BASELINE CHARACTERIZATION AND EMISSIONS CONTROL TECHNOLOGY ASSESSMENT OF HD GASOLINE ENGINES

by
Karl J. Springer

FINAL REPORT
Contract EHS 70-110

Prepared for
Environmental Protection Agency
Office of Air Programs
Mobile Source Pollution Control Program

November 1972

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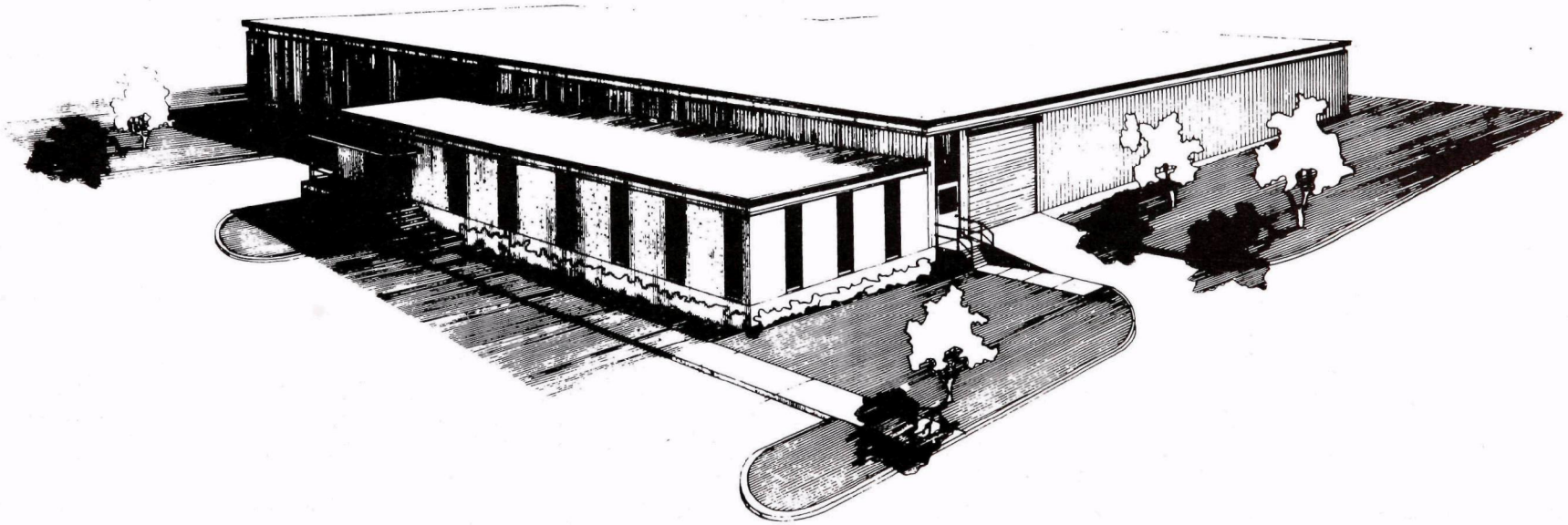

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Approved:

John M. Clark, Jr.
Technical Vice President
Department of Automotive Research

FOREWORD

This project was initiated by the Characterization and Control Development Branch, Division of Emission Control Technology, Environmental Protection Agency, 2565 Plymouth Road, Ann Arbor, Michigan 48105. The engineering effort on which this report is based was accomplished by Southwest Research Institute, 8500 Culebra Road, San Antonio, Texas, under contract number EHS 70-110. The author, Mr. Karl J. Springer, was the Project Leader of the research and development work. This project, authorized by Modification No. 3 to EHS 70-110, began on March 1, 1972, and was completed November 10, 1972.

The principal engineers associated with this project were Mr. Robert McFarland, who assisted with baseline data and Mr. Clifford D. Tyree, responsible for laboratory control technology evaluation.

The Project Officer cognizant of this project was Mr. John J. McFadden of the Characterization and Control Development Branch, Division of Emission Control Technology, Environmental Protection Agency, 2565 Plymouth Road, Ann Arbor, Michigan 48105. This project was identified within Southwest Research Institute as No. 11-2877-01.

ABSTRACT

Six 1972 spark-ignited gasoline engines, used in trucks above 6,000 lbs. gross vehicle weight, were subjected to baseline exhaust emissions tests. Two groups of three engines, representing various cylinder configurations and displacements were tested by the current 1972 Federal test procedure, a nine-mode constant speed engine dynamometer test method. The concentrations were then converted to mass emissions for the nine-mode schedule using the 1974 Federal Test Procedure applicable to heavy-duty gasoline engines. Each engine was also tested by an experimental three-speed and multi-load schedule with expressions of emissions on a grams per bhp-hour basis. The emissions of interest were unburned hydrocarbons, oxides of nitrogen, carbon monoxide and aldehydes. One popularly used V-8 engine from each manufacturer's group was subjected to a limited series of laboratory tests to demonstrate control device effectiveness. This part of the study was restricted to the use of light-duty items or laboratory-type approaches because of the apparent lack of technology for gasoline engines in heavy-duty service. The experimental multi-modal test procedure was employed to evaluate various control strategies such as basic spark timing, carburetion (air-fuel ratio), air injection, exhaust gas recirculation and an oxidation catalyst singly and in combination. Substantial reductions in all emissions were effected on both engines with a combination of exhaust gas recirculation, air injection and an oxidation catalyst with some increase in fuel consumption and loss in maximum power.

TABLE OF CONTENTS

		Page
FOREWORD		ii
ABSTRACT		iii
LIST OF ILLUSTRATIONS		v
LIST OF TABLES		vii
I.	INTRODUCTION	1
	A. Previous Projects	1
	B. Assistance by the Manufacturer	2
	C. Project Reviews	3
II.	OBJECTIVE AND APPROACH	4
	A. Baseline Data	4
	B. Control Technology	4
III.	EQUIPMENT, INSTRUMENTS, ENGINES, PREPARATION AND PROCEDURES	5
	A. Exhaust Sampling and Analysis	5
	B. Dynamometry and Related Facilities	8
	C. Engines	13
	D. Preparations	14
	E. Fuels	14
	F. Experimental Procedures	14
	G. Calculational Procedures	20
IV.	RESULTS	30
	A. Baseline Results	30
	B. Control Technology Assessment	39
V.	SUMMARY AND CONCLUSIONS	94
VI.	RECOMMENDATIONS	98
LIST OF REFERENCES		99
APPENDIXES		

LIST OF ILLUSTRATIONS

Figure		Page
1	Emissions Measuring Equipment Used With Nine Mode FTP and Experimental 23 Mode Procedure	9
2	Baseline Emissions Tests Equipment and Facilities	10
3	Dynamometer and Related Instruments and Equipment Baseline Tests	11
4	Engine Under Stationary Dynamometer Baseline Emissions Tests	12
5	Effect of Spark Timing on Emissions Engine 2-3, 23 Mode Test	46
6	Carburetor Rods, Jets, and Their Location (Engine 2-3)	48
7	Effect of Air-Fuel Ratio on Emissions Engine 2-3, 23 Mode Test	49
8	Exhaust Manifold Air Injection Equipment	51
9	Effect of Light Duty EGR and Air Injection on Emissions, Engine 2-3, 23 Mode Test	52
10	Light Duty EGR Equipment	53
11	Laboratory EGR System	54
12	Effect of Laboratory Cold EGR on Emissions Engine 2-3, 23 Mode Test	57
13	Oxidation Catalyst Test Set-up Engine 2-3	58
14	Effect of Oxidation Catalyst on Emissions Engine 2-3, 23 Mode Test	61
15	Effect of Oxidation Catalyst on 1972 Standard Engine Without Air and With Fuel Rich Mixture Engine 2-3, 23 Mode Test	62
16	Various Views of Oxidation Catalyst and Air Injection System Engine 1-3	72

LIST OF ILLUSTRATIONS (Cont'd)

Figure		Page
17	Laboratory Set-up for EGR Engine 1-3	74
18	Effect of Basic Spark Timing on Emissions Engine 1-3 23 Mode Test	76
19	Effect of Air-Fuel Ratio on Emissions Engine 1-3, 23 Mode Test	77
20	Effect of Laboratory Cold EGR on Emissions Engine 1-3, 23 Mode Test	79
21	Light Duty Exhaust Manifold Air Injection System	82
22	Effect of Oxidation Catalyst on Emissions with Slightly Modified Air Injection System Engine 1-3, 23 Mode Test	84
23	Effect of Combination of Hot EGR (Sch A), Oxidation Catalyst, Modified Air Injection on Emissions Engine 1-3, 23 Mode Test	88

LIST OF TABLES

Table		Page
1.	Fuel Inspection Results	15
2.	Current Federal Nine-Mode Constant Speed Procedure for Heavy Duty Gasoline Trucks	16
3.	Experimental 23 Mode Emissions Test Schedule (Heavy Duty Gasoline Engines)	18
4.	Explanation of Nine-Mode FTP Concentration Computer Printout Sheets	21
5.	Explanation of Nine-Mode FTP Brake Specific Computer Printout Sheets	24
6.	Explanation of Experimental 23 Mode Brake Specific Computer Printout Sheets	27
7.	Nine-Mode FTP Emission Results Concentrations per FTP	31
8.	Nine-Mode Emission Results per 1974 FTP Calculation Procedure	32
9.	Experimental 23-Mode Procedure Dry corrected Emission Results	34
10.	Comparison of Average Nine-Mode and 23 Mode Results, Six Engine Baseline	38
11.	Plan of Test, Engine 2-3	42
12.	Engine 2-3, 23-Mode Emission Reductions	65
13.	Engine 2-3 Nine-Mode 1972 FTP Emission Reductions (Concentration Basis)	66
14.	Engine 2-3 Nine-Mode 1974 FTP Emission Reductions (Mass Basis)	66
15.	Analysis of Nine Mode FTP HC Results, Engine 2-3	68
16.	Plan of Test, Engine 1-3	70
17.	Effect of Basic Spark Timing on Emissions 23-Mode Test, Engine 1-3	72

LIST OF TABLES (Cont'd).

Table		Page
18.	Tailored EGR Schedules for Engine 1-3	80
19.	Comparison of Emissions With and Without Light-Duty Air Injection System, Engine 1-3, 23-Mode Test	81
20.	Effect of Exidation Catalyst on Emissions, Engine 1-3, 23-Mode Test	85
21.	Effect of Various Control Combinations on Emissions, Engine 1-3, 23-Mode Test	86
22.	Effect of "Best Combination" on Emissions, Engine 1-3, 23-Mode Test	90
23.	Engine 1-3 Nine Mode FTP Emission Reductions (Concentration Basis)	92

I. INTRODUCTION

According to statistical information[1]*, all trucks in 1970 comprised about 17 percent (18,747,781) of the total vehicles registered and burn approximately 28 percent of the gasoline consumed in the United States. From sales data[1], approximately 44 percent of the trucks and buses sold in 1970 were above 6,000-lb gross vehicle weight (GVW). This estimate includes diesel vehicles which are a relatively small number.

The Environmental Protection Agency (EPA) has sponsored two programs, one at the Bureau of Mines under Inter Agency Agreement 0129 and the other at Southwest Research Institute to characterize baseline emissions from 15 heavy duty vehicle engine candidates and investigate the effectiveness of control technology. The effort described in this report by SwRI includes six (6) HDV engines supplied by two of the seven manufacturers who cooperated in the overall effort. The engine selection rationale considered engines with low emission levels, distribution of the application range greater than 6,000-lb gross vehicle weight (GVW), high annual sales volume, diversified combustion chamber designs and availability of advanced emission control devices.

A. Previous Projects

Southwest Research Institute's Emissions Research Laboratory has conducted a considerable amount of research with HDVs beginning in June 1967. Past efforts included acquisition of baseline emissions data from 150 gasoline and LPG fueled spark-ignited engine-powered trucks and buses using three experimental road-like chassis dynamometer procedures. To acquire the emissions, a special truck version of the constant volume sampler (CVS) was used, which permitted expression of contaminants on a mass basis. The results of the survey are contained in the SwRI final report[2] which concluded that the three proposed experimental variable-speed cycles were not recommended for use in testing emissions from heavy-duty vehicles powered by spark-ignited engines. The findings of these earlier studies were summarized in AIChE and SAE papers[3, 4] which described the preparations and baseline data results, respectively.

The second major work in this program compared hydrocarbon (HC), carbon monoxide (CO), and nitric oxide (NO) emissions while driving in traffic to chassis dynamometer emissions by the Federal nine-mode constant speed cycle (FTP) for six trucks of various sizes and makes. Using a CVS, the current Federal cycle was submitted to a number of modifications to investigate what improvements might be made to make the Federal procedure agree more with road operation[5].

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*Superscript numbers in parentheses refer to the List of References at the end of this report.

The third in this series of projects, sponsored by the Environmental Protection Agency, was completed in April, 1972. The first of the three-phase project was a broad emission characterization study of four 1969 trucks under a wide variety of engine speeds and power levels. Emission rates of hydrocarbons, carbon monoxide, and nitric oxide were expressed in mass units of grams per minute, per pound of fuel and per bhp-hr. In addition to the steady-state emission maps, a number of transient accelerations and decelerations were studied using a variety of simulated vehicle inertias. The second phase was a four-vehicle study of the effect of four different road routes on emission rates. The road routes were sufficiently different to be distinct, yet were considered representative of actual truck driving. The three phases of this project generated a large body of data that is summarized in the report[6] and included in some detail in a number of appendixes.

The precedent for the operation of gasoline engines on a 23-mode test procedure, with raw exhaust emission measurements expressed on a mass basis, was established in the project completed in April 1972[6]. This present effort utilizes the equipment, instrumentation, and general test approach of the earlier project.

B. Assistance by the Manufacturer

Several meetings were held, beginning in January 1972, with representatives of two H.D. engine manufacturers involved in the SwRI studies. In attendance at these meetings were Mr. John J. McFadden and Dr. Jose Louis Bascunana representing the EPA and Mr. Karl Springer from SwRI. The objective of these meetings was to obtain the assistance, advice, and general support of the manufacturers in the project. As a result of these meetings, agreements were obtained as to engine displacement and selection of the three engines per manufacturer. Through the courtesy of the manufacturers, 1972 model engines were furnished for test. In the case of one manufacturer, the engines were new and in the case of the other, the engines were 125 hour certification engines. Also furnished by the manufacturers were the necessary exhaust piping, muffler, engine mounts, intake air cleaner, etc.

The major area of need for assistance from the manufacturers was in control technology hardware, data, and advice. Here, the manufacturers were unable to furnish more than selected items now used or previously used on light duty car engines. The general lack of help seemed to reflect the low priority given to emission control from gasoline engines in heavy duty service (above 6,000-lb GVW). The manufacturer's inability to furnish any specific or advanced concepts was taken to be a genuine and sincere expression of the current state-of-the-art as of that time. The manufacturers were quite helpful otherwise in assisting SwRI engineers in the course of the laboratory effort in furnishing technical assistance and special

parts when requested. The efforts of the manufacturers must be commended, because without the help given, this project would have been much more difficult to perform. The unqualified thanks of SwRI go to both manufacturers.

C. Project Reviews

A number of meetings, discussions and status reviews were held during the course of this project with the Project Officer. They occurred on March 7th and 30th, June 1st, July 17th and August 16, 1972. These meetings, held on site in the Emissions Research Laboratory, were helpful in overall project management. Monthly progress reports and letter reports were issued to keep the Project Officer fully informed with complete data for analysis. Telephone reports were also made to augment the reports and correspondence.

II. OBJECTIVE AND APPROACH

The objective of this project was to obtain basic emissions data from six currently-produced gasoline-fueled engines and to investigate potentialities for emissions control with two of the more popular engines.

A. Baseline Data

The approach used with the six engines, three each from two manufacturers, was to measure their emission levels or rates using current and experimental test procedures. All engines were 1972 models and were operated on the stationary dynamometer test bed. The test procedure included both operations by the current nine-mode procedure described by the FTP[7] for expression as concentration and in brake specific emissions terms according to the method specified by the California ARB[8, 9]. An experimental 23-mode engine test procedure with expression in grams per bhp-hour (brake specific) was also employed as specified by the Project Officer[10].

B. Control Technology

Two popularly used engines were subjected to a stepwise series of experiments to evaluate the effectiveness of various control approaches singly and in combination. For purpose of evaluation, the primary test procedure was the 23-mode EPA experimental method with nine-mode tests made of the best combination. Methods of control and parameters investigated included basic ignition timing, air-fuel ratio (main jet size variations). exhaust gas recirculation (EGR), oxidation catalysis, and exhaust manifold oxidation by air injection among others.

III. EQUIPMENT, INSTRUMENTS, ENGINES, PREPARATIONS AND PROCEDURES

This section contains a brief description of the instruments, equipment and facilities, engines, preparations and procedures used to conduct this project.

A. Exhaust Sampling and Analysis

Two basic types of exhaust sampling techniques were used during this program. The most familiar set of instruments used was the nondispersive infrared (NDIR) sampling train for raw exhaust gases specified in the Federal Register[7] for the nine-mode cycle (FTP). This system is described first. Another technique used was a variation of the continuous NDIR system in which raw exhaust was also analyzed by flame ionization detector (FID) and chemiluminescence (CL) instruments.

1. Nine-Mode Continuous Sampling, Analysis, and Instrumentation

The exhaust gas sampling and analysis system, for the FTP nine-mode cycle, meets the requirements and specifications established in the Federal regulations[7] for heavy-duty vehicle exhaust sampling. A component description of the system is detailed in the above referenced Federal regulations. Nominal full-scale concentration levels for the five NDIR analyzers are as follows:

(1) Low-Range HC - 1000 ppm hexane
(2) High-Range HC - 10,000 ppm hexane
(3) CO - 11 percent
(4) CO_2 - 16 percent
(5) NO - 4000 ppm

Although nitric oxide was not included in the current Federal regulations relating to gasoline HDVs at the time this project was done, this contaminant was important from a research standpoint.

The output of each analyzer is fed to strip-chart recorders. The concentrations from each trace can be obtained from the continuous traces by hand as specified in the nine-mode FTP. The average concentrations are then transferred to computer cards for further processing to obtain composite values for HC, CO, and NO. This method was used as a back-up to the real time computer system normally used. The computer system was designed and assembled by SwRI. This computer utilizes a Data General Super Nova, 8K central processor, and a Computer Products Series RTP 7410 multiplex. The computer program was also prepared by Institute personnel. This computer system was very helpful during this program to determine nine-mode FTP results immediately after completion of the

tests. The reliability and repeatability of the on-line computer has been shown to be equal or better than manual chart reading and computer reduction of data.

The NDIR cart was subjected to a calibration according to EPA requirements. Both static and dynamic gas simulator tests were run initially on this cart by Mr. Matt Macocha of EPA during the period of September-November, 1971. Frequent calibrations of all NDIR, CL, and FID instruments were made to assure optimum accuracy. One of the EPA checks was to name an unknown contaminant to ± 1 percent, a difficult requirement since the basic detector is only specified to ± 1 percent by the manufacturer. Suffice to say that no tests were made until initial calibrations were satisfactorily completed.

2. Experimental 23-Mode Instrumentation

The use of direct stream, raw exhaust, emission sampling and analysis instruments has ample precedent in the case of NDIR type analyzers in which a fairly dry, clean sample is analyzed. To measure CO and CO_2, by NDIR, the usual continuous NDIR cart used for nine-mode FTP work was used. HC by NDIR was of secondary importance since it is known to grossly understate the HC concentrations in most modes of engine operation. The 23-mode method was to use an FID on the direct tailpipe raw exhaust that has not been cooled below the dew point of the water vapor contained therein. Condensation of water causes severe operational problems and it also is indicative of possible losses of some unburned hydrocarbons by condensation. For gasoline engine exhaust, the industry-accepted practice is to hold the sample, sample lines, and FID analyzers at about 160° F and, of course, no ice-water condensate trap was employed. Good operability at this temperature with an SwRI design HC analyzer had been found on another project dealing with off-road sources for EPA (Contract EHS 70-108).

In a previous project dealing with the 23-mode test[6], it was found that the Beckman Model 400 FID, widely used with diluted gasoline exhaust, was unsuited for raw gasoline engine exhaust. Rather than attempt to modify the instrument with uncertain results, it was decided to use an SwRI design FID and operate same at 160° F. The basic design and theory of operation was discussed in an SAE paper. Please refer to reference 11 for further details and description of the HC instrument.

To improve time response, the SwRI FID oven was located adjacent to the engine exhaust pipe. A fairly short stainless steel sample line, heated by a cylindrical heater, was controlled to maintain a 160° F gas temperature while oven temperature was held at 160° F. The sample probe was of standard design for auto exhaust and located adjacent to the probes used for the CO, CO_2, and NO_x samples.

To monitor the HC sample bypass flow, a small rotameter was connected to the effluent from the FID. Since the water vapor was still in the exhaust and as it tends to condense in the rotameter at room temperature, a small ice trap was added before the rotameter but after the sample was split from the main stream and forced through the sample capillary. This is standard laboratory practice when a flowmeter is used to help monitor sample bypass flow.

A Thermal Electron Corp. (TECO) Model 10A chemiluminescent NO_x-NO analyzer, furnished by EPA, was used to measure NO_x. The TECO instrument analyzed a sample obtained via a separate line from the exhaust pipe. Since water vapor has a sizeable positive interference on the NDIR NO reading, a bone dry sample, commonly achieved by a chemical drying agent such as Aquasorb or Drierite has been standard practice. This has always been a controversial step in sample preparation and the recent trend has been, where possible, to use the chemiluminescent method which does not require it.

The TECO and other commercial chemiluminescent analyzers, however, were not designed to handle raw, undiluted, exhaust and suffer from operational difficulties if the majority of the water vapor is not removed. The current chemiluminescent analyzers operate at room temperature and do well with highly diluted exhaust such as from a constant volume sampler or with atmospheric samples. Raw exhaust contains the water vapor from combustion along with the intake air humidity and removal via an ice-water-type trap is necessary to prevent filling or coating the sample lines and capillary, leading to the reaction chamber, with water.

NO_2 is readily absorbed by water and the efficiency depends on residence and contact area. As the lesser of two evils, an ice-water-type trap with minimal residence time and water-to-sample contact time was used to prevent the sampling lines and other tubing, capillary, etc., within the instrument from becoming water logged. In practice, the same trap used for the NDIR was employed. No chemical drying agent such as Aquasorb or Drierite was used. On several occasions, the effect of the trap on NO_2 was checked by flowing a known concentration of NO_2 span gas through the system at various times during the run with the trap wet and the fiberglass particulate filter "dirty". From this, it was found that on an average about 10 to 15 percent of the NO_2 was lost, making all measurements of NO_2 subject to this error. One solution would be to heat the sample line, pump, etc., from point of sample to entrance of the sample into the reaction chamber.

An analysis of side-by-side NDIR and CL data from a previous project[6] revealed extremely close results and good correlation. The conclusion of such tests was that either system was satisfactory and the CL was preferred since it eliminates the difficult-to-resolve question of the

effect of chemical drying agents on NO readings. The CL is not, however, without certain drawbacks as mentioned earlier.

Figure 1 shows several views of the instruments used for the nine-mode FTP and the 23-mode procedure with stationary-operated engines. The tall cabinet in the upper right and middle right view houses the NDIR NO and the CL NO_x instruments. Shown in the middle right view is the NDIR cart for HC, CO, and CO_2 analysis. The CO and CO_2 analyzers in this cart were used both ways, for nine and 23 mode testing. The lower right view shows the oven containing the heated portion of the HC instrument. The pump, filter, valves and detector, etc., are located in the oven with flow control module and electrometer located to the right of the oven.

Shown in the extreme right side of the lower right view is the glassware used to bubble exhaust through reagent for collection of aldehydes. Several runs on each engine, by the 23-mode procedure, included measurement of aliphatic aldehydes by the 3-methyl-2-benzylthiozolone hydrazine (MBTH) method[12, 13]. This is a wet chemical method which is the popularly used technique for aldehyde determination. Its precision and adequacy for raw gasoline exhaust determination has not been thoroughly researched. The method was selected as the best available for a first approximation.

The lower left view in Figure 1 shows the heated sample line used for both HC and aldehyde sample transfer. It was felt important to locate instruments and glassware as close as practical to the exhaust system. All tests were made with samples obtained at a point representing average exhaust system length and the sample lines length kept to a minimum. Usually the sample lines were less than 36 inches. Other views of the instruments will be shown later in the report.

B. Dynamometry and Related Facilities

The two stationary all-electric engine dynamometers used in this project were completely equipped for constant speed motoring-absorbing and could perform the nine-mode FTP and the 23-mode experimental schedules satisfactorily.

1. Baseline Engines

The six baseline engines were operated in Cell 3 of the U. S. Army Fuels and Lubricants Research Laboratory at SwRI. The dynamometer and several typical engine installations are shown in Figures 2 to 4. This Eaton Dynamatic dynamometer is capable of 300 hp absorbing from 2,000 to 5,000 rpm and 50 hp motoring.

2. Control Technology Engines

Both control technology engines were then operated in the Emissions

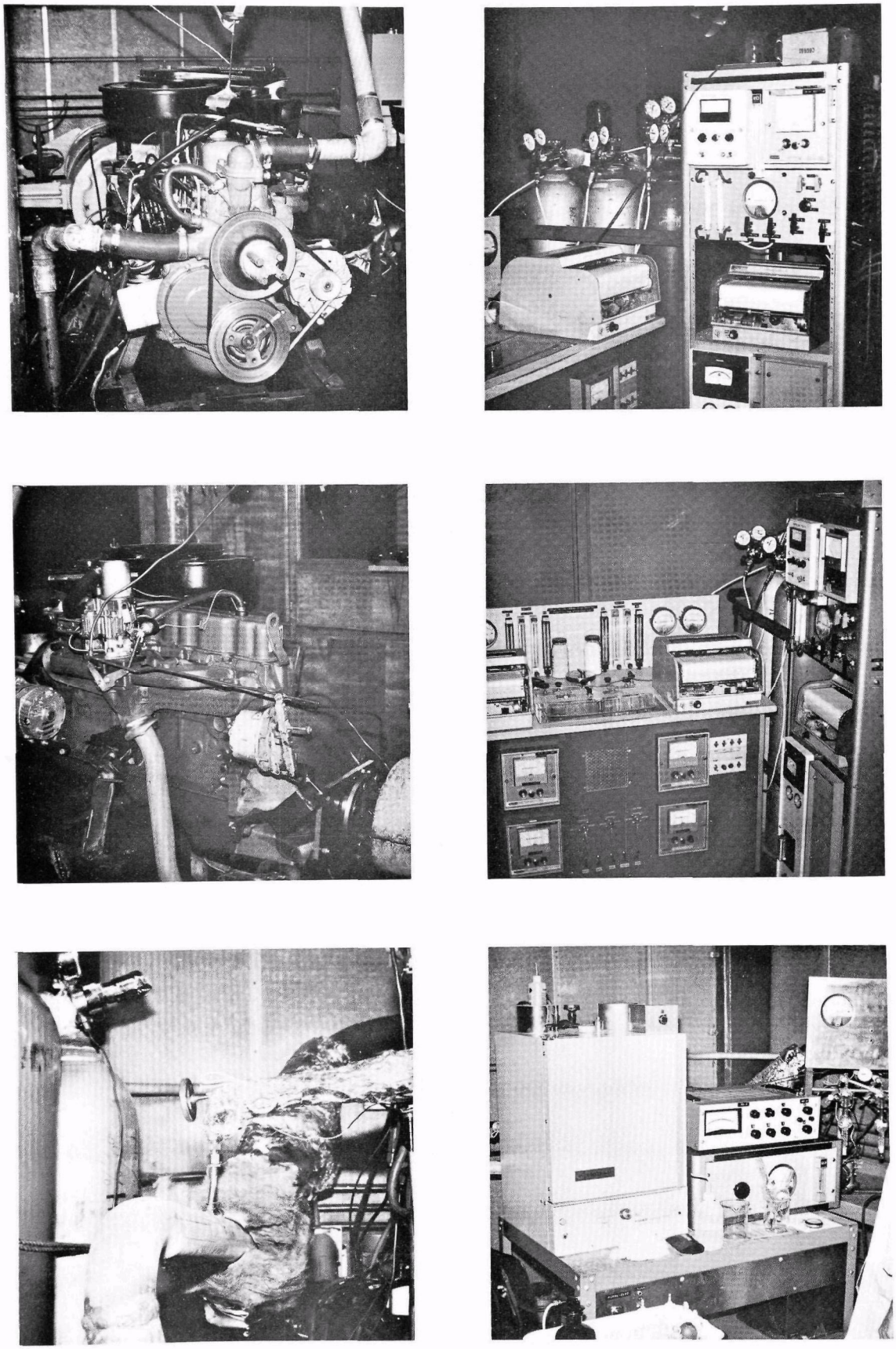


FIGURE 1. EMISSIONS MEASURING EQUIPMENT USED WITH NINE MODE FTP AND EXPERIMENTAL 23 MODE PROCEDURE

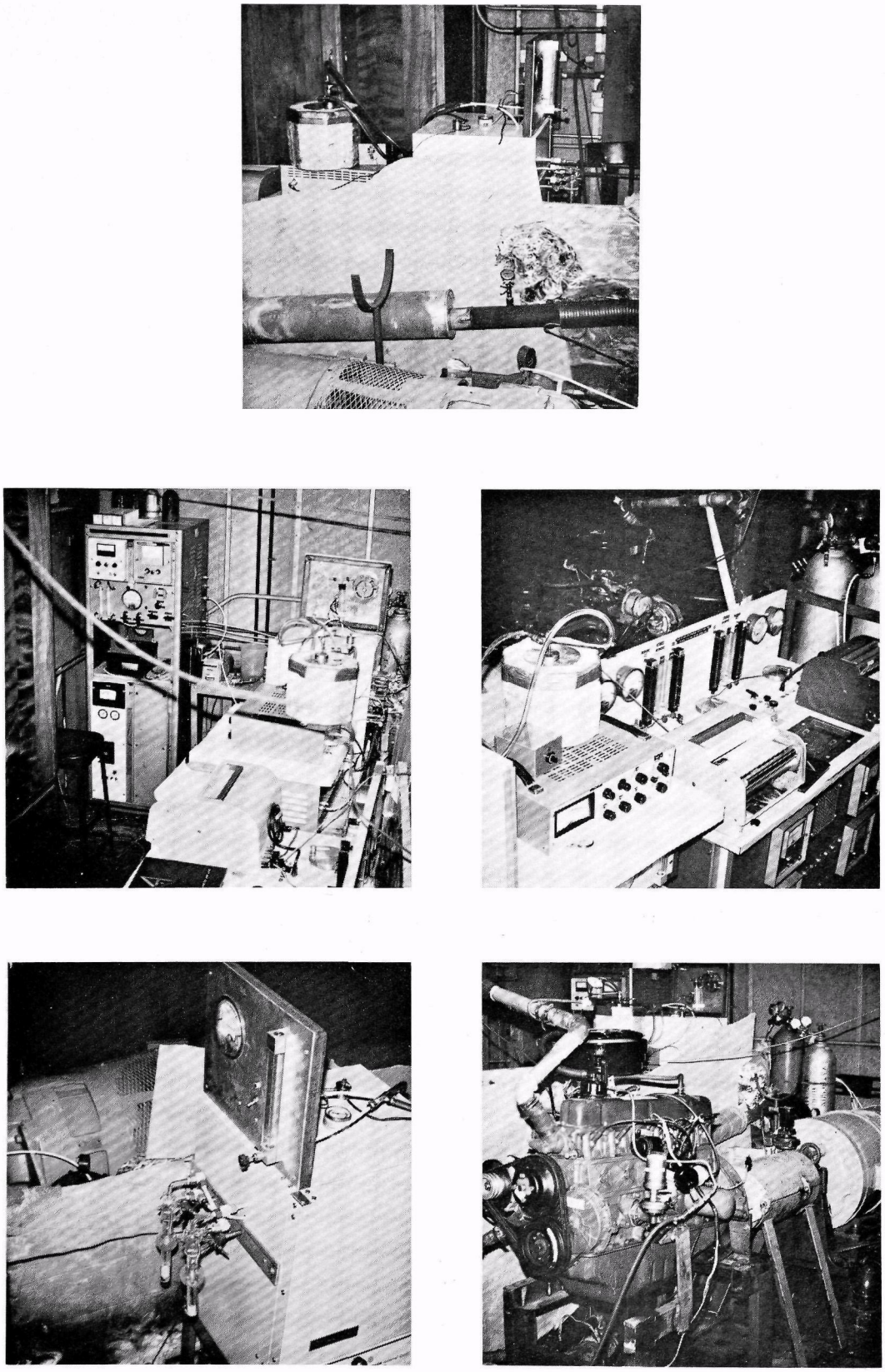


FIGURE 2. BASELINE EMISSIONS TESTS EQUIPMENT AND FACILITIES

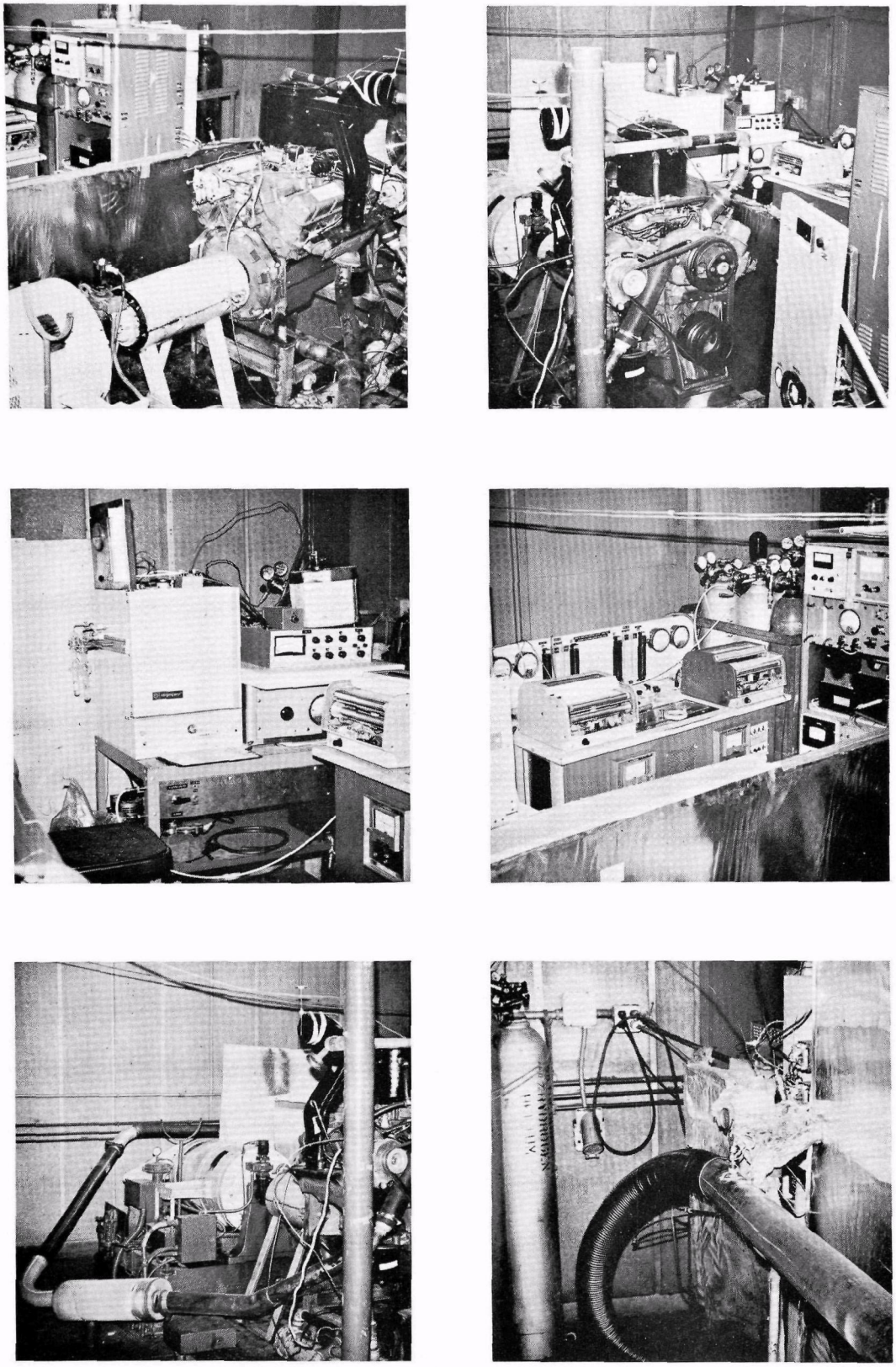


FIGURE 3. DYNAMOMETER AND RELATED INSTRUMENTS AND EQUIPMENT BASELINE TESTS

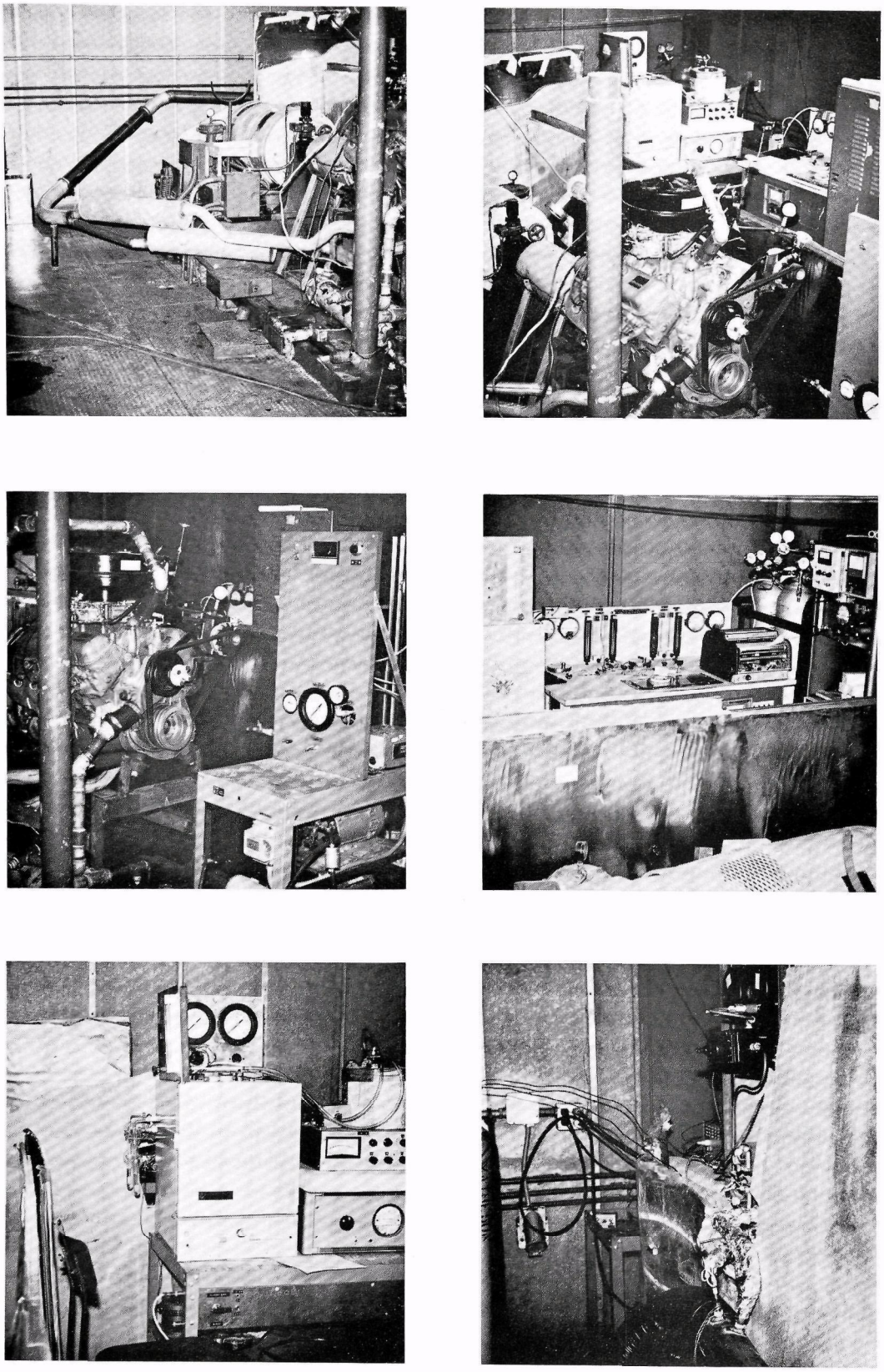


FIGURE 4. ENGINE UNDER STATIONARY DYNAMOMETER BASELINE EMISSIONS TESTS

Research Laboratory on a similar but larger Eaton Dynamatic dynamometer. This unit has capability to handle 500 hp absorbing (2,000 to 5,000 rpm) with 200 hp motoring. This dynamometer facility will be shown in the various views of engines and control systems later in this report.

3. Related Facilities

As important as the actual emissions measurements are the measurements of engine speed, power output and fuel consumption. The calibrations of the Standard Electric Time Co. speed systems were made by a calibrated strobotac (General Radio) and the hydraulic loading readout system by dead weight test. Fuel flow was measured by a Flo-Tron or weigh scale. Only weigh scale readings for the time (stop watch) to consume a known mass of fuel were used to compute mass emission rates with the baseline engines. A weigh scale calibrated Flo-Tron was used for the control technology engines.

A complete dynamometer installation was provided for measurement and control of engine operating parameters including inlet and outlet water temperature, inlet air temperature, exhaust temperature, oil pressure, exhaust backpressure and intake manifold vacuum. The latter pressure is critical to the nine-mode test and was periodically calibrated against a mercury column. Inlet air humidity was measured using a Bendix Model 566 wet-dry bulb temperature measuring instrument. The Bendix unit was periodically checked against a sling psychrometer. A conventional liquid-in-glass mercury barometer was used to measure barometric pressure and the observed reading suitably corrected.

C. Engines

In all, a total of six engines were obtained through the courtesy of the manufacturers. Two six cylinder in-line engines and four V-8 engines were used in the program. The engines were coded at the request of the manufacturers and with the concurrence of the Project Officer. The characteristics of the engines are listed below.

Test Engine Description

Engine Code	Adv. Flywheel Power(1) Bhp	@ rpm	Peak Torque Lb - Ft	rpm	GVW Application Min - Max, lbs
1-1	132	3500	239	2000	6,200 - 24,000
1-2	217	3200	398	1800	23,000 - 80,000(2)
1-3	152	3600	278	2200	16,000 - 50,000(2)
2-1	110	3800	185	1600	6,200 - 18,000
2-2	230	4000	360	2400	21,000 - 64,000(2)
2-3	175	4000	290	2400	6,200 - 26,000

(1)SAE J-245 (net)
(2)Gross Combined Weight

Engines 1-3 and 2-3 were used in the control technology assessment portion of the project. All engines were truck or truck version 1972 model year engines and had been built under the provisions of the 1972 certification regulations. Engines 1-1, 1-2, and 1-3 were the 125 hour certification engines. All engines were furnished to SwRI by the manufacturers along with necessary engine mounts, clutch-flywheel where desired and exhaust piping.

