6
	03	3.439%	.93610	1.323	.98529	300	.6
	04	.075%	.00000	.010	.00000	303	.6
	TOT	3.213%	.95860	.477	.98685	58	.6

A.39 Low Transience ICOMIA (CAAB Fuel) Hot Start #2

HD920199
999 CRUSADER350MAR92 0
1B ACB5

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 10/08/92 TIME: 15:45:07 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams
Bag 1 NLLN HS	7.689	10.311	107.790	183.120	245.568	2567.350	556.89	746.80	7807.58	3.151	4.226	44.180

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/Bhphr
Bag 1 NLLN HS	1.171	8.453	.603
Measured Fuel Flow: HS	1.450 Gals	10.470 Lbs	

BAG DETAIL REPORT

Bag # 1 NLLN HS			----BACKGROUND----			-----EXHAUST-----			CORRECTED		GMS/BHP-HR
Length	: 1167.	SEC.	SITE EMISSION	RNG DEFL.	CONC.	RNG DEFL.	CONC.	CONCENTRATION	GRAMS		
Bhp-Hr	: 14.020		A009 MEAS HC	16	1.2	3.66	16	76.2	228.34	224.91 PPMC	107.79
Dilut. Factor:	16.055		A009 MEAS CO	22	.1	7.04	22	33.7	2659.72	2653.12 PPM	2567.35
Bag Fill Time:	965.0	Sec.	A009 MEAS CO2	22	4.1	.035	22	58.1	.546	.513 %	7807.58
Exh. Volume	: 29350.	Cu.Ft.	A009 MEAS NOX	15	.0	.00	15	59.8	29.73	29.73 PPM	44.18
Fuel Consump.	: 1.171 Gal.	4.42 L.									
"	: 8.45 Lb.	3834.1 Gm									
BSFC	: .603 Lb/Bhp-Hr										
"	: 366.79 Gm/Kw-Hr										

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	8.453	10.470	-19.27%

HD920197
999 CRUSADER350MAR92 0
1B ACB3

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 10/08/92 TIME: 08:51:38 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920197
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 10- 7-92 16: 0
Processing Time: 10/08/92 08:51:35

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 11165 MIKE MATTHEWS

TEST CONDITIONS:

Barometer: 29.21 "HG
Dew Point Temperature: 51.9 F
Dry Bulb Temperature: 80.0 F
Humidity (Abs.): 58.92 grains H2O/lbs. dry air
Humidity (Rel.): 37.70 %
NOx Corr. Factor: .9297

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 15 CLEAN AIR ACT BASELINE
Alpha(H/C Ratio): 1.8382
Fuel Specific Gravity: .8670
Lbs Fuel/Gals Fuel: 7.2210

COMMENTS:

ALT CYCLE BOAT 1ST RUN 2ND ICOMIA CYCLE

VALIDATION CHECKS:

<WARNING>: The following cycle performance stats exceed limits:
* SPEED STD ERR (H) = 162.114 RPM (LIMITS: 0.0 TO 100.0 RPM).
* HP SLOPE (H) = .92304 (LIMITS: 0.93 TO 1.03).

<WARNING>: This test is invalid (Gasoline Regulations).

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	273	5.121	5.254	-2.53
02	273	4.130	4.229	-2.34
03	300	4.077	4.197	-2.86
04	305	1.304	1.352	-3.55
TOT	305	14.631	15.032	-2.67

Remark: 1ST RUN ICOMIA 4 MIN # 1

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	163.667	1.00036	8.262	.98342	273	.6
	02	147.183	.99990	4.683	.98320	273	.6
	03	146.054	1.00058	.900	.98351	300	.6
	04	265.930	.97857	101.873	.96623	305	.6
	TOT	162.114	.99933	9.200	.98206	305	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	5.922%	.91893	2.127	.95900	273	.6
	02	4.612%	.92285	1.717	.96810	300	.6
	03	4.613%	.92658	1.426	.96837	300	.6
	04	6.228%	.88523	3.213	.96117	305	.6
	TOT	5.151%	.92001	1.828	.96493	58	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	6.407%	.92603	1.436	.95787	273	.6
	02	4.690%	.92623	1.016	.96875	273	.6
	03	4.753%	.92737	.911	.96784	300	.6
	04	5.787%	.88114	2.666	.97015	305	.6
	TOT	5.354%	.92304	1.191	.96538	58	.6

A.40 Medium Transience ICOMIA (CAAB Fuel) Hot Start #1

HD920200
999 CRUSADER350MAR92 0
1B ACB6

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 10/13/92 TIME: 15:43:45 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams
Bag 1 NLLN HS	7.906	10.602	110.760	185.835	249.209	2603.360	557.98	748.26	7816.75	3.108	4.168	43.540

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/ Bhp-hr
Bag 1 NLLN HS	1.178	8.505	.607
Measured Fuel Flow: HS	1.430 Gals	10.326 Lbs	

BAG DETAIL REPORT

Bag # 1	NLLN HS			---BACKGROUND---			-----EXHAUST-----			CORRECTED		GMS/ BHP-HR	
				RNG	DEFL.	CONC.	RNG	DEFL.	CONC.	CONCENTRATION	GRAMS		
Length	: 1167.	SEC.	SITE EMISSION	16	1.4	4.27	16	78.4	234.94	230.94	PPMC	110.76	7.906
Bhp-Hr	: 14.009		A009 MEAS HC	22	.1	7.04	22	34.1	2695.11	2688.51	PPM	2603.36	185.835
Dilut. Factor:	15.955		A009 MEAS CO2	22	4.2	.035	22	58.2	.547	.514	%	7816.75	557.980
Bag Fill Time:	965.0	Sec.	A009 MEAS NOX	15	.0	.00	15	58.8	29.22	29.22	PPM	43.54	3.108
Exh. Volume	: 29370.	Cu.Ft.											
Fuel Consump.:	1.178	Gal.	4.45 L.										
"	: 8.50	Lb.	3857.7 Gm										
BSFC	: .607	Lb/Bhp-Hr											
"	: 369.22	Gm/Kw-Hr											

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	8.505	10.326	-17.64%

HD920198
999 CRUSADER350MAR92 0
1B ACB4

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 10/08/92 TIME: 08:54:55 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920198
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 10- 7-92 16:36
Processing Time: 10/08/92 08:54:52

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 11165 MIKE MATTHEWS

TEST CONDITIONS:

Barometer: 29.20 "HG
Dew Point Temperature: 59.9 F
Dry Bulb Temperature: 81.0 F
Humidity (Abs.): 79.15 grains H2O/lbs. dry air
Humidity (Rel.): 48.70 %
NOx Corr. Factor: 1.0199

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 15 CLEAN AIR ACT BASELINE
Alpha(H/C Ratio): 1.8382
Fuel Specific Gravity: .8670
Lbs Fuel/Gals Fuel: 7.2210

COMMENTS:

ALT CYCLE BOAT 2ND RUN 2ND ICOMIA CYCLE

VALIDATION CHECKS:

<WARNING>: The following cycle performance stats exceed limits:
* SPEED STD ERR (H) = 163.110 RPM (LIMITS: 0.0 TO 100.0 RPM).
* HP SLOPE (H) = .92383 (LIMITS: 0.93 TO 1.03).

<WARNING>: This test is invalid (Gasoline Regulations).