D. Preparations

The six engines subjected to baseline emissions measurements were provided by the manufacturers in ready-to-run condition. Since engines 2-1, 2-2, and 2-3 were new, a 25 hour break-in was given these engines before starting the emission test series. The variable speed and load run-in schedule was in accord with the manufacturer's recommendations. Once the engine was run-in or checked to make certain it was operating properly, the basic timing and idle speed were checked to make certain their adjustments were within the EPA factory sticker tune specifications. If not, adjustments were made. No adjustments were made to the idle air screws. These engines and carburetors were furnished with the usual plastic idle air screw adjustment limiters.

E. Fuels

The leaded premium fuel used during all baseline and control technology emissions tests met the requirements of the Federal Register[5]. A typical fuel analysis of the fuel used and purchased locally is given in Table 1. Also shown on Table 1 is an inspection of the low lead Indolene clear motor fuel used in all control technology experiments involving the oxidation catalyst.

F. Experimental Procedures

All the engines were subjected to two basic laboratory stationary-operated engine procedures.

1. Nine-Mode FTP Schedule

The 1970 FTP (nine-mode 2,000 rpm constant speed procedure) is adequately described in the Federal Register[7]. The test schedule is listed in Table 2. The procedure is 20 minutes in length and consists of the Table 2 schedule being run four times. The weighting factors, listed in the last column, are used to calculate the concentration results.

Please note that in reality, only six modes, of which only three are power-producing, are included in this 2,000 rpm constant speed procedure. The 16-inch condition is repeated four times for 35.6 percent of the weight. The other power-producing modes, Modes 3 and 7, the 10-inch and 3-inch

TABLE 1. FUEL INSPECTION RESULTS

	Leaded	Clear
Gravity, deg API (D287)	59.3	58.0
Distillation Range (D86)		
Initial Boiling Point, °F	88	86
5% Point, °F	116	
10% Point, °F	127	128
20% Point, °F	150	
30% Point, °F	175	
40% Point, °F	200	
50% Point, °F	220	220
60% Point, °F	235	
70% Point, °F	254	
80% Point, °F	276	
90% Point, °F	305	315
95% Point, °F	327	
End Point	340	409
% Recovery	98.0	98.0
% Residue	1.0	1.0
% Loss	1.0	1.0
Octane No., Research (D1656)	103.4	98.3
Total, % wt (D1266)	0.004	0.01
Reid Vapor Pressure, psi (D323)	9.1	9.2
Hydrocarbon Composition (D1319)		
Olefins, %	0.4	3.0
Aromatics, %	27.3	30.0
Saturates, %	72.3	67.0
Lead (Organic) g/gal (D526)	3.271	0.01
Phosphorus, Theory	0.0	0.0
Oxidation Stability (D525)	600+	
Existent Gum, mg (D381)	0.6	0.2

TABLE 2. CURRENT FEDERAL NINE-MODE CONSTANT SPEED PROCEDURE FOR HEAVY DUTY GASOLINE TRUCKS

Sequence Number	Manifold Vacuum	Time in Mode, sec	Cumulative Time, sec	Weighting Factors
1	Idle	70	70 (1:10)	0.036
2	16 in. Hg	23	93 (1:33)	0.089
3	10 in. Hg	44	137 (2:17)	0.257
4	16 in. Hg	23	160 (2:40)	0.089
5	19 in. Hg	17	177 (2:57)	0.047
6	16 in. Hg	23	200 (3:20)	0.089
7	3 in. Hg	34	234 (3:54)	0.283
8	16 in. Hg	23	257 (4:17)	0.089
9	Closed Throttle	43	300 (5:00)	0.021

Engine Speed 2000 ± 100 rpm.

An initial 5-min idle, two warmup cycles and two hot cycles constitute a complete dynamometer run.

modes, account for another 54 percent of the schedule. The three power modes, 16-inch, 3-inch, and 10-inch vacuum, represent a total of 89.6 percent of the cycle weight. The idle (3.6 percent weight), 19 inch (4.7 percent weight) and the closed throttle (2.1 percent weight) represent the remaining 10.4 percent of the cycle weight.

2. Experimental 23-Mode Schedule

The experimental 23-mode schedule is listed on Table 3 and is taken directly from the preliminary procedure, reference 10, provided by the Project Officer. A copy of this reference is included as Appendix Y. Note that modes 7, 9, and 10, at 1200 rpm engine speed, and modes 18, 20, and 21, at 2300 rpm engine speed, carry a zero weighting factor. Modes 7, 9, 10, 18, 20 and 21 were measured to obtain emission data that may be of use later. The 23-mode schedule and procedure is quite similar to the 1500-2500 rpm schedule studied earlier in the basic project and described in detail in the final report[6].

Although a 230 minute long, ten minutes per mode, test was described by the preliminary procedure, earlier work indicated that three minute long modes were quite adequate for an engine mapping-type procedure. As described in the final report[6] dealing with procedural development, the first minute is devoted to changing speed and load, the second minute for stabilization and only the time average of the third minute emission concentration used.

When measuring aliphatic aldehydes, a three-minute sampling period is needed and the three-minute schedule is extended to six minutes, with the third, fourth, and fifth minutes given over to wet collection of aldehydes. The sixth minute and first and second minutes of the next mode were used to wash down the fritted bubblers and exchange the bubbling reagent and holders.

Note that 12 minutes are allocated to mode 12. The additional nine minutes are provided to allow the HC analyzer and sampling system to purge after the very high HC concentration closed throttle (CT) raw exhaust samples have been analyzed. This procedure was found to be quite acceptable with regard to HC hang-up and is felt a necessary part of measuring the very high CT conditions.

One item that would have been helpful and is felt necessary for future 23-mode procedure work is a dual range CO or two different CO instruments. A 0-11 percent CO instrument is necessary under the WOT conditions, while at optimum combustion efficiency, such as about 50 ± 25 percent power, a much lower, say 0-1 percent CO instrument could be employed for improved accuracy. The situation is somewhat similar to the nine-mode NDIR HC instruments where two are needed, one for CT and selected other modes on

TABLE 3. EXPERIMENTAL 23 MODE EMISSIONS TEST SCHEDULE
(Heavy Duty Gasoline Engines)

Mode	Engine Speed, rpm	Power Out, %*	Mode Time	Cumulative Time	Weighting Factor
1	Idle	0	3	3	0.07
2	1200	2	3	6	0.06
3	1200	8	3	9	0.06
4	1200	18	3	12	0.05
5	1200	25	3	15	0.03
6	1200	50	3	18	0.06
7	1200	75	3	21	0.00
8	1200	82	3	24	0.04
9	1200	92	3	27	0.00
10	1200	100	3	30	0.00
11	Idle	0	3	33	0.07
12	1200	0 (CT)**	12	45	0.12
13	2300	100	3	48	0.025
14	2300	92	3	51	0.055
15	2300	82	3	54	0.035
16	2300	75	3	57	0.06
17	2300	50	3	60	0.06
18	2300	25	3	63	0.00
19	2300	18	3	66	0.065
20	2300	8	3	69	0.00
21	2300	2	3	72	0.00
22	Idle	0	3	75	0.08
23	2300	0 (CT)**	3	78	0.06

*Observed at the flywheel, percent of maximum at a given engine rpm.
**Power out is zero. Engine requires motoring in this mode.

occasion,while all others are read on a 0-1000 ppm scale. A multirange unit like a 315 B Beckman is only good to a five times factor, making say 0-1 and 0-11 percent impossible by merely the range gain amplification. Either stacked cells or two separate instruments is the answer in this regard.

3. Engine Test Method

The specific test procedure followed for a baseline engine, assuming the engine has been proof tested with power, torque, fuel rate, etc., as expected and any run-in or break-in completed, was essentially as follows:

First, replicate nine-mode tests were made, at least three times with one hour shut down between tests. The full 20 minute schedule was followed. Then, the engine power readings and fuel consumption rates were determined in replicate. These measurements are necessary to convert the nine-mode concentrations to grams per bhp-hour using the carbon balance method specified in the California ARB Procedure[8, 9]. It is not possible to measure the fuel accurately during the fairly busy nine-mode schedule (see Table 2 for mode times) and therefore, such measurements are normally obtained at the conclusion of the test.

Next, NO NDIR and both NDIR HC analyzers were switched out and the NO-NO_2 CL and heated FID were switched into the sampling and analysis system. The 23-mode procedure calls for operation at specific percentages of maximum power at 2300 and 1200 rpm. As soon as the engine was thoroughly warmed up, the maximum observed flywheel power output of the engine was determined by operating alternatively at WOT at 1200 rpm and 2300 rpm.

In actual operation, the 23-minute procedure was preceded by a 10-minute operation at 2000 rpm, half-load to warm up the engine. During the last few minutes, the analyzers were zeroed and spanned, ice-water traps drained and filters renewed. The engine then began the initial idle mode of the 23-mode test. In practice, the test was not difficult since the first minute of each 3-minute mode was allocated to adjust engine speed and load, the second minute was devoted to engine-emission stabilization, and the final minute the emissions were continuously recorded and integrated to determine modal concentrations.

More than 3 minutes may be used at the center idle, mode 11, to do maintenance on the sampling and analysis equipment. Normally, as soon as the first closed throttle was complete, Mode 12, the HC system was purged with zero N_2 while other instruments were spanned and zeroed. Then the HC instrument was spanned and zeroed, water traps were drained, filters replaced, and all instruments rechecked for zero and span before starting Mode 13. At any mode during the test, the instruments could be zeroed and spanned, if desired, as long as it was done during the first 1-1/2

minutes of the mode. In practice, the ice-water traps were drained after the 5th and 17th modes of the test.

G. Calculational Procedures

The emission results were calculated in three ways:

1. Nine-Mode FTP - Concentrations

The calculations of the final result of ppm n hexane HC, and percent CO followed the nine-mode procedure as specified in detail by the Federal Register[7]. In effect, the raw NDIR readings in ppm are adjusted by a dilution factor

$$\text{Dilution Factor} = \frac{14.5}{CO_2\,\% + 0.5\,(CO\% + 10.8\ HC\ \%\ n\ hexane)}$$

and then multiplied by the appropriate weighting factor. These were listed earlier in Table 2.

The on-line process computer was normally used with manual strip chart-computer reduction as an alternative. The computer print-out is so arranged to list as-measured raw concentrations, the adjusted, weighted and sum composite values. Since this is a standard method, the reader is referred to Reference 7 for complete details. Table 4 is an explanation of the nine-mode FTP concentration computer print-outs.

Although not covered by current Federal regulations, NO during the nine-mode FTP was measured by NDIR. The results were treated the same as the CO and HC, i.e., adjusted for dilution and application of the weighting factor. Since water vapor or inlet air humidity has a measurable effect on NO formation in combustion engines, this reading is normally presented both on an observed and corrected basis. The conventional correction basis is 75 grains of water per pound of dry air absolute humidity and is determined by multiplying the observed NO by the correction factor

$$\text{Correction Factor (K)} = 0.6272 + 0.00629H - 0.0000176H^2$$

where H = absolute humidity of the air

This expression is identical to that in the current heavy-duty gasoline truck surveillance project (Contract EHS 70-113). The factor came from results of an AMA project described in Reference 14.

2. Nine-Mode ARB - Brake Specific

This method, described in References 8 and 9 utilizes the carbon

TABLE 4. EXPLANATION OF NINE-MODE FTP CONCENTRATION COMPUTER PRINTOUT SHEETS

1. Column Explanation

Column	Column Title	Explanation
1	FEDERAL MODE	Mode number and inlet vacuum (inches of mercury)
2	AS MEASURED HC	Measured hydrocarbon emissions, ppm or n-hexane
3	AS MEASURED CO	Measured carbon monoxide emissions in percent
4	AS MEASURED CO_2	Measured carbon dioxide emissions in percent
5	AS MEASURED NO	Measured nitrogen oxide emissions in ppm
6	DILUTION FACTOR	Dilution factor for each mode calculated by equation shown at bottom of printout
7	ADJUSTED HC	Measured HC times the dilution factor (PPM-hexane)
8	ADJUSTED CO	Measured CO times the dilution factor (percent)
9	ADJUSTED NO	Measured NO times the dilution factor (PPM)
10	WEIGHTING FACTOR	Weighting factor assigned to each mode
11	WEIGHTED HC	Adjusted HC times weighting factor
12	WEIGHTED CO	Adjusted CO times weighting factor
13	WEIGHTED NO	Adjusted NO times weighting factor

2. Line Explanation

1st Line

(X) - (XX) - 72	Date in month, day and year
ENGINE (X) - (X)	SwRI engine identification number
RUN (X)	Run Number. Runs numbered sequentially. The first run for a given day in run 1.

TABLE 4 (CON'T). EXPLANATION OF NINE-MODE FTP CONCENTRATION COMPUTER PRINTOUT SHEETS

K = (X.XX)	Humidity correction factor for cycle composite NO. $K = .6272 + .00629\,H - .0000176H^2$. Where H = absolute humidity in grams/lb DA
HUM = (XXX) GR/LB	Absolute humidity in grams/lb DA during run
Line Starting	
SUM - CYCLE COMPOSITE	Sumation of each weighted emission type
AVERAGE SUM - (COMPOSITE VALUES FOR CYCLES 1 AND 2)	$\frac{\text{SUM (cycle 1)} + \text{SUM (cycle 2)}}{2}$
AVERAGE SUM - (COMPOSITE VALUES FOR CYCLES 3 AND 4)	$\frac{\text{SUM (cycle 3)} + \text{SUM (cycle 4)}}{2}$
FOUR CYCLE COMPOSITE	Composite value for each emission using formula shown
CORRECTED NO	Composite NO times K

balance method to establish the exhaust mass rate. It is necessary to know precisely the fuel consumption rate as well as CO, CO_2, and HC, the principal carbon-bearing products of combustion. Since it is desired to express the emission rate on a brake specific basis in terms of grams of contaminant per brake horsepower-hour, it is also necessary to accurately measure or know the power output at the flywheel. With the modal concentrations (raw) from the nine-mode test and the fuel rate and power output modally, the determination of mass rates by the 1974 FTP is a straightforward calculation. A computer was used and the print-out sheets are explained on Table 5.

All data presented in this report use the latest density, correction factor for NO_2 and weighting factors per Reference 9. The correction factor

$$K = 0.634 + 0.00654H - 0.0000222H^2$$

where H is the grains of water per pound of dry air was used to correct observed NO to NO at 75 grains humidity, standard.

Reference 9 also changed the weighting factors from those historically used with the California and Federal nine-mode test for weighting the emission concentrations. Because of the importance of weighting factors on the final result, the current ARB weighting factors are listed along with the FTP weighting factors.

ARB Weighting Factors for Nine-Mode Mass Emissions

Mode	Vac, in Hg	Previous*	Current
1	Idle	0.036	0.232
2	16	0.089	0.077
3	10	0.257	0.147
4	16	0.089	0.077
5	19	0.047	0.057
6	16	0.089	0.077
7	3	0.283	0.113
8	16	0.089	0.077
9	C.T.	0.021	0.143

*Currently used in the FTP[7] and contained in earlier ARB proposals[8].

In essence, the latest California ARB factors give substantially more weight to closed throttle and idle modes and less weight to the 10-inch and 3-inch modes. Recall that neither the idle or closed throttle are power producing, with the net effect that cycle power is less when weighted making the denominator smaller and the quotient larger.

TABLE 5. EXPLANATION OF NINE-MODE FTP BRAKE SPECIFIC COMPUTER PRINTOUT SHEETS

1. Column Explanation

Column	Column Title	Explanation
1	MASS MODE	Mode number and inlet vacuum (inches of mercury)
2	AS MEASURED HC	Measured hydrocarbon emissions, ppm or n-hexane
3	AS MEASURED CO	Measured carbon monoxide emissions in percent
4	AS MEASURED CO_2	Measured carbon dioxide emissions in percent
5	AS MEASURED NO	Measured nitrogen oxide emissions in ppm
6	TOTAL CARBON	The percentage of exhaust gas that is carbon containing gases
7	FUEL CONS.	Engine fuel consumption in Grams/Hr.
8	ADJUSTED (MASS) HC	Hydrocarbon emissions in Grams/Hr. calculated from measured HC
9	ADJUSTED (MASS) CO	Carbon monoxide emissions in Grams/Hr. calculated from measured CO
10	ADJUSTED (MASS) NO_2	Nitrogen dioxide emissions in Grams/Hr. calculated from measured NO
11	WT. FACT.	Weighting factor for each mode
12	WEIGHTED (MASS) HC	Hydrocarbon emissions in Grams/Hr. times the weighting factor
13	WEIGHTED (MASS) CO	Carbon monoxide emissions in Grams/Hr. times the weighting factor
14	WEIGHTED (MASS) NO_2	Oxides of nitrogen emissions as NO_2 Grams/Hr. times the weighting factor
15	HP	Engine horsepower from dynamometer

TABLE 5 (CONT.) EXPLANATION OF NINE-MODE FTP BRAKE SPECIFIC COMPUTER PRINTOUT SHEETS

2. Line Explanation	Explanation
1st Line	
(X) - (XX)-72	Date in month, day and year
ENGINE (X)-(X)	SwRI engine identification number
RUN (X)	Run number. Runs numbered sequentially. The first run for a given day in run 1.
K = (X.XX)	Humidity correction factor for cycle composite NO_2. $K = .634 + .00654\,H - .0000222H^2$. Where H = absolute humidity in grams/lb DA
HUM = (XXX) GR/LB	Absolute humidity in grams/lb DA during run
Line Starting	
SUM - CYCLE COMPOSITE	Grams/BHP-HR for cycle, sumation of each weighted emission divided by the sumation of horsepower times weighting factor, i.e. $\frac{\sum \text{Emission} \times \text{W.F.}}{\sum \text{H.P.} \times \text{W.F.}}$
AVERAGE SUM -(COMPOSITE VALUES FOR CYCLES 1 AND 2)	$\frac{\text{SUM (cycle 1)} + \text{SUM (cycle 2)}}{2}$ Grams/BHP-HR
AVERAGE SUM -(COMPOSITE VALUES FOR CYCLES 3 AND 4)	$\frac{\text{SUM (cycle 3)} + \text{SUM (cycle 4)}}{2}$
FOUR CYCLE COMPOSITE	Composite of all four cycles in Grams/BHP-HR using formula shown
CORRECTED NO_2	Four cycle composite NO_2 in grams/BHP-HR times the humidity correction factor, K.

3. Experimental 23-Mode Calculations

This experimental procedure and its calculational method was provided by the Project Officer for use in this project[10]. The calculational methods followed fairly closely those established for the 23-mode procedure used in Reference 6. The engine speeds were slightly lower, the power levels changed and the weighting factors were different but the method of calculation, using the carbon balance technique, remained the same. As a consequence of correspondence between Mr. Mel Ingalls of Southwest Research Institute and Mr. John Bozek of Environmental Protection Agency, the calculation procedure for the 23-mode data was clarified. As confirmed by letter from Mr. Ingalls to Mr. Bozek on April 17, 1972, all data was expressed on a dry basis.

Table 6 is an explanation of the computer print-out sheets and illustrates how the final grams of HC, CO, or NO_2 were determined from the raw concentrations, fuel rate and power output data. Note that the print-out includes aldehydes so that this emission could be expressed on a brake specific basis of grams of formaldehyde per bhp-hour. The colorimetric determination of aliphatic aldehydes is in terms of the simplest aldehyde, formaldehyde.

Beginning with engine 2-3, the last baseline and the first control technology engine, the computer print-out included air-fuel ratio (AFR) by the Spindt calculation method. This is listed on the computer print-out where fuel in grams per hour once was. This addition to the print-out information necessitated the addition of O_2 measurement by a Beckman polarographic method. The Spindt Calculation is included in the explanation of the 23-mode computer print-out, Table 6. For additional description of this method, please refer to Reference 15. The air-fuel ratio computed by this method agrees with the air-fuel ratio calculated by one other method and was felt reliable enough for purposes of this project. All of the calculational methods used in this project were discussed in detail with the Project Officer and his approval obtained for their use. Changes in print-out format, factors, corrections, etc., were effected when requested to conform with the latest procedures and methods available to EPA and SwRI.

TABLE 6. EXPLANATION OF EXPERIMENTAL 23 MODE BRAKE SPECIFIC COMPUTER PRINTOUT SHEETS

Column	Column Label	Explanation
Upper table		
1	MODE	Mode number (1-23)
2	SPEED	Engine speed in rpm
	DYNAMOMETER LOAD	Measured dynamometer load in ft-lbs
4	HP	Horsepower calculated from dynamometer load and speed using equation: $HP = \frac{(ft\text{-}lbs) \times rpm}{5252}$
5	MAN. VAC.	Measured manifold vacuum in inches of Mercury
6	FUEL RATE LB/HR	Measured lb/hr of fuel used
7 *	FUEL RATE GM/HR	Fuel rate in grams per hour calculated from equation: $GM/HR = 453.6 \times lbs/hr$
8	DRY CONCENTRATION ALDE	Measured aldehyde emission concentration as formaldehyde (ppm) corrected to a dry (water from combustion removed) basis by the equation: $ALDE = ALDE\ (\text{as measured wet}) \times K_1$ where $K_1 = \frac{(100 + .925\ (CO\% + CO_2\%)}{100}$
9	DRY CONCENTRATION HC	Measured hydrocarbon emission concentration (ppmC) corrected to a dry basis as above.
10	DRY CONCENTRATION CO	Measured carbon monoxide emission concentration, % by volume. Measured dry with water of combustion removed.
11	DRY CONCENTRATION CO_2	Measured carbon dioxide emission concentration, % by volume. Measured dry.
12	DRY CONCENTRATION NO_x	Measured oxides of nitrogen emission concentration as NO (ppm). Measured dry.

TABLE 6. (Cont'd) EXPLANATION OF EXPERIMENTAL 23 MODE BRAKE SPECIFIC COMPUTER PRINTOUT SHEETS

Column	Column Label	Explanation
Lower Table		
1	MODE	Mode number (1-23)
2	CALCULATED GRAM/HR ALDE	Calculated aldehyde emission concentration as formaldehyde in grams/hr $ALDE(gm/hr) = 2.16 \times \frac{ALDE}{10000} \times \frac{\text{fuel flow(grams/hr)}}{\text{total carbon}}$ where Total Carbon $= CO_2\% + CO\% + \frac{HC(ppm)}{10000}$
3	CALCULATED GRAM/HR HC	Calculated hydrocarbon emission concentration in grams/hr $HC(gm/hr) = \frac{HC}{10000} \times \frac{\text{fuel flow(grams/hr)}}{\text{total carbon}}$
4	CALCULATED GRAM/HR CO	Calculated carbon monoxide emission concentration in grams/hr $CO = 2.02 \times CO \times \frac{\text{fuel flow(grams/hr)}}{\text{total carbon}}$
5	CALCULATED GRAM/HR NO_2	Calculated oxides of nitrogen emission concentration as NO_2 in grams/hr $NO_2 = 3.32 \times \frac{NO}{1000} \times \frac{\text{fuel flow(grams/hr)}}{\text{total carbon}}$
6	WT. FAC.	Weighing factor for each mode
7	WT. HP	Weighted horsepower. HP (Column 4) times weighting factor (Column 16)
8	BRAKE SPECIFIC ALDE	Aldehyde, gm/hr, (Column 2) divided by HP (Column 4, upper table) for the individual mode. "R" in table indicates indeterminate value.
9	BRAKE SPECIFIC HC	HC, gm/hr, (Column 3) divided by HP (Column 4, upper table) for the individual mode
10	BRAKE SPECIFIC CO	CO, gm/hr, (Column 4) divided by HP (Column 4, upper table) for the individual mode.
11	BRAKE SPECIFIC NO_2	NO_2, gm/hr, (Column 5) divided by HP (Column 4, upper table) for the individual mode.

TABLE 6. (Cont'd) EXPLANATION OF EXPERIMENTAL 23 MODE BRAKE SPECIFIC COMPUTER PRINTOUT SHEETS

CYCLE COMPOSITE	Explanation
HC, CO, NO_2, ALDE	Summation of emission for each mode times weighting factor divided by summation of weighted horsepower for each mode. $\frac{\sum_{i=1}^{23} \text{Emission}_{(i)} \times \text{W.F.}_{(i)}}{\sum_{i=1}^{23} \text{HP}_{(i)} \times \text{W.F.}_{(i)}}$
BSFC	Summation of fuel flow (lbs/hr) times weighting factor for each mode divided by summation of weighed horsepower for each mode. $\frac{\sum_{i=1}^{23} \text{Fuel flow (lb/hr)}_{(i)} \times \text{W F}_{(1)}}{\sum_{i=1}^{23} \text{HP}_{(i)} \times \text{W F}_{(i)}}$

* For engine 2-3, this column was replaced with air-fuel ratio by the Spindt calculation formula and all control technology data includes AFR by this method.

$$FB(I) = \frac{(CO(I) + CO_2(I))}{TC(I)}$$

$$AFR = FB\left\{9.8831\left[\frac{\left(1 + \frac{CO(I)}{2(CO_2(I)} + \frac{O_2(I)}{CO_2(I)}\right)}{1 + \frac{CO(I)}{CO_2(I)}}\right] + \left[\frac{16.8}{3.5 + \frac{CO(I)}{CO_2(I)}}\right]\right\}$$

IV. RESULTS

The results of this project are presented in two segments; the first, covering the six baseline engines and the second, the control technology experiments with two engines.

A. Baseline Results

The baseline results for all six engines are described by the type of test conducted namely, FTP concentration, FTP mass and 23-mode mass.

1. Nine-Mode FTP Concentration

Table 7 is a complete listing of the nine-mode results in terms of ppm n hexane, percent CO and ppm NO observed and corrected. The replicate run data for each engine is listed by engine in the order tests were run. An average of the three run results is shown and may be directly compared to the current 1972 limits of 275 ppm n hexane and 1.5 percent CO. For a given engine, the test repeatability was judged normal and satisfactory.

Different engines had different emissions behavior with the range in HC from 88 to 234 ppm n hexane, the range in CO from 0.31 to 1.42 percent, and the range in corrected NO from 1322 to 2174 ppm. Engine 1-1, 1-2, and 1-3 results compare favorably with certification results. Little more can be said about these results, except to compare them to proposed standards of 160 ppm n hexane, 0.8 percent CO and 2,000 ppm NO (corrected) published in the October 5, 1971 Federal Register.[16]

2. Nine-Mode FTP Mass Emissions

Table 8 summarizes the replicate runs made on the six baseline engines in the order tested. It is difficult to make many comments on the results relative to the 1973 California and 1974 Federal limits of 40 grams of CO per bhp-hour and 16 grams of HC + NO_2 (corrected). The range of CO was 14.8 to 69.2 grams per bhp-hour and the range of HC + NO_2 was 14.6 to 21.3 grams per bhp-hour. Most engines appear to have little problem in meeting the CO and are nearly there on HC + NO_2. Generally, the manufacturers try to have a fairly good margin between the engine emissions rate and the limits.

What action will be taken by the manufacturers to meet 1975 California limits of 25 grams CO and 5 grams HC + NO_2 per bhp-hour is unknown at this time. It would seem that substantial improvements will be necessary to meet the apparently stringent 5 gram standard. Just as the nine-mode FTP concentration run-to-run repeatability was good, so was the repeatability good for the mass calculations. The fuel rate and power levels are fairly constant so that only raw emission concentrations have an effect on run-to-run repeatability. The FTP mass rates "track" the concentrations as would be expected.

TABLE 7. NINE-MODE FTP EMISSION RESULTS
CONCENTRATIONS PER FTP

Engine	Date	Run	HC ppm Hex	CO %	Observed NO, ppm	Corrected NO, ppm	Humidity gr/lb d.a.
2-1	3/6/72	1	90	0.35	2188	2041	58
2-1	3/6/72	2	95	0.29	2052	1998	68
2-1	3/6/72	3	80	0.29	2071	2032	70
		Average	88	0.31	2104	2024	
1-1	3/21/72	1	112	0.39	2020	1902	60
1-1	3/21/72	2	99	0.40	2132	1980	57
1-1	3/21/72	3	106	0.52	2691	2641	70
		Average	106	0.44	2281	2174	
1-2	4/6/72	2	228	0.71	1894	2052	101
1-2	4/6/72	3	233	0.71	1934	2153	113
1-2	4/6/72	4	240	0.70	1988	2163	103
		Average	234	0.71	1939	2123	
2-2	4/14/72	2	162	1.42	1173	1313	116
2-2	4/14/72	3	164	1.43	1227	1364	112
2-2	4/14/72	4	170	1.42	1177	1290	106
		Average	165	1.42	1192	1322	
1-3	4/24/72	1	117	0.36	1825	1517	36
1-3	4/25/72	2	124	0.30	1749	1578	51
1-3	4/25/72	3	114	0.27	1836	1488	32
		Average	118	0.31	1803	1528	
2-3	5/12/72	1	111	0.66	1411	1593	120
2-3	5/12/72	2	110	0.65	1398	1589	124
2-3	5/12/72	3	126	0.67	1432	1622	122
		Average	116	0.66	1414	1601	
	1972 Limit (Fed)		275	1.5	No Standard		

TABLE 8. NINE-MODE EMISSION RESULTS PER 1974 FTP CALCULATION PROCEDURE

Engine	Date	Run	Grams/bhp-hr HC	CO	Obs. NO_2	Corr. NO_2	Corr. $HC+NO_2$	Humidity gr/lb d.a.
2-1	3/6/72	1	3.28	17.3	15.6	14.6	17.9	58
2-1	3/6/72	2	3.41	13.5	14.7	14.3	17.7	68
2-1	3/6/72	3	2.76	13.5	14.8	14.5	17.3	70
		Average	3.15	14.8	15.0	14.5	17.6	
1-1	3/21/72	1	3.24	17.0	13.4	12.6	15.9	60
1-1	3/21/72	2	2.88	16.6	14.1	13.2	16.0	57
1-1	2/21/72	3	3.10	21.2	17.8	17.5	20.6	70
		Average	3.07	18.3	15.1	14.4	17.5	
1-2	4/6/72	2	7.16	32.8	12.7	13.6	20.7	101
1-2	4/6/72	3	7.36	32.7	13.1	14.1	21.5	113
1-2	4/6/72	4	7.46	32.2	13.3	14.3	21.8	103
		Average	7.33	32.6	13.0	14.0	21.3	
2-2	4/14/72	2	5.62	69.3	9.1	10.0	15.6	116
2-2	4/14/72	3	5.61	69.4	9.6	10.4	16.0	112
2-2	4/14/72	4	5.88	68.9	9.2	9.9	15.8	106
		Average	5.70	69.2	9.3	10.1	15.8	
1-3	4/24/72	1	4.42	18.3	14.4	12.1	16.5	36
1-3	4/25/72	2	4.71	15.3	13.8	12.6	17.3	51
1-3	4/25/72	3	4.45	13.9	14.5	11.9	16.4	32
		Average	4.53	15.8	14.3	12.2	16.7	
2-3	5/12/72	1	3.22	31.2	10.2	11.2	14.4	120
2-3	5/12/72	2	3.23	31.1	10.1	11.1	14.3	124
2-3	5/12/72	3	3.63	31.9	10.3	11.3	15.0	122
		Average	3.36	31.4	10.2	11.2	14.6	
1973 Limit (Cal.)				40			16	
1975 Limit (Cal.)				25			5	

The analysis made using the FTP procedure indicated that it is very sensitive to fuel rate, especially HC results. Low fuel rates occur at idle, CT, and 19 inch vacuum modes where HC are generally high. A small error in fuel rate can make a severe error in the HC results. Since only three modes actually produce measurable power, the 16, 10, and 3 inch modes, the cycle composite is quite dependent on precise power measurements.

3. Experimental 23-Mode Mass Emissions

Table 9 contains summary data for the many replicate runs made to determine baseline emissions from the six engines by the experimental 23-mode procedure. The overall run-to-run repeatability seemed satisfactory for HC, CO, and NO_2. A comparison against a target or desired level is not possible since, at this writing, none exist.

Measurement of aldehydes was attempted and though the overall run-to-run results look good, the modal concentration repeatability was not very good. The problem of trying to measure aldehydes by MBTH was of continual concern during this project. Calibration of the entire system using bags of air + trace quantities of formaldehyde have given routine precision of ± 10 to 15 percent normally. Some if not most of the lack of repeatability must be due to the engine and the remainder to the sampling, gas washing and colorimetric analysis. It is uncertain whether the MBTH approach is satisfactory, but it is the best known method for measurement of repetitive samples.

The following is an engine-by-engine summary of the general operation and experience regarding the 23-mode test.

(a) Engine 2-1: Testing of this engine began on March 6, 1972 with the running of the nine-mode Federal test. Prior to making the tests, a 25 hour break-in at various speeds and loads (according to a schedule used by the manufacturer) was completed. The basic timing and engine idle speed was then adjusted to that specified by the manufacturer, namely 4° BTDC and 700 rpm. Three runs were then made with satisfactory run-to-run and mode-to-mode agreement. Generally speaking plus or minus ten percent of the mean is acceptable with plus or minus five percent of the mean excellent test repeatability. There is no hard and fast rule since test repeatability is dependent on engine, procedure and exhaust contaminant.

Eight runs were made using the 23-mode procedure of which seven were used. The large number of runs were possible because of the delay in receiving additional engines for test. This allowed certain instruments to be checked for repeatability. HC, CO, NO_2, and aldehydes exhibited mode-to-mode variability (one run had to be discarded), but on an overall test brake specific basis, the run-to-run repeatability looked good. Little more can be

TABLE 9. EXPERIMENTAL 23-MODE PROCEDURE
DRY CORRECTED EMISSION RESULTS

Engine	Date	Run	Grams/Bhp-Hr HC	CO	NO_2 Obs.	Alde.	Cycle Weighted BSFC	Humidity gr/lb d.a.
2-1	3/8/72	2	12.17	53.0	12.0	-	0.750	61
2-1	3/8/72	3	11.02	49.2	12.4	-	0.750	55
2-1	3/9/72	1	9.50	40.7	13.4	0.130	0.750	44
2-1	3/9/72	2	9.16	46.4	13.4	-	0.748	59
2-1	3/10/72	1	9.11	46.4	11.2	0.125	0.750	73
2-1	3/13/72	1	9.50	47.7	10.2	-	0.750	94
2-1	3/13/72	2	9.88	51.3	10.9	-	0.750	101
	Average		10.05	47.8	11.9	0.127	0.750	
1-1	3/29/72	1	8.62	46.1	13.8	0.206	0.661	35
1-1	3/29/72	2	8.75	45.6	14.6	0.200	0.685	37
1-1	3/31/72	1	9.35	46.5	14.8	-	0.678	39
1-1	3/31/72	2	9.05	46.6	14.8	-	0.678	37
1-1	4/3/72	1	9.98	49.2	12.1	0.221	0.679	85
1-1	4/3/72	2	9.44	43.5	13.7	-	0.679	91
	Average		9.20	46.2	13.9	0.209	0.677	
1-2	4/7/72	1	11.98	58.6	10.5	0.295	0.675	116
1-2	4/10/72	1	13.61	41.6	13.3	0.289	0.675	114
1-2	4/10/72	2	12.68	42.4	14.5	0.256	0.675	104
1-2	4/11/72	1	13.12	44.6	12.8	-	0.674	109
	Average		12.85	46.8	12.8	0.280	0.675	
2-2	4/17/72	1	11.91	80.7	9.4	0.226	0.757	46
2-2	4/17/72	2	12.16	85.3	9.3	0.182	0.756	55
2-2	4/18/72	1	13.28	95.0	6.9	0.177	0.756	101
2-2	4/18/72	2	13.34	94.7	6.6	-	0.756	104
2-2	4/18/72	3	12.35	93.4	7.1	-	0.756	96
	Average		12.61	89.8	7.9	0.195	0.756	
1-3	4/27/72	2	12.56	39.6	11.1	0.196	0.719	91
1-3	4/28/72	1	13.69	35.6	11.7	0.176	0.733	97
1-3	4/28/72	2	13.34	32.3	11.7	0.190	0.733	106
1-3	5/1/72	1	13.03	36.1	10.8	-	0.733	118
1-3	5/1/72	2	12.88	35.3	11.6	-	0.733	111
	Average		13.10	35.8	11.4	0.187	0.730	

TABLE 9. EXPERIMENTAL 23-MODE PROCEDURE
DRY CORRECTED EMISSION RESULTS (Cont'd)

Engine	Date	Run	Grams/Bhp-Hr. HC	CO	NO_2 Obs.	Alde.	Cycle Weighted BSFC	Humidity gr/lb d.a.
2-3	5/11/72	1	10.27	28.4	10.5	0.272	0.655	98
2-3	5/15/72	1	8.41	30.1	11.3	0.254	0.614	80
2-3	5/16/72	1	8.73	29.6	10.3	0.261	0.630	101
2-3	5/16/72	2	8.19	33.2	10.7	-	0.620	95
2-3	5/17/72	1	9.37	27.9	10.7	-	0.642	92
2-3	5/17/72	2	9.41	33.1	10.6	0.259	0.627	98
	Average		9.06	30.4	10.7	0.262	0.631	

said regarding the results other than the revised experimental procedure was operable and acceptable data was obtained.

(b) Engine 1-1: Testing of engine 1-1 was begun on March 21, 1972 by running the nine-mode tests. A full break-in was not required on this engine because it had been used previously by the manufacturer for emission test purposes. A short run of about 8 hours, however, was made to make sure everything was in order before testing began. Timing and idle speed were adjusted as specified to 6° BTDC at 600 rpm. Three nine-mode runs were made with fair repeatability and no problems were encountered.

Further testing of engine 1-1 utilizing the experimental 23-mode procedure was begun on March 29, 1972. As noted in a letter dated April 7, 1972, to the Project Officer, Mr. John McFadden, the low rpm portion of the 23-mode cycle was performed at 1300 rpm instead of 1200 rpm, because the engine would not hold steady loads at high power levels at the 1200 rpm speed. There was no appreciable vibration or noticeable malfunction of the engine i.e. misfiring, surging, etc. and no explanation can be offered at this time as to the difficulty encountered.

Although the overall brake specific results in Table 9 were repeatable from run-to-run, the individual mode repeatability was sometimes much less than the summary table would indicate. It was felt that this may be due to this specific engine, however, whatever the reason, we were concerned about some of the more-to-mode agreement for this engine. This phenomenon is expected during certain modes i.e. C.T. and idle, and light loads, especially at low speed. These modes have always been difficult to run and obtain highly repeatable values, ± 5 percent of the mean for example.

(c) Engine 1-2: After a short run-in, similar to engine 1-1, testing of engine 1-2 began on April 6, 1972. The nine-mode runs went smoothly with no problems. Summary Tables 7 and 8 show good repeatability for both the Federal Test Procedure concentration and mass results. Run 2 NO and NO_2 were low and Run 4 HC was high, but investigation has shown the runs were made properly and the values represent actual engine operation at that time and not a chart reading error or computation error.

The usual mode-to-mode variability of certain modes of the 23-mode procedure were experienced. When the calculations were made of the run composite, the variations in mode concentrations apparently have a self-compensating effect so that cycle results are quite comparable.

(d) Engine 2-2: Baseline runs for engine 2-2 began with the nine-mode test procedure on April 14, 1972. The three runs used went smoothly with no problems. The major point of interest with the 23-mode test was the difference in emission levels on different days. During a single day the mode-to-mode repeatability was good but the gross difference in weather between the 17th and 18th of April are felt to have influenced the emission levels of

the engine. Both changes in barometer and inlet air humidity were significant as a result of a cold front.

On mode 13, the maximum power, 2300 rpm condition, CO went off scale and was greater than 11 percent full scale of the instrument. This occurred during each test. Since the instrument is routinely spanned to 11 percent CO at 100 percent chart deflection, this value was entered for the CO. Mode-to-mode repeatability appeared good for all the tests run including aldehydes which were more repeatable than usual.

(e) Engine 1-3: Testing of engine 1-3 began on April 24, 1972 when the nine-mode FTP tests were begun. The results were quite repeatable. The 23-mode results per Table 9 also show good repeatability on a run-to-run basis. The computer print-outs of the various tests did not show a good modal repeatability as the run-to-run results might have indicated. Several modes of the nine-mode tests look suspicious and steps were taken to check the strip charts for possible errors in reading.

The 23-mode results were acceptable on a mode-to-mode basis although some strange points were evident. Specifically, Run 2 on April 27, 1972, shows modes 9 and 14 (the 92 percent power modes) to have very high CO concentrations. This has happened before, with engine 1-2 made by the same manufacturer, and is felt to represent a transition point on the carburetor. Several times the various emissions would exhibit a string of high or low readings on a particular run. This is felt to represent actual engine performance as no errors were made in reading the emission levels.

(f) Engine 2-3: The nine-mode testing of engine 2-3 began on May 12, 1972 with no problems. The run-to-run repeatability was very good. The modal repeatability was felt to be satisfactory also. The overall 23-mode results also showed good run-to-run repeatability as seen in Table 9. The computer print-out sheets showed good modal repeatability as well. As with all the engines tested, the modal repeatability was not as good as the run-to-run repeatability on this engine, and also as usual, aldehyde measurement showed more variability than the other emission measurements.

4. Comparison of Nine-Mode and 23-Mode Emissions

Table 10 is a comparison of the average results obtained by the nine-mode and 23-mode test procedures for the six baseline engines. To facilitate the comparison, a comparison ratio (CR) was computed by dividing the 23-mode by the nine-mode brake specific emission rates. CR values greater than one indicate the 23 mode results were greater than the nine-mode. From Table 10, HC ratios ranged from 1.8 to 3.3, CO ratios ranged from 0.97 to 3.2 while NO_x ratios varied from 0.77 to 0.96. Although the two procedures result in essentially equivalent NO_x, the CO and HC range of variation does not justify direct comparison of the procedures.

TABLE 10. COMPARISON OF AVERAGE NINE-MODE AND 23 MODE RESULTS
Six Engine Baseline

Engine Code	Brake Specific Emission Rates, Grams per bhp-hour HC 9 Mode	HC 23 Mode	HC CR	CO 9 Mode	CO 23 Mode	CO CR	NO2 9 Mode	NO2 23 Mode	NO2 CR
2-1	3.15	10.05	3.3	14.77	47.8	3.2	14.48	11.92	0.82
1-1	3.07	9.20	3.0	18.27	46.2	2.5	14.42	13.94	0.96
1-2	7.33	12.85	1.8	32.6	46.8	1.4	14.00	12.78	0.91
2-2	5.70	12.61	2.2	69.2	89.8	1.3	10.11	7.87	0.77
1-3	4.53	13.10	2.9	15.8	35.8	2.3	12.22	11.38	0.93
2-3	3.36	9.06	2.7	31.4	30.4	0.97	11.20	10.69	0.95

Several other analyses were made to establish correlation between the two procedures with inconsistent results. No clear cut trends of agreement between procedures or prediction of say 23 mode from nine-mode results was evident from the data for the six 1972 baseline engines. Although beyond the scope of this project, there are probably several good reasons for this difference. One likely reason for the higher HC by the 23 mode test was the use of a lightly heated (160°F) FID for analysis instead of the NDIR sensitized to a paraffin, n hexane, used in the nine-mode. A factor of 1.8 is used in the mass calculation of nine-mode HC concentrations to compensate for this difference. The lightly heated FID also eliminates the cold trap required for NDIR analysis, where some HCs are lost.