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	273	5.127	5.254	-2.42
02	273	4.142	4.229	-2.06
03	300	4.081	4.197	-2.76
04	305	1.302	1.352	-3.70
TOT	305	14.652	15.032	-2.53

"Remark: 2ND RUN ICOMIA 4 MIN # 2"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	166.279	1.00020	9.126	.98289	273	.6
	02	151.377	.99964	5.833	.98223	273	.6
	03	143.934	1.00097	-.095	.98399	300	.6
	04	262.322	.97909	99.044	.96714	305	.6
	TOT	163.110	.99935	9.343	.98184	305	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	5.917%	.91935	2.166	.95910	273	.6
	02	4.790%	.92449	1.730	.96580	300	.6
	03	4.591%	.93098	1.273	.96895	300	.6
	04	6.075%	.88291	3.339	.96279	305	.6
	TOT	5.187%	.92175	1.802	.96457	58	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	6.403%	.92632	1.467	.95795	273	.6
	02	4.867%	.92680	1.065	.96646	273	.6
	03	4.704%	.92984	.873	.96864	300	.6
	04	5.633%	.88011	2.674	.97161	305	.6
	TOT	5.381%	.92383	1.206	.96511	58	.6

A.41 Medium Transience ICOMIA (CAAB Fuel) Hot Start #2

HD920197
999 CRUSADER350MAR92 0
1B ACB3

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 10/08/92 TIME: 08:51:39 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams
Bag 1 NLLN HS	8.254	11.069	120.770	171.130	229.489	2503.810	562.80	754.72	8234.28	3.395	4.553	49.680

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/Bhphr
Bag 1 NLLN HS	1.206	8.708	.595
Measured Fuel Flow: HS	1.480 Gals	10.687 Lbs	

BAG DETAIL REPORT

Bag # 1 NLLN HS	Length : 1167. SEC.	Bhp-Hr : 14.631	Dilut. Factor: 15.723	Bag Fill Time: 964.0 Sec.	Exh. Volume :29530. Cu.Ft.	Fuel Consump.: 1.206 Gal. 4.56 L.	" : 8.71 Lb. 3949.9 Gm	BSFC : .595 Lb/Bhp-Hr	" : 361.92 Gm/Kw-Hr	---BACKGROUND---			-----EXHAUST-----			CORRECTED		GRAMS	GMS/BHP-HR
										SITE EMISSION	RNG	DEFL.	CONC.	RNG	DEFL.	CONC.	CONCENTRATION		
A009 MEAS HC										16	1.0	3.05	16	84.5	253.29	250.43	PPMC	120.77	8.254
A009 MEAS CO										22	.0	.00	22	32.7	2571.69	2571.69	PPM	2503.81	171.130
A009 MEAS CO2										22	4.0	.034	22	60.4	.570	.538	%	8234.28	562.797
A009 MEAS NOX										15	.0	.00	15	67.1	33.41	33.41	PPM	49.68	3.395

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	8.708	10.687	-18.52%

Medium Transience ICOMIA (CAAB Fuel) Hot Start #1

HD920195
999 CRUSADER350MAR92 0
1B ACB1

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 10/08/92 TIME: 08:43:44 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920195
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 10- 7-92 14:22
Processing Time: 10/08/92 08:43:41

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 11165 MIKE MATTHEWS

TEST CONDITIONS:

Barometer: 29.23 "HG
Dew Point Temperature: 51.6 F
Dry Bulb Temperature: 80.0 F
Humidity (Abs.): 58.22 grains H2O/lbs. dry air
Humidity (Rel.): 37.20 %
NOx Corr. Factor: .9269

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 15 CLEAN AIR ACT BASELINE
Alpha(H/C Ratio): 1.8382
Fuel Specific Gravity: .8670
Lbs Fuel/Gals Fuel: 7.2210

COMMENTS:

ALT CYCLE BOAT ICOMIA # 1

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	273	4.950	5.095	-2.85
02	273	4.917	5.095	-3.49
03	300	4.927	5.095	-3.30
04	305	.986	1.019	-3.24
TOT	305	15.781	16.305	-3.21

"Remark: 1ST ICOMIA CYCLE WITH E/M"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	317.973	.98891	101.476	.93327	273	.6
	02	309.698	.99356	85.815	.93715	273	.6
	03	306.954	.99611	77.103	.93868	300	.6
	04	315.524	.98888	100.609	.93377	305	.6
	TOT	311.658	.99277	88.383	.93632	305	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	8.281%	.81286	4.941	.90927	273	.6
	02	8.424%	.81828	4.993	.90965	300	.6
	03	8.464%	.82335	4.773	.90981	300	.6
	04	8.700%	.81597	5.316	.90377	305	.6
	TOT	8.415%	.81830	4.924	.90922	58	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	8.683%	.82263	3.460	.90012	273	.6
	02	8.994%	.83101	3.477	.89699	273	.6
	03	8.941%	.83356	3.389	.89813	300	.6
	04	9.195%	.83000	3.693	.89357	305	.6
	TOT	8.902%	.82940	3.456	.89802	58	.6

A.42 High Transience ICOMIA (CAAB Fuel) Hot Start #1

HD920198
999 CRUSADER350MAR92 0
1B ACB4

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 10/08/92 TIME: 08:54:56 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams	Gms/Bhphr	Gms/Kw-Hr	Grams
Bag 1 NLLN HS	8.347	11.194	122.300	172.227	230.960	2523.460	563.40	755.53	8254.90	3.661	4.909	53.640

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/Bhphr
Bag 1 NLLN HS	1.211	8.747	.597

Measured Fuel Flow: HS 1.480 Gals 10.687 Lbs

BAG DETAIL REPORT

Bag # 1	NLLN HS		SITE EMISSION	----BACKGROUND----		----EXHAUST-----		CORRECTED		GMS/
		SEC.		RNG DEFL.	CONC.	RNG DEFL.	CONC.	CONCENTRATION	GRAMS	BHP-HR
Length	: 1167.		A009 MEAS HC	16	.4	1.22	16	84.9	254.50	8.347
Bhp-Hr	: 14.652		A009 MEAS CO	22	.0	.00	22	32.9	2589.25	172.227
Dilut. Factor:	15.688		A009 MEAS CO2	22	3.9	.033	22	60.4	.570	563.398
Bag Fill Time:	965.0	Sec.	A009 MEAS NOX	15	.0	.00	15	66.0	32.85	3.661
Exh. Volume	:29560.	Cu.Ft.						32.85	PPM	
Fuel Consump.:	1.211	Gal.								
"	: 8.75	Lb.								
BSFC	: .597	Lb/Bhp-Hr								
"	: 363.14	Gm/Kw-Hr								

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	8.747	10.687	-18.15%

Medium Transience ICOMIA (CAAB Fuel) Hot Start #2

HD920196
999 CRUSADER350MAR92 0
1B ACB2

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 10/08/92 TIME: 08:48:46 PAGE: 1

ADMINISTRATIVE REPORT

ADMINISTRATIVE INFORMATION:

Test No.: HD-920196
Test Type: EXPERIMENTAL
Test Procedure: HD GAS TRANSIENT

Manufacturer: 999 EXPERIMENTAL
Engine I.D.: CRUSADER350MAR92
Version: 0

Engine Test Class: 92 TECHNOLOGY ASSESSMENT -
Test Date/Time: 10- 7-92 15:25
Processing Time: 10/08/92 08:48:43

EQUIPMENT AND PERSONNEL IDENTIFIERS:

Dyno: D101
Dyno Operator: 56432 JOE HURLEY

CVS I.D.: 36C
CVS Type: CFV

Test Requestor: 56432 JOE HURLEY
Analyzer Operator: 13923 TIM DAVIS

TEST CONDITIONS:

Barometer: 29.22 "HG
Dew Point Temperature: 51.8 F
Dry Bulb Temperature: 80.3 F
Humidity (Abs.): 58.68 grains H2O/lbs. dry air
Humidity (Rel.): 37.20 %
NOx Corr. Factor: .9288

TEST OPTIONS:

Hot Start Only
Manual Zero and Span
Digalog Dyno Controller

One Bag Only

FUEL PROPERTIES:

Fuel Type: 15 CLEAN AIR ACT BASELINE
Alpha (H/C Ratio): 1.8382
Fuel Specific Gravity: .8670
Lbs Fuel/Gals Fuel: 7.2210

COMMENTS:

ALT CYCLE BOAT ICOMIA # 2

VALIDATION CHECKS:

<WARNING>: The following cycle performance stats exceed limits:
* SPEED STD ERR (H) = 152.098 RPM (LIMITS: 0.0 TO 100.0 RPM).
* HP SLOPE (H) = .92487 (LIMITS: 0.93 TO 1.03).

<WARNING>: This test is invalid (Gasoline Regulations).

<COMMENT>: Torque & BHP standard errors are validated by the Digalog.

SEGMENT	LENGTH	ACT BHP-HR	REF BHP-HR	% DIFF
01	273	5.138	5.254	-2.21
02	273	4.147	4.229	-1.94
03	300	4.091	4.197	-2.53
04	305	1.310	1.352	-3.11
TOT	305	14.685	15.032	-2.31

"Remark: 1ST RUN ICOMIA 4 MIN # 1"

SPEED	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	153.535	1.00137	7.208	.98541	273	.6
	02	137.124	1.00107	2.400	.98542	273	.6
	03	138.556	1.00150	.566	.98516	300	.6
	04	248.181	.98169	91.400	.97064	305	.6
	TOT	152.098	1.00048	7.480	.98421	305	.6

TORQUE	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	5.945%	.92073	2.098	.95886	273	.6
	02	4.831%	.92450	1.710	.96523	300	.6
	03	4.706%	.92777	1.440	.96720	300	.6
	04	6.736%	.87874	3.635	.95422	305	.6
	TOT	5.292%	.92088	1.850	.96312	58	.6

HP	SEG	STD.ERR	SLOPE	CONST	RSQUARE	NSIZE	SHIFT
	01	6.231%	.92942	1.419	.96034	273	.6
	02	4.788%	.92808	1.055	.96760	273	.6
	03	4.783%	.92878	.950	.96754	300	.6
	04	6.134%	.87802	2.938	.96636	305	.6
	TOT	5.358%	.92487	1.228	.96547	58	.6

A.43 High Transience ICOMIA (CAAB Fuel) Hot Start #2

HD920195
999 CRUSADER350MAR92 0
1B ACB1

HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 10/08/92 TIME: 08:43:46 PAGE: 3

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams
Bag 1 NLLN HS	9.025	12.103	142.420	188.885	253.299	2980.800	559.15	749.83	8823.92	3.343	4.483	52.760

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/ Bhp-hr
Bag 1 NLLN HS	1.341	9.685	.614
Measured Fuel Flow: HS	1.640 Gals	11.842 lbs	

BAG DETAIL REPORT

Bag # 1 NLLN HS			----BACKGROUND----	----EXHAUST-----	CORRECTED		GMS/ BHP-HR			
Length	: 1167.	SEC.	SITE EMISSION	RNG DEFL.	CONC.	CONCENTRATION	GRAMS			
Bhp-Hr	: 15.781		A009 MEAS HC	14	9.1	6.77	16 100.7 302.43	296.13 PPMC	142.42	9.025
Dilut. Factor:	14.148		A009 MEAS CO	16	3.0	2.96	22 38.3 3072.68	3069.93 PPM	2980.80	188.885
Bag Fill Time:	964.0	Sec.	A009 MEAS CO2	22	4.0	.034	22 64.2 .610	.578 %	8823.92	559.149
Exh. Volume	:29450.	Cu.Ft.	A009 MEAS NOX	15	.0	.00	15 71.6 35.68	35.68 PPM	52.76	3.343
Fuel Consump.:	1.341 Gal.	5.07 L.								
"	: 9.68 Lb.	4392.9 Gm								
BSFC	: .614 Lb/Bhp-Hr									
"	: 373.48 Gm/Kw-Hr									

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	9.685	11.842	-18.22%

Table B.1 :
Certification Fuel ICOMIA/BSO Steady-State #1

Mode	1	2	3	4	5	6	7	8
Date	7/23/92							
Speed, rpm	4258	3406	2556	1704	700	2132	2982	3830
Torque, ft-lb	277	197	129	71	1	99	161	209
Power, hp	224.6	127.8	62.8	23.0	0.1	40.0	91.4	152.4
Water in, deg F	118.0	128.6	115.2	86.1	76.0	85.8	103.6	121.7
Water out, deg F	159.5	163.2	152.2	143.6	139.9	146.6	151.6	159.9
Oil, deg F	245.0	255.7	232.0	191.1	171.9	169.5	216.1	246.7
Inlet air, deg F	81.7	77.5	75.0	75.3	75.3	77.1	78.2	81.0
Exhaust restriction, Hg	2.4	0.8	0.25	0.5	0	0.15	0.45	0.15
Corrected HC, ppm	348.21	165.54	80.62	53.53	208.23	65.15	105.43	232.01
Corrected CO, ppm	13740	2709	707	820	524	776	890	7118
Corrected NO _x , ppm	103.23	134.20	64.35	4.71	0.25	24.32	114.46	83.78
Corrected CO ₂ , %	1.975	1.288	0.681	0.257	0.071	0.475	0.979	1.446
Stabilization time, min	5	5	5	5	5	5	5	5
Collection time, min	5	5	5	5	5	5	5	5

Table B.2 :
Certification Fuel ICOMIA/BSO Steady-State #2

Mode	1	2	3	4	5	6	7	8
Date	7/23/92							
Speed, rpm	4256	3404	2554	1704	700	2132	2980	3828
Torque, ft-lb	276	198	129	72	1	99	161	211
Power, hp	223.7	128.3	62.5	23.4	0.1	40.0	91.4	153.4
Water in, deg F	126.2	126.9	113.5	99.5	78.5	86.5	96.0	114.2
Water out, deg F	165.1	161.5	151.6	145.2	140.3	146.9	149.9	155.9
Oil, deg F	258.0	254.0	228.7	206.4	178.5	172.2	208.4	238.7
Inlet air, deg F	81.0	77.1	75.0	75.3	75.3	77.1	78.2	81.0
Exhaust restriction, Hg	2.4	0.95	0.35	0.5	0.0	0.0	0.5	1.2
Corrected HC, ppm	322.70	170.32	80.20	59.52	222.03	67.46	107.60	242.11
Corrected CO, ppm	13103	3109	688	961	544	794	862	7707
Corrected NO _x , ppm	108.47	123.46	65.35	4.22	0.00	22.83	110.47	72.32
Corrected CO ₂ , %	2.002	1.276	0.705	0.303	0.073	0.492	0.966	1.432
Stabilization time, min	5	5	5	5	5	5	5	5
Collection time, min	5	5	5	5	5	5	5	5