One obvious reason for higher CO by the 23 mode procedure is that several high power conditions are included in the 23 mode that are not in the nine-mode schedule. These conditions, all typically at intake manifold vacuums less than 2.5 in. Hg. (adjacent to and including WOT operation), are producers of substantial quantities of CO. A third possible reason for the lack of agreement in HC and CO may be the large number of modes and weighting factors used in the 23 mode test relative to the nine-mode procedure. The origin of the 23 mode test schedule operating speeds, loads, and weighting factors was from a computer analysis of the original 1961 Ethyl truck and bus survey data. The computer analysis and subsequent formulation of the test schedule was performed by EPA's Procedural Development Branch, Division of Emission Control Technology.

The nine-mode test procedure was reportedly arrived at by the State of California Motor Vehicle Pollution Control Board, now known as the Air Resources Board, in conjunction with the Automobile Manufacturers Association and certain gasoline truck manufacturers. A direct comparison of the modes and weighting factors is not obvious. While the specific origin of and basis for the 23 mode test is known, the nine-mode procedure is mostly unknown. Although both procedures are engine exercises, the nine-mode test is recognized as much easier to design around than the 23 mode

test. Neither include transients (acceleration-deceleration) and this is a shortcoming of simplistic engine speed-load emissions mapping procedures.

5. Computer Print-out of Modal Data

Appendixes A through F to this report contain computer print-outs for every run summarized in Tables 7, 8 and 9. One appendix is devoted to the baseline results for each engine and follows the chronological schedule of test, i.e., engine 2-1 is covered by Appendix A while Appendix F contains data for the last engine tested, number 2-3. Each appendix is subdivided into three sections, the first containing nine-mode concentrations, the middle section the California calculation of the nine-mode test in mass per bhp-hour, and the final section listing all the 23-mode run data obtained. To find a specific print-out for a given engine, locate the proper section of the respective appendix and then match up date and run number to that listed in the text summary table.

There is a substantial amount of data in these six appendices starting with raw, as-measured concentrations and ending up with weighted modal results. There are many ways this data may be useful and accordingly, full details are shown. For some print-outs, such as the Federal FTP mass and the 23 mode test, engine operating parameters of observed flywheel hp, fuel consumption, intake manifold vacuum are listed.

In the case of the 23-mode, grams of emissions per hour, are computed and shown. This is the best method for expression of mass rate for all modes. A cycle weighted brake specific fuel consumption (BSFC) is shown based on modal fuel and power readings. The same weighting factors used for emissions were used for BSFC. Modal air-fuel ratio was calculated and printed by the computer for Engine 2-3. The reader is referred to Appendixes A through F for the full data and particulars regarding the baseline test series.

B. Control Technology Assessment

The intent of the control technology phase of this project was not one of design and development, rather of screening, confirmation, evaluation and assessment both of laboratory run experiments at SwRI and data available from the manufacturer. In addition to the meetings held on January 13 and 14, 1972, with the two manufacturers, two additional separate meetings were held on March 7 and 15, 1972.

The specific objective of these meetings was to obtain advice and as many devices and equipment, parts, ideas, etc., as possible to make the in-depth study of future control technology as meaningful as possible. Some of the specific methods discussed were:

Exhaust Gas Recirculation (EGR) Internal-External
Spark Retard plus Oxidation Catalyst
Spark Retard plus Manifold Reactor
Lower Compression Ratio (add head gaskets)
Derate Engine by Using Smaller Carburetor
Electronic Fuel Injection (Open-Closed)
Capacitor Discharge Ignition
Variable Venturi Carburetor

Of course, there are many other possibilities and not all items on the above list were to be accommodated within the time and money constraints of the project. For example, electronic fuel injection holds promise, but requires development. Capacitor discharge will do little to reduce emissions from a new engine, but should go far in maintaining low emissions due to the improved durability of the equipment and lack of wear, etc.

Little in the way of data or experience was provided by the manufacturers with regard to making substantial improvements in emissions from their engines. The discussions also covered the usual concern about the relationship of laboratory engine results to driveability and durability. It was emphasized that this control technology project had to begin with laboratory studies which would have to be followed by studies of other aspects.

From the control technology standpoint and the availability of test results, etc., the meetings were not nearly as productive as hoped. Little was offered in the way of assistance by one manufacturer and only limited assistance was promised by the other. The representatives of both companies were sincere in wanting to be of help, but, since their major concern was passenger cars, they plainly could not offer much at that time in the program.

The general lack of technology in the industry required SwRI to respond quickly with control approaches that required little or no design and development. Within the desired time constraints, this limited the items for test to those normally used for light duty engines, such as oxidation catalysts, EGR, manifold air injection, etc. As soon as the full impact of these findings with the manufacturer was felt, the staff of the Emissions Research Laboratory, on the advice and consent of the Project Officer, began a series of contacts with the control equipment supply industry. Manufacturers and suppliers of EGR valves and control equipment, oxidation catalysts, oxidation-reduction catalysts, fuel injection systems, and turbochargers were contacted and where available samples obtained for consideration.

The time constraints of the project precluded the operation of many items since additional development would be necessary to adapt most of these components to the engine. Essentially no time or effort was available for such studies and optimization so that of all the items considered, only a

popularly-used commercially-available precious metal type oxidation catalyst was selected for evaluation. A pair of platinum-type honeycomb catalytic reactors, as well as technical information and support, were obtained from the reactor manufacturer. These reactors were of a size that could be used with both control technology engines.

1. Engine 2-3 Control Technology Results

Conversations with the Project Officer on April 28, 1972, resulted in the test plan shown on Table 11 for the control technology assessment of engine 2-3. The test plan was not considered a rigorous parametric study in the classical sense in that one parameter is not always varied over the entire range of conditions at a time to determine effects singly. Engine timing experiments, Step 1, were parametric in nature as was step 5. Only one catalyst and one air pump system were considered. Clearly, there were too many dimensions of possible interest to investigate each singly, much less in all the possible combinations and permutations to meet the time and financial constraints of the project.

The plan was to explore possibilities of gross emission effects due to gross changes in engine operation. This approach was somewhat unconventional, but with only two months to complete the tests with engine 2-3, there was no alternative. As specified by the Project Officer, the experimental 23-mode test procedure was the primary basis for comparison of HC, CO, and NO_x emissions performance. A shortened version of this procedure was used in which mode times were reduced to approximately 1.5 minutes. This is sufficient time to obtain stable engine and emissions performance under most all operating modes.

(a) 1972 Versus 1973 Version Tests -

Prior to starting Step 1, the engine was operated in its 1973 California version with a different distributor, carburetor, carburetor air cleaner assembly and water thermostat. These items were furnished by the manufacturer and their installation and adjustment specifications strictly adhered to. Repeated 23-mode runs were made with the 1973 version of the engine with emission rates of CO substantially higher and NO_x substantially lower than the 1972 basic engine. These results are summarized below and the computer run sheets included in Appendix G.

Engine 2-3. Experimental 23 Mode Mass Emission Rates, grams per bhp-hr (Army Laboratory)

	CO	HC	NO_x
1972 Baseline Engine	30.4	9.06	10.69
1973 California Configuration	70.77	10.09	5.82
1972 Engine (Retest)	33.37	8.54	11.57

TABLE 11. PLAN OF TEST, ENGINE 2-3

Step	Description
1	Convert Engine to 1973 California version and vary basic timing, i.e., say 10° and 5° advanced, standard and 5° and 10° retarded timing.
2	Install larger and smaller carburetor jets to modify engine air-fuel ratio at standard timing.
3	Install air pump system and run engine at standard timing and one extreme each side of standard.
4	Install standard EGR system and run at standard timing and one extreme advanced and retarded timing. Use standard engine with the air pump off.
5	Investigate modified EGR, i.e., other flow rates at various modes.
6	Install catalytic reactors, clean fuel system, and run with and without air pump at standard timing advanced and/or retarded (operate on clear fuel unleaded) run longer modes and sample exhaust before and after catalysts.
7	Carburetor modification - derate engine by running with two large barrels of 4 barrel carburetor blocked. Standard engine otherwise.
8	Combine best EGR with best air pump - catalyst-ignition timing found in Steps 2, 3, and 4.
9	Investigate other combinations of the above or control approaches as they develop.

The higher CO and lower NO_x with the 1973 engine on the 23-mode test are unexplained although the run-to-run agreement for each series of tests was satisfactory and the changes were real. Several runs were made with the engine returned to its 1972 standard configuration to verify the large differences in CO and NO_x. The baseline (six tests) and retest data were in agreement.

Although the 23-mode test schedule was established by the Project Officer as the test procedure for use in control technology assessment, it was felt of interest to determine what the engine would emit on the nine-mode schedule both in concentration by the current FTP and in mass by the 1974

FTP. It is the latter which applies to gasoline engines in heavy duty service in California beginning in 1973 and nationwide beginning in 1974. These results are summarized below:

Engine 2 -3, Nine-Mode FTP Concentration Results

	HC, ppm n Hex.	CO, %	NO*, ppm
1972 Standard Engine (Baseline)	116	0.66	1601
1973 California Configuration	88	0.78	971

*Corrected to 75 grains humidity

Engine 2-3, Nine-Mode 1974 FTP Mass Results, grams/bhp-hr

	CO	HC	NO_x*	HC + NO_x
1972 Standard Engine	31.4	3.36	11.20	14.56
1973 California Configuration	33.73	2.57	6.59	9.15

*Corrected to 75 grains humidity

Based on the nine-mode schedule, the difference in emissions between the 1973 and 1972 engines were much less than earlier shown on the 23-mode except in NO_x. The only good explanation is that an engine calibrated for a schedule incorporating only six different modes (nine-mode FTP) may result in a quite different conclusion if operated on a schedule comprising many more modes such as the 23-mode schedule where 21 different modes are employed. Note, only 15 different modes are used in the calculations since some modes had a zero weighting factor. Of course, weighting factors, choice of power levels and, to a much lesser extent, engine rpm play important parts in establishing an engine's total emission rate.

It may be noted that the 1973 California configuration brought the engine's HC+NO_x well below the 1973 California and 1974 Federal limit of 16 grams per bhp-hr without materially changing CO which was below the 1973 limit of 40 grams per bhp-hour. To this end, the 1973 version is considered an improvement over the 1972 engine. The 23-mode procedure, an experimental method, yields a much different conclusion in terms of CO and NO_x. Run data for this series of tests are included in Appendix G of this report for further analysis on a mode-by-mode basis, etc. The conclusion from this series of tests was to utilize the 1972 standard engine as the basis for control technology assessment. In effect, these experiments indicate that changing back from 1973 to 1972 would be an important improvement in exhaust pollution from this engine, based on the 23-mode tests.

The arrangements for use of Cell 3 of the U. S. Army Fuels and Lubricants Laboratory called for release of this facility on June 1, 1972. Accordingly, the test efforts were transferred to the Emissions Laboratory on June 1, but not before all items of equipment, dynamometer, etc., were checked and recalibrated. Power curves were run at several speeds with engine 2-3 to ensure the new facility dynamometer power and speed read-outs would be identical to that previously used. After several days of work, the physical installation was completed and the dynamometer in operation. Power, speed, fuel, manifold vacuum and other physical operating characteristics were replicated and operation of the engine was found to be essentially identical to the previous location.

Before continuing with the control technology phase of the project, several more days were used to rerun the 1972 and 1973 engine version 23-mode tests discussed earlier. These results are summarized below and show close to the same magnitude of difference between 1972 and 1973 engines.

Engine 2-3. Experimental 23 Mode Mass Emission Rates, grams per bhp-hr (Emissions Laboratory)

	CO	HC	NO_x
1972 Baseline Engine	56.20	7.01	8.60
1973 California Configuration	72.40	8.22	6.61

The 1973 version of the engine repeated the tests made earlier in the Army Laboratory with CO 72.4 versus 70.77, HC 8.22 versus 10.09 and NO_x 6.61 versus 5.82. Trendwise the 1972 engine was still better than the 1973 engine per the 23-mode test, but the 1972 engine data were not as close to earlier 1972 data as desired.

The same instruments, sampling system and fairly similar exhaust piping, muffler, etc., were used. The same emissions test fuel, exhaust restriction and calibration, span and zero gases were used. The engine was not damaged or altered in making the move and to date, no really good explanation for the differences in 1972 emission rates has been found.

In the last part of Appendix G may be found the 23-mode computer print-out sheets. Comparing the modal data for these runs against that from the earlier data, also in Appendix G, obtained in the original installation, reveals that the differences are predominately in the light load portion of the schedule. This is, of course, one of the big contributors of HC and is the most difficult part of the 23-mode schedule to operate.

In summary, no really satisfactory explanation of the difference in Army Lab 1972 and Emissions Lab 1972 data could be found. The good repeatability for the 1973 version of the engine indicates that the test location, procedure, etc., was not necessarily the cause.

(b) Step 1 - Effect of Timing

The intent of this series was to determine what effect gross changes in basic engine spark timing would have on emissions and performance. In running these tests, the 1972 engine was used and the basic distributor timing set at 25° BTDC, 16°BTDC, standard timing (4°BTDC), 4°ATDC and 12°ATDC. The results are summarized on Figure 5 and are 23-mode composite data on a grams per bhp-hour basis. Setting the timing later and later resulted in a nearly uniform decrease in NO_2, the greatest reduction occurring between 15°BTDC and 4°ATDC. This same range had the opposite effect on CO, however, with about a 35 percent increase in CO between 15°BTDC and 4°ATDC range.

HC increased greatly between 4°ATDC and 12°ATDC indicating a loss in combustion efficiency. Settings of 25°BTDC and 12°ATDC represent the approximate advance and retard limits of the engine as far as engine operation was concerned. Cycle weighted BSFC is also plotted on Figure 7 as an indication of the effect of timing on fuel consumption and economy. Note the effect of retarded timing on cycle BSFC with a significant loss in economy of operation shown at 4 and 12°ATDC.

Appendix H contains tabular, computer print-out, data for modal analysis and plots of the data. Figures H-1, H-2, and H-3 show the effect of power on the mass rate, grams per hour for HC, CO and NO_x as NO_2. Also plotted are the 1973 California configuration modal results (from data in Appendix G) for comparison to the 1972 standard engine. By oversight, one run at 12°ATDC was made with the distributor vacuum advance line disconnected. The run was valid otherwise and the results are plotted for general information. Both 1200 rpm, broken line, and 2300 rpm, solid line data are plotted. Also shown are closed throttle (CT) and idle results.

Figures H-4 and H-5 of Appendix H are similar plots of engine intake manifold vacuum and fuel consumption. Other plots of the data in the Appendix H computer print-outs could be made such as power versus emissions on a brake specific or concentration basis. Plots of air-fuel ratio versus certain of the emissions would also be informative. In summary, retarding the spark 4 to 8 degrees from manufacturers standard timing of 4° BTDC would reduce both HC and NO_x with an increase in CO. Assuming performance is not jeopardized too much, this might be considered in conjunction with other approaches, especially one that reduces CO.

The importance of the closed throttle mode on HC production and its effect on the 23-mode result is dramatic. The two closed throttles are given 18 percent of the weight (12 percent at 2300 rpm and 6 percent at 1200 rpm). Any device or approach that can substantially reduce concentrations, nominally 30,000 to 90,000 ppmC, during these modes can have a noticeable influence on the final results.

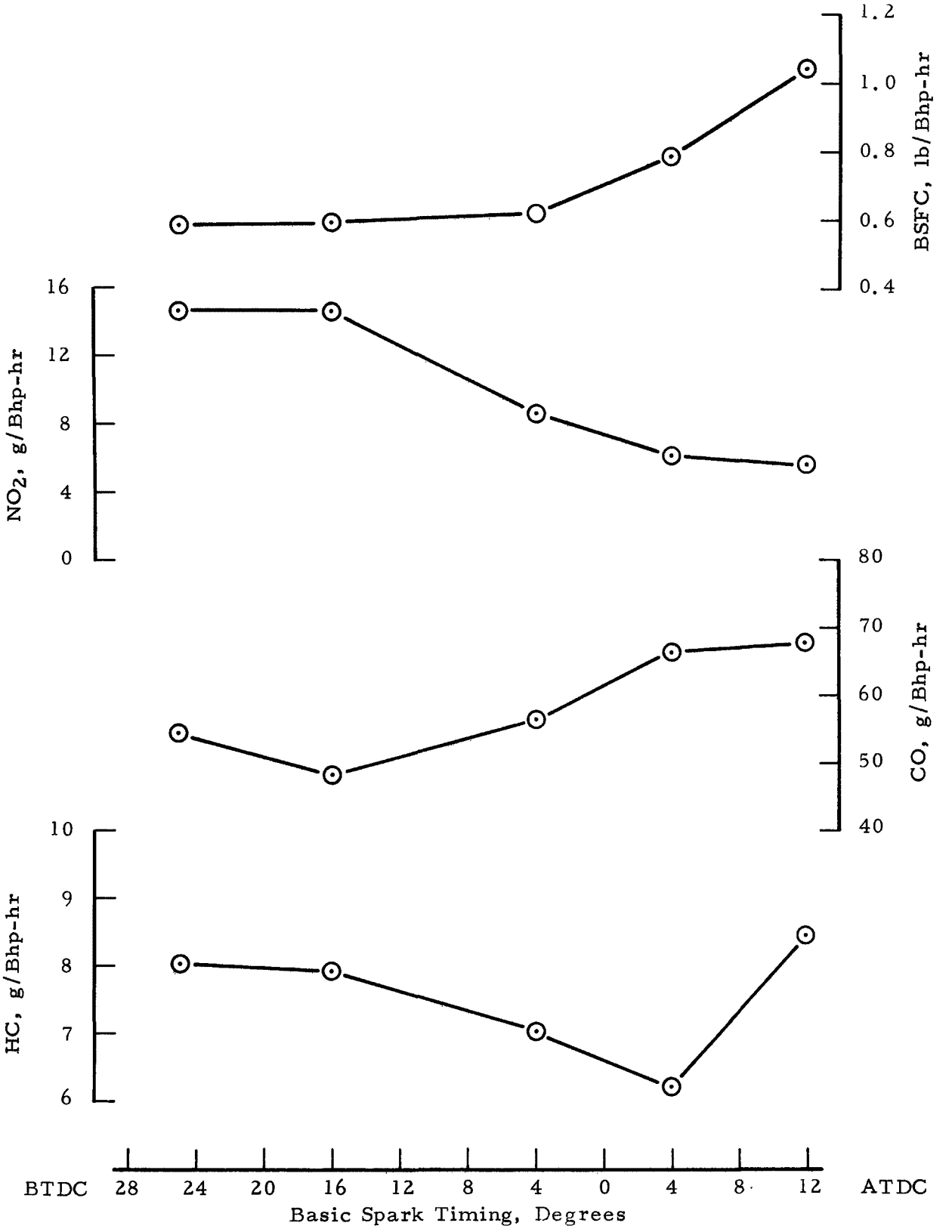


FIGURE 5. EFFECT OF SPARK TIMING ON EMISSIONS
ENGINE 2-3, 23 MODE TEST

(c) Step 2 - Effect of Air-Fuel Ratio

The usual way to investigate the effect of air-fuel ratio is to run tests with the main metering system modified to admit more or less fuel for a given air flow requirement. Several main metering jet and metering rod combinations shown in Figure 6 were furnished by the manufacturer and experimented with. The air-fuel ratio was determined for each of the 23 modes using the "Spindt Method" of calculation. From the modal air-fuel ratios, an overall "weighted air-fuel ratio" for the entire 23-mode test was computed using the modal weighting factors.

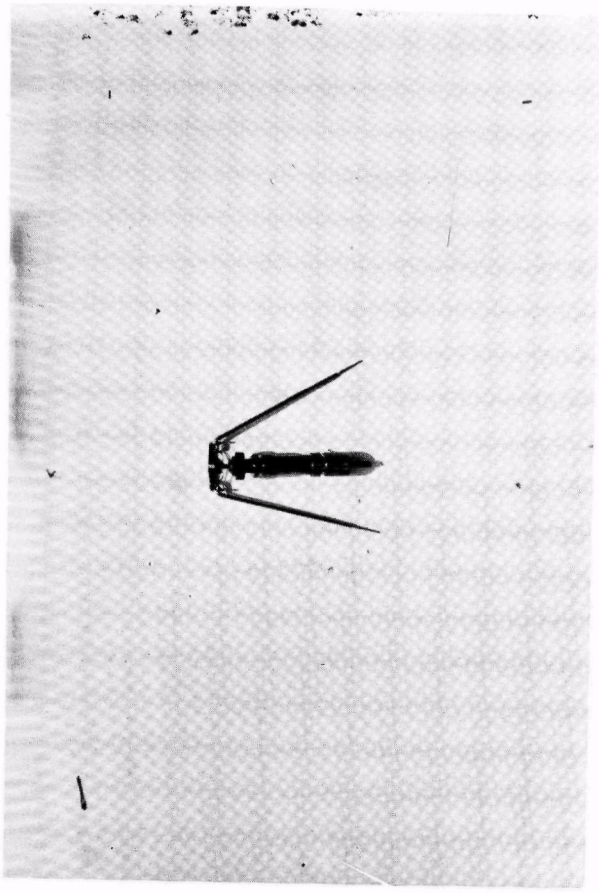
Figure 7 is a summary plot of the 23-mode results with the various jet-rod combinations. Also shown are the various size jets that were larger or smaller than the standard 0.073 inch jet, 0.0368 inch rod, combination. Note the plots of NO_x, CO and HC show that the mixture has an important effect on emissions. The trends of lower NO_x and higher HC and CO as air-fuel mixture becomes richer with fuel was as expected. The dramatic increase in CO was not unexpected based on our experience with a number of in-service gasoline trucks. On the fuel lean side, the 1972 engine was not too far from its "lean limit" as noted by the attempted operation of the engine with very small jets (0.064 inch). Weighted BSFC seemed little affected by the change in air-fuel ratio except at the rich mixtures.

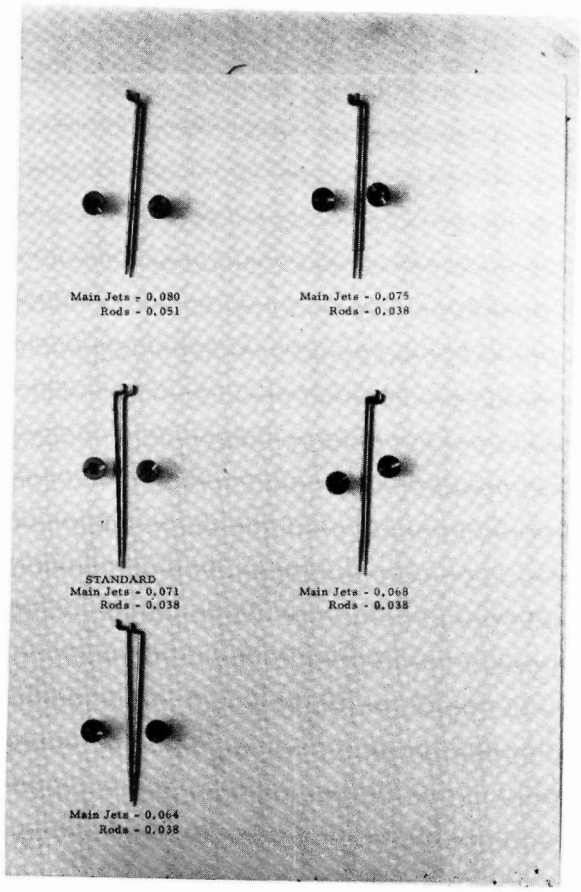
Appendix I contains the computer sheets listing the modal results for this series of experiments. The gram per hour emission rate has been plotted against percent power for the several modes included in the 23-mode test. Grams per hour was selected as the primary expression since all modes have such a rate. Grams per bhp-hour is not applicable or appropriate where no usable load is obtained as in idle, closed throttle and very light load, i.e., 0-2 percent power. Concentration results, on the other hand, may be misleading since they do not include the air flow and thereby lack the direct contribution to the cycle result where mass rate is important.

Appendix Figures I-1, I-2, and I-3 portray HC, CO and NO_x as NO_2 in this way and are similar in appearance, but not in trend, to those in Appendix H for the effect of timing. Figures I-4 and I-5 show manifold vacuum and fuel consumption as a function of the power output. Time has not permitted further graphing and analysis of the results, although more could be done in this regard. In summary, this series of experiments confirmed the effect of air-fuel ratio on carbureted gasoline engines; namely, that richening the mixture with fuel reduces NO_x at the great expense of increasing CO and HC, as well as fuel consumption. As with the study of spark timing, this is another item which should be considered with after-treatment approaches such as air injection with or without catalysis.

(d) Step 3 - Effect of Exhaust Manifold Air Injection

Engine 2-3 was fitted with the factory exhaust manifold reaction





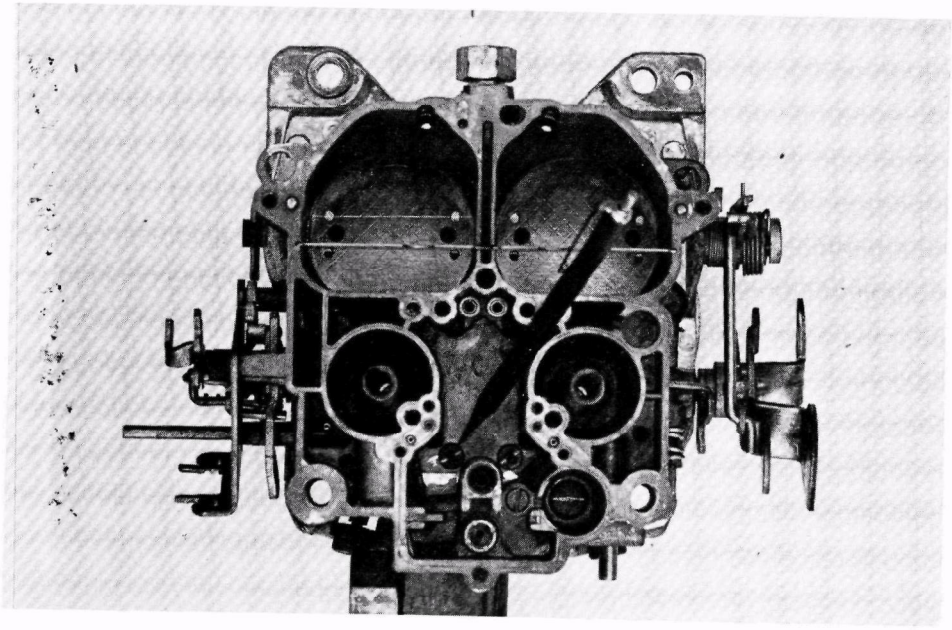


FIGURE 6. CARBURETOR RODS, JETS, AND THEIR LOCATION (ENGINE 2-3)

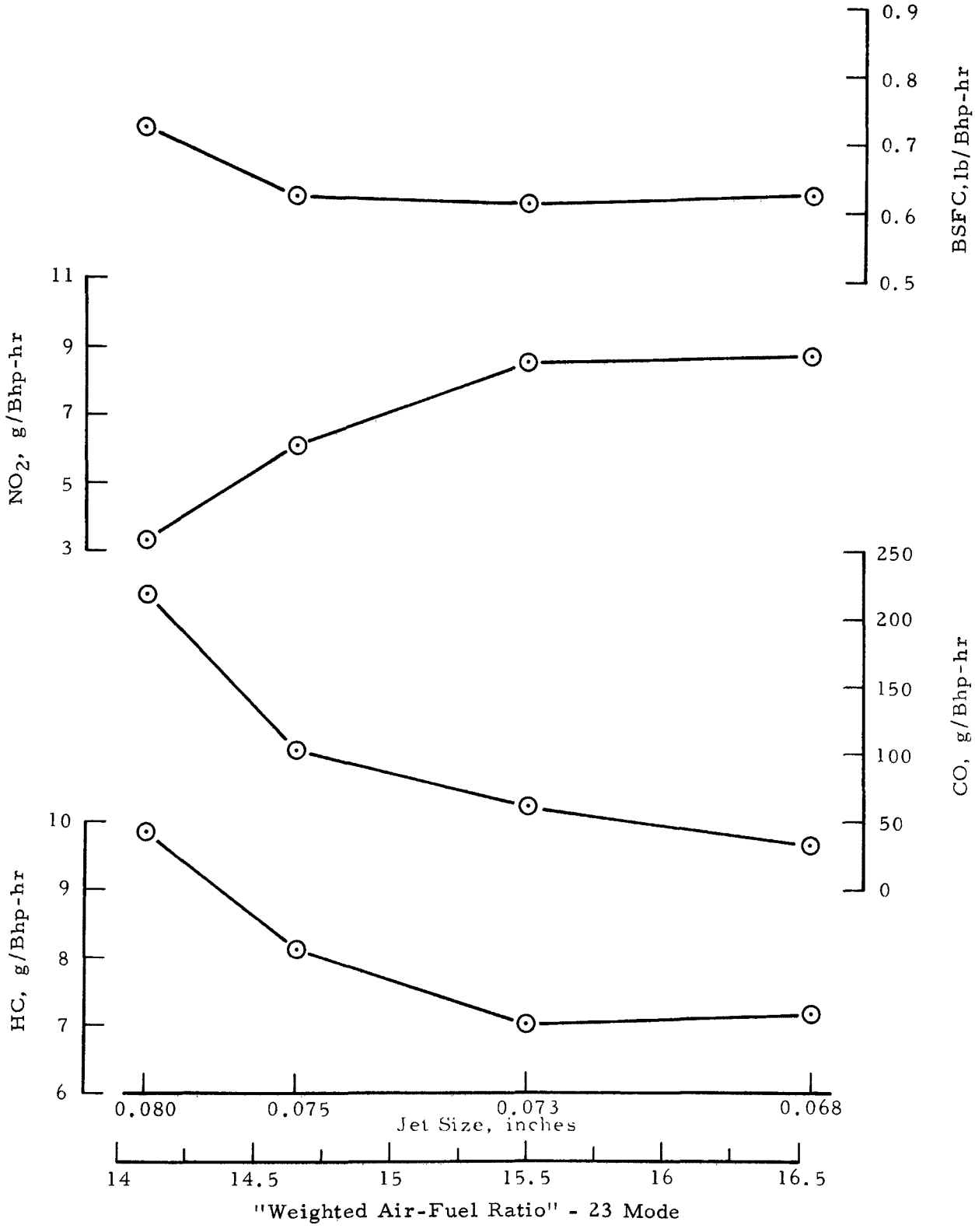


FIGURE 7. EFFECT OF AIR-FUEL RATIO ON EMISSIONS
ENGINE 2-3, 23 MODE TEST

equipment, as shown in Figure 8. This involved replacing exhaust manifolds and installing air pump, belt, pulleys and required lines, fittings and injection tubes, so that air is admitted on the exhaust valve tulip. Several 23-mode runs were made at various basic injection timing settings including standard (4°BTDC), advanced settings of 16 and 25°BTDC and a retarded setting of 4°ATDC. The computer print-outs for this series of tests are included as Appendix J.

The grams per bhp-hr 23-mode results for HC, CO and NO_x and weighted BSFC are depicted on Figure 9. Also shown are the standard engine emissions versus timing for comparison. The brake specific NO_x emission values show little variation with timing that are not due to timing alone. And, relative to the engine run without air, the influence of air injection on HC is somewhat disappointing. Air injection did seem to reduce CO, however, especially at the standard 4°BTDC and at 4°ATDC.

Part of the explanation may lie in the large weighting given idle, closed throttle and light loads where exhaust oxidation would have a limited effect. Recall that the air injection acts as a diluent as well as a source for oxygen and that the diluent effect, which reduces concentrations, does not reduce emissions on a mass basis. Appendix J contains modal plots, Figures J-1 through J-5, of the run results for HC, CO, and NO_x, manifold vacuum and fuel consumption as a function of power level. Please refer to these plots for further insight on the effect of exhaust manifold oxidation by injected air.

(e) Step 4 - Effect of Light Duty EGR System on Emissions

This series of experiments required an experimental intake manifold furnished by the manufacturer that had been machined and prepared for exhaust gas recirculation from the exhaust heat crossover back to a central point in the intake manifold directly below the carburetor. The EGR is routed completely internal within the intake manifold and all that shows is a valve and the valve control vacuum hose that connects to the distributor vacuum line. Photographs of this system are shown in Figure 10. The system as used was the same as used in light duty vehicles and was installed and operated according to manufacturer's recommendations. The EGR rate was essentially zero, from 0 to 2 inches intake vacuum and constant at approximately 1 lb per minute above 8 inches of vacuum. The EGR rate increased in a nearly linear fashion between 2 and 8 inches of H_2O vacuum.

As with other similar studies, a series of 23-mode experiments was made at basic timing of 25, 16, and 4 (standard) °BTDC and 4°ATDC. The 23-mode composite results are also plotted on Figure 9 along with the standard engine without light duty EGR for comparison. Note that EGR is most effective on reducing NO_x at advanced settings where maximum NO_x was produced. To optimize the EGR as far as basic timing is concerned, it seems that a 4°ATDC or 8° retard from standard, results in the lowest

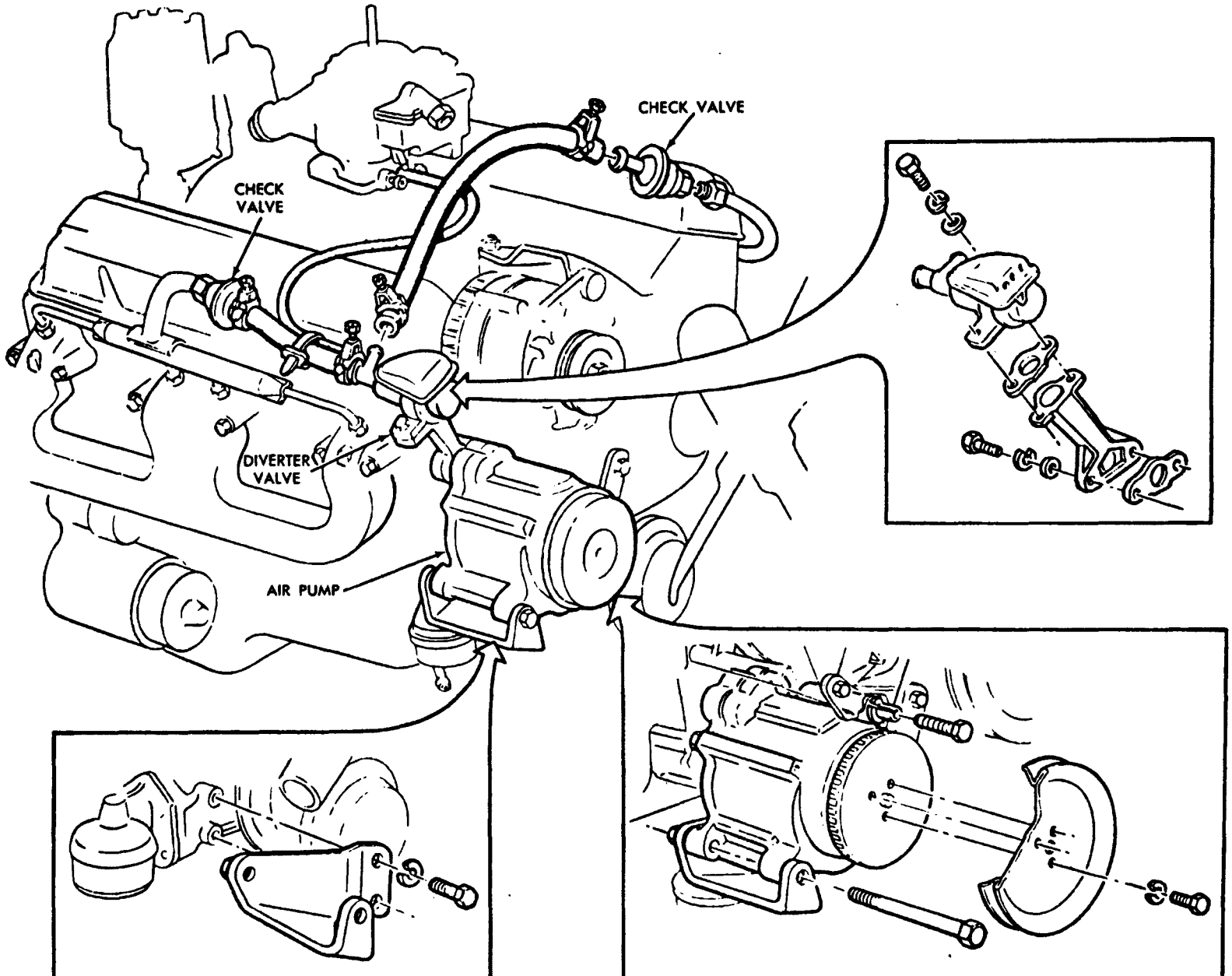


FIGURE 8. EXHAUST MANIFOLD AIR INJECTION EQUIPMENT

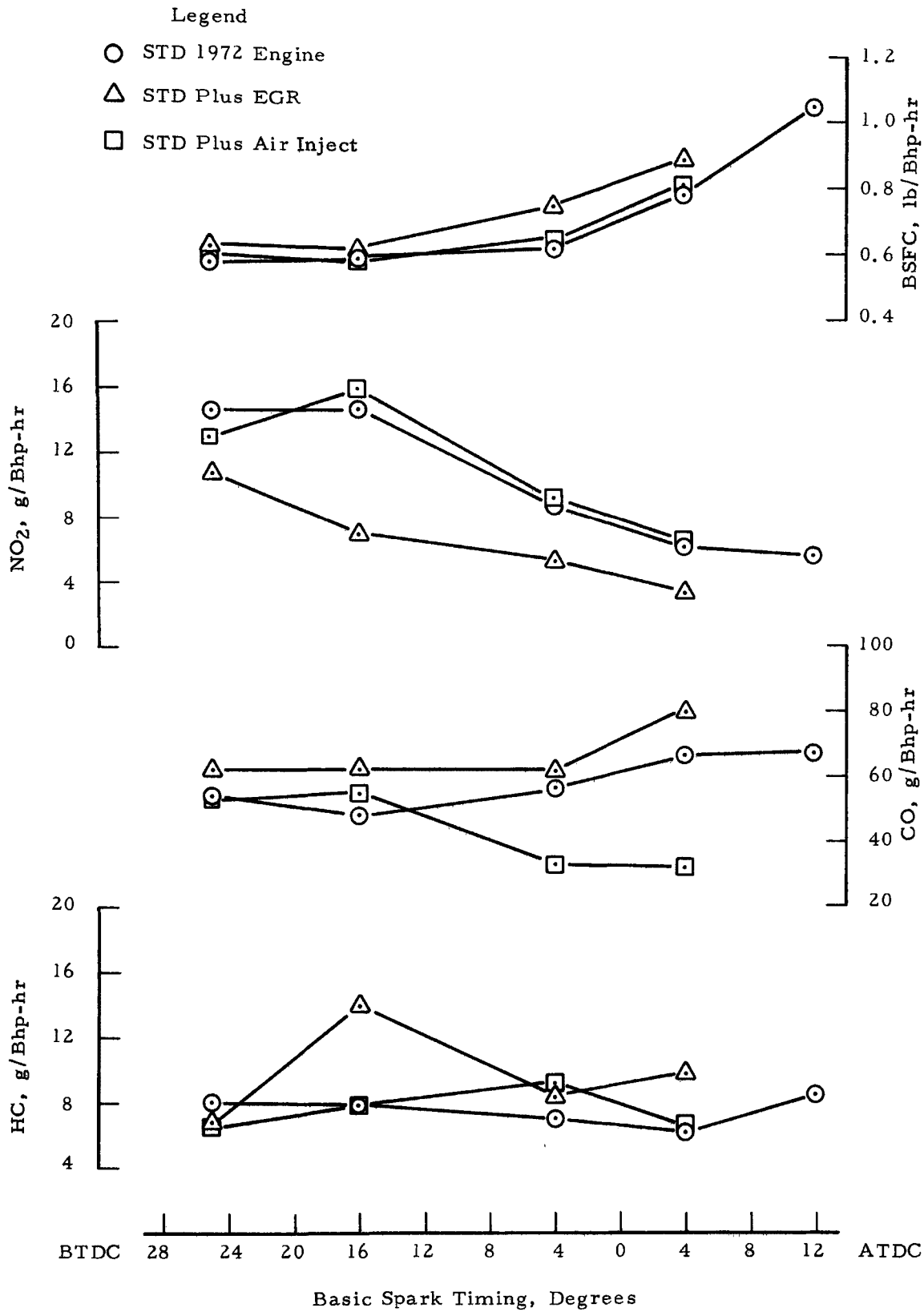


FIGURE 9. EFFECT OF LIGHT DUTY EGR AND AIR INJECTION ON EMISSIONS, ENGINE 2-3, 23 MODE TEST

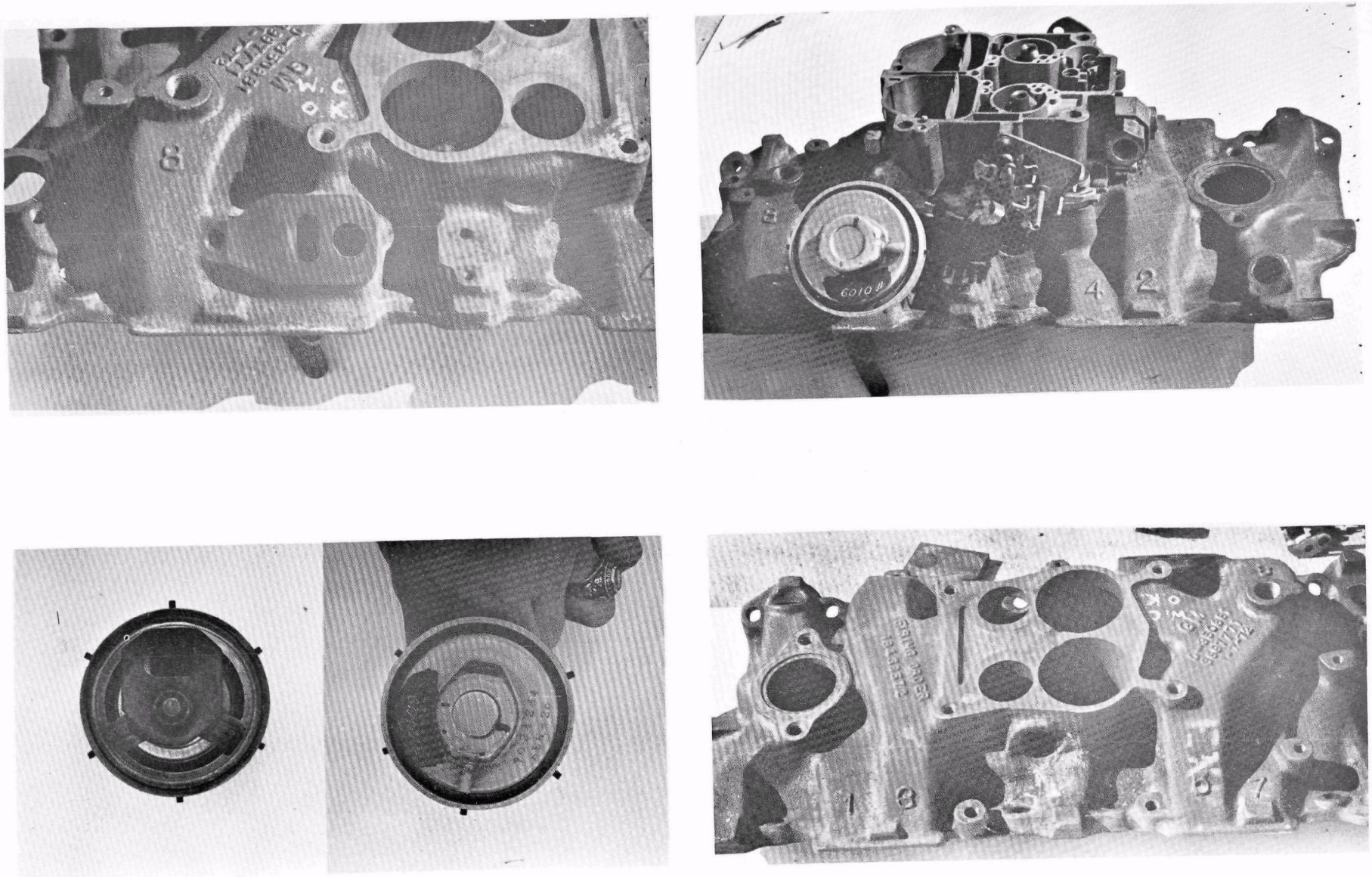


FIGURE 10. LIGHT DUTY EGR EQUIPMENT

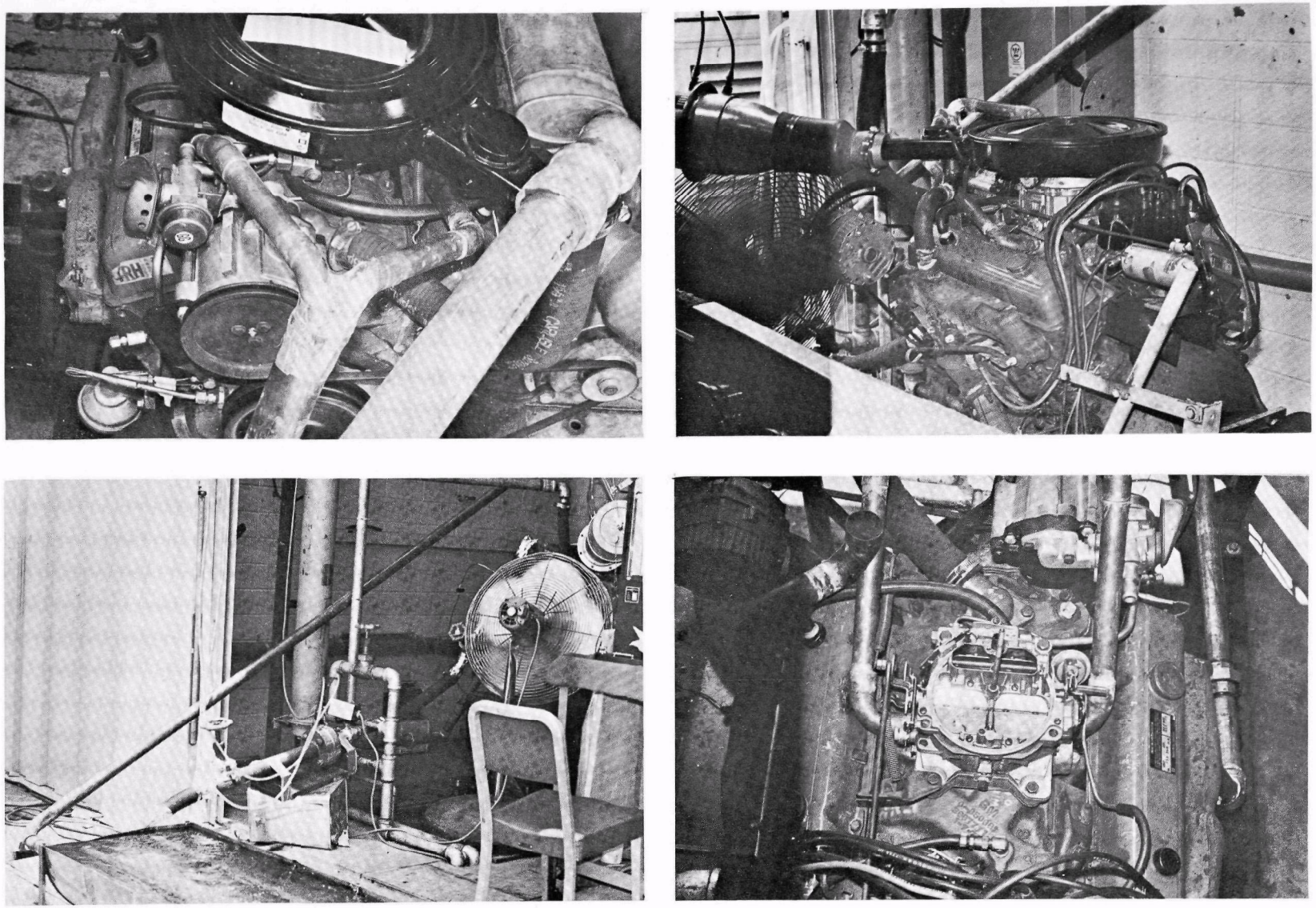


FIGURE 11. LABORATORY EGR SYSTEM

NO_x of about 4 grams per bhp-hr.

This is not necessarily the best operating point for CO, however, as shown on Figure 9, since this gives the maximum CO. HC, like CO, was adversely affected, i.e., increased by EGR throughout the range of timing studied, and , like CO, 4° ATDC was not the best setting for HC. It may be that in combination with other control approaches, the 4°ATDC will emerge as a possible operating point.

Appendix K contains the tabular computer print-out sheets and graphed results on a modal basis for the series of tests on the light duty EGR system. Please refer to these for additional detail or if a more thorough analysis is desired.

(f) Step 5 - Effect of Laboratory EGR on Emissions

This step was originally intended to involve tests at a given basic timing, such as standard, with a flow of exhaust modified from the light duty flow schedule. The light duty valve recirculates exhaust based on signal pressure from the distributor manifold vacuum line. On inspection of the flow capacity, it was found that even operating at maximum signal pressure the EGR rate would not give the desired flow for this step of the project.

To investigate EGR more fully, a laboratory EGR system was prepared that split-off some of the exhaust from the tailpipe at a point downstream of the muffler. The exhaust then passed through a simple two-pass single large tube air-to-water-heat exchanger and then through a flow measuring section thin plate orifice, a manual, gate type, control valve and then to the intake manifold.

The system shown in Figure 11 was designed to permit EGR at a specified flow in percent of carburetor intake air flow rate at 5, 10, 15, and 20 percent. These tests were made with the air injection system inoperative. The heat exchanger was a low pressure drop simple two-pass unit made hurriedly from 2-inch steel exhaust pipe with a total length of 18 ft. The outlet temperature was on the order of 95 to 100°F and represented what might be possible with a good air-to-air heat exchanger on a moderately cool day.

The return of the exhaust into the intake manifold was through two 3/4" pipe openings (1.05 inch ID opening in manifold). It is known that the distribution and mixing, etc., of recycled exhaust with the carbureted fuel-air mixture is tricky and requires substantial effort to perfect. In the very short time available, it was decided to add another 3/4" pipe opening directly across from the one already machined in the experimental manifold used as an access for internal machining for the factory EGR. The system was leak-checked and found satisfactory for a preliminary evaluation

of EGR on the engine by the 23-mode schedule. It was a laboratory system used strictly for basic experimental purposes.

The results, all obtained at standard timing of 4° BTDC with standard carburetor, etc., are plotted in Figure 12 for EGR at various percentages of total engine requirement defined as:

$$\text{Percent EGR} = \frac{\text{EGR (SCFM)} \times 100\%}{\text{Total Flow Requirement (SCFM)}}$$

$$= \frac{\text{EGR (SCFM)} \times 100\%}{\text{Carburetor Air (SCFM)} + \text{EGR (SCFM)}}$$

The results are reduced to the 23-mode values, plotted in Figure 12, using the carbon balance method that has been employed throughout this project to determine exhaust mass rate. Recall that carbon bearing compounds, such as HC, CO, and CO_2 and fuel input are necessary measurements for this computation method. It can be shown, though it is not necessarily obvious, that this method will determine the mass of exhaust products exhausted into the atmosphere even though some of the exhaust is recirculated. The method is valid if the recirculated exhaust is admitted after the carburetor and throttle plate. It should be understood that EGR can reduce the mass of exhaust products emitted to the atmosphere. For example, at wide open throttle and constant speed, the mass flow rate of emissions can be less even though the concentrations of HC and CO are not reduced.

From Figure 12 the laboratory EGR was found to be quite effective on reducing NO_x. At about 10 percent EGR, the benefits of increased EGR are more than offset by the apparent steep increases in emission rates of HC and CO. Though 10 percent EGR was not necessarily optimum, it is probably in this vicinity that best NO_x control results under the 23-mode schedule. Above 10 percent EGR, the engine, at 1200 rpm, would not run when the power level was about 75 percent (15 percent EGR) and 50 percent load (20 percent EGR).

It is interesting to follow the effect of EGR on brake specific fuel consumption and on maximum power output. These results are summarized below. The cycle weighted BSFC results are also plotted on Figure 12. The BSFC and power loss at 10 percent EGR is substantial relative to no

Percent EGR	Overall BSFC 23-Mode Weighted	Power Output, Max bhp, Obs 1200 rpm	2300 rpm
0	0.648	52	108
5	0.681	50	99
10	0.750	47	88
15	0.915	42	78
20	1.075	35	67

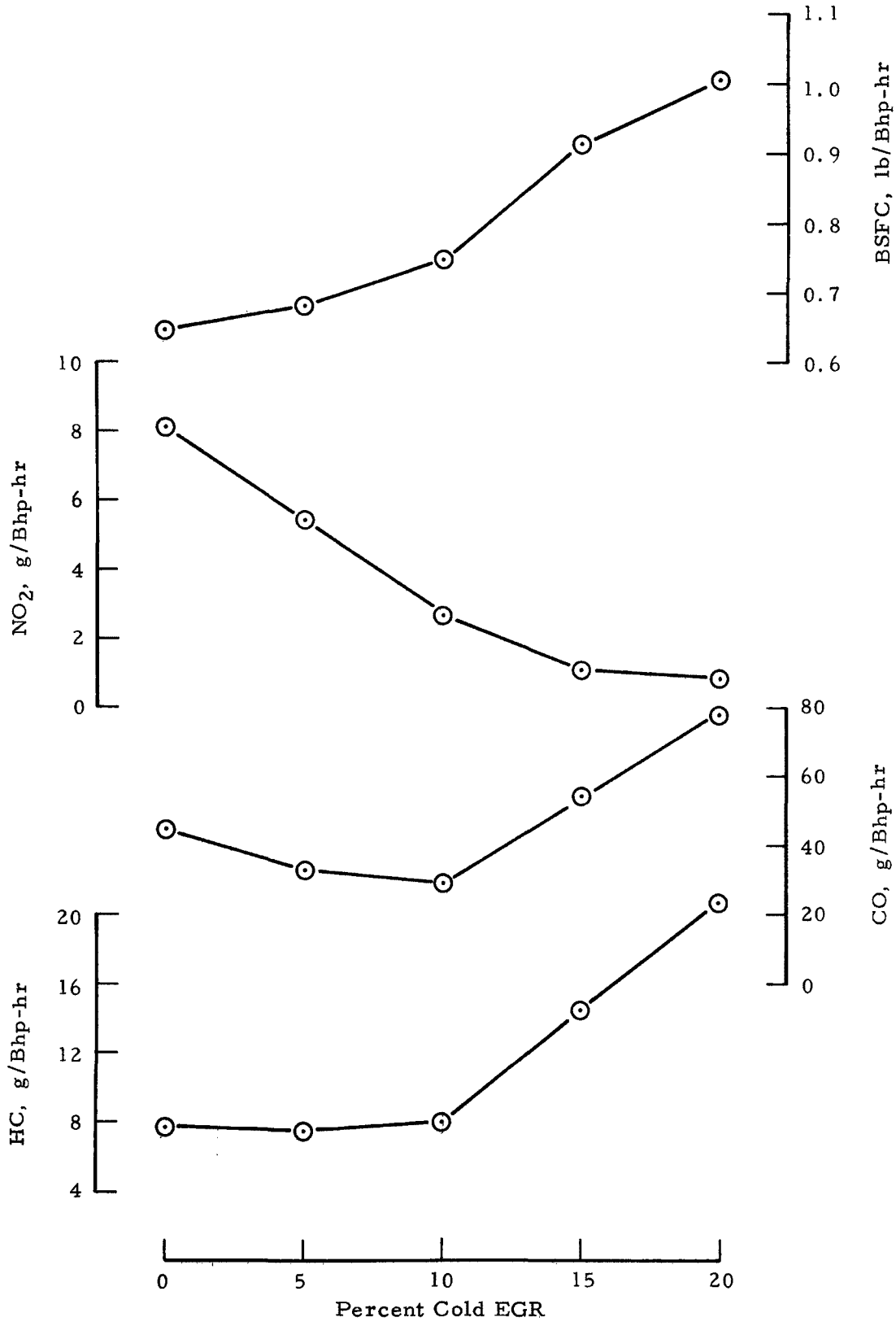


FIGURE 12. EFFECT OF LABORATORY COLD EGR ON EMISSIONS
ENGINE 2-3, 23 MODE TEST

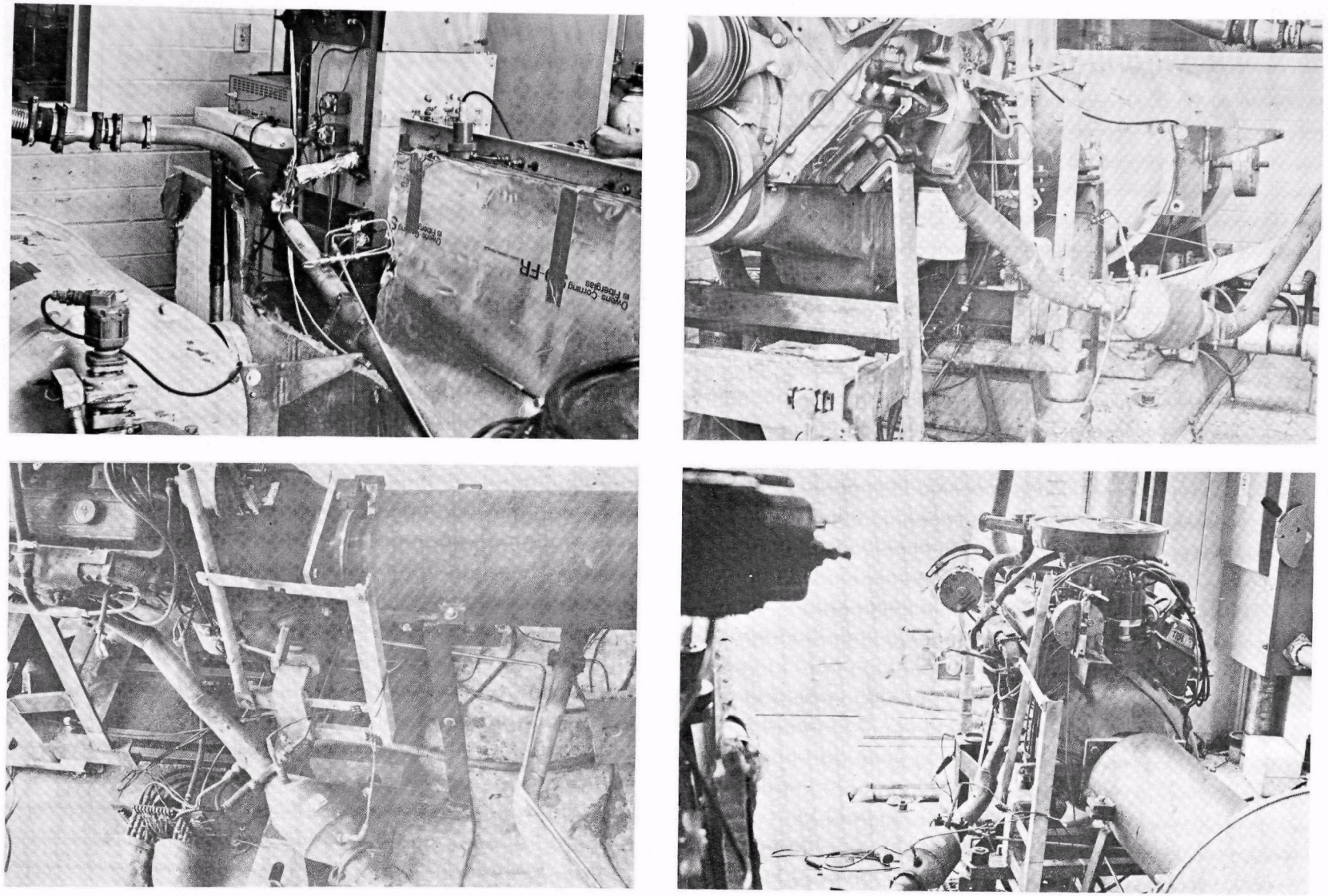


FIGURE 13. OXIDATION CATALYST TEST SET-UP
ENGINE 2-3

EGR. The maximum power could be restored by eliminating EGR at WOT. This will help BSFC only slightly however, since BSFC is a weighted value per the 23-mode test.

The results of this series of tests are included in Appendix L both in tabular and graphical form. Please refer to this Appendix for additional details. In conclusion, no tests were made to optimize for best performance taking into account fuel economy, brake specific fuel consumption, and driveability aspects such as roughness, misfiring, etc. It does point toward the possible benefits of EGR and illustrates what EGR might do for emissions from this size and make engine on a 23-mode or engine exercise type test schedule.

From the modal results in Appendix L, it is possible to select an EGR schedule that is optimum for NO_x that, in combination with other systems to remove CO and HC, could be driveable. The time limitations of this project have prevented this from being done on an engine. The results may be predicted, however, from data at various timing, air injection, carburetor settings with and without oxidation catalyst. Some combination effects may be seen from factory EGR plus catalysts and air injection at modified spark timing to allow a reasonable prediction.

(g) Step 6 - Effect of an Oxidation Catalyst on Emissions

This series of tests were made with Indolene clear, a well known American Oil Company low lead fuel that is a laboratory standard fuel for operation of devices such as catalytic mufflers. To prepare for these tests, a new fuel pump and fuel handling system up to the carburetor was installed and the carburetor bowl drained. A gallon of Indolene clear was run through the engine before the catalysts were installed. The exhaust system was replaced with new pipe such that the inlet of each of the two catalytic devices were located twenty inches from the exhaust manifold outlet flange. The dual exhausts were then joined together into a single exhaust. The conventional stock muffler was removed.

Samples were obtained from the exhaust at a point five feet downstream for analysis. A common sample of the gases as they entered the devices was obtained at a point one inch before each catalyst and these two samples "Teed" together to obtain a common sample for analysis. Thus, by alternatively sampling the inlet and exit gases, it was possible to determine relative effectiveness of the catalyst.

Inlet and outlet temperatures and pressures were also measured and recorded. The manufacturer required that the exit temperature never exceed 1800°F. This temperature was closely monitored at each condition to make certain the catalyst was not damaged. The manufacturer felt that for the catalyst to be effective, a minimum inlet temperature on the order of 800°F would be needed. There are a number of operating modes in the

23-mode schedule where this was not possible even with the catalysts close-mounted.

Figure 13 illustrates the installation and sampling arrangement for this step of the project. Additional air for oxidation was provided by the exhaust manifold air injection system normally used for such purposes.

Figure 14 shows the "before" and "after" HC, CO and NO_x for the series of tests made with the oxidation type catalyst. It is difficult to make a direct comparison between the results on Figure 14 and other treatments such as the standard engine with air injection alone, or light duty EGR as were described on Figure 9. This is because fuel and exhaust systems were different, as was the point at which the exhaust was obtained, especially the "before" sample. Incidentally, audible detonation or knock, though intermittent, was experienced on the Indolene Clear at 17 and 25° BTDC when operating at part to WOT throttle position at 1200 and 2300 rpm (above 50 percent power). The knock was not excessive though it was worse at 1200 than at 2300 rpm. An accurate indication of the catalysts effectiveness is, however, portrayed by Figure 14 as to its dramatic reduction of both HC and CO. BSFC, computed on a cycle weighted basis, shows a minimum at 16°BTDC.

Figure 15 is a bar chart representation of the influence of the catalyst on emissions when non-standard carburetor jets and rods (0.075 and 0.028) were employed to richen the mixture. Also, the effect of the catalysts on emissions without air injection is shown. This test, made at standard timing, indicates the need for supplemental air for adequate catalyst operation with this particular engine. In any event, CO reduction was judged poor.

Richening the mixture lowered NO_x, but in doing so, increased CO substantially while having the same effect on HC. It seems that the catalyst is capable of removing a certain amount of CO under the conditions experienced and purposely increasing fuel to air to quench NO formation is not adequately compensated for by the catalyst as tested. Possibly more surface area, i.e., two in series with additional air injection may have helped, though the temperature release can become excessive.

Appendix M contains the tabular and graphed results of the exhaust emissions, etc., for this series of tests. Computer print-outs for the "before" and "after" test series are included. The "after" results, i.e., the emission rates from the engine after passing through the catalyst devices, are plotted against percent power per the 23-mode test.

In summary, it appears that an oxidation catalyst of the type tested has great promise in reducing tailpipe emissions from engine 2-3 on the experimental 23-mode test procedure. Though a sweeping statement regarding the use of catalysts on trucks and their durability <u>cannot</u> be made,

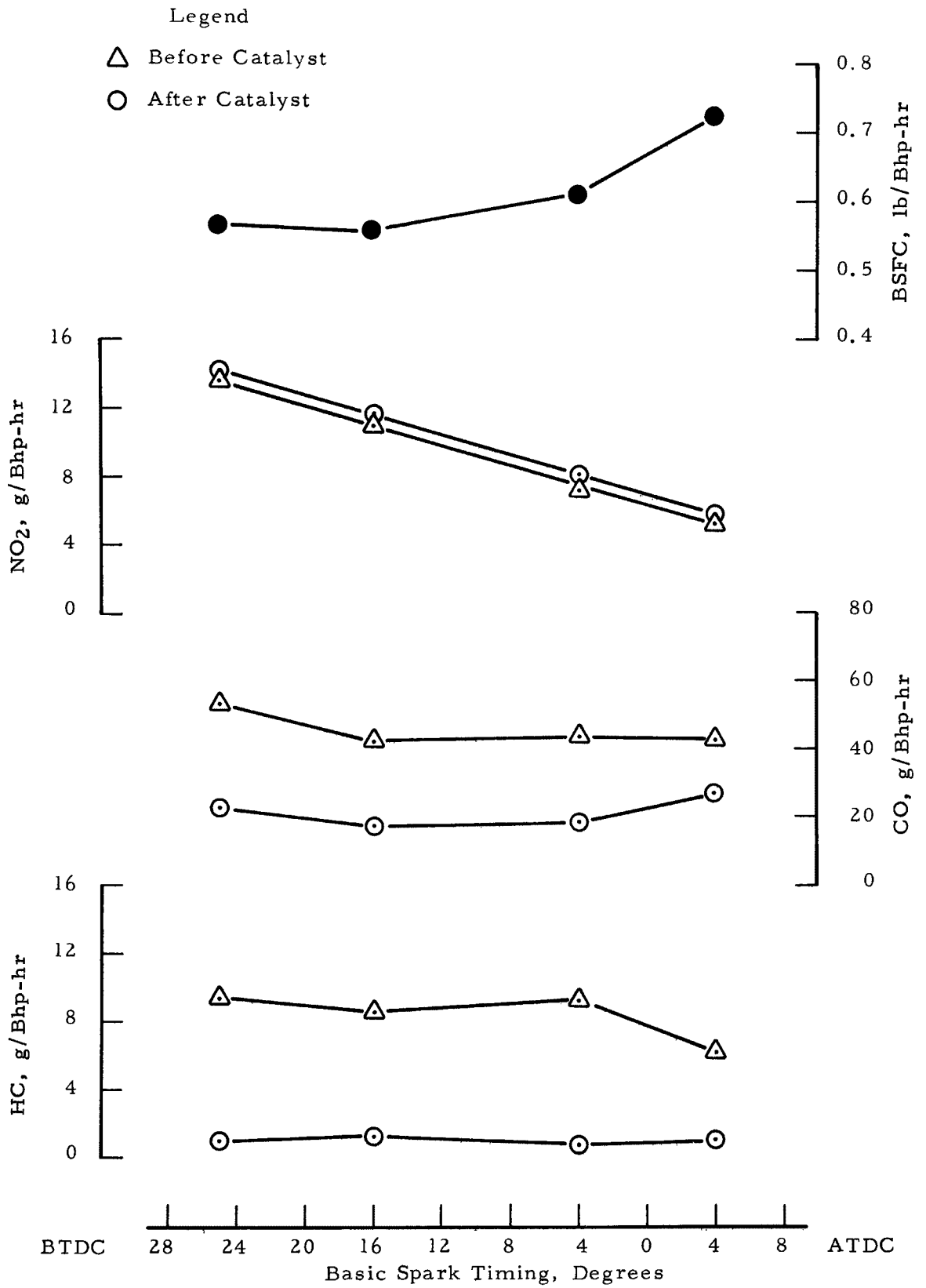


FIGURE 14. EFFECT OF OXIDATION CATALYST ON EMISSIONS ENGINE 2-3, 23 MODE TEST

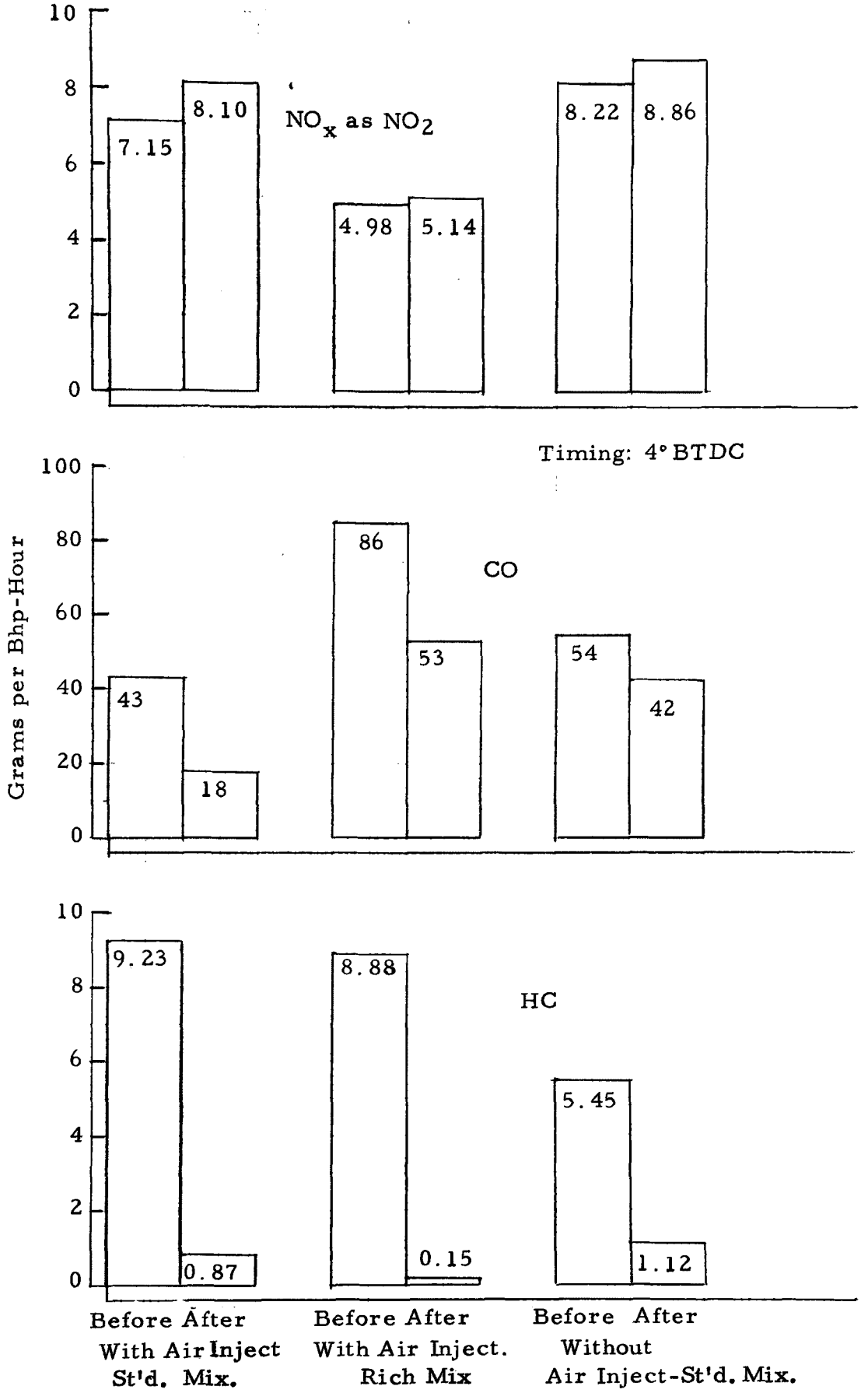


FIGURE 15. EFFECT OF OXIDATION CATALYST ON 1972 STANDARD ENGINE WITHOUT AIR AND WITH FUEL RICH MIXTURE ENGINE 2-3, 23 MODE TEST

the improvements in emission concentrations and mass rates tend to agree with the extensive light-duty experience with this commercially available material. Whether it is sufficiently durable in truck service and whether lead sterile fuel is available are factors that remain to be seen. There were no obvious engine malfunctions or problems due to the catalyst that might affect driveability since no changes are necessarily needed to the carburetor and distributor or the engine to obtain the improvements noted. There are controls that must be applied to prevent the item from being run on fuel containing lead at excessive temperatures (i.e., with excessive CO and HC, etc.), and in isolating the items such as reactor and adjacent piping that experience high temperatures from the vehicle or the environment.

(h) Step 7 - Derating by Carburetor Restriction

This item, of low priority, was considered of interest since the effect of a power reduction on emissions might more than compensate for the power loss that may be associated with some controls. Incidentally, in several steps of this phase, the engine power output was unintentionally derated because of the control device characteristics.

One fairly simple way to intentionally derate the engine was to operate engine 2-3 with only the front two, small, venturis of the four barrel Rochester carburetor. A plate was made that effectively blocked off the rear two venturis, which normally are not in use, and a 23-mode test was run. The engine appeared to run fine at 1200 and at 2300 rpm with little derating of power at 2300 rpm noted. No doubt, that the engine's high speed power was reduced, but at the two speeds used in the 23-mode test schedule, only about 8 percent loss in peak power was found at 2300 rpm. The tests of this item were terminated at this point since time and funds did not permit further testing. Operation on only one barrel was considered, but would require a special mixing section between the carburetor and the intake manifold to improve mixture distribution.

The results of the single run are compared below with a standard engine with unmodified carburetor. Only CO seemed affected to any extent, however, this result has not been verified by sufficient replication.

	grams per bhp-hr 23-mode					
	HC	CO	NO_x	BSFC*	Max. Power, hp *	
Standard Engine Carburetor Standard	7.01	56.2	8.6	0.621	@ 1200	53
					2300	114
Standard Engine Rear Barrels of Carburetor Blocked	7.97	32.4	9.3	0.609	1200	53
					2300	105

*Weighted per 23-mode test.
**Observed flywheel.

For further details on this single test, please refer to Appendix N.

(i) Step 8 - Combination Tests

The test plan called for combination of the best features of experiments in previous steps and then performing emissions tests. A natural adjunct of this step would be optimization of the control combination(s). The limited time and funds prevented this from being done and only the one best overall combination, with slight variation, was tested. The test series involved 23-mode tests, then nine-mode tests, then additional 23-mode tests with aldehyde measurement (extended tests). Then the engine was returned to original condition as closely as possible and a 23-mode, nine-mode series performed.

The combination tested was standard 4° BTDC spark timing, standard carburetor jets, standard, light-duty EGR, oxidation catalyst and manifold air injection. For comparison, the results are shown in Table 12. Samples were obtained before and after the oxidation catalyst. No optimization or calibration was made of the control engine. A 4°ATDC alternative to the standard 4° BTDC was tried. The slight improvements in emissions hardly justified the loss in fuel economy, i.e., higher brake specific fuel consumption.

The second entry on Table 12 summarizes the results of a series of runs made after the engine was returned to its original, standard, 1972 configuration for direct comparison to the tests made on 6-15, 16-72. The standard engine did not change materially during the two months of experimentation. Appendix P contains the run results for the two 23-mode tests made on 8-3-72 with the engine returned to standard configuration.

Using the last, 8-3-72, test made on the standard engine as a basis for reference, the following comparison is offered. Roughly a 70 percent reduction in HC (from 7.31 to 2.13 grams per bhp-hour), a 68 percent reduction in CO (from 51.4 to 16.61 grams per bhp-hour), a 30 percent reduction in NO_2 (from 9.0 to 6.24 grams per bhp-hour), and a 58 percent reduction in aldehydes (from 0.262 to 0.110 grams per bhp-hour) was obtained. This was achieved with only a nominal change in cycle weighted BSFC from 0.622 to 0.668 or a 7.4 percent change (loss) and essentially no change in top end power at 2300 rpm.

More could be done to improve control effectiveness given additional time and funds. A different EGR schedule, tailored to the 23-mode test, would have shown more improvement in NO_x for example or a reduction catalyst may well have made an even greater reduction in NO_x. An advanced technology oxidation catalyst might have done more to reduce CO, HC, and aldehydes as well.

TABLE 12. ENGINE 2-3, 23-MODE EMISSION REDUCTIONS

Configuration	Date	Runs	Grams/bhp-hour, average HC	CO	NO2	Alde.	BSFC	Hp. Obs. @ 2300 rpm
Standard 1972	6-15,16-72	2	7.01	56.20	8.60	0.262	0.621	114
Standard 1972	8-3-72	2	7.31	51.40	9.00	N/A	0.622	109
Controlled*	7-28,8-1,2-72						0.668	
Before Cat.		4	13.08	28.99	6.20	N/A		110
After Cat.			2.13	16.61	6.24	0.110		
Controlled**	7-28-72	1				N/A	0.827	97
Before Cat.			8.33	29.08	4.32			
After Cat.			1.67	18.92	4.23			

*1972 Standard Engine with oxidation catalyst and Light Duty Air Injection and EGR system.
**Same as *, but 4° ATDC Basic Timing.

In conclusion, the extent of control is far from optimum and appears to be a minimal level that could be achieved using commercially available devices. Though the engine was never installed in a truck and the resulting driveability assessed, it is unlikely that a serious impairment will result since the light duty EGR schedule was adhered to and timing was unchanged. Only negligible changes in power output and brake specific fuel consumption resulted based on the 23-mode test.

For additional details, modal and individual 23-mode run results, please refer to Appendix O. The tabular data in Appendix O for the four runs made with the best combination on 7-28, 8-1, 2- 1972 show satisfactory test repeatability. The graphed results for the best combination, after catalyst, are shown in Figures 0-1 through 0-3 for HC, CO and NO_x, and are included for further consideration if desired.

Tests were also made using the nine-mode FTP with the results expressed in concentration and grams per bhp-hour. These results are summarized in Tables 13 and 14. The first two entries in both tables, for Standard 1972, show good agreement even though over two months had elapsed between tests of this configuration.

Comparing the Table 13 concentration results with the controlled engine to those with the most recent test series in standard configuration, the emission controlled engine must be termed an improvement with regard to CO and NO, but a penalty regarding HC. This same conclusion may be

TABLE 13. ENGINE 2-3 NINE-MODE 1972 FTP EMISSION REDUCTIONS
(Concentration Basis)

Configuration	Date	Runs	Concentrations, Average HC ppm Hex.	CO, %	NO, ppm Corr.
Standard 1972	5-12-72	3	116	0.66	1601
Standard 1972	8-4-72	3	117	0.57	1660
Controlled*	8-2-72	3	129	0.09	641
Current Federal Limit			275	1.5	None
Proposed Federal Limit			160	0.8	2000

*1972 Standard Engine with oxidation catalyst, Light Duty Air Injection, and EGR System.

TABLE 14. ENGINE 2-3 NINE-MODE 1974 FTP EMISSION REDUCTIONS
(Mass Basis)

Configuration	Date	Runs	Grams/Bhp-Hour, Average CO	HC	NO_2	HC + NO_2
Standard 1972	5-12-72	3	31.4	3.36	11.20	14.56
Standard 1972	8-4-72	3	22.1	2.87	9.74	12.61
Controlled*	8-2-72	3	4.7	2.86	6.26	9.12
1973 California Limit			40			16
1975 California Limit			25			5

*1972 Standard Engine with oxidation catalyst, Light Duty Air Injection and EGR System.

reached from the data in Table 14. Although the nine-mode CO and NO results seem fairly consistent with the 23-mode, HC definitely was not. Incidentally, the nine-mode overstates the reduction made in CO relative to the 23-mode test while the nine-mode seems to understate the HC improvement relative to the 23 mode. Had the nine-mode FTP been used to evaluate the control technology assessment instead of the 23-mode test, it is unlikely that the same optimization of the final emissions control system would have been used.

It appears that the catalyst and air pump did little if anything to reduce HC even though it is known by the 23-mode test mode-by-mode results that it was doing a job.

To try and understand more about what causes these apparent inconsistencies, a mode-by-mode analysis of nine-mode FTP results in standard and control equipped configuration was made. Table 15 lists the dilution factors and weighting factors for the average standard and the average control equipped run. Also listed are the average CO_2 raw concentrations which have the major influence on the dilution factor. The air pump dilutes the exhaust sufficiently to cause the modal difference shown, and when multiplied by the appropriate FTP weighting factor and summed, the air pump can be seen to change the overall dilution factor from near unity (1.1) as normal, to 1.7.

The dilution factor is not, however, the only reason since it affects CO and NO also. It then reverts to the ability of the control system to show the large reductions throughout the nine-mode test, especially those with a large dilution and weighting factor. Data to substantiate this are also listed on Table 15. Note the raw, adjusted (for dilution) and weighted HC values for standard and controlled. For discussion, consider the weighted HC for each engine configuration.

Modes 1, 3, 7, and 8 (Idle, 10-inch, 3-inch, and the last 16-inch Hg intake manifold vacuum) were lower with the controlled engine. Modes 2, 4, and 6, all 16-inch, modes 5 and 9, the 19-inch and closed throttle, were substantially higher in some cases with the controlled engine. The modes in which the controlled engine was better than standard amount to 66.5 percent of the cycle weight. Even so, the rather poor performance of the controlled engine, i.e., HC worse than standard due to EGR, etc., caused the HC to remain about the same overall.

A history effect may also be noted by looking at the repeated 16-inch condition, modes 2, 4, 6, and 8. Apparently the catalyst and air injection system, which depend heavily on available heat energy in the exhaust stream, were adversely affected by the prior conditions. Only after the 3-inch, near wide open throttle condition was the catalyst effective on hydrocarbons. The 19-inch, mode 5, was quite interesting since apparently the EGR spoiled normal combustion with insufficient heat energy available from the mode or previous mode to effect any clean-up. When using the light duty EGR system, employed in the 23 mode runs, it would be necessary to develop a different rate controller component to preclude operation under those conditions of the nine-mode schedule where EGR had an adverse effect. For further analysis of the data along these and other lines, please refer to Appendix O and P. Appendix O contains nine-mode concentration and mass results with the "best combination" while concentration and mass results by the FTP are included in Appendix P.

TABLE 15. ANALYSIS OF NINE MODE FTP HC RESULTS
ENGINE 2-3

Mode	Intake Vac, in Hg.	Wt. Fact.	Standard 1972 Raw CO_2, %	Standard 1972 Dil. Fact.	Standard 1972 HC, ppm n Hex. Raw	Standard 1972 HC, ppm n Hex. Adjusted	Standard 1972 HC, ppm n Hex. Weighted	Controlled Raw CO_2, %	Controlled Dil. Fact.	Controlled HC, ppm n Hex. Raw	Controlled HC, ppm n Hex. Adjusted	Controlled HC, ppm n Hex. Weighted
1	Idle	0.036	13.32	1.032	209	216	7.78	9.09	1.585	23	36	1.30
2	16	0.089	13.35	1.073	81	87	7.74	8.79	1.605	190	305	27.15
3	10	0.257	13.51	1.063	49	52	13.36	10.67	1.350	13	18	4.63
4	16	0.089	13.48	1.065	44	47	4.18	9.00	1.592	56	89	7.92
5	19	0.047	13.52	1.063	30	32	1.50	7.02	1.868	647	1299	56.82
6	16	0.089	13.46	1.067	42	45	4.01	9.03	1.583	72	114	10.15
7	3	0.283	13.90	0.998	78	78	22.07	13.15	1.088	12	13	3.68
8	16	0.089	13.59	1.056	35	37	3.29	9.25	1.640	14	23	2.05
9	Closed Throttle	0.021	8.14	1.354	1935	2620	55.02	4.74	2.873	320	919	19.30
						TOTAL	118.95					133.00

In summary of the nine-mode FTP experiments, the emission results appear quite cycle dependent. The findings here do not necessarily conflict with earlier reported data which showed that the 1973 standard version to give higher emission results than the 1972 standard version by the 23-mode test, yet represented an improvement by the nine-mode FTP. It means that it depends on how one goes about reducing emissions. On one procedure it may help and on another, it may not.

(j) Step 9 - Other Methods

Time and financial limitations constrained this research to the previous items listed. However, several other promising control approaches applicable to the gasoline truck above 6,000 lbs. were seriously considered. Turbocharging was considered seriously enough to request engineering and performance data from the manufacturer, who provided turbochargers appropriate for engines 2-3 and 1-3. Time and funds precluded their inclusion in the test program.

Electronic fuel injection was also investigated with representatives of a leading component company. Such a system, though under active development for use on engines similar to numbers 2-3 and 1-3, was not available for our test. There are programs in progress to bring electronic fuel injection to a reality in the future and this method and its potential for control should not be overlooked. Electronic fuel injection with closed loop control, seems to be the ultimate and its potential emissions benefit could be substantial.

The third major item, and one that was nearly included, was a reduction catalyst for NO_x control. This item was disclosed at the EPA suspension hearings in April of 1972 with dramatic performance on NO_x claimed on the light-duty test. Used in combination with an oxidation catalyst, the strict 1976 light-duty standards were claimed to be met. Repeated attempts to obtain samples for evaluation resulted in an impasse regarding the rights-in-data clause of the manufacturer's Non-Disclosure Agreement. This point could not be resolved in the time remaining under the project and accordingly the item was not evaluated. Had there been at least a month of test time available for engine-catalyst optimization, this issue could have been resolved. The short time frame for testing under this project made this impossible. These three major items should definitely be included in any future control technology assessment project. They all have potential for heavy-duty trucks.