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HEAVY DUTY GASOLINE TRANSIENT TEST

DATE: 10/08/92 TIME: 08:48:48 PAGE: 2

BAG EMISSIONS REPORT

BAG EMISSION RESULTS:

	HC			CO			CO2			NOx		
	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams	Gms/ Bhp-hr	Gms/ Kw-Hr	Grams
Bag 1 NLLN HS	9.310	12.485	136.720	200.047	268.267	2937.690	590.57	791.96	8672.47	3.653	4.899	53.650

FUEL CONSUMPTION:

	Fuel		
	Gals	Lbs	Lbs/ Bhp-hr
Bag 1 NLLN HS	1.318	9.520	.648
Measured Fuel Flow: HS	1.640 Gals	11.842 Lbs	

BAG DETAIL REPORT

Bag # 1 NLLN HS											
Length	: 1167.	SEC.		SITE EMISSION	RNG DEFL.	CONC.	RNG DEFL.	CONC.	CORRECTED	GRAMS	GMS/ BHP-HR
Bhp-Hr	: 14.685			A009 MEAS HC	14	5.8	4.31	16 96.0	284.09	136.72	9.310
Dilut. Factor:	14.383			A009 MEAS CO	16	4.0	3.94	22 37.8	3023.48	2937.69	200.047
Bag Fill Time:	964.0	Sec.		A009 MEAS CO2	22	4.1	.035	22 63.3	.568	8672.47	590.567
Exh. Volume	: 29470.	Cu.Ft.		A009 MEAS NOX	15	.0	.00	15 72.6	36.19	53.65	3.653
Fuel Consump.:	1.318	Gal.	4.98 L.								
"	: 9.52	Lb.	4318.3 Gm								
BSFC	: .648	Lb/Bhp-Hr									
"	: 394.16	Gm/Kw-Hr									

FUEL CONSUMPTION - CARBON BALANCE COMPARED TO MEASURED FUEL FLOW:

	Carbon Balance	Measured Fuel Flow	Difference
HS	9.520	11.842	-19.61%

High Transience ICOMIA (CAAB Fuel) Hot Start #2

Table B.5 :
Clean Air Act Baseline Fuel ICOMIA/BSO Steady-State #3

Mode	1	2	3	4	5	6	7	8
Date	8/19/92							
Speed, rpm	4262	3404	2554	1704	700	2130	2980	3834
Torque, ft-lb	273	197	130	72	4	98	161	212
Power, hp	221.5	127.4	63.0	23.2	0.5	39.8	91.1	154.4
Water in, deg F	132.3	128.2	111.5	95.0	74.3	89.2	106.0	124.1
Water out, deg F	170.9	163.5	150.6	144.6	139.6	147.2	151.9	160.9
Oil, deg F	261.3	251.0	225.7	201.1	166.2	180.8	219.1	252.0
Inlet air, deg F	83.7	80.6	78.2	79.2	79.2	80.3	80.6	83.4
Exhaust restriction, Hg	2.2	0.9	0.4	0.2	0.1	0.1	0.4	1.1
Corrected HC, ppm	252.65	150.46	72.21	54.31	213.93	65.84	100.83	191.67
Corrected CO, ppm	12570	3021	652	899	524	769	1115	5833
Corrected NO _x , ppm	108.72	130.95	71.57	5.36	0.54	25.25	111.97	101.49
Corrected CO ₂ , %	1.907	1.278	0.719	0.287	0.075	0.486	0.981	1.432
Stabilization time, min	5	5	5	5	5	5	5	5
Collection time, min	5	5	5	5	5	5	5	5

Table B.6 :
McLaren Modes CAAB Fuel ICOMIA/BSO Steady-State #4

Mode	1	2	3	4	5	6	7	8
Date	8/19/92							
Speed, rpm	4394	3516	2638	1760	750	2200	3078	3952
Torque, ft-lb	268	207	134	76	7	103	171	246
Power, hp	224.2	138.2	67.1	25.5	0.9	43.1	99.9	185.1
Water in, deg F	89.5	128.2	111.8	94.7	76.4	84.4	112.1	122.1
Water out, deg F	151.2	163.5	151.2	144.9	139.9	146.9	154.2	160.9
Oil, deg F	250.3	252.3	225.4	200.4	160.5	166.5	226.7	247.7
Inlet air, deg F	85.1	82.0	79.2	79.2	79.2	80.0	81.0	83.0
Exhaust restriction, Hg	2.5	0.95	0.3	0.1	0.1	0.15	0.5	1.6
Corrected HC, ppm	255.76	165.48	78.89	54.53	208.84	66.12	106.45	220.66
Corrected CO, ppm	12570	3990	644	857	618	711	1450	9429
Corrected NO _x , ppm	110.22	130.45	87.27	7.19	0.00	36.49	127.45	60.62
Corrected CO ₂ , %	1.901	1.331	0.788	0.299	0.078	0.525	1.023	1.374
Stabilization time, min	5	5	5	5	5	5	5	5
Collection time, min	5	5	5	5	5	5	5	5

Table B.3 :
Clean Air Act Baseline Fuel ICOMIA/BSO Steady-State #1

Mode	1	2	3	4	5	6	7	8
Date	8/12/92							
Speed, rpm	4258	3404	2556	1704	700	2132	2980	3836
Torque, ft-lb	272	196	128	72	4	99	161	210
Power, hp	220.5	127.0	62.3	23	0.5	40.0	91.1	153.0
Water in, deg F	100.5	128.6	112.1	98.4	74.3	87.1	104.6	116.6
Water out, deg F	161.9	171.9	159.9	153.9	148.6	155.6	160.5	165.9
Oil, deg F	260.0	264.6	238.0	218.7	183.2	187.8	231.7	252.7
Inlet air, deg F	90.2	87.1	85.8	85.8	86.5	87.1	87.8	89.9
Exhaust restriction, Hg	2.25	0.8	0.3	0.1	0.1	0.15	0.45	1.5
Corrected HC, ppm	271.30	153.42	77.15	52.27	241.56	65.57	109.26	197.12
Corrected CO, ppm	11639	3152	734	934	547	820	1150	5615
Corrected NO _x , ppm	124.46	128.95	75.56	5.46	0.64	24.92	119.98	107.51
Corrected CO ₂ , %	1.954	1.268	0.755	0.285	0.062	0.473	1.020	1.424
Stabilization time, min	5	5	5	5	5	5	5	5
Collection time, min	5	5	5	5	5	5	5	5

Table B.4 :
Clean Air Act Baseline Fuel ICOMIA/BSO Steady-State #2

Mode	1	2	3	4	5	6	7	8
Date	8/12/92							
Speed, rpm	4260	3408	2558	1706	700	2132	2982	3830
Torque, ft-lb	275	197	130	72	3	98	162	211
Power, hp	222.7	127.5	63.1	23.2	0.4	39.6	91.7	153.5
Water in, deg F	130.0	131.9	119.3	99.1	80.6	86.8	103.9	119.9
Water out, deg F	176.8	175.8	162.5	154.2	150.6	155.9	160.5	165.2
Oil, deg F	286.0	272.2	248.3	219.4	171.5	188.5	230.7	250.0
Inlet air, deg F	91.6	88.5	85.8	86.1	86.8	87.5	87.8	89.5
Exhaust restriction, Hg	2.35	0.95	0.35	0.15	62.9	63.2	62.9	63.6
Corrected HC, ppm	253.33	160.59	79.10	57.63	226.83	68.51	111.20	231.68
Corrected CO, ppm	11329	3401	709	995	645	801	1186	9840
Corrected NO _x , ppm	142.96	136.45	80.29	6.99	0.79	30.03	125.46	65.35
Corrected CO ₂ , %	1.989	1.323	0.755	0.320	0.078	0.511	1.035	1.378
Stabilization time, min	5	5	5	5	5	5	5	5
Collection time, min	5	5	5	5	5	5	5	5

Table B.9 :
Low T-90 Fuel ICOMIA/BSO Steady-State #2

Mode	1	2	3	4	5	6	7	8
Date	7/30/92							
Speed, rpm	4262	3410	2559	1707	702	2135	2984	3833
Torque, ft-lb	273	197	128	71	1	100	162	211
Power, hp	221.5	128.2	62.4	23.1	0.1	40.5	91.9	153.9
Water in, deg F	128.9	134.9	115.9	95.7	82.7	87.8	94.3	114.2
Water out, deg F	163.2	166.9	151.9	144.9	143.3	147.2	149.6	155.9
Oil, deg F	269.0	256.3	219.4	190.5	153.2	184.5	221.1	247.0
Inlet air, deg F	83.0	81.0	79.2	78.9	78.5	80.0	81.0	82.7
Exhaust restriction, Hg	2.3	0.9	0.4	0.15	0.05	0.15	0.45	1.05
Corrected HC, ppm	279.34	141.60	57.40	53.08	162.00	56.44	88.36	197.53
Corrected CO, ppm	10541	2385	378	799	507	547	776	5861
Corrected NO _x , ppm	139.20	150.21	75.31	6.45	0.54	29.17	117.96	110.47
Corrected CO ₂ , %	1.977	1.324	0.713	0.321	0.081	0.505	0.976	1.534
Stabilization time, min	5	5	5	5	5	5	5	5
Collection time, min	5	5	5	5	5	5	5	5

Table B.10 :
Low T-90 Fuel ICOMIA/BSO Steady-State #3

Mode	1	2	3	4	5	6	7	8
Date	8/20/92							
Speed, rpm	4262	3410	2558	1706	702	2134	2984	3834
Torque, ft-lb	273	196	129	72	5	99	160	210
Power, hp	221.6	127.3	62.8	23.2	0.6	40.2	90.9	153.3
Water in, deg F	126.5	126.2	112.8	90.2	76.0	87.1	105.3	122.1
Water out, deg F	165.5	161.2	151.6	144.2	139.9	146.9	151.9	160.2
Oil, deg F	255.0	256.0	225.7	194.1	175.2	174.5	218.4	245.0
Inlet air, deg F	83.4	81.7	79.6	79.3	78.9	80.0	80.6	82.3
Exhaust restriction, Hg	2.3	1.0	0.5	0.2	0.1	0.15	0.3	0.9
Corrected HC, ppm	273.06	144.31	62.24	46.75	166.75	55.29	92.36	156.75
Corrected CO, ppm	10793	2626	421	763	499	537	960	4432
Corrected NO _x , ppm	147.46	148.46	82.28	6.70	0.74	30.28	119.46	109.97
Corrected CO ₂ , %	2.004	1.290	0.784	0.278	0.077	0.494	0.972	1.291
Stabilization time, min	5	5	5	5	5	5	5	5
Collection time, min	5	5	5	5	5	5	5	5

Table B.7 :
McLaren Modes CAAB Fuel ICOMIA/BSO Steady-State #5

Mode	1	2	3	4	5	6	7	8
Date	8/19/92							
Speed, rpm	4406	3520	2640	1760	750	2200	3076	3956
Torque, ft-lb	267	207	133	75	3	105	171	247
Power, hp	224.0	138.4	66.9	25.0	0.4	44.0	100.0	186.1
Water in, deg F	128.6	129.3	112.5	11.6	80.0	89.9	115.6	125.8
Water out, deg F	167.9	164.2	151.2	144.2	141.6	147.6	154.2	162.9
Oil, deg F	262.9	253.7	224.7	197.1	159.5	184.5	232.4	252.0
Inlet air, deg F	83.7	80.0	78.2	78.5	78.5	80.0	80.6	82.3
Exhaust restriction, Hg	2.4	0.9	0.35	0.1	61.8	61.8	60.4	58.3
Corrected HC, ppm	243.36	165.97	75.80	49.20	215.14	66.16	122.06	232.24
Corrected CO, ppm	12701	3951	615	887	615	719	2128	10201
Corrected NO _x , ppm	111.47	133.70	87.02	6.94	0.25	34.75	111.72	53.40
Corrected CO ₂ , %	1.984	1.377	0.785	0.295	0.081	0.542	1.056	1.423
Stabilization time, min	5	5	5	5	5	5	5	5
Collection time, min	5	5	5	5	5	5	5	5

Table B.8 :
Low T-90 Fuel ICOMIA/BSO Steady-State #1

Mode	1	2	3	4	5	6	7	8
Date	7/27/92							
Speed, rpm	4668	3406	2560	1704	698	2128	2982	3834
Torque, ft-lb	271	196	128	71	1	99	160	210
Power, hp	241.0	127.1	62.4	23.0	.1	40.1	90.8	152.9
Water in, deg F	133.6	132.6	109.7	94.0	77.1	88.2	101.5	119.3
Water out, deg F	172.5	167.9	150.2	144.6	140.6	147.2	150.9	158.2
Oil, deg F	271.5	260.3	224.7	202.1	176.5	181.2	214.7	245.3
Inlet air, deg F	82.3	79.6	76.4	75.7	75.3	77.1	78.2	81.3
Exhaust restriction, Hg	2.4	0.95	0.4	0.05	0.0	0.1	0.5	1.15
Corrected HC, ppm	308.64	170.82	78.09	59.99	173.32	67.26	96.16	226.68
Corrected CO, ppm	12903	3311	542	893	490	608	615	7088
Corrected NO _x , ppm	109.47	128.20	72.57	6.20	0.88	27.81	124.96	37.52
Corrected CO ₂ , %	1.982	1.290	0.706	0.307	0.081	0.504	0.988	1.482
Stabilization time, min	5	5	5	5	5	5	5	5
Collection time, min	5	5	5	5	5	5	5	5

Table B.13 :
30% Ethanol Blend Fuel ICOMIA/BSO Steady-State #1

Mode	1	2	3	4	5	6	7	8
Date	10/1/92							
Speed, rpm	4258	3406	2556	1706	700	2132	2982	3832
Torque, ft-lb	273	196	127	71	3	100	161	210
Power, hp	221.3	127.1	61.8	23.1	0.4	40.4	91.4	153.2
Water in, deg F	136.6	128.9	104.3	84.4	73.2	80.0	101.1	125.2
Water out, deg F	176.8	163.5	147.9	142.9	138.6	143.5	150.6	162.5
Oil, deg F	268.0	249.3	213.1	189.1	168.9	171.9	215.1	248.7
Inlet air, deg F	86.0	84.4	81.7	80.0	78.9	80.0	81.0	85.4
Exhaust restriction, Hg	2.1	1.1	0.5	0.1	0.1	0.1	0.5	1.3
Corrected HC, ppm	146.67	48.80	29.01	24.41	124.47	26.54	33.92	96.51
Corrected CO, ppm	3920.26	238.88	49.83	51.81	259.44	39.95	71.90	1203.31
Corrected NO _x , ppm	323.48	209.08	52.86	9.51	1.82	23.66	112.24	229.51
Corrected CO ₂ , %	2.231	1.414	0.746	0.326	0.083	0.518	1.046	1.648
Stabilization time, min	5	5	5	5	5	5	5	5
Collection time, min	5	5	5	5	5	5	5	5