2. Engine 1-3 Control Technology Results

Tests were conducted on this engine following the preliminary plan of test shown on Table 16. This schedule was revised some from that originally provided the Project Officer by letter dated July 18, 1972 in that

TABLE 16. PLAN OF TEST, ENGINE 1-3

Step	Description
1.	Vary basic timing i. e. say 10° advanced, standard and 10° retarded timing.
2.	Install larger and smaller carburetor jets to modify engine air-fuel ratio at standard timing.
3.	Run laboratory EGR system at standard timing at say 5, 10, and 15 percent total intake air flow as EGR.
4.	Operate exhaust manifold air injection system at standard, advanced, and retarded basic spark timing with standard carburetor.
5.	Install oxidation type catalytic reactor, clean fuel system, and run with air pump at standard timing, advanced and/or retarded. Operate on clear fuel (unleaded), run longer modes and sample exhaust before and after catalysts.
6.	Combine best EGR or catalyst - ignition timing found in Steps 2, 3, 4, and 5.

the reduction catalyst alternative was deleted with its non-availability. Discussions with the engine manufacturer were successful in obtaining carburetor jets larger and smaller in size than standard. Also furnished by the engine manufacturer were cylinder heads and associated air pump valve and tubing for exhaust manifold oxidation experiments. The work plan was a simplified, abbreviated, series that was similar in scope to that used for engine 2-3.

Before starting the test program, the engine heads were removed and replaced with the factory-furnished standard light-duty heads normally used to inject air into the exhaust stream as it leaves the combustion chamber. The heads were all new with new valves, springs, etc. The air pump delivery hoses and tubing for connection of the pump to the injection tubes were installed and connected. The vacuum-operated distribution valve, which is intended to prevent possible exhaust backfiring during closed throttle, was also installed and connected as specified by the manufacturer.

The laboratory exhaust gas recirculation system was identical to that used with engine 2-3. One major difference was the way in which the recirculated exhaust was introduced into the engine. As pointed out with engine 2-3, this is very important in order to maintain even mixture distribution, etc. In the short period of time available, it was decided to use a separate plastic distribution block under the carburetor much as the positive crankcase ventilation system uses. To simplify the design, it was decided to use the same type of plastic block as is used for the PCV and locate both between the carburetor and the intake manifold. To facilitate connection of the EGR and PCV hoses, a 3/4 inch thick aluminum block was inserted between the two plastic blocks. The plastic block has a nicely formed passageway communicating from the common inlet to each of the two openings (barrels) and was well suited for even distribution of the EGR to each throat of the intake system.

It was during the reassembly of the carburetor on the taller stack of items that one ear of the bottom flange of the carburetor broke off. It was felt that a replacement carburetor should be obtained from from the manufacturer and after some conversation with the manufacturer's representative, it was decided to use a 1973 carburetor, not a 1972 unit. They are identical except in jet size. The change in jets was so slight, according to the manufacturer, that it would be within the normal carburetor production tolerance.

The pair of oxidation catalysts were installed as with engine 2-3. The inlets were positioned 20 inches from each engine bank's exhaust manifold flange. The dual exhausts were then connected into a single exhaust pipe and stock muffler. The sample probes were positioned as with engine 2-3 with provision for sampling before and after the catalysts. When the catalytic reactors were not to be tested, they were removed and short, straight pipes inserted in their place.

All operation was with leaded emissions test gasoline except when the catalytic reactors were installed necessitating the use of low lead, Indolene clear, fuel. Figures 16 and 17 show various views of the engine prepared for test. Some of the test items and instruments are also shown.

(a) Step 1 - Effect of Basic Spark Timing on Emissions

The following, Table 17, lists the 23-mode results at various basic spark timings:

TABLE 17. EFFECT OF BASIC SPARK TIMING ON EMISSIONS 23-MODE TEST, ENGINE 1-3

			Grams per bhp-hr				Max. Bhp.	
Date	Run	Timing	HC	CO	NO_2 Obs.	Weighted BSFC	1200 rpm	2300 rpm
8-17-72	2	30°BTDC	15.7	61.1	17.9	0.669	56	113
8-17-72	1	15°BTDC	8.7	72.7	13.6	0.679	57	115
8-16-72	2	6° BTDC	9.4	71.3	8.7	0.720	53	110
8-16-72	3	6° BTDC	8.9	72.8	8.7	0.717	53	110
	Average		9.3	72.1	8.7	0.719	53	110
8-18-72	1	TDC*	8.5	110.1	5.5	0.855	46	99
8-17-72	4	5°ATDC*	9.8	167.8	4.6	1.061	42	87
8-17-72	3	10°ATDC*	9.5	187.7	4.6	1.143	35	79

* Engine operational difficulties encountered

The two runs made on 8-16-72 at 6° BTDC represents the standard engine as far as the control technology laboratory studies are concerned. The first tendency is to compare the average with earlier tests on engine 1-3 that were presented under the baseline portion of the results. Such a comparison should be avoided since the heads and carburetor were new and different from those used as baseline. Thus the lower HC and NO_2 and higher CO reported from the modified engine 1-3 than baseline has no basis for comparison.

The data listed in Table 17 are plotted in Figure 18 and illustrate the trade-off between NO_2 and CO with timing. As timing is adjusted later and later, NO_2 decreased almost linearly. CO seemed to take-off upward after operation at the factory standard of 6° BTDC. The question from these curves is, which is most important, CO or NO_2? In one case, a change in timing of 11° from 6° BTDC to 5° ATDC brought NO_2 down to half while the same timing change almost doubled CO by the 23-mode test.

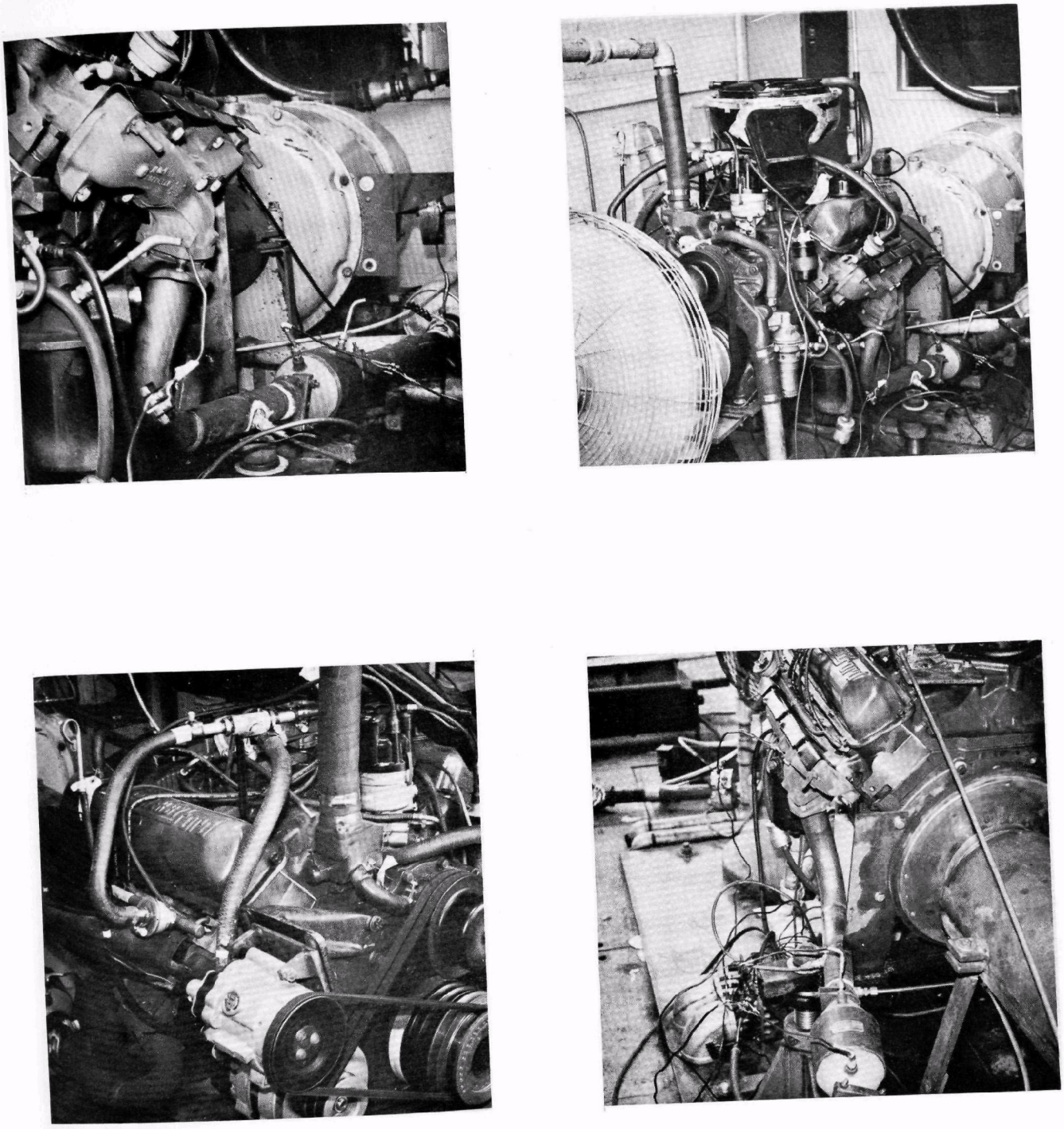
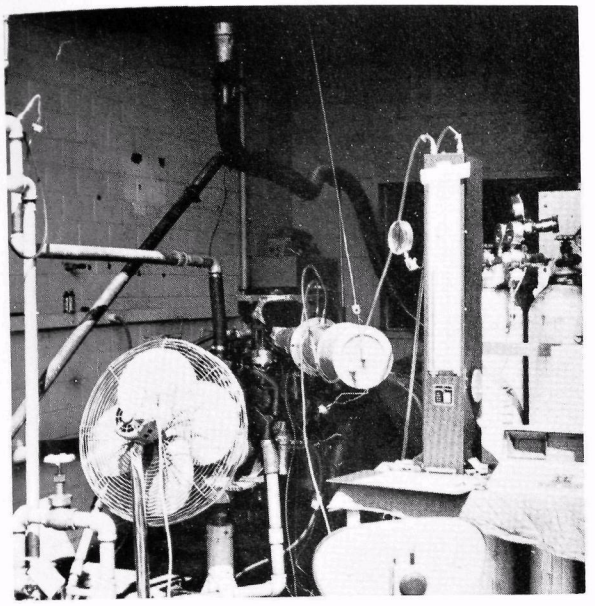
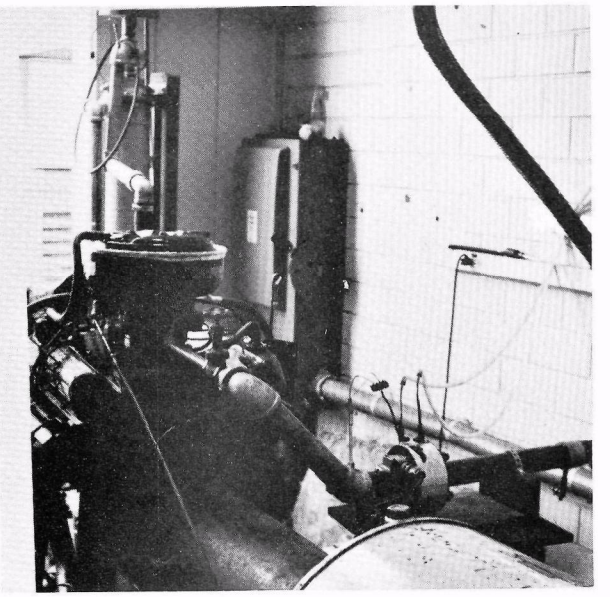
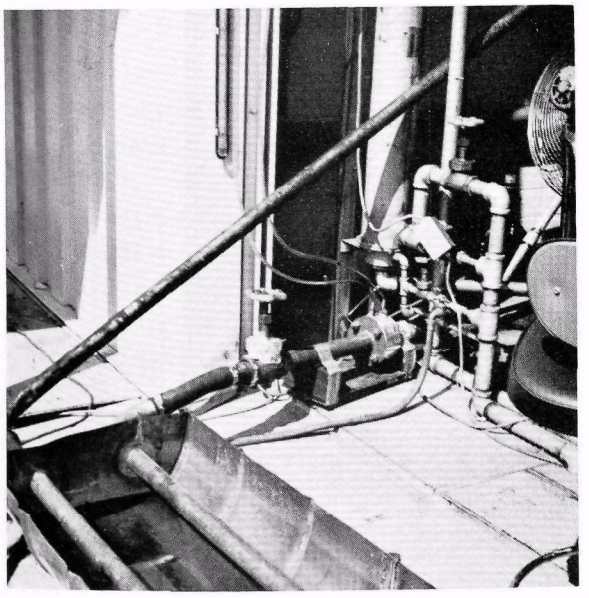


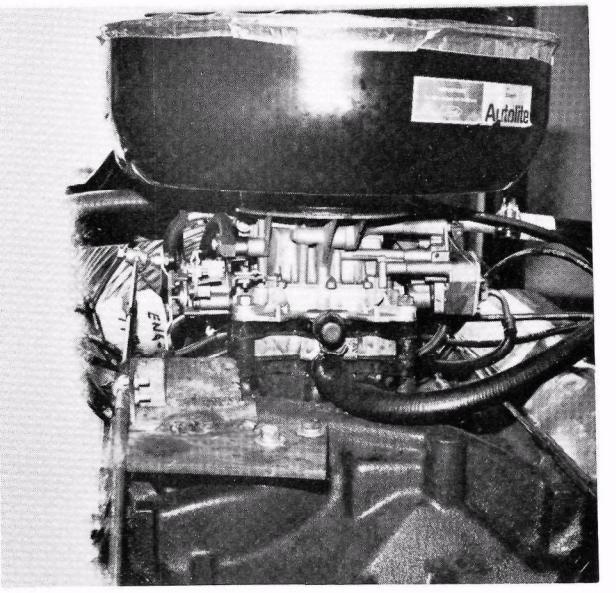
FIGURE 16. VARIOUS VIEWS OF OXIDATION CATALYST AND AIR INJECTION SYSTEM
Engine 1-3





"Cold" EGR





"Hot" EGR

FIGURE 17. LABORATORY SET-UP FOR EGR
Engine 1-3

HC seemed to be little affected by timing. Operational difficulties were encountered at one or more modes at TDC, 5 and 10° ATDC resulting in less than complete 23 mode data. Looking back at Table 17, BSFC was degraded as was top end power at 2300 and 1200 rpm. Cycle weighted BSFC is plotted on Figure 18 for graphical representation. The question from this is: Can the excessive CO be reduced by an oxidation catalyst? Some experiments along these lines will be discussed later.

For more details in terms of computer print-outs and graphs of the results, please refer to Appendix Q. It may be noted from the computer print-outs that several modes were not operable at retarded spark timing. The engine refused to operate at 75 and 82 percent load at 1200 rpm with TDC timing. When the timing was retarded still further from standard, to 5° ATDC and 10° ATDC, the engine would not run at 75, 82 and 92 percent power, 1200 rpm and 75 percent power at 2300 rpm.

(b) Step 2 - Effect of Air-Fuel Ratio on Emissions

To investigate this effect, the main fuel jets were replaced with smaller and larger items and thereby change the air-fuel ratio. As with engine 2-3, the emissions and BSFC behavior of engine 1-3 was plotted against 23-mode cycle weighted air-fuel ratio. The carburetor main jet size in inches is also indicated. The standard size, 0.056 inch, is shown with two richer jets, 0.060 and 0.065 inch, and one leaner jet, 0.051 inch, on Figure 19. A fairly good plot results from this method of presentation. Attempt to operate with larger and smaller jets than those shown were made with unsatisfactory engine operation resulting.

Figure 19 illustrates that the standard engine could be made to produce less NO but again at the expense of a dramatic increase in CO and a small increase in HC. This approach may have some merit in reducing NO_2, if rich enough jets are used. However, something like an oxidation catalyst will have to destroy CO and HC. The remaining point is whether this approach, which increases weighted BSFC from the reference 0.719 to 0.789 for the 0.060 inch jets, as shown in Figure 19, is worth it. Maximum power at 2300 and 1200 rpm seemed little affected by the 0.060 inch jets. An opportunity to compare a larger jet with a catalytic reactor will be given later in this section. For further details and modal data, both on a tabular and a graphical basis, please refer to Appendix R. The engine would not run in mode 6 with 0.051 jets, and in modes 13 and 14 with 0.065 jets.

(c) Step 3 - Effect of Laboratory EGR on Emissions

This step of the project involved using the laboratory system previously described to recirculate a part of the engine's exhaust back into the intake system below the carburetor throttle plate. The system was normally controlled to recirculate exhaust at a fixed percentage of the engine

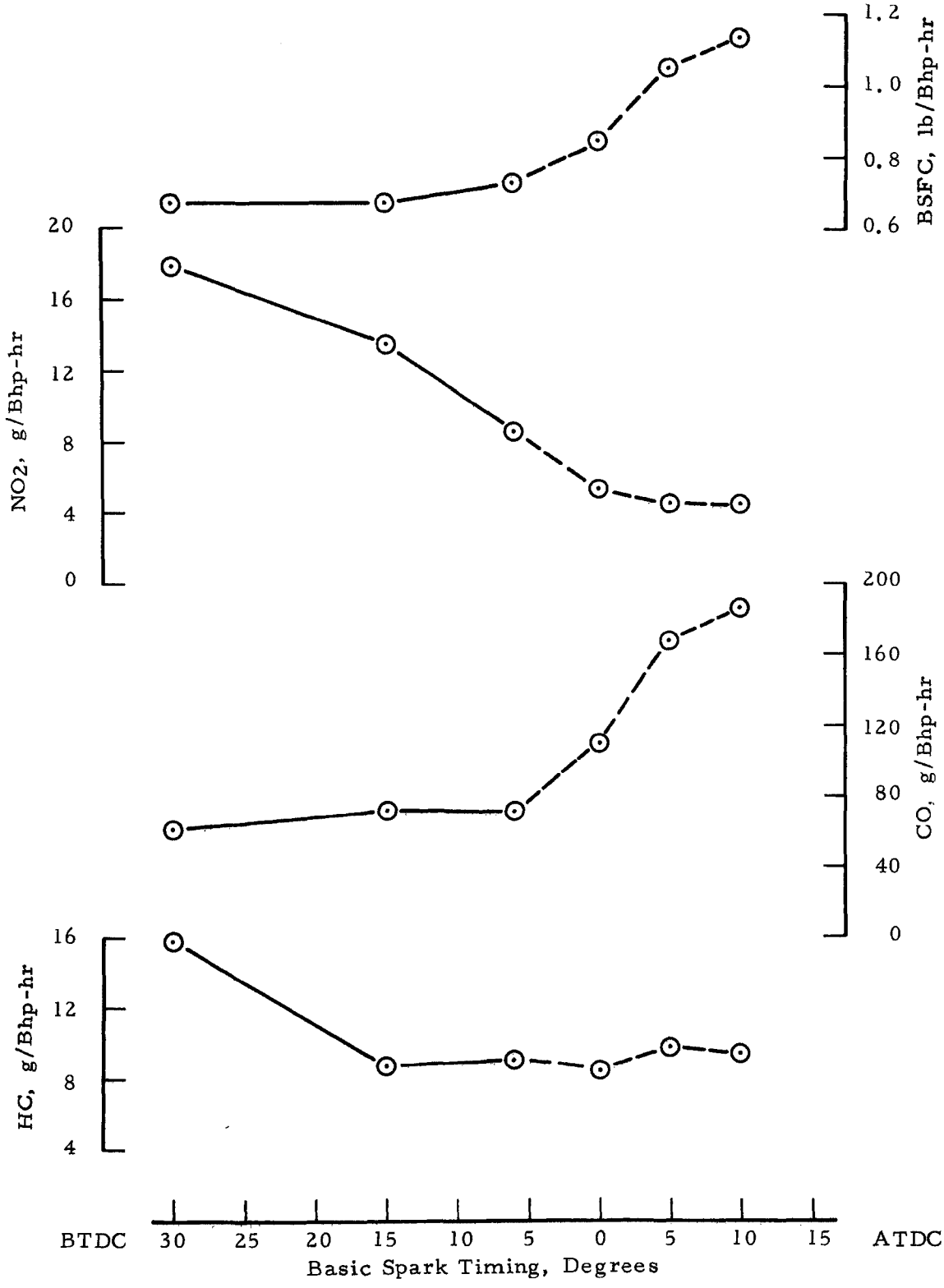


FIGURE 18. EFFECT OF BASIC SPARK TIMING ON EMISSIONS
ENGINE 1-3, 23 MODE TEST

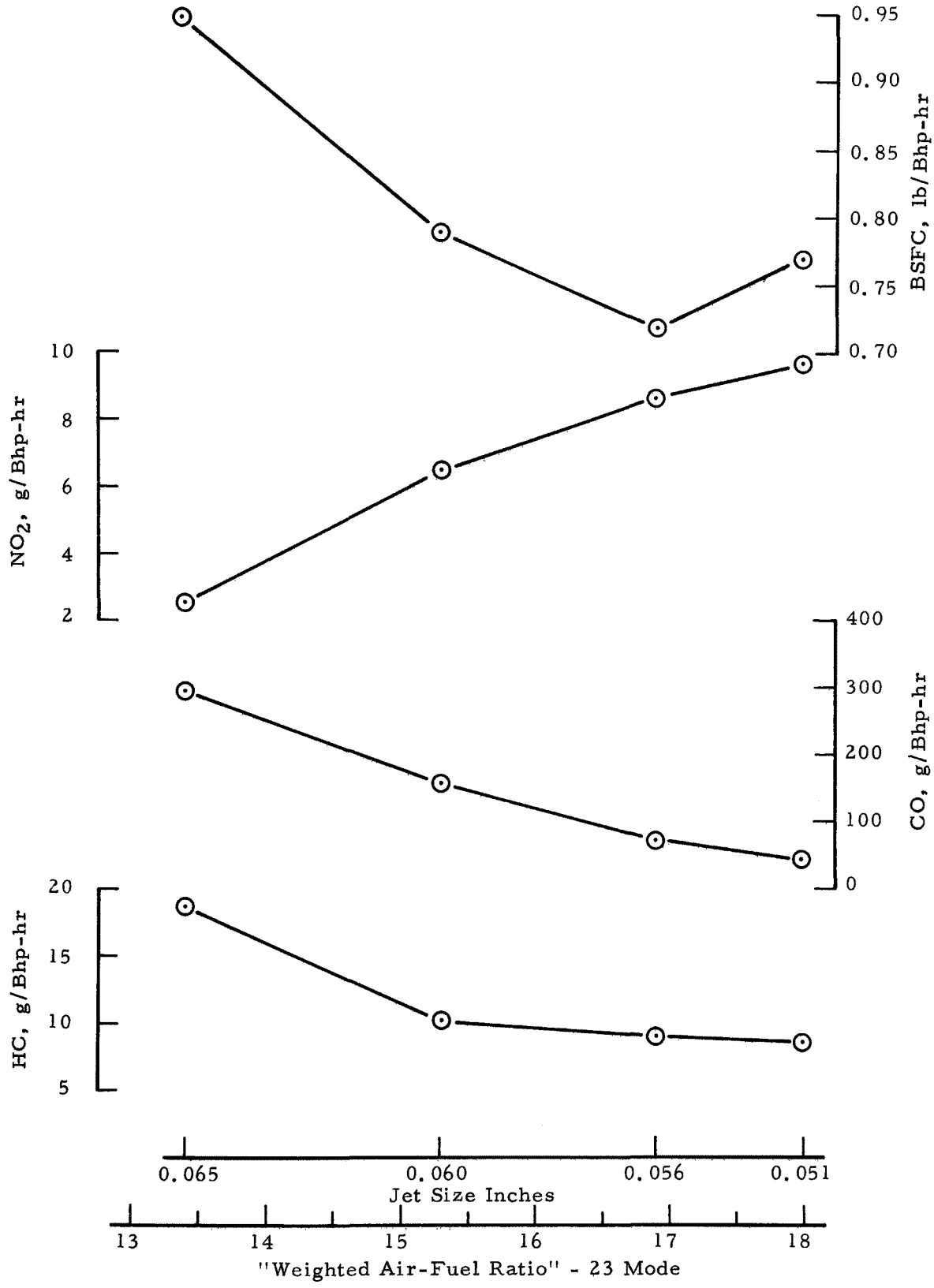


FIGURE 19. EFFECT OF AIR-FUEL RATIO ON EMISSIONS
ENGINE 1-3, 23 MODE TEST

inlet flow. The temperature of the recirculated exhaust was generally 100 to 110°F. A strict 23-mode schedule was performed in that the maximum power was first determined using a given fixed EGR rate. Then, the various power points were calculated from the maxiumu per the usual test procedure.

During the running of the 23-mode test, the dynamometer operator was instructed to maintain certain power output and speed and vary throttle setting to do so. The test engineer would adjust EGR rate to obtain the desired fixed percentage EGR by measuring both the carburetor inlet air and exhaust recycle at the same time and pe rforming necessary calculations. It generally required about five minutes to establish the condition properly before exhaust emission measurements could be made.

Figure 20 depicts the HC, CO, and NO_2 emission and cycle weighted BSFC results obtained at 5, 10, and 15 percent EGR. From engine 2-3, it was found that 10 percent EGR was about optimum for NO reduction, yet without seriously jeopardizing engine performance. Accordingly, the EGR rates were selected to bracket 10 percent. Recall that a constant rate of EGR was employed with the exception of closed throttle and idle modes where NO is negligible. Certainly, a constant EGR rate is not optimum for top-end performance or NO_x reduction for that matter. The three constant levels depicted along with zero EGR for reference makes a somewhat complete laboratory study of cooled EGR. The engine was standard otherwise with standard size jets and spark timing.

Cooled EGR has a substantial effect on NO_x formation and results in significant NO_x reductions. Recall that EGR can reduce exhaust volume so that when multiplied by reduced emission concentrations, the result can be substantially lower NO_x. This assumes little or no maximum power output is lost. For additional details, data and graphs covering this series of experiments, please refer to Appendix S. There are many ways the modal data given in Appendix S may be used. One way is to try and derive the best schedule of EGR, tailored to produce minimum NO, without loss in maximum power, with acceptable increases in CO and HC, assuming an oxidation catalyst, and without seriously impairing fuel economy. It is difficult to obtain a large decrease in NO_x by EGR without increase in fuel consumption. The steady increase in weighted BSFC, Figure 20, points up the fuel and inherent operating cost penalty associated with EGR. As a fairly rapid approximation, the EGR schedules shown in Table 18 were selected for test later in the project.

These schedules will be discussed more in a later section where both cooled EGR and hot EGR will be run at 6° and TDC timing. Hot, or unintentionally cooled EGR seems to be the currently accepted method for light-duty vehicles. The use of hot EGR will undoubtedly lower the charge density and thereby degrade top-end performance. The engine will necessarily run as if it is operating on a very hot day. The water of combustion in the recirculated

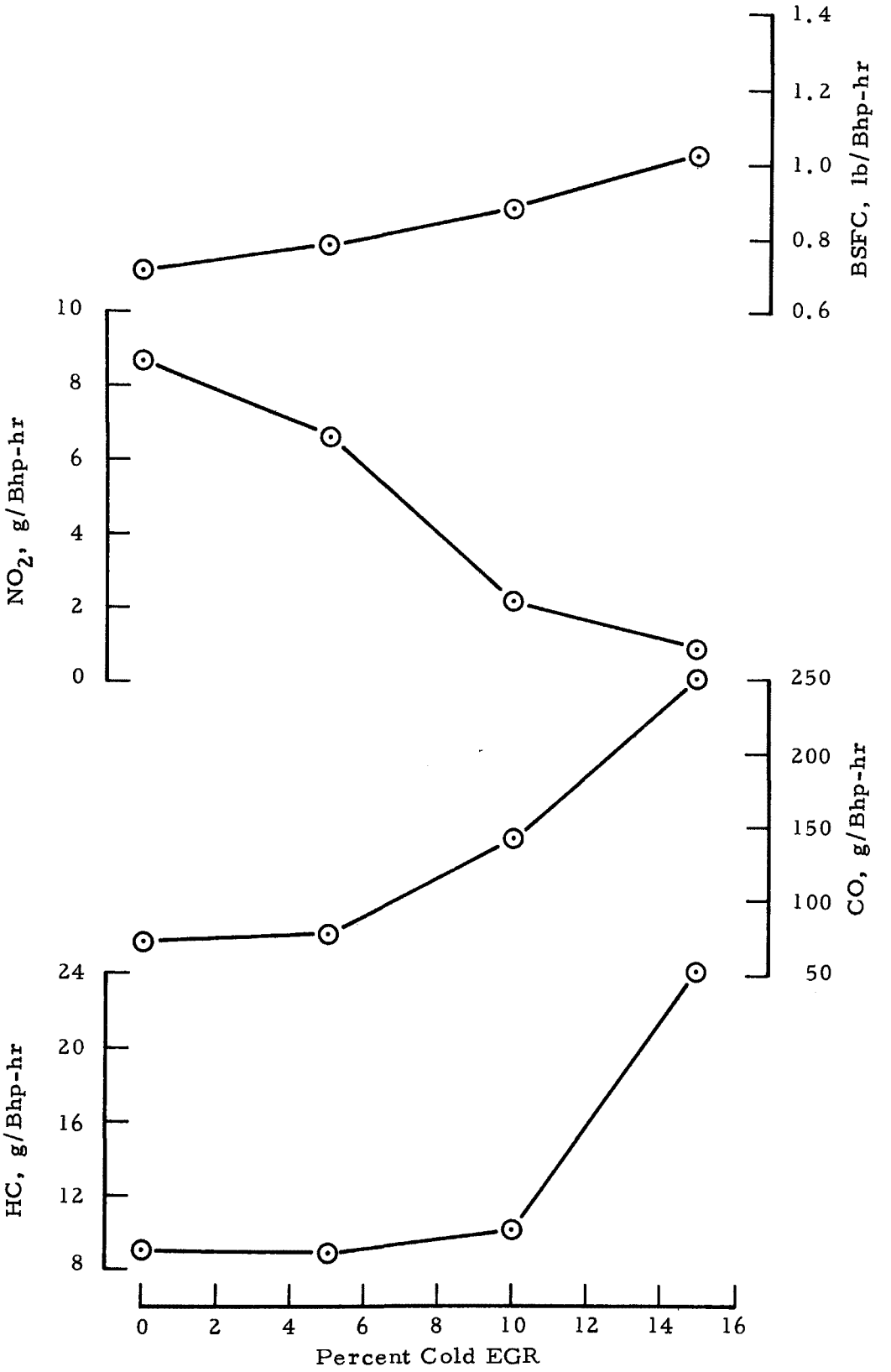


FIGURE 20. EFFECT OF LABORATORY COLD EGR ON EMISSIONS ENGINE 1-3, 23 MODE TEST

exhaust will remain in the recycle and this should help. The EGR will be monitored and adjusted to give a mass percent EGR.

TABLE 18. TAILORED EGR SCHEDULES FOR ENGINE 1-3

Mode	Speed	Percent Load	Percent "Hot" EGR Sch. A	Sch. B	Weight Factor
1	600	0	0	0	0.070
2	1200	2	10	10	0.060
3	1900	8	10	10	0.060
4	1900	18	10	10	0.050
5	1900	25	10	10	0.030
6	1900	50	10	10	0.060
7	1900	75	10	10	0.000
8	1900	82	10	10	0.040
9	1900	92	0	0	0.000
10	1900	100	0	0	0.000
11	600	0	0	0	0.070
12	1200	0(CT)	0	0	0.120
13	2300	100	5	5	0.025
14	2300	92	10	5	0.055
15	2300	85	10	5	0.035
16	2300	75	10	5	0.060
17	2300	50	10	10	0.060
18	2300	25	10	10	0.000
19	2300	18	10	10	0.065
20	2300	8	10	10	0.000
21	2300	2	10	10	0.000
22	600	0	0	0	0.080
23	2300	0(CT)	0	0	0.060

(d) Step 4 - Effect of Factory Air Injection on Emissions

Through the courtesy of the manufacturer, a light-duty air injection system was obtained and utilized in this study. Although air injection by itself had only a slight effect on engine 2-3, it was uncertain what it would do on engine 1-3. In any event, supplemental air or oxygen in the exhaust stream was necessary for oxidation catalyst operation. The light-duty exhaust manifold air injection system is shown in the drawing in Figure 21. It was also shown as installed on the engine in Figure 16 photographs.

The test series involved operation with the complete light-duty system at several basic spark timings namely, TDC, standard (6° BTDC) and 15° BTDC. From Step 1, effect of timing on emission rates, it was shown that this was the range of interest as far as engine operability and emissions

performance was concerned. Table 19 lists the 23-mode results when operating with and without the air injection system operative.

TABLE 19. COMPARISON OF EMISSIONS WITH AND WITHOUT LIGHT-DUTY AIR INJECTION SYSTEM
Engine 1-3, 23-Mode Test

Basic Timing	Configuration	Grams per bhp-hr. HC	CO	NO_2	Weighted BSFC
15° BTDC	with air	10.4	45	10.6	0.667
	without air	8.7	72	13.6	0.679
6° BTDC	with air	9.8	60	8.3	0.712
	without air	9.3	72	8.7	0.719
TDC	with air	9.9	64	6.5	0.768
	without air	8.6	110	5.5	0.855

No really gross or consistent improvement on HC and CO may be found by such a comparison when operating with the air system. In all, air injection as a control item on this engine, subjected to the 23-mode test, lacks justification from an emissions reduction standpoint. It will be necessary, however, to utilize an air pump or something similar to provide supplementary oxygen for the oxidation catalyst. For further details, modal results both tabular and graphical, please refer to Appendix T to this report.

(e) Step 5 - Effect of Oxidation Catalyst on Emissions

Before beginning the experiments with the two precious metal catalytic reactors, the manufacturer of the engine and the catalyst were contacted to make certain the light duty air injection system would deliver the proper amount of air for optimum catalyst performance. In discussions with a representative of the engine manufacturer, it was learned that the vacuum-operated valve, item 2 in View A of Figure 21, could be replaced with a simple "tee" fitting. The vacuum-operated valve acts somewhat as a wastegate so that under some engine vacuum conditions, more or less of the air is wasted and not injected.

There are a number of reasons for this valve in the light-duty system and there may be justification for its use in heavy duty. But, it was decided to eliminate the valve with the concurrence of the manufacturer. Trial runs revealed operation to be satisfactory with no backfiring during the closed throttle conditions, etc. Sufficient O_2 in the exhaust was achieved

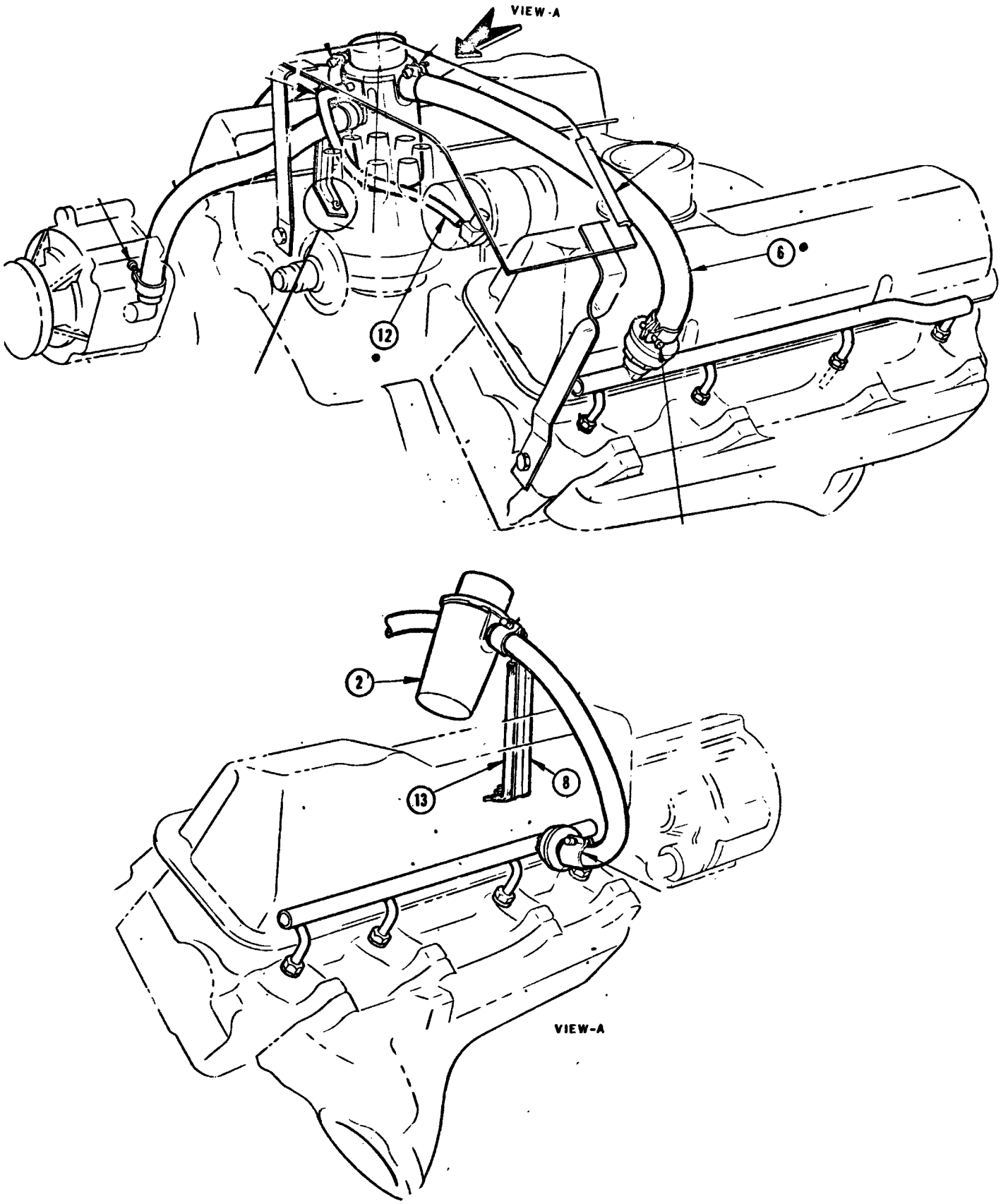


FIGURE 21. LIGHT DUTY EXHAUST MANIFOLD AIR INJECTION SYSTEM

to promote satisfactory catalysis. Please refer to Figure 16 which shows a one-half inch pipe tee used in place of the vacuum valve. The air from the pump is accordingly simply distributed to each bank of the engine.

Figure 22 is a graph of the exhaust emissions measured before and after the catalyst. As with engine 2-3, the catalysts have little effect on NO_x, as expected, an important effect on CO, and a substantial effect on HC. The catalyst must be judged an important item of emissions control and performs a very vital role in lowering CO and HC while not affecting NO_x. It did not seem to matter where the timing was set, although the TDC CO point does not agree in trend with earlier curve of CO versus timing namely, Figure 18. Exactly why CO behavior is erratic at TDC is unknown, but it is apparently not a good engine operating point as mentioned earlier.

The run results made with catalyst treatment are listed on Table 20 and are those plotted on Figure 22. Of interest was the duplicate runs made at 6° BTDC (standard timing) with the light duty air injection system including vacuum-operated distribution valve listed on Table 20. Higher CO and HC by the 23-mode test, were found when the vacuum valve was used. The data points on Figure 22 were obtained with the simple pipe Tee substituted for the waste gate. Weighted BSFC, plotted on Figure 22, shows the familar increase with retarded timing.

The run results seem to indicate that better emissions control can be achieved with catalyst when the full delivery of the air pump is utilized. It may be thought that the effect is one of more exhaust dilution. But, this is not the case when the calculations are based on the carbon balance method as are the 23-mode and Federal nine-mode mass methods.

From Figure 22, it can be seen that most any timing within the TDC to 15° BTDC range may be selected for about equivalent emission improvement. This is the important conclusion to be drawn from the fairly brief series of tests. The "before" and "after" catalyst data are published in tabular form, as computer print-outs, in Appendix U. The "after" modal grams per hour data are graphed against power level and included in Appendix U for further study.

(f) Step 6 - Effect of Various Combinations on Emissions

A few combinations were experimented with to determine how well various control approaches might work overall. Because of interactions, it is not possible to simply add the benefits of control devices. One combination tried under this step, shown in summary on Table 21, was to look quickly at richer jets, 0.063 inch, the modified light-duty air injection with oxidation catalysts but no EGR. Two basic timing settings of 6° BTDC (standard) and an advanced, 15° BTDC were tried. Although the bigger jets at standard timing with the catalyst gives some reduction in NO_2, the CO is unacceptably

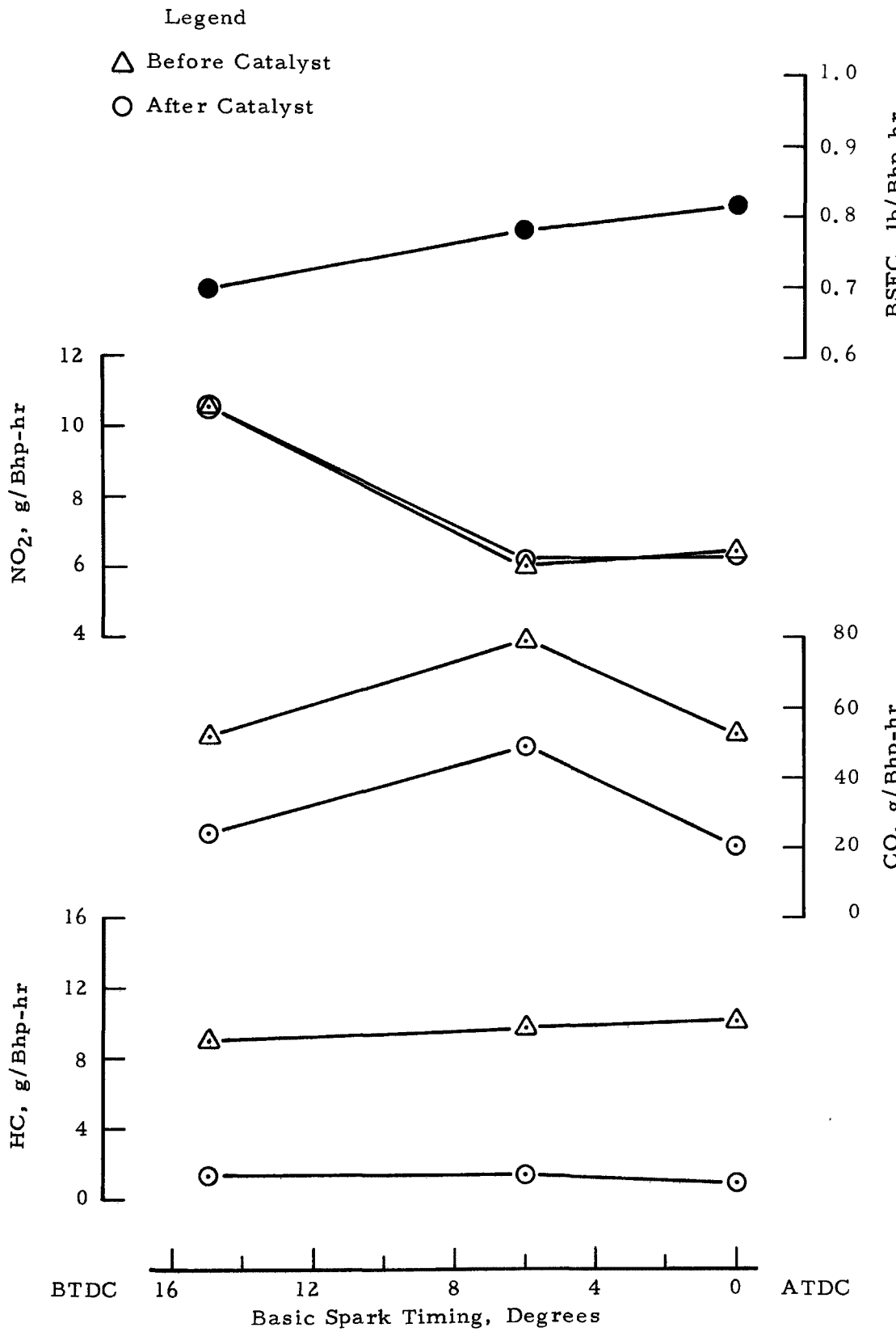


FIGURE 22. EFFECT OF OXIDATION CATALYST ON EMISSIONS WITH SLIGHTLY MODIFIED AIR INJECTION SYSTEM ENGINE 1-3, 23 MODE TEST

TABLE 20. EFFECT OF OXIDATION CATALYST ON EMISSIONS
Engine 1-3, 23-Mode Test

Date	Run	Spark Timing	Sample Point	Grams per bhp-hr HC	CO	NO_2	Weighted BSFC
			Light Duty Air Injection System Intact				
8-24-72	2	6°	Before Cat.	10.37	98.7	7.48	0.745
8-25-72	1	BTDC	Before Cat.	10.48	96.8	6.32	0.752
		AVERAGE		10.42	97.6	6.90	0.749
8-24-72	2	6°	After Cat.	2.29	61.1	6.78	
8-25-72	1	BTDC	After Cat.	3.13	59.9	6.63	
		AVERAGE		2.71	60.5	6.70	
			Vacuum Operated Air Injection Distribution Valve Replaced by Simple Pipe "Tee"				
8-25-72	3	TDC	Before Cat.	10.08	52.6	6.43	0.818
			After Cat.	0.98	21.2	6.37	
8-25-72	2	6°	Before Cat.	9.72	79.7	6.14	0.782
		BTDC	After Cat.	1.43	49.6	6.22	
8-28-72	1	15°	Before Cat.	9.19	52.1	10.61	0.695
		BTDC	After Cat.	1.44	24.2	10.59	

TABLE 21. EFFECT OF VARIOUS CONTROL COMBINATIONS ON EMISSIONS
Engine 1-3, 23-Mode Test

Date	Run	Spark Timing	Catalyst	Grams per Bhp-Hr HC	CO	NO_2	Weighted BSFC
0.063 inch (rich) Jets, Modified LD Air Injection, Oxidation Catalyst No EGR							
8/31/72	1	15°BTDC	Before	8.68	140.8	4.60	0.759
			After	1.70	83.5	5.27	0.759
8/31/72	2	6°BTDC	Before	10.91	211.3	2.97	0.853
			After	2.14	156.6	3.28	0.853
0.056 inch (St'd) Jets, Modified LD Air Injection, Oxidation Catalyst Cold EGR Per Schedule A Rate							
8/28/72	2	6°BTDC	Before	11.73	105.3	2.50	0.855
			After	1.13	63.8	2.41	0.855
0.056 inch (St'd) Jets, Modified LD Air Injection, Oxidation Catalyst Hot EGR Per Schedule A Rate							
8/30/72	1	TDC	Before	13.49	174.2	1.60	0.993
			After	2.11	134.3	1.63	0.993
8/29/72	1	6°BTDC	Before	12.72	149.4	2.51	0.862
			After	1.87	112.2	2.51	0.862
8/30/72	2	15°BTDC	Before	11.51	116.5	2.84	0.766
			After	2.23	73.3	2.54	0.766
0.056 inch (St'd) Jets, Oxidation Catalyst, Hot EGR Per Schedule A Rate, But No Air							
8/31/72	3	6°BTDC	Before	10.40	205.4	2.18	0.852
			After	5.48	169.8	2.09	0.852

high, about double the standard or unmodified engine, and the BSFC is also increased.

The results of another combination tried is also shown on Table 21 for the system. Here the engine was operated with standard 0.056 inch jets, the modified light-duty air injection system and with EGR on a cold and hot basis. The EGR schedule used was Schedule A from Table 18. Schedule A was designed to give the maximum rate of EGR and the maximum NO_2 reduction without serious engine problems. The exhaust was first recirculated through the heat exchanger with the very low NO_2 values resulting per the 8-28-72 runs. CO was not particularly better than unmodified and this caused great concern over this approach. The catalyst was apparently unable to overcome the increased CO by the Schedule A EGR rate.

To study the Schedule A under the more conventional approach of recirculating the exhaust with little or no cooling, i.e. internal EGR as with light-duty gasoline engines, the piping was close connected between the engine's exhaust and the reentry plate located below the carburetor. It may be helpful to look back at the Figure 17 photographs that show only a control valve and thin plate orifice with thermocouple for gas temperature measurement in a relatively short length of pipe. To manually operate the valve, the mass flow of the EGR was instantly computed and compared to the mass flow of air into the engine. The rate was then adjusted as closely as possible to that given for Schedule A in Table 18 and determined on a mass basis.

The results are summarized on the bottom half of Table 21 and are for the engine with standard jets, modified air injection, oxidation catalyst and hot EGR according to rate Schedule A. Three spark timings were run to determine this effect. Basically the same effect on emissions with this combination was found as with cold EGR, namely very low NO_x, high CO and low HC.

Figure 23 shows the before and after catalyst 23-mode results for hot EGR (Schedule A) versus the three timing settings studied, TDC, 6° BTDC (standard) and 15° BTDC. Although 15° BTDC timing looks best, it was decided that this combination had to be improved upon because essentially no reduction in CO was obtained. As with Figure 22, the cycle weighted BSFC increased as basic spark timing was retarded.

Before stopping this series of tests, a run was made to simulate operation with the air pump inoperative as with a broken belt. The results of this run are listed on the bottom of Table 21 and may be compared to Run 1 on 8-29-72 when the air pump was operative. Note the great need for air to oxidize the HC and CO in this test configuration. For more data of a detailed nature, please refer to Appendix V for all the tests summarized

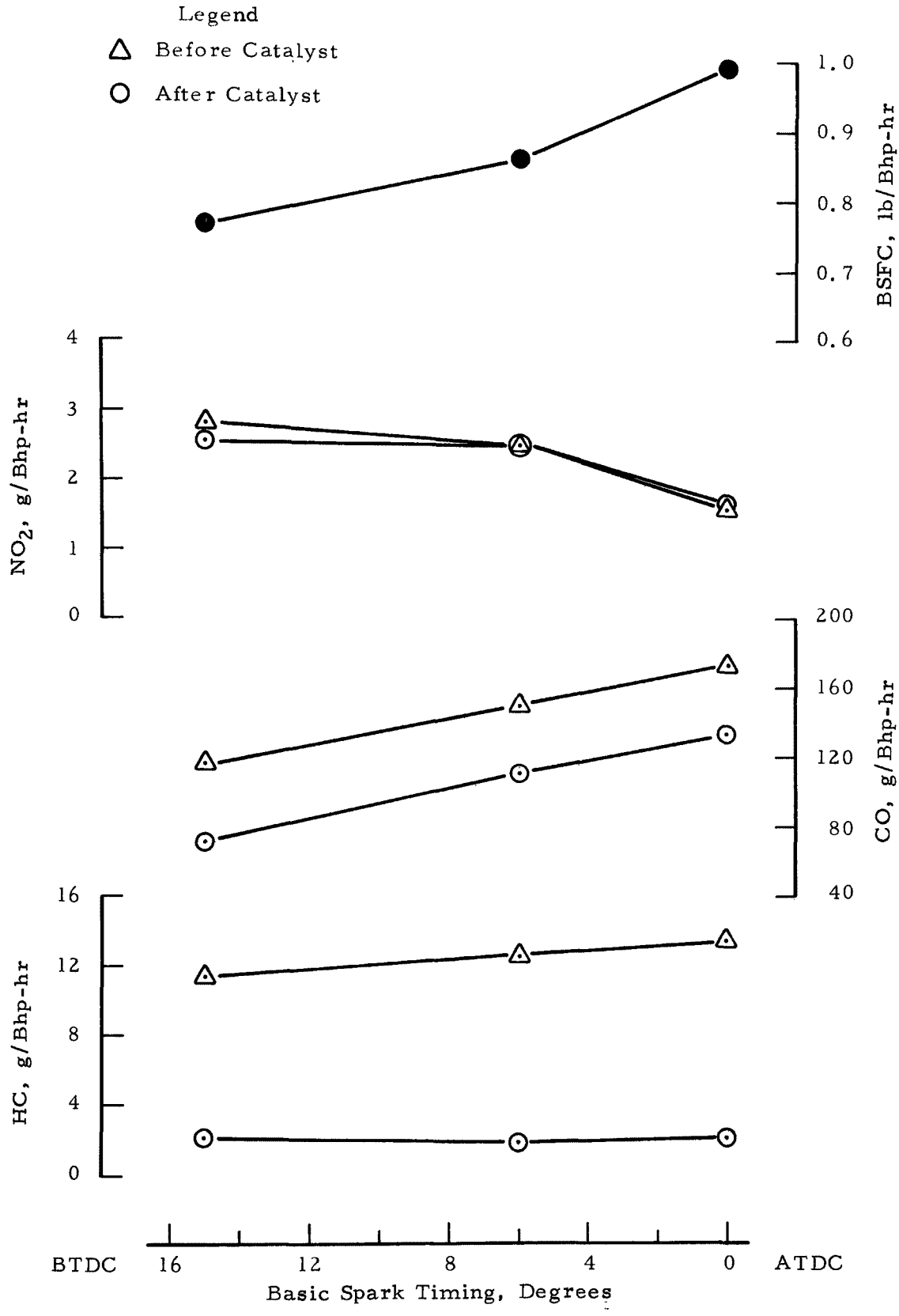


FIGURE 23. EFFECT OF COMBINATION OF HOT EGR (SCH A), OXIDATION CATALYST, MODIFIED AIR INJECTION ON EMISSIONS ENGINE 1-3, 23 MODE TEST

on Table 21. The series of tests with hot EGR versus timing made on 8-29-72 and 8-30-72, are graphed in Appendix V also.

(g) Step 6a - Effect of Best Combination on Emissions

Clearly, a better overall reduction was needed than was found with hot EGR rate Schedule A. Engine 1-3 is extremely sensitive to CO because of a number of factors, one of which is the carburetor action on approaching and operating at wide open throttle. In trying to develop the best compromise, the maximum or top end power should be preserved as much as possible. In this engine, operation at less than two inches Hg intake manifold depression was disasterous on CO in standard or modified condition. Accordingly, Schedule B tailored the EGR to get out of the high CO modes as quickly as possible and, if need be, take the NO_x penalty.

Using Schedule B, also listed on Table 18, fairly good reductions in all emissions were effected and they are shown on Table 22. First, the catalyst did a good job in lowering HC and CO for the best combination as shown by the average before and after results for the three runs made on 9-5 and 9-6, 1972. The resulting HC, CO, NO_2 and aldehydes may be directly compared to the standard, unmodified engine runs made on September 7 and 8, 1972 shown next.

HC was reduced from 8.52 to 1.31 grams per bhp-hr or 85 percent. CO was reduced from 65.9 to 19.2 grams per bhp-hr or 71 percent. NO_x was reduced from 8.34 to 4.09 grams of NO_2 per bhp-hr or 51 percent. Aliphatic aldehydes were also reduced from 0.278 to 0.131 grams of formaldehyde per bhp-hr for a 53 percent change. Cycle weighted brake specific fuel consumption was increased from 0.738 to 0.831 lbs fuel per bhp-hr or 13 percent increase in fuel consumption. In doing so, the "best combination" control strategy reduced top-end power at 2300 rpm from 108 to 95 hp or 12 percent with no effect on power at 1200 rpm.

The data listed on Table 22 is a summary of the individual run results included in Appendix W. In addition to the before and after catalyst "best combination" tabular results, a series of graphs are included that show the average HC, CO, NO_2 intake vacuum, and fuel rate versus power level for 1200 and 2300 rpm. For clarity only, the "best combination" and standard engine results are graphed. The standard engine results are included in Appendix X.

Listed at the bottom on Table 22 are the results of the runs made on August 16, 1972 with the engine in the standard condition prior to the series of tests with control devices, etc. Note the fairly good agreement between the HC, CO, NO_2, power and BSFC between the beginning and ending tests. This indicates the engine did not change or deteriorate materially during the test period. Recall that engine 1-3 used for control technology was modified from that used for baseline testing in that air

TABLE 22. EFFECT OF "BEST COMBINATION" ON EMISSIONS
Engine 1-3, 23-Mode Test

Date	Run	Catalyst	Grams Per bhp-hour HC	CO	NO_2	Alde.	Weighted BSFC	Max. Hp Obs. at 1200	2300
0.056 inch Jets (Standard), Modified Light-Duty Air Injection, Standard Timing (6° BTDC), Hot EGR Per Schedule B									
)-5-72	1	Before	11.77	56.9	3.94	---	0.846	50	95
)-6-72	1	Before	11.08	49.1	3.60	---	0.833	52	95
)-6-72	2	Before	10.89	44.2	4.40	---	0.813	52	95
AVERAGE			11.25	50.1	3.98		0.831	51	95
)-5-72	1	After	1.19	23.1	4.03	0.130	0.846	50	95
)-6-72	1	After	1.34	18.4	3.70	0.135	0.833	52	95
)-6-72	2	After	1.41	16.1	4.53	0.129	0.813	52	95
AVERAGE			1.31	19.2	4.09	0.131	0.831	51	95
Standard Engine with 0.056 Jets and 6° BTDC Timing									
)-7-72	1	None	8.14	70.9	8.27	0.285	0.740	52	108
)-7-72	2	None	9.01	67.2	8.32	0.283	0.736	52	108
)-8-72	3	None	8.41	59.6	8.43	0.265	0.738	52	108
AVERAGE			8.52	65.9	8.34	0.278	0.738	52	108
Previously Run Standard Engine with 0.056 Jets and 6° BTDC Timing									
-16-72	2	None	9.4	71.3	8.7	---	0.720	53	110
-16-72	3	None	8.9	72.8	8.7	---	0.717	53	110
AVERAGE			9.3	72.1	8.7		0.719	53	110

injection cylinder heads and other changes were incorporated.

It was also important to assess the "best combination" control system by the Federal nine-mode test procedure. This was done in a series of tests and expressed in concentration and mass terms on Table 23.

Some fairly respectable reductions in HC, CO and NO concentrations were achieved by the "best combination" relative to the standard engine. HC was reduced from 109.7 ppm to 54.4 ppm n hexane or 50 percent. CO was reduced from 0.44 to 0.06 percent for a 86 percent reduction. NO, corrected, was reduced from 1597 to 624 for a 61 percent improvement. All this was achieved with the standard engine with modified light-duty air injection, an oxidation catalyst, and tailored hot EGR. These levels may be directly compared to the current and proposed Federal limits listed on Table 23.

Only during the higher power modes, the 3 inch and 10 inch intake vacuum levels, was any EGR allowed. The manual control system recirculated 5 percent during the 3 inch conditions and 10 percent of the airflow (mass basis) during the 10 inch mode. All other times, idle, closed throttle, 19 inch and 16 inch, the EGR valve was shut-off.

Table 24 shows a summary of the "best combination" control engine relative to the unmodified engine in terms of grams per bhp-hour using the 1974 Federal Test Procedure calculational method. Note that HC was reduced 48 percent from an average of 3.99 to 2.07 grams per bhp-hour. CO was reduced 85 percent from 24.1 to 3.6 grams per bhp-hour. NO_2 was also reduced by 54 percent from 12.92 to 5.92. $HC+NO_2$ was 7.99 with the controlled engine relative to 16.91 grams per bhp-hour with the standard engine. These levels may be compared with the 1973 California and 1974 Federal standards of 40 grams of CO and 16 grams of $HC+NO_2$ per bhp-hour. Appendix W contains the nine-mode concentration and mass emission results for the engines equipped with the "best combination" of control technology. The results for the two runs made in standard configuration are included as Appendix X. It is interesting to observe the dissimilarity in nine-mode results of engine 1-3 and 2-3. Recall engine 2-3, run with the "best combination" of light-duty air injection, light-duty EGR, oxidation catalyst and standard otherwise was not as effective on the nine-mode test as it was on the 23 mode test. The light-duty EGR valve and its schedule resulted in sufficiently higher HC that could not be reduced by the oxidation catalyst. With engine 1-3, the manual control, laboratory EGR system was not used in those modes of the nine-mode procedure where the reductions in NO_x were outweighed by increases in HC and CO.

Of course, the laboratory EGR with manual control tailored for optimum improvement is nothing more than a laboratory approach, a gadget

TABLE 23. ENGINE 1-3 NINE MODE FTP EMISSION REDUCTIONS (CONCENTRATION BASIS)

Configuration	Date	Runs	Concentrations, Average HC ppm Hex	CO %	NO, ppm Corr
"Best-Combination"	9-1-72 9-5-72	3	54.5	0.06	624
Standard	9-8-72	2	109.7	0.44	1597
Current Federal Limit			275	1.5	none
Proposed Federal Limit			160	0.8	2000

TABLE 24. ENGINE 1-3 NINE MODE FTP EMISSION REDUCTIONS (BRAKE SPECIFIC BASIS)

Configuration	Date	Runs	Grams per bhp-hour, average CO	HC	NO_2	HC + NO_2
"Best Combination"	9-1-72 9-5-72	3	3.6	2.07	5.92	7.99
Standard	9-8-72	2	24.1	3.99	12.92	16.91
1973 California and 1974 Federal Limit			40			16
1975 California Limit			25			5

or means to an end. It demonstrated control possibilities but is, of course, not a proven scheme. No really good idea was obtained about driveability, although the final system could run smoothly in all steady state modes regardless of test schedule. Durability along with driveability for the entire system remains to be demonstrated and, of course, its applicability to engines in general. In defense of the control system, it employed proven oxidation catalysts, light-duty air injection and a fairly simple to automate EGR schedule. No drastic power derating or increase in fuel consumption resulted. The final strategy for both engines 1-3 and 2-3 were almost similar in final design. The only significant difference was in the EGR rate schedule employed. The tailored schedule employed with engine 1-3 was found superior overall for both 23 and nine-mode tests to the light-duty EGR system rates.

Much the same comment regarding advanced or additional control items for study with engine 1-3 can be made as with engine 2-3. The advanced oxidation and oxidation-reduction catalysts, turbochargers, automated EGR valves, fuel injection, etc. were clearly beyond the scope of this project but are not beyond the realm of possibility for effecting even greater reductions than found in this initial project. Such items may effect the same level of control without driveability, fuel and power penalties associated with the currently discussed "best combination". The words "best combination" have always been with quotes because with the fast moving field of emissions technology, this is expected to be short-lived. Another such study is bound to result in a further advance in knowledge and far surpass the performance of the work done so far.

V. SUMMARY AND CONCLUSIONS

The following key points summarize the important findings during this project. Where appropriate, conclusions are presented.

(1) Six 1972 spark-ignited gasoline-fueled engines, three each from two manufacturers, were subjected to a series of baseline exhaust emission tests. The engines included small six cylinder and large V-8 displacement sizes representative of engines popularly used in vehicles rated over 6,000-lb gross vehicle weight. The nine-mode Federal test method, in terms of concentration of hydrocarbons, carbon monoxide, and nitric oxide was performed. The emission results were then converted to mass units of grams of contaminant per bhp-hour using the California ARB procedure for 1973. The latter procedure requires the accurate measurement of flywheel power output and fuel consumption at each mode to permit calculation of brake specific emissions using a carbon balance method.

(2) The six engines were also subjected to an experimental EPA three-speed, multi-load operating schedule which included a much wider variety of operation than the nine-mode procedure. Instrumentation differences must also be accounted for as follows.

(a) The CL method eliminates the troublesome chemical drier used in non-dispersive infrared (NDIR) analysis of nitric oxide and measures both nitric oxide and nitrogen dioxide. It is compatible with the light-duty regulations. There is one drawback and that is removal of the water of combustion from the exhaust sample. Currently an ice trap, which removes on the order of eleven percent of the NO_2, is used but could be eliminated by preparation of a heated CL. On engines evaluated in this and previous projects, NO_2 in raw gasoline engine exhaust has been less than a few percent.

(b) The heated FID method is considered a vast improvement over the NDIR hydrocarbon analyzers used in the Federal nine-mode test. The NDIR method grossly understates exhaust hydrocarbons since they are sensitive to just normal paraffins and an ice trap is employed in the sample system. Although the FID system cannot be considered an absolute or total method, it is substantially better than NDIR and is consistent with the light-duty regulations. There are some slight drawbacks, such as the need for extended purge following a high HC level as occurs during closed throttle operation.

(3) The baseline emissions phase of the project required measurement of oxygenates. The best known method for repetitive samples is the

MBTH method, a wet collected colorimetric procedure that expresses aliphatic aldehydes as formaldehyde. Although the run-to-run repeatability seems satisfactory, the mode-to-mode repeatability was unacceptable. Generally only two of every three demonstrated acceptable ± 20 percent repeatability. The data thus reported must be judged in terms of the method and its precision. Certainly more needs to be done to develop a precise measurement of oxygenates on repetitive samples.

(4) The experimental EPA test method resulted in run-to-run repeatability as good as the nine-mode Federal Test. It is longer and more inclusive and easier to reduce and calculate in terms of a final answer. Precautions must be taken to obtain as accurate power and fuel rate measurements as when measuring exhaust contaminants. Measurement of flywheel power and fuel rate at light loads and lower engine speed is more difficult than at the higher loads and speed.

(5) Engines generally operate on the experimental EPA procedure without problem, although one of the six engines refused to operate at the lower engine speed. The exact selection of engine speeds, power levels, and their respective weighting factors were beyond the scope of this project. These rely on available road data from the operation of vehicles above 6,000-lb GVW. It is difficult to comment on those used in the experimental procedure without substantial additional data.

(6) Two engines, one popular V-8 engine from each group of three, were selected for evaluation of emission control technology. This phase of the study, intended to rely mostly on manufacturer's data and items developed for engines in heavy duty operation, was limited to factory-furnished light-duty items such as air injection (both engines) and EGR (one engine). This was supplemented by SwRI with a commercially-available platinum-type oxidation catalyst reactor and a laboratory manually-controlled EGR system. In addition to a study of these devices, the effect of basic spark timing and carburetor main jet size (air-fuel ratio) was studied. All these were studied singly and in combination to determine emission reduction. The goal was to obtain gross reductions in HC, CO and NO_x without an increase in fuel consumption nor decrease in power available.

(7) Gross reductions with the first engine exhaust emissions were achieved based on the experimental EPA test schedule. Hydrocarbons were reduced by 70 percent, carbon monoxide by 68 percent, oxides of nitrogen were lowered by 30 percent and oxygenates were reduced by 58 percent. Fuel consumption, in terms of weighted brake specific fuel consumption, was increased by 7.4 percent while maximum power was unchanged. Factory light-duty EGR and air injection, standard 1972 engine trim, and basic spark timing were retained. A commercially-available platinum-type oxidation catalyst played a key role in effecting the HC and CO reductions. Driveability and durability aspects have not been specifically determined, though

all the components have been proven in light-duty service. The platinum catalyst depends on lead-free gasoline for operation. Driveability should not be any more affected than light-duty vehicles with the same equipment, though this has yet to be established in a truck.

(8) Operating the first control-equipped engine on the Federal nine-mode procedure failed to give the same degree of emissions control as with the 23-mode EPA procedure. Relative to the experimental procedure, the nine-mode tended to understate the HC and overstate the CO and NO_x. For example, the 70 percent reduction in HC by the 23 mode test may be compared to no change in HC by the nine-mode test. A similar level of reduction in CO by the 23-mode test was found to give about a 90 percent CO reduction by the nine mode. NO_x, reduced 30 percent based on 23-mode data, was reduced by almost 60 percent. The light-duty EGR schedule, creating excessive HC, and the inability of the catalyst to reduce HC during the 19- and 16-inch modes is felt to be the major reason. Had the control-equipped engine been experimented with on the nine-mode schedule, a different combination of control devices would have been used in the 19- and 16-inch intake vacuum modes. From this it may be concluded that the type of test procedure can influence the design and development of an emissions control strategy.

(9) Based on the experimental EPA test procedure, HC was reduced by 85 percent, CO by 71 percent, NO_x by 51 percent and oxygenates by 53 percent with the second engine studied. The engine was operated with standard 1972 trim (carburetor, distributor and basic spark timing), but with light-duty air injection system. The air injection vacuum operation distribution valve was replaced with a simple pipe "Tee" and the same platinum-type commercially-available oxidation catalysts employed. Since no light-duty or heavy-duty EGR system was available from the manufacturer, a manually-controlled laboratory EGR system was employed. An EGR schedule was tailored to minimize NO_x while not seriously affecting HC, CO, power, and fuel consumption. These reductions had penalties in top-end performance at 2300 rpm (13 hp or 12 percent) with no loss in power at 1200 rpm. Weighted brake specific fuel consumption was increased by 13 percent. As with the first engine studied, no assessment of driveability or durability can be given. These were laboratory studies confined to engines operated on stationary dynamometers under constant speed-load engine "mapping"-type conditions.

(10) Operation of the second control-equipped engine on the nine-mode Federal schedule involved re-tailoring the EGR so that five percent was recirculated in the 3-inch mode and ten percent was recirculated in the 10-inch mode. No EGR was used at any other mode and the HC, CO, and NO_x reductions were on the same order of magnitude as obtained on the 23-mode test. The key to this was modifying the EGR schedule specifically for the nine-mode test. The oxidation catalyst seemed to do a better job on HC from this engine than on the first engine. The catalyst supplier

indicated that this was not surprising since the catalyst will preferentially accelerate oxidation of the olefins, aromatics, and certain paraffinic hydrocarbons.

(11) The objectives of the six engine baseline study were achieved and the merits of the experimental test procedure demonstrated. Likewise, the goals of the two engine control technology assessment portion of the project were met in that gross reductions in exhaust emissions were demonstrated. The substantial reductions did not come without a known fuel consumption penalty and an unknown driveability and durability penalty. Only two engines were involved in this limited assessment and much caution must be taken in control technology potentialities of all engines. It is generally true that each manufacturer's engine and even different displacements of a given make will respond differently to emission control strategies. However, limited laboratory demonstration has been made of control potentialities.

VI. RECOMMENDATIONS

This project must be termed a success since substantial reductions in emissions were demonstrated even though limited to three months of laboratory work, two months on one engine and one month on the other.

There were many items uncovered or made known during the last few months that could not be included in this time and fund-limited project. Advanced oxidation catalysts, newly announced oxidation-reduction catalysts, improved exhaust recirculation valves and control modules, turbochargers, to name a few, are still waiting to be considered in depth. And, the hurried nature of the tests conducted under this project could stand some replication and refinement as well as demonstration with additional engine makes and sizes. For example, the light-duty EGR system on one engine reduced NO_x, but more could have been achieved using a schedule tailored for the heavy-duty test procedure.

It is recommended that consideration be given to a long range project to continue research and development on a long term planned basis of control technology for heavy-duty gasoline engines. The intent of such a project would not be to do the manufacturer's job for him, but to demonstrate proof of principle and to evaluate the state of the art. In a way, the effort could act to provide stimulation to the engine manufacturers and those who manufacture control equipment. Those advantages would accrue in addition to the basic objective, namely, determine potential ways to reduce emissions from heavy-duty engines. In closing, the work reported herein represents a good start on what should be a long-range program.

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APPENDIX A

EMISSION RESULTS FROM ENGINE 2-1

TABULAR FORM

ENGINE 2-1

NINE MODE FTP EMISSION RESULTS

CONCENTRATION BASIS

3-06-72 ENGINE 2-1 RUN 1 K = .933 HUM = 58 GR/LB

	FEDERAL MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
	1 IDLE	119	2.415	12.630	117	1.038	124	2.507	121	.036	4.448	.090	4.373
	2 16'HG	90	.185	13.950	2252	1.025	92	.190	2309	.089	8.214	.017	205.535
	3 10'HG	30	.143	13.350	2084	1.078	32	.154	2246	.257	8.309	.040	577.232
	4 16'HG	80	.239	13.950	2306	1.024	82	.245	2362	.089	7.293	.022	210.223
	5 19'HG	70	.513	14.070	891	1.007	70	.516	897	.047	3.312	.024	42.162
	6 16'HG	78	.191	13.950	2378	1.026	80	.196	2440	.089	7.124	.017	217.188
	7 3'HG	39	.500	13.740	2263	1.033	40	.517	2338	.283	11.405	.146	661.783
	8 16'HG	76	.264	14.010	2414	1.019	77	.269	2461	.089	6.895	.024	219.014
	9 C.T.	980	.335	6.210	72	1.950	1911	.653	140	.021	40.131	.014	2.948
	SUM----------(CYCLE COMPOSITE)----------										97.132	.394	2140.458
CYCLE 2													
	1 IDLE	119	2.415	12.630	117	1.038	124	2.507	121	.036	4.448	.090	4.373
	2 16'HG	83	.187	13.980	2263	1.024	85	.191	2317	.089	7.563	.017	206.197
	3 10'HG	28	.143	13.460	2150	1.069	30	.153	2299	.257	7.694	.039	590.778
	4 16'HG	75	.208	13.980	2428	1.024	77	.213	2485	.089	6.833	.019	221.203
	5 19'HG	74	.588	14.110	943	1.001	74	.589	944	.047	3.482	.028	44.370
	6 16'HG	78	.205	13.470	2419	1.024	80	.210	2478	.089	7.110	.019	220.511
	7 3'HG	40	.612	13.790	2294	1.026	41	.628	2353	.283	11.609	.178	665.768
	8 16'HG	78	.225	13.990	2456	1.022	80	.230	2510	.089	7.095	.020	223.411
	9 C.T.	1010	.261	6.590	85	1.856	1875	.484	158	.021	39.372	.010	3.313
	SUM----------(CYCLE COMPOSITE)----------										95.205	.420	2179.924
CYCLE 3													
	1 IDLE	54	.170	13.310	111	1.078	58	.183	120	.036	2.095	.007	4.307
	2 16'HG	84	.189	13.920	2267	1.028	86	.194	2330	.089	7.685	.017	207.410
	3 10'HG	20	.144	13.300	2110	1.083	22	.156	2284	.257	5.565	.040	587.065
	4 16'HG	75	.188	13.940	2406	1.027	77	.193	2472	.089	6.857	.017	219.975
	5 19'HG	73	.517	14.020	940	1.010	74	.522	949	.047	3.465	.025	44.619
	6 16'HG	62	.205	13.920	2414	1.029	64	.211	2484	.089	5.679	.019	221.106
	7 3'HG	40	.562	13.670	2328	1.036	41	.582	2412	.283	11.729	.165	682.636
	8 16'HG	70	.217	13.840	2415	1.034	72	.224	2497	.089	6.441	.020	222.229
	9 C.T.	934	.292	6.980	97	1.782	1665	.520	173	.021	34.962	.011	3.631
	SUM----------(CYCLE COMPOSITE)----------										84.478	.320	2192.978
CYCLE 4													
	1 IDLE	54	.170	13.310	111	1.078	58	.183	120	.036	2.095	.007	4.307
	2 16'HG	85	.176	13.880	2398	1.031	88	.182	2473	.089	7.802	.016	220.104
	3 10'HG	26	.147	13.260	2134	1.085	28	.160	2316	.257	7.251	.041	595.165
	4 16'HG	71	.195	13.800	2354	1.038	74	.202	2443	.089	6.557	.018	217.389
	5 19'HG	70	.461	13.990	1016	1.014	71	.468	1030	.047	3.337	.022	48.433
	6 16'HG	77	.186	13.900	2370	1.030	79	.192	2441	.089	7.059	.017	217.281
	7 3'HG	39	.595	13.720	2329	1.031	40	.614	2402	.283	11.383	.174	679.752
	8 16'HG	73	.222	13.980	2475	1.023	75	.227	2533	.089	6.648	.020	225.407
	9 C.T.	974	.258	6.740	94	1.831	1783	.472	172	.021	37.443	.010	3.614
	SUM----------(CYCLE COMPOSITE)----------										89.576	.325	2211.453
	AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------										96.169	.407	2160.191
	AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------										87.027	.322	2202.215

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(96.169) + 0.65*(87.027) =	90.226	PPM
CO	0.35*(.407) + 0.65*(.322) =	.352	PERCENT
NO	0.35*(2160.191) + 0.65*(2202.215) =	2187.507	PPM
	CORRECTED NO =	2040.536	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

3-06-72 ENGINE 2-1 RUN 2 K = .974 HUM = 68 GR/LB

	FEDERAL MODE	CONCENTRATION HC	CO	AS CO2	MEASURED NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHED HC	CO	NO
CYCLE 1													
	1 IDLE	81	.167	13.650	97	1.049	85	.175	102	.036	3.059	.006	3.664
	2 16'HG	86	.152	14.140	2018	1.013	87	.154	2045	.089	7.756	.014	182.001
	3 10'HG	32	.130	13.440	1885	1.071	34	.139	2019	.257	8.807	.036	518.810
	4 16'HG	78	.164	14.160	2215	1.012	79	.166	2242	.089	7.026	.015	199.526
	5 19'HG	76	.432	14.360	876	.989	75	.427	867	.047	3.533	.020	40.728
	6 16'HG	83	.168	13.990	2226	1.024	85	.172	2279	.089	7.562	.015	202.819
	7 3'HG	48	.562	13.900	2144	1.019	49	.573	2184	.283	13.839	.162	618.141
	8 16'HG	73	.185	14.070	2281	1.018	74	.188	2322	.089	6.615	.017	206.696
	9 C.T.	978	.233	6.400	81	1.915	1873	.446	155	.021	39.325	.009	3.257
	SUM----------(CYCLE COMPOSITE)----------										97.524	.294	1975.641
CYCLE 2													
	1 IDLE	81	.167	13.650	97	1.049	85	.175	102	.036	3.059	.006	3.664
	2 16'HG	88	.146	13.990	2104	1.024	90	.150	2155	.089	8.021	.013	191.779
	3 10'HG	29	.139	13.440	1961	1.071	31	.149	2100	.257	7.981	.038	539.677
	4 16'HG	73	.170	13.990	2193	1.024	75	.174	2247	.089	6.656	.016	199.950
	5 19'HG	75	.439	14.140	813	1.004	75	.441	816	.047	3.540	.021	38.368
	6 16'HG	76	.180	13.790	2188	1.039	79	.187	2272	.089	7.025	.017	202.234
	7 3'HG	44	.571	13.770	2197	1.028	45	.587	2259	.283	12.803	.166	639.252
	8 16'HG	76	.189	13.930	2255	1.028	78	.194	2318	.089	6.953	.017	206.292
	9 C.T.	924	.219	6.310	89	1.955	1806	.428	174	.021	37.932	.009	3.654
	SUM----------(CYCLE COMPOSITE)----------										93.969	.303	2024.871
CYCLE 3													
	1 IDLE	55	.155	13.320	101	1.078	59	.167	109	.036	2.133	.006	3.918
	2 16'HG	83	.149	13.870	2156	1.033	86	.154	2228	.089	7.632	.014	198.254
	3 10'HG	36	.139	13.250	1960	1.085	39	.151	2128	.257	10.043	.039	546.768
	4 16'HG	82	.179	13.920	2263	1.029	84	.184	2328	.089	7.506	.016	207.149
	5 19'HG	83	.545	14.060	885	1.005	83	.548	890	.047	3.922	.026	41.820
	6 16'HG	83	.155	13.780	2254	1.040	86	.161	2343	.089	7.680	.014	208.558
	7 3'HG	47	.494	13.670	2201	1.038	49	.513	2285	.283	13.808	.145	646.618
	8 16'HG	73	.176	13.820	2301	1.037	76	.182	2385	.089	6.735	.016	212.302
	9 C.T.	902	.214	6.140	95	2.008	1811	.430	191	.021	38.035	.009	4.006
	SUM----------(CYCLE COMPOSITE)----------										97.495	.285	2069.393
CYCLE 4													
	1 IDLE	55	.155	13.320	101	1.078	59	.167	109	.036	2.133	.006	3.918
	2 16'HG	73	.163	13.640	2210	1.051	77	.171	2322	.089	6.826	.015	206.662
	3 10'HG	27	.137	13.040	1936	1.104	30	.151	2137	.257	7.659	.039	549.147
	4 16'HG	69	.151	13.630	2270	1.052	73	.159	2389	.089	6.462	.014	212.586
	5 19'HG	76	.443	13.920	876	1.019	77	.452	893	.047	3.641	.021	41.972
	6 16'HG	67	.152	13.720	2244	1.046	70	.159	2346	.089	6.235	.014	208.812
	7 3'HG	45	.532	13.560	2188	1.045	47	.556	2287	.283	13.309	.157	647.115
	8 16'HG	74	.173	13.720	2339	1.044	77	.181	2442	.089	6.877	.016	217.369
	9 C.T.	931	.222	6.350	103	1.942	1808	.431	200	.021	37.968	.009	4.201
	SUM----------(CYCLE COMPOSITE)----------										91.111	.292	2091.781

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 95.746 .299 2000.256

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 94.303 .289 2080.587

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(95.746) + 0.65*(94.303) =	94.808	PPM
CO	0.35*(.299) + 0.65*(.289) =	.292	PERCENT
NO	0.35*(2000.256) + 0.65*(2080.587) =	2052.471	PPM
	CORRECTED NO =	1998.158	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

3-06-72 ENGINE 2-1 RUN 3 K = .981 HUM = 70 GR/LB

	FEDERAL MODE	CONCENTRATION HC	CO	AS CO2	MEASURED NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
	1 IDLE	47	.151	13.900	95	1.034	49	.156	98	.036	1.749	.006	3.536
	2 16'HG	75	.149	14.250	2103	1.007	75	.150	2117	.089	6.719	.013	188.395
	3 10'HG	27	.135	13.740	1992	1.048	28	.141	2087	.257	7.272	.036	536.487
	4 16'HG	66	.170	14.320	2242	1.002	66	.170	2246	.089	5.884	.015	199.865
	5 19'HG	73	.437	14.470	916	.982	72	.429	899	.047	3.369	.020	42.273
	6 16'HG	73	.185	14.320	2262	1.001	73	.185	2263	.089	6.501	.016	201.438
	7 3'HG	43	.570	14.210	2244	.997	43	.568	2238	.283	12.134	.161	633.242
	8 16'HG	74	.202	14.380	2363	.996	74	.201	2353	.089	6.558	.018	209.427
	9 C.T.	522	.214	6.690	130	1.970	1028	.422	256	.021	21.594	.009	5.378
	SUM----------(CYCLE COMPOSITE)----------										71.780	.295	2020.040
CYCLE 2													
	1 IDLE	47	.151	13.900	95	1.034	49	.156	98	.036	1.749	.006	3.536
	2 16'HG	83	.171	14.290	2268	1.002	83	.171	2273	.089	7.405	.015	202.338
	3 10'HG	22	.134	13.650	2027	1.055	23	.141	2139	.257	5.966	.036	549.723
	4 16'HG	68	.173	14.060	2304	1.020	69	.176	2349	.089	6.171	.016	209.095
	5 19'HG	76	.465	14.340	946	.989	75	.460	936	.047	3.534	.022	43.993
	6 16'HG	67	.165	14.200	2328	1.010	68	.167	2352	.089	6.023	.015	209.287
	7 3'HG	43	.604	14.150	2215	1.000	43	.604	2215	.283	12.170	.171	626.912
	8 16'HG	70	.204	14.260	2368	1.004	70	.205	2378	.089	6.257	.018	211.663
	9 C.T.	642	.249	5.820	91	2.184	1402	.544	199	.021	29.451	.011	4.174
	SUM----------(CYCLE COMPOSITE)----------										78.727	.310	2060.721
CYCLE 3													
	1 IDLE	49	.176	13.490	104	1.064	52	.187	111	.036	1.876	.007	3.983
	2 16'HG	87	.169	14.090	2286	1.016	88	.172	2323	.089	7.869	.015	206.756
	3 10'HG	29	.138	13.510	2102	1.065	31	.147	2239	.257	7.940	.038	575.527
	4 16'HG	70	.165	14.060	2355	1.020	71	.168	2402	.089	6.354	.015	213.751
	5 19'HG	70	.420	14.310	949	.993	70	.417	943	.047	3.268	.020	44.311
	6 16'HG	78	.183	14.170	2318	1.011	79	.185	2343	.089	7.017	.016	208.520
	7 3'HG	35	.489	13.980	2173	1.017	36	.497	2209	.283	10.070	.141	625.208
	8 16'HG	62	.163	14.090	2284	1.018	63	.166	2326	.089	5.619	.015	207.010
	9 C.T.	704	.203	6.740	115	1.907	1343	.387	219	.021	28.200	.008	4.606
	SUM----------(CYCLE COMPOSITE)----------										78.213	.274	2089.671
CYCLE 4													
	1 IDLE	49	.176	13.490	104	1.064	52	.187	111	.036	1.876	.007	3.983
	2 16'HG	79	.168	13.950	2162	1.027	81	.173	2220	.089	7.221	.015	197.606
	3 10'HG	30	.138	13.200	2027	1.090	33	.150	2210	.257	8.405	.039	567.881
	4 16'HG	73	.163	13.890	2282	1.032	75	.168	2355	.089	6.705	.015	209.598
	5 19'HG	72	.458	14.130	825	1.004	72	.460	829	.047	3.399	.022	38.945
	6 16'HG	71	.159	13.780	2306	1.040	74	.165	2399	.089	6.575	.015	213.537
	7 3'HG	40	.551	13.820	2188	1.026	41	.565	2244	.283	11.609	.160	635.027
	8 16'HG	73	.202	14.040	2359	1.020	74	.206	2405	.089	6.625	.018	214.087
	9 C.T.	754	.198	6.010	94	2.094	1579	.415	197	.021	33.162	.009	4.134
	SUM----------(CYCLE COMPOSITE)----------										85.577	.299	2084.799

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 75.253 .302 2040.381

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 81.895 .287 2087.235

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(75.253) + 0.65*(81.895) =	79.570	PPM
CO	0.35*(.302) + 0.65*(.287) =	.292	PERCENT
NO	0.35*(2040.381) + 0.65*(2087.235) =	2070.836	PPM
	CORRECTED NO =	2032.029	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