Table B.14 :
30% Ethanol Blend Fuel ICOMIA/BSO Steady-State #2

Mode	1	2	3	4	5	6	7	8
Date	10/1/92							
Speed, rpm	4258	3406	2556	1704	700	2130	2980	3836
Torque, ft-lb	271	197	129	72	4	98	160	210
Power, hp	219.7	127.8	62.5	23.4	0.5	39.7	90.8	153.0
Water in, deg F	134.9	129.6	109.1	86.3	75.3	87.1	101.5	119.7
Water out, deg F	175.2	165.5	149.6	143.6	139.6	147.2	150.9	159.5
Oil, deg F	267.0	254.3	219.1	196.1	168.2	179.5	215.1	243.3
Inlet air, deg F	83.4	82.0	80.0	79.6	79.2	80.3	81.3	83.0
Exhaust restriction, Hg	2.1	1.35	0.7	0.5	0.3	0.35	0.6	0.95
Corrected HC, ppm	184.39	64.12	31.67	28.73	128.68	30.68	35.82	112.58
Corrected CO, ppm	6299.36	312.56	39.23	66.39	284.70	33.88	59.35	1241.54
Corrected NO _x , ppm	274.03	193.81	54.40	7.68	2.41	23.85	110.22	166.98
Corrected CO ₂ , %	2.176	1.390	0.728	0.301	0.088	0.554	1.027	1.461
Stabilization time, min	5	5	5	5	5	5	5	5
Collection time, min	5	5	5	5	5	5	5	5

Table B.11 :
Gasohol Fuel ICOMIA/BSO Steady-State #1

Mode	1	2	3	4	5	6	7	8
Date	8/25/92							
Speed, rpm	4260	3408	2558	1708	702	2132	2982	3832
Torque, ft-lb	274	195	129	70	5	97	160	210
Power, hp	222.2	126.5	62.6	22.8	0.7	39.4	90.8	153.2
Water in, deg F	138.3	131.6	114.5	93.3	78.9	87.5	104.6	121.0
Water out, deg F	177.5	166.5	151.9	144.6	139.6	147.2	151.9	159.5
Oil, deg F	264.6	250.3	219.4	193.1	155.2	170.2	209.1	234.7
Inlet air, deg F	87.1	84.4	80.3	79.2	79.2	80.6	81.0	84.1
Exhaust restriction, Hg	2.2	0.9	0.35	0.1	0.1	0.15	0.5	1.1
Corrected HC, ppm	269.36	155.81	63.21	54.73	207.35	58.31	87.32	189.44
Corrected CO, ppm	9449	2692	328	617	470	412	591	5727
Corrected NO _x , ppm	131.45	131.20	65.10	5.31	0.59	24.15	105.73	93.50
Corrected CO ₂ , %	1.895	1.371	0.774	0.320	0.083	0.535	1.040	1.501
Stabilization time, min	5	5	5	5	5	5	5	5
Collection time, min	5	5	5	5	5	5	5	5

Table B.12 :
Gasohol Fuel ICOMIA/BSO Steady-State #2

Mode	1	2	3	4	5	6	7	8
Date	8/26/92							
Speed, rpm	4258	3406	2556	1706	702	2132	2982	3836
Torque, ft-lb	276	196	128	71	5	98	161	211
Power, hp	224.1	127.1	62.1	23.1	0.6	39.8	91.4	153.7
Water in, deg F	130.9	127.2	111.5	85.1	82.0	87.5	99.1	123.4
Water out, deg F	169.5	162.2	150.6	143.3	141.6	146.9	150.6	160.9
Oil, deg F	253.0	244.0	217.4	181.5	152.6	171.2	205.1	241.0
Inlet air, deg F	84.1	81.3	77.8	78.9	78.5	80.0	80.0	82.7
Exhaust restriction, Hg	2.2	0.95	0.5	0.2	0.0	0.1	0.4	1.15
Corrected HC, ppm	270.84	149.33	58.57	52.11	193.00	57.41	85.23	192.14
Corrected CO, ppm	10261	2537	302	633	418	347	512	5601
Corrected NO _x , ppm	147.21	136.95	66.59	5.66	0.98	24.35	111.22	97.99
Corrected CO ₂ , %	2.061	1.375	0.753	0.328	0.079	0.528	1.057	1.526
Stabilization time, min	5	5	5	5	5	5	5	5
Collection time, min	5	5	5	5	5	5	5	5

**Table B.16 :
40% Ethanol Blend Fuel ICOMIA/BSO Steady-State #3**

Mode	1	2	3	4	5	6	7	8
Date	9/16/92							
Speed, rpm	4262	3408	2558	1706	700	2132	2980	3836
Torque, ft-lb	274	195	129	71	3	98	160	210
Power, hp	221.9	126.5	62.6	23.1	0.4	39.6	90.8	153.4
Water in, deg F	132.9	132.6	106.7	89.9	73.9	87.8	102.9	123.1
Water out, deg F	172.2	167.9	149.9	143.6	138.6	146.6	150.6	160.9
Oil, deg F	264.0	259.6	224.4	199.5	176.2	182.5	217.6	249.3
Inlet air, deg F	82.7	82.0	80.6	80.6	81.3	80.6	82.3	82.7
Exhaust restriction, Hg	2.25	0.95	0.5	0.2	0.05	0.05	0.5	1.1
Corrected HC, ppm	121.14	40.85	32.77	24.23	95.52	24.17	27.78	95.17
Corrected CO, ppm	2900.50	186.03	51.81	59.13	274.56	38.64	71.90	1172.01
Corrected NO _x , ppm	357.90	216.11	40.42	12.14	2.01	17.17	18.26	229.76
Corrected CO ₂ , %	2.449	1.513	0.731	0.374	0.077	0.533	0.447	1.692
Stabilization time, min	5	5	5	5	5	5	5	5
Collection time, min	5	5	5	5	5	5	5	5

Table B.15 :
40% Ethanol Blend Fuel ICOMIA/BSO Steady-State #1

Mode	1	2	3	4	5	6	7	8
Date	9/15/92							
Speed, rpm	4262	3410	2558	1706	702	2132	2980	3836
Torque, ft-lb	272	196	127	72	3	99	162	210
Power, hp	220.7	127.3	61.6	23.2	0.4	40.2	91.9	153.4
Water in, deg F	121.7	134.3	108.0	95.0	80.3	87.8	100.5	127.2
Water out, deg F	163.2	169.5	149.6	144.2	139.6	146.9	150.2	164.5
Oil, deg F	243.0	254.3	218.4	195.5	181.5	178.5	209.8	249.3
Inlet air, deg F	82.0	80.3	80.6	80.0	80.6	80.0	82.0	82.0
Exhaust restriction, Hg	2.2	0.95	0.35	0.1	0.05	0.15	0.55	1.2
Corrected HC, ppm	135.59	47.68	28.26	36.28	257.22	33.85	30.11	103.29
Corrected CO, ppm	2871.45	258.85	51.42	92.69	388.21	43.38	74.21	1272.42
Corrected NO _x , ppm	300.78	194.56	43.61	11.09	1.13	18.76	96.77	230.52
Corrected CO ₂ , %	2.116	1.389	0.745	0.369	0.061	0.526	1.065	1.744
Stabilization time, min	5	5	5	5	5	5	5	5
Collection time, min	5	5	5	5	5	5	5	5