ENGINE 2-1

NINE MODE FTP EMISSION RESULTS

BRAKE SPECIFIC BASIS

3-06-72 ENGINE 2-1 RUN 1 K = .94 HUM = 58 GR/LB

MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1														
1 IDLE	119	2.415	12.63	117	15.174	1639	14	527	4	.232	3.2	122	1.0	0
2 16 HG	90	.185	13.95	2252	14.232	5970	41	157	314	.077	3.1	12	24.1	18
3 10 HG	30	.143	13.35	2084	13.525	8626	21	184	441	.147	3.0	27	64.9	32
4 16 HG	80	.239	13.95	2306	14.275	5970	36	202	320	.077	2.8	16	24.7	18
5 19 HG	70	.513	14.07	891	14.659	4622	24	327	93	.057	1.4	19	5.3	8
6 16 HG	78	.191	13.95	2378	14.225	5970	35	162	331	.077	2.7	12	25.5	18
7 3 HG	39	.500	13.74	2263	14.282	12848	38	909	676	.113	4.3	103	76.4	50
8 16 HG	76	.264	14.01	2414	14.356	5970	34	222	333	.077	2.6	17	25.7	18
9 C.T.	980	.335	6.21	72	7.603	1732	241	154	5	.143	34.5	22	.8	0
SUM----------(CYCLE COMPOSITE)----------											3.5	21	15.2	
CYCLE 2														
1 IDLE	119	2.415	12.63	117	15.174	1639	14	527	4	.232	3.2	122	1.0	0
2 16 HG	83	.187	13.98	2263	14.257	5970	38	158	315	.077	2.9	12	24.2	18
3 10 HG	28	.143	13.46	2150	13.633	8626	19	183	452	.147	2.8	27	66.4	32
4 16 HG	75	.208	13.98	2428	14.269	5970	34	176	337	.077	2.6	14	26.0	18
5 19 HG	74	.588	14.11	943	14.778	4622	25	371	98	.057	1.4	21	5.6	8
6 16 HG	78	.205	13.97	2419	14.259	5970	35	173	336	.077	2.7	13	25.9	18
7 3 HG	40	.612	13.79	2294	14.445	12848	38	1100	677	.113	4.3	124	76.5	50
8 16 HG	78	.225	13.99	2456	14.299	5970	35	190	340	.077	2.7	15	26.2	18
9 C.T.	1010	.261	6.59	85	7.942	1732	238	115	6	.143	34.0	16	.9	0
SUM----------(CYCLE COMPOSITE)----------											3.5	22	15.5	
CYCLE 3														
1 IDLE	54	.170	13.31	111	13.538	1639	7	42	4	.232	1.6	10	1.0	0
2 16 HG	84	.189	13.92	2267	14.200	5970	38	161	316	.077	2.9	12	24.4	18
3 10 HG	20	.144	13.30	2110	13.466	8626	14	186	449	.147	2.0	27	66.0	32
4 16 HG	75	.188	13.94	2406	14.209	5970	34	160	336	.077	2.6	12	25.8	18
5 19 HG	73	.517	14.02	940	14.616	4622	25	330	99	.057	1.4	19	5.6	8
6 16 HG	62	.205	13.92	2414	14.192	5970	28	174	337	.077	2.2	13	26.0	18
7 3 HG	40	.562	13.67	2328	14.275	12848	39	1022	696	.113	4.4	115	78.6	50
8 16 HG	70	.217	13.84	2415	14.133	5970	32	185	339	.077	2.5	14	26.1	18
9 C.T.	934	.292	6.98	97	8.281	1732	211	123	7	.143	30.2	18	1.0	0
SUM----------(CYCLE COMPOSITE)----------											3.1	15	15.6	
CYCLE 4														
1 IDLE	54	.170	13.31	111	13.538	1639	7	42	4	.232	1.6	10	1.0	0
2 16 HG	85	.176	13.88	2398	14.148	5970	39	150	336	.077	3.0	12	25.9	18
3 10 HG	26	.147	13.26	2134	13.435	8626	18	191	455	.147	2.7	28	66.9	32
4 16 HG	71	.195	13.80	2354	14.072	5970	33	167	332	.077	2.5	13	25.5	18
5 19 HG	70	.461	13.99	1016	14.527	4622	24	296	107	.057	1.4	17	6.1	8
6 16 HG	77	.186	13.90	2370	14.169	5970	35	158	332	.077	2.7	12	25.5	18
7 3 HG	39	.595	13.72	2329	14.357	12848	38	1076	692	.113	4.3	122	78.2	50
8 16 HG	73	.222	13.98	2475	14.281	5970	33	187	344	.077	2.5	14	26.5	18
9 C.T.	974	.258	6.74	94	8.050	1732	226	112	7	.143	32.4	16	1.0	0
SUM----------(CYCLE COMPOSITE)----------											3.3	15	15.8	

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 3.5 22 15.4

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 3.2 15 15.7

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(3.5) + 0.65(3.2) = 3.281 (MASS)
CO 0.35(22) + 0.65(15) = 17.3 (MASS)
NO2 0.35(15.4) + 0.65(15.7) = 15.579 (MASS)
CORRECTED NO2 = 14.623 (MASS)

3-06-72 ENGINE 2-1 RUN 2 K = .98 HUM = 68 GR/LB

MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1														
1 IDLE	81	.167	13.65	97	13.904	1639	10	40	4	.232	2.4	9	.9	0
2 16 HG	86	.152	14.14	2018	14.385	5970	39	127	278	.077	3.0	10	21.4	18
3 10 HG	32	.130	13.44	1885	13.605	8626	22	167	397	.147	3.2	24	58.3	32
4 16 HG	78	.164	14.16	2215	14.408	5970	35	137	305	.077	2.7	11	23.5	18
5 19 HG	76	.432	14.36	876	14.874	4622	26	271	90	.057	1.5	15	5.2	8
6 16 HG	83	.168	13.99	2226	14.248	5970	38	142	310	.077	2.9	11	23.8	18
7 3 HG	48	.562	13.90	2144	14.514	12848	46	1005	630	.113	5.2	114	71.2	50
8 16 HG	73	.185	14.07	2281	14.334	5970	33	156	315	.077	2.5	12	24.3	18
9 C.T.	978	.233	6.40	81	7.689	1732	238	106	6	.143	34.0	15	.9	0
SUM----------(CYCLE COMPOSITE)----------											3.5	14	14.1	
CYCLE 2														
1 IDLE	81	.167	13.65	97	13.904	1639	10	40	4	.232	2.4	9	.9	0
2 16 HG	88	.146	13.99	2104	14.231	5970	40	124	293	.077	3.1	10	22.6	18
3 10 HG	29	.139	13.44	1961	13.610	8626	20	178	413	.147	2.9	26	60.7	32
4 16 HG	73	.170	13.99	2193	14.239	5970	33	144	305	.077	2.5	11	23.5	18
5 19 HG	75	.439	14.14	813	14.660	4622	26	280	85	.057	1.5	16	4.9	8
6 16 HG	76	.180	13.79	2188	14.052	5970	35	154	309	.077	2.7	12	23.8	18
7 3 HG	44	.571	13.77	2197	14.389	12848	42	1030	651	.113	4.8	116	73.6	50
8 16 HG	76	.189	13.93	2255	14.201	5970	35	160	315	.077	2.7	12	24.2	18
9 C.T.	924	.219	6.31	89	7.527	1732	230	102	7	.143	32.8	15	1.0	0
SUM----------(CYCLE COMPOSITE)----------											3.4	14	14.4	
CYCLE 3														
1 IDLE	55	.155	13.32	101	13.534	1639	7	38	4	.232	1.7	9	.9	0
2 16 HG	83	.149	13.87	2156	14.109	5970	38	127	303	.077	2.9	10	23.3	18
3 10 HG	36	.139	13.25	1960	13.428	8626	25	180	418	.147	3.7	27	61.4	32
4 16 HG	82	.179	13.92	2263	14.188	5970	37	152	316	.077	2.9	12	24.3	18
5 19 HG	83	.545	14.06	885	14.695	4622	28	346	92	.057	1.6	20	5.3	8
6 16 HG	83	.155	13.78	2254	14.025	5970	38	133	319	.077	2.9	10	24.5	18
7 3 HG	47	.494	13.67	2201	14.215	12848	46	902	660	.113	5.2	102	74.6	50
8 16 HG	73	.176	13.82	2301	14.075	5970	33	151	324	.077	2.6	12	25.0	18
9 C.T.	902	.214	6.14	95	7.328	1732	230	102	7	.143	32.9	15	1.1	0
SUM----------(CYCLE COMPOSITE)----------											3.5	13	14.8	
CYCLE 4														
1 IDLE	55	.155	13.32	101	13.534	1639	7	38	4	.232	1.7	9	.9	0
2 16 HG	73	.163	13.64	2210	13.882	5970	34	142	316	.077	2.6	11	24.3	18
3 10 HG	27	.137	13.04	1936	13.206	8626	19	181	420	.147	2.8	27	61.7	32
4 16 HG	69	.151	13.63	2270	13.856	5970	32	131	325	.077	2.5	10	25.0	18
5 19 HG	76	.443	13.92	876	14.445	4622	26	286	93	.057	1.5	16	5.3	8
6 16 HG	67	.152	13.72	2244	13.944	5970	31	131	319	.077	2.4	10	24.6	18
7 3 HG	45	.532	13.56	2188	14.141	12848	44	976	660	.113	5.0	110	74.6	50
8 16 HG	74	.173	13.72	2339	13.973	5970	34	149	332	.077	2.6	11	25.5	18
9 C.T.	931	.222	6.35	103	7.577	1732	230	103	8	.143	32.9	15	1.1	0
SUM----------(CYCLE COMPOSITE)----------											3.3	13	14.9	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------											3.5	14	14.3	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------											3.4	13	14.8	

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(3.5) + 0.65(3.4) = 3.411 (MASS)
CO 0.35(14) + 0.65(13) = 13.5 (MASS)
NO2 0.35(14.3) + 0.65(14.8) = 14.639 (MASS)
CORRECTED NO2 = 14.289 (MASS)

3-06-72 ENGINE 2-1 RUN 3 K = .98 HUM = 70 GR/LB

	MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1															
	1 IDLE	47	.151	13.90	95	14.102	1639	6	35	4	.232	1.4	8	.9	0
	2 16 HG	75	.149	14.25	2103	14.480	5970	33	124	288	.077	2.6	10	22.2	18
	3 10 HG	27	.135	13.74	1992	13.904	8626	18	169	410	.147	2.7	25	60.3	32
	4 16 HG	66	.170	14.32	2242	14.561	5970	29	141	305	.077	2.3	11	23.5	18
	5 19 HG	73	.437	14.47	916	14.986	4622	24	272	94	.057	1.4	16	5.3	8
	6 16 HG	73	.185	14.32	2262	14.584	5970	32	153	307	.077	2.5	12	23.7	18
	7 3 HG	43	.570	14.21	2244	14.826	12848	40	998	646	.113	4.5	113	73.0	50
	8 16 HG	74	.202	14.38	2363	14.662	5970	33	166	319	.077	2.5	13	24.6	18
	9 C.T.	522	.214	6.69	130	7.468	1732	131	100	10	.143	18.7	14	1.4	0
	SUM----------(CYCLE COMPOSITE)----------											2.4	14	14.4	
CYCLE 2															
	1 IDLE	47	.151	13.90	95	14.102	1639	6	35	4	.232	1.4	8	.9	0
	2 16 HG	83	.171	14.29	2268	14.551	5970	37	142	309	.077	2.8	11	23.8	18
	3 10 HG	22	.134	13.65	2027	13.808	8626	15	169	420	.147	2.2	25	61.8	32
	4 16 HG	68	.173	14.06	2304	14.306	5970	31	146	319	.077	2.4	11	24.6	18
	5 19 HG	76	.465	14.34	946	14.887	4622	25	292	98	.057	1.5	17	5.6	8
	6 16 HG	67	.165	14.20	2328	14.437	5970	30	138	320	.077	2.3	11	24.6	18
	7 3 HG	43	.604	14.15	2215	14.800	12848	40	1059	638	.113	4.6	120	72.1	50
	8 16 HG	70	.204	14.26	2368	14.540	5970	31	169	323	.077	2.4	13	24.9	18
	9 C.T.	642	.249	5.82	91	6.762	1732	178	129	8	.143	25.4	18	1.1	0
	SUM----------(CYCLE COMPOSITE)----------											2.8	14	14.7	
CYCLE 3															
	1 IDLE	49	.176	13.49	104	13.719	1639	6	42	4	.232	1.5	10	1.0	0
	2 16 HG	87	.169	14.09	2286	14.353	5970	39	142	316	.077	3.0	11	24.3	18
	3 10 HG	29	.138	13.51	2102	13.679	8626	20	176	440	.147	2.9	26	64.7	32
	4 16 HG	70	.165	14.06	2355	14.301	5970	32	139	326	.077	2.4	11	25.1	18
	5 19 HG	70	.420	14.31	949	14.806	4622	24	265	98	.057	1.3	15	5.6	8
	6 16 HG	78	.183	14.17	2318	14.437	5970	35	153	318	.077	2.7	12	24.5	18
	7 3 HG	35	.489	13.98	2173	14.507	12848	33	875	639	.113	3.8	99	72.2	50
	8 16 HG	62	.163	14.09	2284	14.320	5970	28	137	316	.077	2.1	11	24.3	18
	9 C.T.	704	.203	6.74	115	7.703	1732	171	92	9	.143	24.4	13	1.2	0
	SUM----------(CYCLE COMPOSITE)----------											2.7	13	14.9	
CYCLE 4															
	1 IDLE	49	.176	13.49	104	13.719	1639	6	42	4	.232	1.5	10	1.0	0
	2 16 HG	79	.168	13.95	2162	14.203	5970	36	143	302	.077	2.8	11	23.2	18
	3 10 HG	30	.138	13.20	2027	13.370	8626	21	180	434	.147	3.1	26	63.8	32
	4 16 HG	73	.163	13.89	2282	14.132	5970	33	139	320	.077	2.6	11	24.6	18
	5 19 HG	72	.458	14.13	825	14.666	4622	25	292	86	.057	1.4	17	4.9	8
	6 16 HG	71	.159	13.78	2306	14.016	5970	33	137	326	.077	2.5	11	25.1	18
	7 3 HG	40	.551	13.82	2188	14.414	12848	39	992	647	.113	4.4	112	73.2	50
	8 16 HG	73	.202	14.04	2359	14.321	5970	33	170	326	.077	2.5	13	25.1	18
	9 C.T.	754	.198	6.01	94	7.022	1732	201	99	8	.143	28.7	14	1.1	0
	SUM----------(CYCLE COMPOSITE)----------											3.0	14	14.9	
	AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------											2.6	14	14.6	
	AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------											2.9	13	14.9	

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(2.6) + 0.65(2.9) = 2.763 (MASS)
CO 0.35(14) + 0.65(13) = 13.5 (MASS)
NO2 0.35(14.6) + 0.65(14.9) = 14.773 (MASS)
CORRECTED NO2 = 14.522 (MASS)

ENGINE 2-1

EXPERIMENTAL 23 MODE EMISSION RESULTS

BRAKE SPECIFIC BASIS

PROJECT 11-2877-01 CONTROL TECHNOLOGY

3-08-72 RUN 2 ENGINE 2-1 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL RATE LB/HR	FUEL RATE GM/HR	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	700	0.0	0	17.5	4.0	1810	0	682	.130	12.71	151
2	1200	2.7	1	19.9	5.7	2604	0	2472	1.590	14.05	109
3	1200	10.8	2	19.4	6.0	2717	0	2679	1.590	14.05	146
4	1200	24.3	6	18.3	6.9	3130	0	2832	1.300	14.05	330
5	1200	33.8	8	17.2	7.6	3452	0	2593	.520	14.31	1787
6	1200	67.5	15	12.6	9.9	4504	0	2129	.130	14.18	1650
7	1200	101.2	23	4.9	15.4	6985	0	581	.130	13.77	1563
8	1200	110.7	25	3.3	16.2	7348	0	609	.130	13.77	1925
9	1200	124.2	28	2.2	18.5	8380	0	1007	.150	14.05	2300
10	1200	135.0	31	0.0	23.3	10569	0	4030	10.400	8.14	80
11	700	0.0	0	17.6	4.0	1805	0	742	.130	13.33	68
12	1200	0.0	0	21.5	4.0	1823	0	38965	.250	3.20	11
13	2300	161.0	71	.9	44.0	19958	0	2941	6.070	11.01	510
14	2300	148.1	65	2.3	36.0	16330	0	1486	2.140	13.33	1737
15	2300	132.0	58	3.4	31.8	14424	0	875	.740	14.05	2350
16	2300	120.7	53	4.7	29.0	13132	0	533	.350	14.05	2400
17	2300	80.5	35	10.6	20.7	9412	0	518	.150	13.48	2900
18	2300	40.2	18	16.7	14.4	6509	0	1709	.210	14.05	2500
19	2300	29.0	13	18.2	12.5	5670	0	1620	.280	14.05	1675
20	2300	12.9	6	20.2	10.4	4695	0	1453	.420	14.18	770
21	2300	3.2	1	21.2	9.1	4128	0	1444	.640	14.18	420
22	700	0.0	0	17.6	3.7	1656	0	726	.100	12.59	63
23	2300	0.0	0	24.8	3.8	1737	0	17539	.130	3.56	7

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	9.6	37	7.0	.070	0.0	I	R	R	R
2	0.0	40.5	526	5.9	.060	.0	0.0	65.68	853.2	9.6
3	0.0	45.7	549	8.3	.060	.1	0.0	18.54	222.3	3.4
4	0.0	56.7	526	21.9	.050	.3	0.0	10.21	94.7	4.0
5	0.0	59.3	240	135.8	.030	.2	0.0	7.69	31.2	17.6
6	0.0	66.0	81	169.9	.060	.9	0.0	4.28	5.3	11.0
7	0.0	29.1	131	259.6	0.000	0.0	0.0	1.26	5.7	11.2
8	0.0	32.1	138	336.4	.040	1.0	0.0	1.27	5.5	13.3
9	0.0	59.0	178	447.5	0.000	0.0	0.0	2.08	6.3	15.8
10	0.0	224.8	11721	14.9	0.000	0.0	0.0	7.29	380.0	.5
11	0.0	9.9	35	3.0	.070	0.0	I	R	R	R
12	0.0	967.1	125	.9	.120	0.0	I	R	R	R
13	0.0	337.9	14085	194.5	.025	1.8	0.0	4.79	199.8	2.8
14	0.0	155.4	4520	603.1	.055	3.6	0.0	2.40	69.7	9.3
15	0.0	84.9	1449	756.4	.035	2.0	0.0	1.47	25.1	13.1
16	0.0	48.4	642	723.9	.060	3.2	0.0	.92	12.1	13.7
17	0.0	35.6	208	662.3	.060	2.1	0.0	1.01	5.9	18.8
18	0.0	77.1	191	374.4	0.000	0.0	0.0	4.37	10.9	21.2
19	0.0	63.4	221	217.6	.065	.8	0.0	4.99	17.4	17.1
20	0.0	46.3	270	81.4	0.000	0.0	0.0	8.20	47.9	14.4
21	0.0	39.8	357	38.5	0.000	0.0	0.0	28.25	252.9	27.3
22	0.0	9.4	26	2.7	.080	0.0	I	R	R	R
23	0.0	559.7	84	.7	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	12.170	GRAM/BHP HR
	CO	52.955	GRAM/BHP HR
	NO2	11.962	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.750	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

3-08-72 RUN 3 ENGINE 2-1 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL RATE LB/HR	FUEL RATE GM/HR	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	700	0.0	0	17.6	4.0	1810	0	896	.100	12.82	32
2	1200	2.7	1	19.8	5.7	2604	0	2357	1.550	14.05	63
3	1200	10.8	2	19.4	6.0	2717	0	2493	1.480	14.05	165
4	1200	24.3	6	18.2	6.9	3130	0	2673	1.200	14.18	370
5	1200	33.8	8	17.2	7.6	3452	0	2477	.440	14.31	730
6	1200	67.5	15	12.6	9.9	4504	0	2038	.130	14.18	1700
7	1200	101.2	23	4.9	15.4	6985	0	547	.130	13.77	1650
8	1200	110.7	25	3.3	16.2	7348	0	575	.130	13.63	1950
9	1200	124.2	28	2.2	18.5	8380	0	831	.150	13.91	2350
10	1200	135.0	31	0.0	23.3	10569	0	4055	10.440	8.14	83
11	700	0.0	0	17.6	4.0	1805	0	696	.130	13.06	68
12	1200	0.0	0	21.4	4.0	1823	0	41548	.250	4.84	12
13	2300	161.0	71	1.0	44.0	19958	0	2939	5.960	11.01	555
14	2300	148.1	65	2.3	36.0	16330	0	1435	1.980	14.05	1862
15	2300	132.0	58	3.4	31.8	14424	0	817	.580	14.05	2500
16	2300	120.7	53	4.7	29.0	13132	0	481	.310	14.05	2600
17	2300	80.5	35	10.7	20.7	9412	0	462	.150	13.48	2950
18	2300	40.2	18	16.7	14.4	6509	0	1526	.180	13.91	2650
19	2300	29.0	13	18.2	12.5	5670	0	1232	.180	13.91	1787
20	2300	12.9	6	20.2	10.4	4695	0	1099	.280	14.05	860
21	2300	3.2	1	21.2	9.1	4128	0	930	.390	14.05	440
22	700	0.0	0	17.7	3.7	1656	0	871	.100	12.47	63
23	2300	0.0	0	24.8	3.8	1737	0	17666	.100	3.35	9

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	12.5	28	1.5	.070	0.0	I	R	R	R
2	0.0	38.8	515	3.4	.060	.0	0.0	62.83	834.5	5.5
3	0.0	42.9	515	9.4	.060	.1	0.0	17.40	208.6	3.8
4	0.0	53.5	485	24.6	.050	.3	0.0	9.63	87.3	4.4
5	0.0	57.0	205	55.8	.030	.2	0.0	7.39	26.5	7.2
6	0.0	63.3	81	175.2	.060	.9	0.0	4.10	5.3	11.4
7	0.0	27.4	131	274.2	0.000	0.0	0.0	1.18	5.7	11.9
8	0.0	30.6	140	344.3	.040	1.0	0.0	1.21	5.5	13.6
9	0.0	49.2	180	462.3	0.000	0.0	0.0	1.73	6.3	16.3
10	0.0	225.7	11740	15.2	0.000	0.0	0.0	7.32	380.6	.5
11	0.0	9.5	36	3.1	.070	0.0	I	R	R	R
12	0.0	819.5	100	.8	.120	0.0	I	R	R	R
13	0.0	339.7	13918	213.0	.025	1.8	0.0	4.82	197.4	3.0
14	0.0	144.9	4038	624.3	.055	3.6	0.0	2.23	62.3	9.6
15	0.0	80.1	1149	813.8	.035	2.0	0.0	1.39	19.9	14.1
16	0.0	43.9	571	786.7	.060	3.2	0.0	.83	10.8	14.9
17	0.0	31.8	209	674.0	.060	2.1	0.0	.90	5.9	19.1
18	0.0	69.7	166	402.1	0.000	0.0	0.0	3.96	9.4	22.8
19	0.0	49.2	145	236.7	.065	.8	0.0	3.87	11.4	18.7
20	0.0	35.7	184	92.8	0.000	0.0	0.0	6.33	32.6	16.5
21	0.0	26.4	224	41.5	0.000	0.0	0.0	18.72	158.7	29.4
22	0.0	11.4	26	2.7	.080	0.0	I	R	R	R
23	0.0	588.3	67	.9	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	11.020	GRAM/BHP HR
	CO	49.177	GRAM/BHP HR
	NO2	12.413	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.750	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

3-09-72 RUN 1 ENGINE 2-1 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL RATE LB/HR	FUEL RATE GM/HR	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	700	0.0	0	17.6	4.0	1810	11	1114	.150	12.22	63
2	1200	2.7	1	20.2	5.7	2604	11	2042	1.450	13.77	115
3	1200	10.8	2	19.7	6.0	2717	10	2330	1.450	13.91	155
4	1200	24.3	6	18.6	6.9	3130	11	2505	1.090	13.91	425
5	1200	33.8	8	17.3	7.6	3452	25	2243	.440	13.91	845
6	1200	67.5	15	12.7	9.9	4504	19	1801	.130	13.48	1962
7	1200	101.2	23	5.0	15.4	6985	16	331	.100	12.94	1825
8	1200	110.7	25	3.4	16.2	7348	15	499	.130	12.94	2212
9	1200	124.2	28	2.2	18.5	8380	43	792	.150	13.18	2650
10	1200	134.0	31	0.0	23.3	10569	35	4049	9.630	8.04	100
11	700	0.0	0	17.6	4.0	1805	11	1109	.100	11.72	66
12	1200	0.0	0	21.6	4.0	1823	30	45688	.350	6.73	15
13	2300	161.0	71	.9	44.0	19958	44	2791	5.080	11.48	830
14	2300	148.1	65	2.5	36.0	16330	57	979	1.270	13.63	2087
15	2300	132.0	58	3.5	31.8	14424	18	508	.280	13.63	2550
16	2300	120.7	53	4.7	29.0	13132	15	332	.210	13.48	2500
17	2300	80.5	35	10.9	20.7	9412	13	420	.150	12.94	2650
18	2300	40.2	18	17.2	14.4	6509	11	1507	.180	13.33	2350
19	2300	29.0	13	18.7	12.5	5670	11	1534	.210	13.63	1700
20	2300	12.9	6	20.4	10.4	4695	10	1264	.310	13.63	800
21	2300	3.2	1	21.3	9.1	4128	10	1222	.490	13.77	430
22	700	0.0	0	17.9	3.7	1656	9	793	.150	12.47	63
23	2300	0.0	0	25.1	3.8	1737	55	31195	.390	8.60	14

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	.3	16.2	44	3.0	.070	0.0	R	R	R	R
2	.4	34.5	494	6.4	.060	.0	.7	55.88	801.5	10.4
3	.4	40.6	510	9.0	.060	.1	.2	16.45	206.8	3.6
4	.5	51.4	452	29.0	.050	.3	.1	9.26	81.4	5.2
5	1.3	53.1	211	66.4	.030	.2	.2	6.89	27.3	8.6
6	1.4	58.8	86	212.8	.060	.9	.1	3.82	5.6	13.8
7	1.8	17.7	108	323.8	0.000	0.0	.1	.76	4.7	14.0
8	1.8	27.9	147	411.4	.040	1.0	.1	1.10	5.8	16.3
9	5.8	49.5	189	549.8	0.000	0.0	.2	1.74	6.7	19.4
10	4.4	236.7	11374	19.4	0.000	0.0	.1	7.73	371.5	.6
11	.4	16.8	31	3.3	.070	0.0	R	R	R	R
12	1.0	715.2	111	.8	.120	0.0	R	R	R	R
13	11.2	330.8	12162	326.6	.025	1.8	.2	4.69	172.5	4.6
14	13.4	106.5	2793	754.6	.055	3.6	.2	1.64	43.1	11.6
15	4.0	52.5	584	874.7	.035	2.0	.1	.91	10.1	15.1
16	3.0	31.8	406	794.2	.060	3.2	.1	.60	7.7	15.0
17	2.1	30.1	217	630.6	.060	2.1	.1	.85	6.2	17.9
18	1.2	71.8	173	371.8	0.000	0.0	.1	4.07	9.8	21.1
19	1.0	62.2	172	228.7	.065	.8	.1	4.90	13.5	18.0
20	.7	42.2	209	88.6	0.000	0.0	.1	7.48	37.1	15.7
21	.6	35.1	284	41.0	0.000	0.0	.4	24.88	201.5	29.1
22	.3	10.3	40	2.7	.080	0.0	R	R	R	R
23	1.7	447.5	113	.7	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	9.495	GRAM/BHP HR
	CO	40.711	GRAM/BHP HR
	NO2	13.358	GRAM/BHP HR
	ALDE	.130	GRAM/BHP HR
	BSFC	.750	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

3-09-72 RUN 2 ENGINE 2-1 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL RATE LB/HR	FUEL RATE GM/HR	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	700	0.0	0	17.7	4.0	1810	0	1121	.150	12.94	77
2	1200	2.7	1	20.2	5.7	2604	0	2174	1.300	14.31	116
3	1200	10.8	2	19.7	6.0	2717	0	2493	1.340	14.18	175
4	1200	24.3	6	18.5	6.9	3130	0	2718	1.050	14.31	425
5	1200	33.8	8	17.3	7.6	3452	0	2522	.420	14.31	860
6	1200	67.5	15	12.7	9.9	4504	0	2104	.150	14.05	1900
7	1200	101.2	23	5.0	15.4	6985	0	647	.150	13.48	1700
8	1200	110.7	25	3.4	16.2	7348	0	552	.190	13.48	2075
9	1200	124.2	28	2.3	18.5	8380	0	773	.150	13.77	2000
10	1200	135.0	31	0.0	23.3	10569	0	4127	10.290	8.34	94
11	700	0.0	0	17.7	4.0	1805	0	685	.150	13.18	68
12	1200	0.0	0	21.6	4.0	1823	0	43866	.390	7.28	16
13	2300	161.0	71	.9	44.0	19958	0	2934	5.780	11.01	610
14	2300	148.1	65	2.5	36.0	16330	0	1231	1.590	13.48	2075
15	2300	132.0	58	3.5	31.8	14424	0	691	.490	13.91	2650
16	2300	120.7	53	4.7	29.0	13132	0	356	.280	13.91	2650
17	2300	80.5	35	10.9	20.7	9412	0	416	.180	13.18	3000
18	2300	40.2	18	17.0	14.4	6509	0	1401	.250	13.77	2700
19	2300	30.0	13	18.5	12.5	5670	0	1344	.250	13.77	1825
20	2300	12.9	6	20.2	10.4	4695	0	1152	.210	13.77	820
21	2300	3.2	1	21.0	9.1	4128	0	1118	.450	13.48	460
22	700	0.0	0	17.8	3.7	1656	0	1007	.150	12.71	83
23	2300	0.0	0	25.0	3.8	1737	0	29299	.280	8.75	17

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	15.4	42	3.5	.070	0.0	I	R	R	R
2	0.0	35.8	432	6.3	.060	.0	0.0	57.98	700.2	10.3
3	0.0	43.0	466	10.0	.060	.1	0.0	17.41	189.0	4.1
4	0.0	54.4	425	28.3	.050	.3	0.0	9.80	76.5	5.1
5	0.0	58.1	195	65.8	.030	.2	0.0	7.54	25.3	8.5
6	0.0	65.8	95	197.2	.060	.9	0.0	4.26	6.1	12.8
7	0.0	33.0	155	287.9	0.000	0.0	0.0	1.43	6.7	12.4
8	0.0	29.6	205	368.8	.040	1.0	0.0	1.17	8.1	14.6
9	0.0	46.3	181	397.5	0.000	0.0	0.0	1.63	6.4	14.0
10	0.0	229.0	11536	17.3	0.000	0.0	0.0	7.43	374.0	.6
11	0.0	9.2	41	3.0	.070	0.0	I	R	R	R
12	0.0	663.4	119	.8	.120	0.0	I	R	R	R
13	0.0	342.8	13640	236.6	.025	1.8	0.0	4.86	193.5	3.4
14	0.0	132.3	3452	740.4	.055	3.6	0.0	2.04	53.2	11.4
15	0.0	68.9	987	877.1	.035	2.0	0.0	1.19	17.1	15.2
16	0.0	32.9	522	812.1	.060	3.2	0.0	.62	9.9	15.4
17	0.0	29.2	255	699.5	.060	2.1	0.0	.83	7.2	19.8
18	0.0	64.4	232	412.1	0.000	0.0	0.0	3.65	13.2	23.4
19	0.0	53.9	202	242.7	.065	.9	0.0	4.10	15.4	18.5
20	0.0	38.4	141	90.7	0.000	0.0	0.0	6.80	25.0	16.1
21	0.0	32.9	267	44.9	0.000	0.0	0.0	23.30	189.5	31.8
22	0.0	12.9	39	3.5	.080	0.0	I	R	R	R
23	0.0	425.6	82	.8	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	9.159	GRAM/BHP HR
	CO	46.396	GRAM/BHP HR
	NO2	13.372	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.748	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

3-10-72 RUN 1 ENGINE 2-1 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL RATE LB/HR	FUEL RATE GM/HR	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	700	0.0	0	17.6	4.0	1810	17	626	.100	12.71	30
2	1200	2.7	1	20.1	5.7	2604	16	2208	1.550	14.05	59
3	1200	10.8	2	19.7	6.0	2717	14	2563	1.520	14.05	83
4	1200	24.3	6	18.5	6.9	3130	14	2784	1.200	14.05	206
5	1200	33.8	8	17.3	7.6	3452	26	2612	.490	14.18	710
6	1200	67.5	15	12.6	9.9	4504	19	2147	.150	13.91	1675
7	1200	101.2	23	4.8	15.4	6985	16	444	.150	13.33	1550
8	1200	110.7	25	3.2	16.2	7348	17	563	.150	13.48	1950
9	1200	124.2	28	2.2	18.5	8380	44	971	.180	13.77	2350
10	1200	135.0	31	0.0	23.3	10569	36	4022	10.140	8.14	82
11	700	0.0	0	17.6	4.0	1805	13	891	.130	12.22	61
12	1200	0.0	0	21.4	4.0	1823	26	45252	.150	7.56	11
13	2300	161.0	71	.9	44.0	19958	36	3030	5.900	11.01	525
14	2300	148.1	65	2.2	36.0	16330	51	1246	1.660	13.77	1825
15	2300	132.0	58	3.4	31.8	14424	19	533	.420	14.05	2300
16	2300	120.7	53	4.4	29.0	13132	16	277	.210	13.91	2250
17	2300	80.5	35	10.6	20.7	9412	11	360	.180	13.18	2250
18	2300	40.2	18	17.0	14.4	6509	24	1558	.210	13.77	2250
19	2300	29.0	13	18.4	12.5	5670	23	1356	.250	13.77	1563
20	2300	12.9	6	20.2	10.4	4695	26	1099	.280	14.05	820
21	2300	3.2	1	21.2	9.1	4128	18	1066	.420	14.05	420
22	700	0.0	0	17.7	3.7	1656	11	862	.150	12.71	57
23	2300	0.0	0	25.0	3.8	1737	52	28534	.420	9.03	17

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	.5	8.8	28	1.4	.070	0.0	R	R	R	R
2	.6	36.3	515	3.2	.060	.0	.9	58.92	835.3	5.2
3	.5	44.0	527	4.7	.060	.1	.2	17.83	213.6	1.9
4	.6	56.1	489	13.8	.050	.3	.1	10.11	88.0	2.5
5	1.3	60.4	229	54.5	.030	.2	.2	7.83	29.7	7.1
6	1.3	67.7	96	175.5	.060	.9	.1	4.39	6.2	11.4
7	1.8	22.9	157	265.8	0.000	0.0	.1	.99	6.8	11.5
8	2.0	30.2	163	347.6	.040	1.0	.1	1.20	6.4	13.7
9	5.7	57.9	217	465.5	0.000	0.0	.2	2.04	7.6	16.4
10	4.4	227.5	11588	15.4	0.000	0.0	.1	7.38	375.7	.5
11	.4	12.9	38	2.9	.070	0.0	R	R	R	R
12	.8	674.4	45	.5	.120	0.0	R	R	R	R
13	9.0	351.3	13819	202.1	.025	1.8	.1	4.98	196.0	2.9
14	11.7	130.8	3520	636.1	.055	3.6	.2	2.02	54.3	9.8
15	4.1	52.9	843	758.4	.035	2.0	.1	.92	14.6	13.1
16	3.2	25.7	394	693.4	.060	3.2	.1	.49	7.4	13.1
17	1.7	25.3	255	524.9	.060	2.1	.0	.72	7.2	14.9
18	2.4	71.8	195	344.0	0.000	0.0	.1	4.07	11.1	19.5
19	2.0	54.3	202	207.8	.065	.8	.2	4.28	15.9	16.4
20	1.8	35.7	184	88.5	0.000	0.0	.3	6.33	32.6	15.7
21	1.1	30.2	240	39.5	0.000	0.0	.8	21.40	170.4	28.0
22	.3	11.0	39	2.4	.080	0.0	R	R	R	R
23	1.6	402.9	120	.8	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	9.109	GRAM/BHP HR
	CO	46.411	GRAM/BHP HR
	NO2	11.245	GRAM/BHP HR
	ALDE	.125	GRAM/BHP HR
	BSFC	.750	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

3-13-72 RUN 1 ENGINE 2-1 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEI RATE LB/HR	GM/HR	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	700	0.0	0	17.8	4.0	1810	0	739	.070	12.94	50
2	1200	2.7	1	20.0	5.7	2604	0	2672	1.590	13.77	104
3	1200	10.8	2	19.4	6.0	2717	0	2831	1.550	13.77	144
4	1200	24.3	6	18.3	6.9	3130	0	3050	1.160	13.77	310
5	1200	33.8	8	17.3	7.6	3452	0	2901	.470	13.91	660
6	1200	67.5	15	12.5	9.9	4504	0	2324	.100	13.77	1600
7	1200	101.2	23	4.8	15.4	6985	0	573	.070	13.18	1525
8	1200	110.7	25	3.1	16.2	7348	0	494	.070	13.18	1700
9	1200	124.2	28	1.9	18.5	8380	0	707	.100	13.18	2175
10	1200	135.0	31	0.0	23.3	10569	0	3633	9.170	8.60	109
11	700	0.0	0	17.9	4.0	1805	0	593	.070	12.71	63
12	1200	0.0	0	21.6	4.0	1823	0	40915	.350	6.73	13
13	2300	161.0	71	.9	44.0	19958	0	3018	5.290	11.13	540
14	2300	148.1	65	2.1	36.0	16330	0	1588	2.050	13.33	1575
15	2300	132.0	58	3.2	31.8	14424	0	702	.470	13.91	2100
16	2300	120.7	53	4.2	29.0	13132	0	373	.210	13.77	2050
17	2300	80.5	35	10.2	20.7	9412	0	337	.150	13.18	2000
18	2300	40.2	18	16.9	14.4	6509	0	1535	.180	13.77	2100
19	2300	29.0	13	18.3	12.5	5670	0	1513	.210	13.77	1362
20	2300	12.9	6	20.2	10.4	4695	0	1233	.310	13.91	660
21	2300	3.2	1	21.2	9.1	4128	0	1224	.470	13.91	490
22	700	0.0	0	17.8	3.7	1656	0	851	.100	12.82	63
23	2300	0.0	0	24.9	3.8	1737	0	30541	.390	8.75	16

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	10.2	20	2.3	.070	0.0	I	R	R	R
2	0.0	44.5	535	5.7	.060	.0	0.0	72.18	867.4	9.3
3	0.0	49.3	545	8.3	.060	.1	0.0	19.98	220.9	3.4
4	0.0	62.7	481	21.1	.050	.3	0.0	11.29	86.7	3.8
5	0.0	68.2	223	51.6	.030	.2	0.0	8.85	29.0	6.7
6	0.0	74.2	65	169.7	.060	.9	0.0	4.81	4.2	11.0
7	0.0	30.1	74	265.8	0.000	0.0	0.0	1.30	3.2	11.5
8	0.0	27.3	78	311.8	.040	1.0	0.0	1.08	3.1	12.3
9	0.0	44.4	127	453.3	0.000	0.0	0.0	1.56	4.5	16.0
10	0.0	211.7	10796	21.0	0.000	0.0	0.0	6.86	350.0	.7
11	0.0	8.3	20	2.9	.070	0.0	I	R	R	R
12	0.0	667.8	115	.7	.120	0.0	I	R	R	R
13	0.0	360.2	12754	214.0	.025	1.8	0.0	5.11	180.9	3.0
14	0.0	166.9	4352	549.5	.055	3.6	0.0	2.57	67.1	8.5
15	0.0	70.1	948	696.0	.035	2.0	0.0	1.21	16.4	12.0
16	0.0	34.9	397	637.6	.060	3.2	0.0	.66	7.5	12.1
17	0.0	23.7	213	467.7	.060	2.1	0.0	.67	6.1	13.3
18	0.0	70.9	168	321.8	0.000	0.0	0.0	4.02	9.5	18.3
19	0.0	60.7	170	181.4	.065	.8	0.0	4.78	13.4	14.3
20	0.0	40.4	205	71.7	0.000	0.0	0.0	7.16	36.3	12.7
21	0.0	34.8	270	46.3	0.000	0.0	0.0	24.70	191.6	32.8
22	0.0	10.8	26	2.7	.080	0.0	I	R	R	R
23	0.0	435.1	112	.7	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	9.496	GRAM/BHP HR
	CO	47.650	GRAM/BHP HR
	NO2	10.240	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.750	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

3-13-72 RUN 2 ENGINE 2-1 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL RATE LB/HR	FUEL RATE GM/HR	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	700	0.0	0	17.3	4.0	1810	0	817	.050	12.82	51
2	1200	2.7	1	19.8	5.7	2604	0	2375	1.300	14.05	106
3	1200	10.8	2	19.3	6.0	2717	0	2652	1.410	14.05	141
4	1200	24.3	6	18.2	6.9	3130	0	2943	1.160	14.05	310
5	1200	33.8	8	17.2	7.6	3452	0	2838	.440	14.18	660
6	1200	67.5	15	12.3	9.9	4504	0	2213	.070	13.91	1537
7	1200	101.2	23	4.7	15.4	6985	0	585	.100	13.33	1425
8	1200	110.7	25	3.1	16.2	7348	0	563	.100	13.48	1725
9	1200	124.2	28	2.0	18.5	8380	0	879	.070	13.63	2100
10	1200	135.0	31	0.0	23.3	10569	0	4421	9.910	8.43	93
11	700	0.0	0	17.7	4.0	1805	0	832	.050	13.33	65
12	1200	0.0	0	21.7	4.0	1823	0	46523	.280	7.18	17
13	2300	161.0	71	.9	44.0	19958	0	3220	5.560	10.66	575
14	2300	148.1	65	2.2	36.0	16330	0	1729	2.140	12.71	1600
15	2300	132.0	58	3.3	31.8	14424	0	882	.610	13.48	2150
16	2300	120.7	53	4.3	29.0	13132	0	446	.350	13.48	2200
17	2300	80.5	35	10.2	20.7	9412	0	303	.210	12.82	2150
18	2300	40.2	18	16.7	14.4	6509	0	1732	.280	13.18	2200
19	2300	29.0	13	18.2	12.5	5670	0	1531	.280	13.33	1500
20	2300	12.9	6	20.1	10.4	4695	0	1354	.420	13.48	720
21	2300	3.2	1	21.1	9.1	4128	0	1288	.520	13.48	390
22	700	0.0	0	17.7	3.7	1656	0	893	.100	12.47	60
23	2300	0.0	0	24.9	3.8	1737	0	29066	.250	8.54	15

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	11.4	14	2.4	.070	0.0	I	R	R	R
2	0.0	39.7	439	5.9	.060	.0	0.0	64.31	711.0	9.6
3	0.0	45.8	492	8.1	.060	.1	0.0	18.57	199.4	3.3
4	0.0	59.4	473	20.8	.050	.3	0.0	10.70	85.2	3.7
5	0.0	65.7	206	50.8	.030	.2	0.0	8.52	26.7	6.6
6	0.0	70.2	45	161.9	.060	.9	0.0	4.55	2.9	10.5
7	0.0	30.3	105	245.0	0.000	0.0	0.0	1.31	4.5	10.6
8	0.0	30.3	109	308.6	.040	1.0	0.0	1.20	4.3	12.2
9	0.0	53.4	86	423.8	0.000	0.0	0.0	1.88	3.0	14.9
10	0.0	248.8	11264	17.3	0.000	0.0	0.0	8.07	365.2	.6
11	0.0	11.2	14	2.9	.070	0.0	I	R	R	R
12	0.0	700.4	85	.8	.120	0.0	I	R	R	R
13	0.0	388.5	13551	230.3	.025	1.8	0.0	5.51	192.2	3.3
14	0.0	187.9	4699	577.4	.055	3.6	0.0	2.90	72.4	8.9
15	0.0	89.7	1254	726.2	.035	2.0	0.0	1.55	21.7	12.6
16	0.0	42.2	669	691.3	.060	3.2	0.0	.80	12.7	13.1
17	0.0	21.8	306	514.4	.060	2.1	0.0	.62	8.7	14.6
18	0.0	82.7	270	348.7	0.000	0.0	0.0	4.69	15.3	19.8
19	0.0	63.1	233	205.2	.065	.8	0.0	4.97	18.4	16.2
20	0.0	45.3	284	80.0	0.000	0.0	0.0	8.03	50.3	14.2
21	0.0	37.6	307	37.8	0.000	0.0	0.0	26.68	217.6	26.8
22	0.0	11.7	26	2.6	.080	0.0	I	R	R	R
23	0.0	431.7	75	.7	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	9.883	GRAM/BHP HR
	CO	51.324	GRAM/BHP HR
	NO2	10.858	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.750	LB/BHP HR