Table B.16 :
40% Ethanol Blend Fuel ICOMIA/BSO Steady-State #2

Mode	1	2	3	4	5	6	7	8
Date	9/16/92							
Speed, rpm	4258	3404	2554	1704	700	2130	2976	3836
Torque, ft-lb	272	196	128	71	3	97	161	210
Power, hp	220.1	127.0	62.0	23.0	0.4	39.1	91.2	153.0
Water in, deg F	135.9	135.6	113.2	93.0	73.9	88.2	101.2	123.1
Water out, deg F	175.8	171.2	150.9	144.6	139.3	146.9	150.6	161.2
Oil, deg F	272.6	250.3	224.4	199.1	170.2	178.2	209.1	244.7
Inlet air, deg F	82.3	81.3	80.6	80.6	80.6	80.3	81.7	82.0
Exhaust restriction, Hg	2.4	1.0	0.5	0.2	0.05	0.1	0.55	1.15
Corrected HC, ppm	125.86	35.72	31.32	25.29	84.17	25.99	26.15	102.65
Corrected CO, ppm	3172.90	218.22	45.26	61.19	283.07	39.29	69.87	1440.79
Corrected NO _x , ppm	332.87	212.64	38.48	13.03	1.57	19.65	86.52	226.71
Corrected CO ₂ , %	2.248	1.489	0.666	0.380	0.074	0.551	1.036	1.724
Stabilization time, min	5	5	5	5	5	5	5	5
Collection time, min	5	5	5	5	5	5	5	5

ENGINEERING OPERATIONS DIVISION

Fuel Analysis Report

Gasohol Test Fuel

Supplier: Howell Hydrocarbons
 Proposed Use('s): Emission Factors
 Quantity: 8000 gallons in Tank #4
 Date placed in service: 8/23/1989
 Date of resupply: 11/90

809 gal

Item	Method	Blend Specifications	Official EOD Values
RVP (psi)	ASTM D 4953	Report	9.1
Distillation			
Initial Boiling Point (°F)		Report	95
10% Evap. Point (°F)		Report	124
50% Evap. Point (°F)		Report	207
90% Evap. Point (°F)		Report	312
End Point (°F)		Report	403
% Evaporated at 160°F		Report	40.6
Sulfur (wt%)	ASTM D 1266	Report	0.0046
Lead (g/gal)	ASTM D 3831	Report	< 0.003
Phosphorous (g/gal)	ASTM D 3231	Report	<0.0001
HC Composition	ASTM D 1319		
Olefins (vol%)		Report	2.1
Aromatics (vol%)		Report	28.8
Saturates (vol%)		Report	69.1
Ethanol (vol%)	EOD TP 107	9.5	9.4
Research octane number	ASTM D 2699	Report	97.4
Motor octane number	ASTM D 2700	Report	87.6
Antiknock Index	ASTM D 439	Report	92.5
Sensitivity	RON-MON	Report	9.8
Weight Fraction Carbon	ASTM E 191	Report	0.8239
Net Heat of Combustion			
(BTU/lb)	ASTM D 240	Report	17893
Specific Gravity (60°F/60°F)	ASTM D 1298	Report	0.7451
Fuel Economy Numerator			
(grams carbon/gallon)		Report	2322
Fuel Economy Numerator with R Factor			
(grams carbon/gallon)		Report	2359

C. Fuel Specifications

Tank #7 8/20/91 CAAB

**Procurement Specification for
Baseline Gasoline Fuel Properties
Clean Air Act Baseline Fuel**

on line 8/20/91

Item	Method	Units	Procurement Specifications	EOD Values
Elemental Composition				
Carbon	Calculated	g/gal	Report	2454
Carbon	ASTM D 3343	weight %	Report	0.8670
Lead	ASTM D 3237	g/gal	0.005 Max	0.0000
Phosphorous	ASTM D 3231	g/gal	0.005 Max	0.0000
Sulfur	ASTM D 3120	PPM	339±94	294
Molecular Composition				
Aromatics	ASTM D 1319	volume %	32.0±1.1	31.2
Benzene	ASTM D 3606	volume %	1.53±0.03	1.2
Oxygen	ASTM D 4815	volume %	0	0.0
Olefins	ASTM D 1319	volume %	9.2±1.2	8.8
Saturates	ASTM D 1319	volume %	58.8±1.5	60.0
Physical Properties				
Distillation				
Initial Boiling Point	ASTM D 86	°F	91±5.0	87
10% Evap. Point	ASTM D 86	°F	128±5.0	131
50% Evap. Point	ASTM D 86	°F	218±5.0	218
90% Evap. Point	ASTM D 86	°F	330±5.0	320
End Point	ASTM D 86	°F	415±7.0	412
% Evap at 160 °F	ASTM D 86	volume %	Report	20.0
Motor Tests				
Antiknock Index	(D 2700+D 2699)/2		87.3±0.5	87.4
Motor octane number	ASTM D 2700		Report	92.0
Research octane number	ASTM D 2699		Report	83.0
Sensitivity	D 2700-D 2699		9.0 Min.	8.9
Net Heat of Combustion	ASTM D 240	BTU/lb	Report	18583
Net Heat of Combustion	ASTM D 3338	BTU/lb	Report	18538
API Gravity (60°F/60°F)	ASTM D 1298	API°	57.4±0.2	57.4
Vapor Pressure	Grabner (Pabs)	psi	8.7-8.9	8.8

21-Jul-92

15415

Item	Method	Units	Procurement Specifications	Official EOD Values
Elemental Composition				
Lead	ASTM D 3237	g/gal	0.005 maximum	0.003
Phosphorous	ASTM D 3231	g/gal	0.005 maximum	<0.0001
Sulfur	ASTM D 1266	weight %	0.01 maximum	0.0056
Oxygen	Report	weight %	1.8-2.2	2.1
Molecular Composition				
Aromatics	ASTM D 1319	volume %	22-27	28.7
Benzene	ASTM D 3606	volume %	0.8-1.2	1.2
Methyl t-butyl ether	ASTM D 4815	volume %	10.8-12.2	12.5
Olefins	ASTM D 1319	volume %	3.0 - 10.0	5.9
Saturates	ASTM D 1319	volume %	Remainder	65.4
Physical Properties				
Distillation		°F		
Initial Boiling Point	ASTM D 86	°F	75-95	90
10% Evap. Point	ASTM D 86	°F	120-135	132
50% Evap. Point	ASTM D 86	°F	200-230	203
90% Evap. Point	ASTM D 86	°F	268-292	290
End Point	ASTM D 86	°F	415 maximum	402
% Evaporated at 160°F	ASTM D 86	volume %	Report	22.3
Motor Tests				
Antiknock Index	(D 2700+D 2699)/2		92.0-93.0	97.5
Motor octane number	ASTM D 2700		87.0-88.0	87.3
Research octane number	ASTM D 2699		96.5-97.5	92.7
Sensitivity	D 2700-D 2699		9.0 minimum	9.1
Net Heat of Combustion	ASTM D 240	BTU/lb	Report	18444
API Gravity (60°F/60°F)	ASTM D 1298	API°	Report	57.5
Vapor Pressure	ASTM D 4953	psi	8.8-9.2	9.2
Weight Fraction Carbon	ASTM E 191	weight %	Report	0.8467

Ethanol Test Program Fuels

Volume % Ethanol 0 100 10 12 12 14 14 17 17 20 25 30 35 42
 Sample Date: 8/20/91 7/28/92 8/3/92 8/4/92 8/5/92 8/5/92 8/11/92 8/12/92 8/13/92 8/26/92 8/28/92 9/1/92 9/8/92

Item	Method	Units														
RVP	ASTM D 323	psi	8.63		9.16	9.38	9.20	9.20	9.22	9.02	9.12	9.03	8.90	8.61	8.63	8.28
RVP Herzog Digital	ASTM D 4953	psi	8.77		9.31	9.53	9.35	9.35	9.37	9.17	9.27	9.18	9.05	8.75	8.77	8.41
Vapor Pressure Grabner	ASTM D 5191	ptot	9.46		10.02	10.24	10.07	10.07	10.08	9.88	9.98	9.89	9.76	9.44	9.40	9.09
		paba	8.88		9.33	9.47	9.40	9.33	9.38	9.24	9.28	9.21	9.08	8.80	8.66	8.34
SwRI	ASTM D 5190	psi														
Distillation	ASTM D 86				10	12	12	14	14	17	17	20	25	30	35	42
Initial boiling point		°F	87	173.3	94	91	94	95	89	92	97	95	96	95	96	94
5% evaporated		°F		173.3	110	106	110	111	117	114	113	114	114	112	117	113
10% evaporated		°F	131	173.3	124	123	123	125	125	127	128	128	129	130	131	132
20% evaporated		°F		173.3	140	139	139	140	143	142	142	143	144	146	148	150
30% evaporated		°F		173.3	151	150	150	151	152	153	153	153	154	156	157	159
40% evaporated		°F		173.3	158	157	157	158	158	158	158	159	159	161	161	163
50% evaporated		°F	218	173.3	193	176	178	168	166	162	162	163	163	163	164	165
60% evaporated		°F		173.3	223	221	222	220	219	195	191	166	165	166	166	167
70% evaporated		°F		173.3	235	237	235	236	237	234	233	222	210	168	168	168
80% evaporated		°F		173.3	256	259	254	254	255	252	252	250	249	237	169	170
90% evaporated		°F	320	173.3	302	308	301	300	302	297	297	291	292	284	276	268
95% evaporated		°F		173.3	338	349	337	343	342	338	336	332	331	332	327	318
end point		°F	412	173.3	407	404	406	402	405	407	405	403	403	399	391	388
evaporated at 160 °F		Vol %	20.0		42.0	43.7	44.0	43.7	43.5	43.7	43.8	42.2	41.3	38.6	35.9	32.4
Sulfur	ASTM D 1266	wt%	0.029	0.000												
Lead	ASTM D 3237	g/gal		0.000												
Phosphorous	ASTM D 3231	g/gal	0.00000	0.00000												
Hydrocarbon Composition	ASTM D 1319															
olefins		Vol %	8.8	0.0												
aromatics		Vol %	0	0												
saturates		Vol %	60.0	0.0												
Research octane number	ASTM D 2699		87.4													
Motor octane number	ASTM D 2700		92.0													
Antiknock index	ASTM D 439		83.0													
Sensitivity	RON-MON		8.9													
Weight fraction Hydrogen	ASTM D 3343		0.1330	0.1313	0.1328	0.1328	0.1328	0.1327	0.1327	0.1327	0.1327	0.1326	0.1325	0.1325	0.1324	0.1323
Weight fraction Oxygen	Calculated		0.0000	0.3473	0.0347	0.0417	0.0417	0.0486	0.0486	0.0590	0.0590	0.0695	0.0868	0.1042	0.1215	0.1389
Weight fraction Carbon	ASTM D 3343		0.8670	0.5214	0.8325	0.8256	0.8256	0.8186	0.8186	0.8083	0.8083	0.7979	0.7806	0.7633	0.7461	0.7288
Hydrogen Carbon/Ratio	Calculated		1.8275	3.0005	1.9010	1.9164	1.9164	1.9321	1.9321	1.9562	1.9562	1.9808	2.0234	2.0679	2.1144	2.1622
Oxygen Carbon/Ratio	Calculated		0.0000	0.5000	0.0313	0.0379	0.0379	0.0446	0.0446	0.0548	0.0548	0.0653	0.0835	0.1025	0.1223	0.1431
Net heat of combustion	ASTM D 240	BTU/lb	18583													
Net heat of combustion	ASTM D 3338	BTU/lb	18538	11929	17918	17785	17785	17651	17651	17452	17452	17252	16920	16587	16254	16493
API Gravity	ASTM D 1289	°API	57.4	47.7	56.9	57.1	57.1	56.7	56.8	56.1	56	55.8	55.7	54.9	54.4	53.8
Specific gravity (60°F/60°F)			0.7491	0.7893	0.7511	0.7503	0.7503	0.7519	0.7515	0.7543	0.7547	0.7555	0.7559	0.7591	0.7591	0.7591
Fuel economy numerator (g carbon/gal)			2454	1555	2362	2340	2340	2325	2324	2303	2304	2277	2229	2189	2140	2090
Fuel economy numerator with R Factor			2435	1915	2388	2378	2378	2371	2370	2359	2360	2347	2323	2302	2276	2205

HCCOF
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CCR

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SPORAL



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

ANN ARBOR, MICHIGAN 48105

MAY 26 1993

OFFICE OF
AIR AND RADIATION

MEMORANDUM

SUBJECT: Exemption from Administrative Review

FROM: Michael J. Samulski, Mechanical Engineer
Engine and Vehicle Regulations Branch

THRU: Joanne I. Goldhand, Chief
Engine and Vehicle Regulations Branch

TO: Chester J. France, Director
Regulation Development and Support Division

The attached report entitled "Sensitivity of Test Cycle and Fuel Type on a Crusader 350 Inboard Marine Engine, Test Results - 1992" contains emission results from a marinized General Motors small-block engine. HC, CO, NOx, and fuel consumption results from this program were obtained for several fuels: Indolene, Clean Air Act Baseline fuel, Low T-90, Gasohol, 20% ethanol, 30% ethanol, and 40% ethanol. The engine was tested using the following procedures: Heavy-Duty Federal Test Procedure (HD-FTP), International Council of Marine Industry Associations (ICOMIA) five-mode marine steady-state test procedure, and the Bodensee Schifffahrts Ordnung (BSO) eight-mode marine steady-state test procedure. In addition, some results were obtained on the sensitivity of this marine engine to transience by combining the ICOMIA modes into three transient tests.

The data from the Crusader engine showed that as the percentage of alcohol in the fuel increased, HC and CO emissions decreased while NOx emissions increased. The addition of MTBE to the fuel (Low T-90) showed the same trend. Adding transience to the ICOMIA cycle increased HC, CO, and fuel consumption and decreased NOx results. Only HC seemed to be affected by the amount of transience added; this was probably due to rich fuel-air ratios during accelerations.

Since this report presents only factual emission data and noncontroversial conclusions, and will be placed in the non-road docket, where it will be publicly reviewed, your concurrence is requested to waive administrative review according to the policy outlined in the directive of April 22, 1982.

Concurrence: _____

Nonconcurrence: _____

Attachment