APPENDIX B

EMISSION RESULTS FROM ENGINE 1-1

TABULAR FORM

ENGINE 1-1

NINE MODE FTP EMISSION RESULTS

CONCENTRATION BASIS

3-21-72 ENGINE 1-1 RUN 1 K = .941 HUM = 60 GR/LB

	FEDERAL MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
	1 IDLE	167	.994	14.320	78	.967	161	.961	75	.036	5.813	.035	2.715
	2 16'HG	58	.139	13.170	2006	1.090	63	.152	2187	.089	5.627	.013	194.611
	3 10'HG	39	.136	12.680	2264	1.134	44	.154	2567	.257	11.363	.040	659.634
	4 16'HG	61	.146	13.260	1710	1.082	66	.158	1851	.089	5.875	.014	164.697
	5 19'HG	36	.147	13.440	1795	1.070	39	.157	1921	.047	1.810	.007	90.264
	6 16'HG	24	.143	13.220	2238	1.089	26	.156	2437	.089	2.326	.014	216.869
	7 3'HG	47	.808	13.330	2055	1.052	49	.850	2162	.283	13.991	.241	611.740
	8 16'HG	40	.165	13.290	1730	1.081	43	.178	1870	.089	3.848	.016	166.414
	9 C.T.	2402	.866	7.480	71	1.380	3315	1.195	98	.021	69.611	.025	2.058
	SUM----------(CYCLE COMPOSITE)----------										120.263	.405	2109.002
CYCLE 2													
	1 IDLE	167	.994	14.320	78	.967	161	.961	75	.036	5.813	.035	2.715
	2 16'HG	40	.144	13.110	1787	1.096	44	.158	1959	.089	3.903	.014	174.373
	3 10'HG	39	.136	12.650	2384	1.136	44	.155	2709	.257	11.390	.040	696.230
	4 16'HG	35	.147	13.140	1866	1.094	38	.161	2042	.089	3.409	.014	181.724
	5 19'HG	42	.169	14.210	1228	1.011	42	.171	1242	.047	1.996	.008	58.361
	6 16'HG	32	.145	13.350	1938	1.078	34	.156	2088	.089	3.069	.014	185.850
	7 3'HG	39	.678	13.300	1394	1.060	41	.719	1477	.283	11.698	.203	418.115
	8 16'HG	28	.158	13.230	1495	1.087	30	.172	2169	.089	2.709	.015	193.006
	9 C.T.	2332	1.010	8.010	98	1.314	3065	1.327	129	.021	64.358	.028	2.705
	SUM----------(CYCLE COMPOSITE)----------										108.343	.371	1913.077
CYCLE 3													
	1 IDLE	144	1.218	14.140	86	.973	140	1.185	84	.036	5.043	.043	3.012
	2 16'HG	49	.147	13.100	1741	1.096	54	.161	1909	.089	4.781	.014	169.869
	3 10'HG	37	.141	12.680	2509	1.134	42	.160	2844	.257	10.780	.041	730.997
	4 16'HG	33	.148	13.240	2025	1.086	36	.161	2199	.089	3.190	.014	195.755
	5 19'HG	42	.186	14.210	1327	1.011	42	.188	1341	.047	1.995	.009	63.028
	6 16'HG	38	.154	13.220	2114	1.087	41	.167	2298	.089	3.677	.015	204.537
	7 3'HG	39	.759	13.300	1554	1.057	41	.802	1642	.283	11.663	.227	464.729
	8 16'HG	27	.163	13.260	2015	1.084	29	.177	2185	.089	2.606	.016	194.482
	9 C.T.	2302	.911	7.580	79	1.378	3172	1.255	109	.021	66.621	.026	2.286
	SUM----------(CYCLE COMPOSITE)----------										110.355	.405	2028.696
CYCLE 4													
	1 IDLE	144	1.218	14.140	86	.973	140	1.185	84	.036	5.043	.043	3.012
	2 16'HG	47	.151	13.070	1795	1.099	52	.166	1972	.089	4.596	.015	175.538
	3 10'HG	36	.142	12.620	2450	1.139	41	.162	2791	.257	10.539	.042	717.204
	4 16'HG	36	.148	13.100	1976	1.097	40	.162	2168	.089	3.516	.014	192.996
	5 19'HG	45	.193	14.170	1263	1.013	46	.195	1279	.047	2.142	.009	60.128
	6 16'HG	39	.149	13.070	2086	1.100	43	.164	2294	.089	3.817	.015	204.145
	7 3'HG	40	.683	13.150	1516	1.071	43	.732	1624	.283	12.127	.207	459.626
	8 16'HG	30	.166	13.110	2118	1.096	33	.182	2322	.089	2.927	.016	206.669
	9 C.T.	2352	.928	7.920	94	1.327	3122	1.232	125	.021	65.560	.026	2.620
	SUM----------(CYCLE COMPOSITE)----------										110.268	.386	2021.938

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 114.303 .388 2011.039

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 110.311 .396 2025.317

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(114.303) + 0.65*(110.311) =	111.708	PPM
CO	0.35*(.388) + 0.65*(.396) =	.393	PERCENT
NO	0.35*(2011.039) + 0.65*(2025.317) =	2020.320	PPM
	CORRECTED NO =	1901.606	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

3-21-72 ENGINE 1-1 RUN 2 K = .929 HUM = 57 GR/LB

	FEDERAL MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
	1 IDLE	114	.856	15.290	80	.915	104	.784	73	.036	3.757	.028	2.636
	2 16'HG	48	.161	13.970	1963	1.028	49	.166	2018	.089	4.392	.015	179.633
	3 10'HG	37	.150	13.690	2604	1.074	40	.161	2796	.257	10.210	.041	718.536
	4 16'HG	34	.166	14.150	2282	1.016	35	.169	2319	.089	3.075	.015	206.376
	5 19'HG	36	.171	15.050	1411	.956	34	.163	1348	.047	1.617	.008	63.370
	6 16'HG	37	.166	14.200	2256	1.012	37	.168	2284	.089	3.334	.015	203.266
	7 3'HG	38	.880	14.320	1639	.980	37	.862	1606	.283	10.535	.244	454.403
	8 16'HG	29	.174	14.290	2447	1.006	29	.175	2463	.089	2.597	.016	219.169
	9 C.T.	2071	.780	8.130	196	1.348	2792	1.051	264	.021	58.626	.022	5.548
	SUM----------(CYCLE COMPOSITE)----------										98.143	.404	2052.937
CYCLE 2													
	1 IDLE	114	.856	15.290	80	.915	104	.784	73	.036	3.757	.028	2.636
	2 16'HG	53	.161	14.180	2021	1.013	54	.163	2047	.089	4.777	.015	182.159
	3 10'HG	38	.145	13.720	2814	1.048	40	.152	2950	.257	10.236	.039	758.040
	4 16'HG	38	.161	14.350	2267	1.002	38	.161	2271	.089	3.389	.014	202.160
	5 19'HG	38	.180	15.200	1375	.946	36	.170	1300	.047	1.689	.008	61.122
	6 16'HG	36	.159	14.320	2414	1.004	36	.160	2424	.089	3.218	.014	215.763
	7 3'HG	34	.922	14.410	1860	.973	33	.897	1809	.283	9.359	.254	511.984
	8 16'HG	34	.169	14.380	2514	1.000	34	.169	2514	.089	3.026	.015	223.727
	9 C.T.	2143	.876	8.410	102	1.299	2784	1.138	132	.021	58.459	.024	2.782
	SUM----------(CYCLE COMPOSITE)----------										97.909	.411	2160.372
CYCLE 3													
	1 IDLE	161	.808	15.550	77	.899	145	.726	69	.036	5.211	.026	2.492
	2 16'HG	52	.155	14.280	2139	1.006	52	.156	2152	.089	4.656	.014	191.511
	3 10'HG	36	.147	13.830	2915	1.040	37	.153	3032	.257	9.622	.039	779.117
	4 16'HG	32	.165	14.340	2346	1.003	32	.165	2353	.089	2.856	.015	209.414
	5 19'HG	45	.194	15.310	1448	.938	42	.182	1358	.047	1.984	.009	63.848
	6 16'HG	35	.166	14.330	2345	1.003	35	.167	2353	.089	3.126	.015	209.416
	7 3'HG	32	.868	14.470	1830	.971	31	.843	1776	.283	8.790	.238	502.686
	8 16'HG	35	.170	14.640	2671	.982	34	.167	2623	.089	3.060	.015	233.487
	9 C.T.	2124	.847	8.300	81	1.316	2795	1.115	107	.021	58.703	.023	2.239
	SUM----------(CYCLE COMPOSITE)----------										98.008	.394	2194.211
CYCLE 4													
	1 IDLE	161	.808	15.550	77	.899	145	.726	69	.036	5.211	.026	2.492
	2 16'HG	48	.165	14.230	1920	1.009	48	.167	1938	.089	4.312	.015	172.494
	3 10'HG	40	.146	13.730	2810	1.047	42	.153	2943	.257	10.765	.039	756.270
	4 16'HG	31	.168	14.250	2224	1.009	31	.170	2245	.089	2.784	.015	199.762
	5 19'HG	44	.187	15.190	1371	.946	42	.177	1297	.047	1.956	.008	60.944
	6 16'HG	37	.166	14.270	2246	1.007	37	.167	2263	.089	3.317	.015	201.381
	7 3'HG	40	.816	14.410	1783	.976	39	.796	1740	.283	11.045	.225	492.325
	8 16'HG	32	.171	14.340	2337	1.003	32	.171	2343	.089	2.856	.015	208.567
	9 C.T.	2219	.868	8.610	114	1.267	2812	1.100	144	.021	59.061	.023	3.034
	SUM----------(CYCLE COMPOSITE)----------										101.308	.382	2097.269

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 98.026 .407 2106.655

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 99.658 .388 2145.740

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(98.026) + 0.65*(99.658) =	99.087	PPM
CO	0.35*(.407) + 0.65*(.388) =	.395	PERCENT
NO	0.35*(2106.655) + 0.65*(2145.740) =	2132.060	PPM
	CORRECTED NO =	1979.719	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

3-21-72 ENGINE 1-1 RUN 3 K = .981 HUM = 70 GR/LB

	FEDERAL MODE	CONCENTRATION HC	CO	AS CO2	MEASURED NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
	1 IDLE	133	.920	13.840	81	1.004	134	.924	81	.036	4.807	.033	2.927
	2 16'HG	38	.149	12.590	2030	1.141	43	.170	2317	.089	3.860	.015	206.187
	3 10'HG	46	.141	12.190	3114	1.178	54	.166	3668	.257	13.925	.043	942.661
	4 16'HG	41	.150	12.710	2602	1.130	46	.170	2941	.089	4.124	.015	261.736
	5 19'HG	35	.160	13.360	1633	1.076	38	.172	1757	.047	1.770	.008	82.572
	6 16'HG	37	.149	12.670	2626	1.134	42	.169	2978	.089	3.735	.015	265.076
	7 3'HG	25	.915	12.670	1651	1.102	28	1.009	1820	.283	7.799	.285	515.024
	8 16'HG	23	.166	12.680	2800	1.134	26	.188	3175	.089	2.321	.017	282.565
	9 C.T.	2100	.772	7.510	279	1.427	2996	1.101	398	.021	62.913	.023	8.358
	SUM----------(CYCLE COMPOSITE)----------										105.253	.455	2567.106
CYCLE 2													
	1 IDLE	133	.920	13.840	81	1.004	134	.924	81	.036	4.807	.033	2.927
	2 16'HG	54	.148	12.590	2352	1.140	62	.169	2681	.089	5.478	.015	238.577
	3 10'HG	37	.140	12.150	3231	1.183	44	.166	3821	.257	11.246	.043	982.085
	4 16'HG	39	.152	12.590	2532	1.141	44	.173	2889	.089	3.960	.015	257.123
	5 19'HG	35	.160	13.370	1713	1.075	38	.172	1842	.047	1.768	.008	86.553
	6 16'HG	36	.149	12.610	2661	1.140	41	.170	3033	.089	3.651	.015	269.898
	7 3'HG	43	1.118	12.690	1698	1.091	47	1.219	1852	.283	13.272	.345	524.070
	8 16'HG	31	.167	12.620	2805	1.138	35	.190	3193	.089	3.141	.017	284.200
	9 C.T.	2469	.198	7.480	146	1.415	3494	.280	207	.021	73.379	.006	4.339
	SUM----------(CYCLE COMPOSITE)----------										120.703	.497	2649.773
CYCLE 3													
	1 IDLE	102	1.081	13.560	115	1.020	104	1.103	117	.036	3.747	.040	4.224
	2 16'HG	28	.150	12.510	2375	1.149	32	.172	2730	.089	2.864	.015	242.955
	3 10'HG	39	.143	12.060	3273	1.191	46	.170	3898	.257	11.938	.044	1001.907
	4 16'HG	21	.150	12.500	2580	1.151	24	.173	2970	.089	2.151	.015	264.294
	5 19'HG	19	.154	13.340	1648	1.079	21	.166	1778	.047	.964	.008	83.580
	6 16'HG	38	.149	12.490	2623	1.150	44	.171	3017	.089	3.890	.015	268.531
	7 3'HG	43	1.112	12.620	1713	1.097	47	1.219	1879	.283	13.345	.345	531.619
	8 16'HG	17	.163	12.580	2937	1.144	19	.186	3359	.089	1.730	.017	298.915
	9 C.T.	2268	.865	7.630	154	1.379	3128	1.193	212	.021	65.697	.025	4.461
	SUM----------(CYCLE COMPOSITE)----------										106.327	.524	2700.486
CYCLE 4													
	1 IDLE	102	1.081	13.560	115	1.020	104	1.103	117	.036	3.747	.040	4.224
	2 16'HG	34	.150	12.520	2486	1.148	39	.172	2854	.089	3.474	.015	253.978
	3 10'HG	23	.143	11.920	3165	1.207	28	.173	3819	.257	7.133	.044	981.528
	4 16'HG	20	.149	12.570	2797	1.145	23	.171	3202	.089	2.038	.015	284.976
	5 19'HG	22	.169	13.320	1647	1.080	24	.182	1778	.047	1.117	.009	83.587
	6 16'HG	23	.152	12.540	3069	1.147	26	.174	3520	.089	2.348	.016	313.313
	7 3'HG	36	1.200	12.640	1775	1.092	39	1.310	1938	.283	11.125	.371	548.519
	8 16'HG	23	.168	12.580	2921	1.143	26	.192	3338	.089	2.339	.017	297.076
	9 C.T.	2147	.821	7.440	149	1.426	3061	1.171	212	.021	64.288	.025	4.462
	SUM----------(CYCLE COMPOSITE)----------										97.607	.551	2771.663

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 112.978 .476 2608.440

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 101.967 .538 2736.075

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(112.978) + 0.65*(101.967) =	105.821	PPM
CO	0.35*(.476) + 0.65*(.538) =	.516	PERCENT
NO	0.35*(2608.440) + 0.65*(2736.075) =	2691.402	PPM
	CORRECTED NO =	2640.965	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

ENGINE 1-1

NINE MODE FTP EMISSION RESULTS

BRAKE SPECIFIC BASIS

3-21-72 ENGINE 1-1 RUN 1 K = .95 HUM = 60 GR/LB

	MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1															
	1 IDLE	167	.994	14.32	78	15.494	1634	19	212	3	.232	4.4	49	.6	0
	2 16 HG	58	.139	13.17	2006	13.372	7150	33	150	356	.077	2.6	12	27.4	20
	3 10 HG	39	.136	12.68	2264	12.858	10451	34	223	611	.147	5.0	33	89.8	43
	4 16 HG	61	.146	13.26	1710	13.472	7150	35	157	301	.077	2.7	12	23.2	20
	5 19 HG	36	.147	13.44	1795	13.626	5509	16	120	241	.057	.9	7	13.7	11
	6 16 HG	24	.143	13.22	2238	13.389	7150	14	154	397	.077	1.1	12	30.6	20
	7 3 HG	47	.808	13.33	2055	14.189	14303	51	1645	688	.113	5.8	186	77.7	66
	8 16 HG	40	.165	13.29	1730	13.498	7150	23	177	304	.077	1.8	14	23.4	20
	9 C.T.	2402	.866	7.48	71	10.940	1401	332	224	3	.143	47.5	32	.4	0
	SUM----------(CYCLE COMPOSITE)----------											3.5	17	13.9	
CYCLE 2															
	1 IDLE	167	.994	14.32	78	15.494	1634	19	212	3	.232	4.4	49	.6	0
	2 16 HG	40	.144	13.11	1787	13.297	7150	23	156	319	.077	1.8	12	24.6	20
	3 10 HG	39	.136	12.65	2384	12.828	10451	34	224	645	.147	5.0	33	94.8	43
	4 16 HG	35	.147	13.14	1866	13.325	7150	20	159	332	.077	1.6	12	25.6	20
	5 19 HG	42	.169	14.21	1228	14.424	5509	17	130	156	.057	1.0	7	8.9	11
	6 16 HG	32	.145	13.35	1938	13.530	7150	18	155	340	.077	1.4	12	26.2	20
	7 3 HG	39	.678	13.30	1394	14.020	14303	43	1397	472	.113	4.9	158	53.4	66
	8 16 HG	28	.158	13.23	1995	13.418	7150	16	170	353	.077	1.2	13	27.2	20
	9 C.T.	2332	1.010	8.01	98	11.539	1401	306	248	4	.143	43.7	35	.6	0
	SUM----------(CYCLE COMPOSITE)----------											3.1	16	12.7	
CYCLE 3															
	1 IDLE	144	1.218	14.14	86	15.514	1634	16	259	3	.232	3.8	60	.7	0
	2 16 HG	49	.147	13.10	1741	13.300	7150	28	160	311	.077	2.2	12	23.9	20
	3 10 HG	37	.141	12.68	2509	12.861	10451	32	231	677	.147	4.8	34	99.5	43
	4 16 HG	33	.148	13.24	2025	13.424	7150	19	159	358	.077	1.5	12	27.6	20
	5 19 HG	42	.186	14.21	1327	14.441	5509	17	143	168	.057	1.0	8	9.6	11
	6 16 HG	38	.154	13.22	2114	13.415	7150	22	166	374	.077	1.7	13	28.8	20
	7 3 HG	39	.759	13.30	1554	14.101	14303	43	1555	523	.113	4.8	176	59.1	66
	8 16 HG	27	.163	13.26	2015	13.452	7150	16	175	356	.077	1.2	13	27.4	20
	9 C.T.	2302	.911	7.58	79	10.977	1401	317	235	3	.143	45.4	34	.5	0
	SUM----------(CYCLE COMPOSITE)----------											3.2	18	13.4	
CYCLE 4															
	1 IDLE	144	1.218	14.14	86	15.514	1634	16	259	3	.232	3.8	60	.7	0
	2 16 HG	47	.151	13.07	1795	13.272	7150	27	164	321	.077	2.1	13	24.7	20
	3 10 HG	36	.142	12.62	2450	12.801	10451	32	234	664	.147	4.7	34	97.6	43
	4 16 HG	36	.148	13.10	1976	13.287	7150	21	161	353	.077	1.6	12	27.2	20
	5 19 HG	45	.193	14.17	1263	14.412	5509	19	149	160	.057	1.1	8	9.1	11
	6 16 HG	39	.149	13.07	2086	13.261	7150	23	162	373	.077	1.7	12	28.8	20
	7 3 HG	40	.683	13.15	1516	13.876	14303	45	1422	519	.113	5.0	161	58.6	66
	8 16 HG	30	.166	13.11	2118	13.308	7150	17	180	378	.077	1.3	14	29.1	20
	9 C.T.	2352	.928	7.92	94	11.388	1401	313	231	4	.143	44.7	33	.5	0
	SUM----------(CYCLE COMPOSITE)----------											3.2	17	13.4	
	AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------											3.3	17	13.3	
	AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------											3.2	17	13.4	

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(3.3) + 0.65(3.2) = 3.237 (MASS)
CO 0.35(17) + 0.65(17) = 17.0 (MASS)
NO2 0.35(13.3) + 0.65(13.4) = 13.336 (MASS)
CORRECTED NO2 = 12.622 (MASS)

3-21-72 ENGINE 1-1 RUN 2 K = .93 HUM = 57 GR/LB

MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1														
1 IDLE	114	.856	15.29	80	16.269	1634	12	174	3	.232	2.9	40	.6	0
2 16 HG	48	.161	13.97	1963	14.183	7150	26	164	329	.077	2.0	13	25.3	20
3 10 HG	37	.150	13.39	2604	13.580	10451	31	233	665	.147	4.5	34	97.8	43
4 16 HG	34	.166	14.15	2282	14.353	7150	18	167	377	.077	1.4	13	29.1	20
5 19 HG	36	.171	15.05	1411	15.260	5509	14	125	169	.057	.8	7	9.6	11
6 16 HG	37	.166	14.20	2256	14.406	7150	20	166	372	.077	1.5	13	28.6	20
7 3 HG	38	.880	14.32	1639	15.241	14303	39	1668	511	.113	4.4	189	57.7	66
8 16 HG	29	.174	14.29	2447	14.495	7150	15	173	401	.077	1.2	13	30.9	20
9 C.T.	2071	.780	8.13	196	11.147	1401	281	198	8	.143	40.2	28	1.2	0
SUM----------(CYCLE COMPOSITE)----------											2.8	17	13.6	
CYCLE 2														
1 IDLE	114	.856	15.29	80	16.269	1634	12	174	3	.232	2.9	40	.6	0
2 16 HG	53	.161	14.18	2021	14.398	7150	28	162	333	.077	2.2	12	25.7	20
3 10 HG	38	.145	13.72	2814	13.906	10451	31	220	702	.147	4.5	32	103.2	43
4 16 HG	38	.161	14.35	2267	14.552	7150	20	160	370	.077	1.6	12	28.5	20
5 19 HG	38	.180	15.20	1375	15.421	5509	15	130	163	.057	.8	7	9.3	11
6 16 HG	36	.159	14.32	2414	14.518	7150	19	158	395	.077	1.5	12	30.4	20
7 3 HG	34	.922	14.41	1860	15.369	14303	34	1733	575	.113	3.9	196	64.9	66
8 16 HG	34	.169	14.38	2514	14.586	7150	18	167	409	.077	1.4	13	31.5	20
9 C.T.	2143	.876	8.41	102	11.600	1401	280	214	4	.143	40.0	31	.6	0
SUM----------(CYCLE COMPOSITE)----------											2.8	17	14.2	
CYCLE 3														
1 IDLE	161	.808	15.55	77	16.532	1634	17	161	3	.232	4.0	37	.6	0
2 16 HG	52	.155	14.28	2139	14.491	7150	28	154	350	.077	2.1	12	27.0	20
3 10 HG	36	.147	13.83	2915	14.016	10451	29	221	722	.147	4.3	33	106.1	43
4 16 HG	32	.165	14.34	2346	14.540	7150	17	164	383	.077	1.3	13	29.5	20
5 19 HG	45	.194	15.31	1448	15.553	5509	17	139	170	.057	1.0	8	9.7	11
6 16 HG	35	.166	14.33	2345	14.534	7150	19	165	383	.077	1.4	13	29.5	20
7 3 HG	32	.868	14.47	1830	15.373	14303	32	1631	565	.113	3.6	184	63.9	66
8 16 HG	35	.170	14.64	2671	14.848	7150	18	165	427	.077	1.4	13	32.9	20
9 C.T.	2124	.847	8.30	81	11.441	1401	281	210	3	.143	40.2	30	.5	0
SUM----------(CYCLE COMPOSITE)----------											2.9	17	14.5	
CYCLE 4														
1 IDLE	161	.808	15.55	77	16.532	1634	17	161	3	.232	4.0	37	.6	0
2 16 HG	48	.165	14.23	1920	14.447	7150	26	165	316	.077	2.0	13	24.3	20
3 10 HG	40	.146	13.73	2810	13.919	10451	32	221	700	.147	4.8	33	103.0	43
4 16 HG	31	.168	14.25	2224	14.451	7150	17	168	365	.077	1.3	13	28.1	20
5 19 HG	44	.187	15.19	1371	15.425	5509	17	135	163	.057	1.0	8	9.3	11
6 16 HG	37	.166	14.27	2246	14.476	7150	20	166	368	.077	1.5	13	28.4	20
7 3 HG	40	.816	14.41	1783	15.269	14303	40	1544	554	.113	4.6	174	62.7	66
8 16 HG	32	.171	14.34	2337	14.546	7150	17	170	381	.077	1.3	13	29.4	20
9 C.T.	2219	.868	8.61	114	11.875	1401	283	207	4	.143	40.4	30	.6	0
SUM----------(CYCLE COMPOSITE)----------											2.9	16	13.8	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------											2.8	17	13.9	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------											2.9	16	14.2	

FOUR CYCLE COMPOSITE = REPORTED VALUES = HC 0.35(2.8) + 0.65(2.9) = 2.882 (MASS)
CO 0.35(17) + 0.65(16) = 16.6 (MASS)
NO2 0.35(13.9) + 0.65(14.2) = 14.071 (MASS)
CORRECTED NO2 = 13.152 (MASS)

3-21-72 ENGINE 1-1 RUN 3 K = .98 HUM = 70 GR/LB

	MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1															
	1 IDLE	133	.920	13.84	81	14.904	1634	16	204	3	.232	3.7	47	.7	0
	2 16 HG	38	.149	12.59	2030	12.780	7150	23	168	377	.077	1.8	13	29.0	20
	3 10 HG	46	.141	12.19	3114	12.381	10451	42	240	873	.147	6.2	35	128.3	43
	4 16 HG	41	.150	12.71	2602	12.904	7150	25	168	479	.077	1.9	13	36.9	20
	5 19 HG	35	.160	13.36	1633	13.558	5509	15	131	220	.057	.9	7	12.6	11
	6 16 HG	37	.149	12.67	2626	12.859	7150	22	167	485	.077	1.7	13	37.3	20
	7 3 HG	25	.915	12.67	1651	13.612	14303	28	1942	576	.113	3.2	219	65.1	66
	8 16 HG	23	.166	12.68	2800	12.871	7150	14	186	516	.077	1.1	14	39.8	20
	9 C.T.	2100	.772	7.51	279	10.550	1401	301	207	12	.143	43.1	30	1.8	0
	SUM----------(CYCLE COMPOSITE)----------											3.1	19	17.0	
CYCLE 2															
	1 IDLE	133	.920	13.84	81	14.904	1634	16	204	3	.232	3.7	47	.7	0
	2 16 HG	54	.148	12.59	2352	12.796	7150	33	167	436	.077	2.5	13	33.6	20
	3 10 HG	37	.140	12.15	3231	12.330	10451	34	240	909	.147	5.0	35	133.7	43
	4 16 HG	39	.152	12.59	2532	12.784	7150	24	172	470	.077	1.8	13	36.2	20
	5 19 HG	35	.160	13.37	1713	13.568	5509	15	131	231	.057	.9	7	13.2	11
	6 16 HG	36	.149	12.61	2661	12.798	7150	22	168	494	.077	1.7	13	38.0	20
	7 3 HG	43	1.118	12.69	1698	13.854	14303	48	2331	582	.113	5.4	263	65.8	66
	8 16 HG	31	.167	12.62	2805	12.820	7150	19	188	519	.077	1.4	14	40.0	20
	9 C.T.	2469	.198	7.48	146	10.345	1401	361	54	7	.143	51.7	8	.9	0
	SUM----------(CYCLE COMPOSITE)----------											3.6	20	17.5	
CYCLE 3															
	1 IDLE	102	1.081	13.56	115	14.751	1634	12	242	4	.232	2.8	56	1.0	0
	2 16 HG	28	.150	12.51	2375	12.690	7150	17	171	444	.077	1.3	13	34.2	20
	3 10 HG	39	.143	12.06	3273	12.245	10451	36	247	927	.147	5.3	36	136.3	43
	4 16 HG	21	.150	12.50	2580	12.673	7150	13	171	483	.077	1.0	13	37.2	20
	5 19 HG	19	.154	13.34	1648	13.515	5509	8	127	223	.057	.5	7	12.7	11
	6 16 HG	38	.149	12.49	2623	12.680	7150	23	170	491	.077	1.8	13	37.8	20
	7 3 HG	43	1.112	12.62	1713	13.778	14303	48	2332	590	.113	5.4	263	66.7	66
	8 16 HG	17	.163	12.58	2937	12.761	7150	10	184	546	.077	.8	14	42.1	20
	9 C.T.	2268	.865	7.63	154	10.944	1401	314	224	7	.143	44.9	32	.9	0
	SUM----------(CYCLE COMPOSITE)----------											3.1	22	17.8	
CYCLE 4															
	1 IDLE	102	1.081	13.56	115	14.751	1634	12	242	4	.232	2.8	56	1.0	0
	2 16 HG	34	.150	12.52	2486	12.707	7150	21	171	464	.077	1.6	13	35.8	20
	3 10 HG	23	.143	11.92	3165	12.088	10451	21	250	909	.147	3.2	37	133.5	43
	4 16 HG	20	.149	12.57	2797	12.741	7150	12	169	521	.077	.9	13	40.1	20
	5 19 HG	22	.169	13.32	1647	13.513	5509	10	139	223	.057	.6	8	12.7	11
	6 16 HG	23	.152	12.54	3069	12.717	7150	14	173	573	.077	1.1	13	44.1	20
	7 3 HG	36	1.200	12.64	1775	13.879	14303	40	2498	607	.113	4.5	282	68.6	66
	8 16 HG	23	.168	12.58	2921	12.773	7150	14	190	543	.077	1.1	15	41.8	20
	9 C.T.	2147	.821	7.44	149	10.580	1401	307	220	7	.143	43.9	31	.9	0
	SUM----------(CYCLE COMPOSITE)----------											2.9	23	18.3	
	AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------											3.3	20	17.2	
	AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------											3.0	22	18.1	

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(3.3) + 0.65(3.0) = 3.102 (MASS)
CO 0.35(20) + 0.65(22) = 21.2 (MASS)
NO2 0.35(17.2) + 0.65(18.1) = 17.779 (MASS)
CORRECTED NO2 = 17.477 (MASS)

ENGINE 1-1

EXPERIMENTAL 23 MODE EMISSION RESULTS

BRAKE SPECIFIC BASIS

PROJECT 11-2877-01 CONTROL TECHNOLOGY

3-29-72 RUN 1 ENGINE 1-1 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL RATE LB/HR	FUEL RATE GM/HR	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.7	3.5	1579	27	2352	.520	13.63	45
2	1200	4.2	1	19.5	6.4	2903	33	519	.070	13.77	89
3	1200	17.0	4	18.7	6.8	3098	27	778	.070	13.77	207
4	1200	38.2	9	17.4	7.9	3593	92	1610	.100	15.26	1052
5	1200	53.0	12	16.2	9.1	4137	53	1651	.100	14.05	1730
6	1200	106.0	24	11.3	11.8	5334	93	1913	.110	14.18	3480
7	1200	159.0	36	6.8	18.2	8246	75	1975	.520	14.05	3070
8	1200	174.0	40	2.6	21.1	9553	94	1240	.610	13.18	2870
9	1200	195.0	45	.8	28.1	12737	47	3372	4.500	10.55	1797
10	1200	212.0	48	0.0	28.8	13064	37	3596	6.570	9.93	559
11	600	0.0	0	17.6	3.5	1597	40	2721	.390	14.05	53
12	1200	0.0	0	22.4	4.0	1796	101	54043	.420	6.30	13
13	2300	218.0	95	1.8	57.6	26127	60	2461	4.980	11.24	875
14	2300	201.0	88	2.2	46.1	20929	29	1690	2.730	12.59	1887
15	2300	179.0	78	3.0	40.8	18507	29	305	.670	13.33	2100
16	2300	163.5	72	4.0	36.7	16629	16	220	.310	13.33	2225
17	2300	109.0	48	10.3	26.5	11998	27	246	.130	12.47	3950
18	2300	54.5	24	15.9	19.1	8673	23	284	.150	12.34	2750
19	2300	39.3	17	17.7	15.5	7026	63	269	.130	12.71	2362
20	2300	17.5	8	19.9	13.2	5997	29	372	.150	13.48	1237
21	2300	4.4	2	21.1	11.3	5135	23	384	.210	13.63	688
22	600	0.0	0	18.0	3.5	1597	25	2258	.310	13.63	53
23	2300	0.0	0	25.0	5.5	2486	45	20917	.180	3.88	9

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	.6	25.8	115	1.7	.070	0.0	R	R	R	R
2	1.5	10.8	30	6.2	.060	.1	1.6	11.19	30.5	6.4
3	1.3	17.3	31	15.3	.060	.2	.3	4.47	8.1	4.0
4	4.6	37.3	47	80.9	.050	.4	.5	4.27	5.4	9.3
5	3.3	47.7	58	166.0	.030	.4	.3	3.94	4.8	13.7
6	7.4	70.5	82	425.6	.060	1.5	.3	2.91	3.4	17.6
7	9.0	110.3	587	569.2	0.000	0.0	.2	3.04	16.1	15.7
8	13.9	85.2	846	654.2	.040	1.6	.4	2.14	21.3	16.5
9	8.4	279.1	7524	494.0	0.000	0.0	.2	6.26	168.9	11.1
10	6.2	278.7	10283	143.8	0.000	0.0	.1	5.75	212.3	3.0
11	.9	29.5	85	1.9	.070	0.0	R	R	R	R
12	3.2	800.7	126	.6	.120	0.0	R	R	R	R
13	20.5	390.5	15962	460.9	.025	2.4	.2	4.09	167.2	4.8
14	8.5	228.3	7451	846.7	.055	4.8	.1	2.59	84.7	9.6
15	8.2	40.2	1785	919.6	.035	2.7	.1	.51	22.8	11.7
16	4.2	26.7	762	899.1	.060	4.3	.1	.37	10.6	12.6
17	5.5	23.3	250	1246.3	.060	2.9	.1	.49	5.2	26.1
18	3.4	19.7	210	632.5	0.000	0.0	.1	.83	8.8	26.5
19	7.4	14.7	143	428.3	.065	1.1	.4	.85	8.3	24.9
20	2.7	16.3	133	180.3	0.000	0.0	.4	2.13	17.4	23.6
21	1.9	14.2	157	84.4	0.000	0.0	1.0	7.43	82.2	44.2
22	.6	25.4	71	2.0	.080	0.0	R	R	R	R
23	3.9	845.2	147	1.2	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	8.623	GRAM/BHP HR
	CO	46.081	GRAM/BHP HR
	NO2	13.823	GRAM/BHP HR
	ALDE	.206	GRAM/BHP HR
	BSFC	.661	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

3-29-72 RUN 2 ENGINE 1-1 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL RATE LB/HR	FUEL RATE GM/HR	DRY CONCENTRATION ALDE.	HC	CO	CO2	NO
1	600	0.0	0	17.9	3.5	1579	39	2266	.350	14.05	48
2	1200	4.1	1	19.7	6.4	2903	24	360	.070	13.48	116
3	1200	16.5	4	18.6	6.8	3098	33	771	.070	12.59	245
4	1200	37.1	8	17.8	7.9	3593	156	1625	.100	13.77	1112
5	1200	51.5	12	16.5	9.1	4137	52	1647	.100	13.77	1775
6	1200	103.0	24	11.8	11.8	5334	63	1677	.070	13.48	3650
7	1200	154.5	35	6.8	18.2	8246	41	1946	.310	13.91	3200
8	1200	169.0	39	3.3	21.1	9553	92	1466	.470	13.33	2900
9	1200	189.5	43	.3	28.1	12737	34	2560	4.070	11.36	1850
10	1200	206.0	47	0.0	28.8	13064	104	3703	6.440	9.78	370
11	600	0.0	0	18.0	3.5	1597	29	3471	.350	13.77	58
12	1200	0.0	0	22.3	4.0	1796	62	53862	.420	6.64	14
13	2300	210.0	92	.7	57.6	26127	76	2622	5.080	11.13	838
14	2300	193.0	85	1.2	46.1	20929	31	1052	2.640	12.82	1575
15	2300	172.0	75	3.0	40.8	18507	26	282	.470	13.48	2050
16	2300	157.5	69	4.9	36.7	16629	12	208	.210	13.18	2650
17	2300	105.0	46	10.5	26.5	11998	24	246	.130	12.47	4000
18	2300	52.5	23	16.0	19.1	8673	63	324	.130	12.47	2850
19	2300	37.8	17	17.6	15.5	7026	33	325	.130	12.82	2287
20	2300	16.8	7	20.2	13.2	5997	23	417	.180	13.63	1212
21	2300	4.2	2	21.3	11.3	5135	38	412	.250	13.77	538
22	600	0.0	0	18.0	3.5	1597	32	2263	.310	13.91	58
23	2300	0.0	0	24.9	5.5	2486	47	27116	.350	4.64	11

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	.9	24.5	76	1.7	.070	0.0	R	R	R	R
2	1.1	7.7	30	8.2	.060	.1	1.2	8.17	32.1	8.8
3	1.7	18.7	34	19.8	.060	.2	.5	4.97	9.1	5.2
4	8.6	41.6	52	94.6	.050	.4	1.0	4.91	6.1	11.2
5	3.3	48.6	60	173.7	.030	.4	.3	4.13	5.1	14.8
6	5.3	65.2	55	471.2	.060	1.4	.2	2.77	2.3	20.0
7	5.1	111.3	358	607.8	0.000	0.0	.1	3.15	10.1	17.2
8	13.6	100.4	650	659.5	.040	1.5	.4	2.60	16.8	17.1
9	6.0	207.8	6676	498.7	0.000	0.0	.1	4.80	154.2	11.5
10	17.7	291.6	10243	96.7	0.000	0.0	.4	6.20	217.6	2.1
11	.7	38.3	78	2.1	.070	0.0	R	R	R	R
12	1.9	777.3	122	.7	.120	0.0	R	R	R	R
13	26.0	415.9	16276	441.0	.025	2.3	.3	4.52	177.0	4.8
14	9.0	141.4	7171	703.1	.055	4.6	.1	1.67	84.8	8.3
15	7.5	37.4	1257	901.1	.035	2.6	.1	.50	16.7	12.0
16	3.2	25.8	526	1090.9	.060	4.1	.0	.37	7.6	15.8
17	5.0	23.3	250	1262.1	.060	2.8	.1	.51	5.4	27.4
18	9.3	22.2	180	649.6	0.000	0.0	.4	.97	7.8	28.3
19	3.9	17.6	142	411.0	.065	1.1	.2	1.06	8.6	24.8
20	2.2	18.1	157	174.3	0.000	0.0	.3	2.46	21.4	23.7
21	3.0	15.1	184	65.2	0.000	0.0	1.6	8.19	100.3	35.4
22	.8	25.0	69	2.1	.080	0.0	R	R	R	R
23	3.2	875.2	228	1.2	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	8.752	GRAM/BHP HR
	CO	45.581	GRAM/BHP HR
	NO2	14.648	GRAM/BHP HR
	ALDE	.200	GRAM/BHP HR
	BSFC	.685	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

3-31-72 RUN 1 ENGINE 1-1 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL RATE LB/HR	FUEL RATE GM/HR	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.0	3.5	1579	0	2946	.210	14.18	54
2	1200	4.1	1	20.3	6.4	2903	0	339	.100	13.91	101
3	1200	16.5	4	18.6	6.8	3098	0	675	.100	13.33	195
4	1200	37.2	8	17.6	7.9	3593	0	1642	.150	14.18	1100
5	1200	51.8	12	16.7	9.1	4137	0	1766	.130	14.18	1875
6	1200	103.5	24	11.6	11.8	5334	0	1749	.100	13.77	3900
7	1200	155.2	35	6.5	18.2	8246	0	2029	.280	14.18	3400
8	1200	170.0	39	3.3	21.1	9553	0	1604	.550	13.48	3050
9	1200	190.5	44	.3	28.1	12737	0	2189	3.060	12.09	2100
10	1200	207.0	47	0.0	28.8	13064	0	3517	5.350	10.78	550
11	600	0.0	0	18.0	3.5	1597	0	4283	.250	13.48	57
12	1200	0.0	0	22.5	4.0	1796	0	51502	.250	5.27	12
13	2300	212.5	93	.8	57.6	26127	0	2580	5.290	11.13	750
14	2300	195.5	86	1.3	46.1	20929	0	1366	2.440	12.47	1987
15	2300	174.0	76	3.0	40.8	18507	0	327	.640	13.06	2075
16	2300	159.0	70	4.8	36.7	16629	0	258	.310	12.94	2550
17	2300	106.3	47	11.0	26.5	11998	0	250	.130	12.09	3700
18	2300	53.2	23	16.5	19.1	8673	0	307	.130	12.47	2650
19	2300	38.3	17	18.0	15.5	7026	0	314	.130	12.82	2250
20	2300	17.0	7	20.3	13.2	5997	0	389	.130	13.63	1212
21	2300	4.3	2	21.4	11.3	5135	0	373	.210	13.91	563
22	600	0.0	0	18.0	3.5	1597	0	2220	.550	13.77	53
23	2300	0.0	0	25.3	5.5	2486	0	24593	.280	4.27	10

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	31.7	46	1.9	.070	0.0	I	R	R	R
2	0.0	7.0	42	6.9	.060	.1	0.0	7.41	44.1	7.3
3	0.0	15.5	46	14.9	.060	.2	0.0	4.09	12.3	3.9
4	0.0	40.7	75	90.5	.050	.4	0.0	4.79	8.8	10.6
5	0.0	50.4	75	177.8	.030	.4	0.0	4.26	6.3	15.0
6	0.0	66.4	77	491.8	.060	1.4	0.0	2.81	3.2	20.8
7	0.0	114.1	318	634.8	0.000	0.0	0.0	3.22	9.0	17.9
8	0.0	108.0	748	681.7	.040	1.6	0.0	2.78	19.3	17.5
9	0.0	181.4	5123	577.8	0.000	0.0	0.0	4.17	117.7	13.3
10	0.0	278.7	8566	144.7	0.000	0.0	0.0	5.89	181.1	3.1
11	0.0	48.3	57	2.1	.070	0.0	I	R	R	R
12	0.0	867.0	85	.7	.120	0.0	I	R	R	R
13	0.0	404.2	16740	390.1	.025	2.3	0.0	4.34	179.9	4.2
14	0.0	189.9	6856	917.8	.055	4.7	0.0	2.22	80.1	10.7
15	0.0	44.0	1742	928.4	.035	2.7	0.0	.58	22.9	12.2
16	0.0	32.3	784	1060.4	.060	4.2	0.0	.46	11.3	15.2
17	0.0	24.5	257	1203.6	.060	2.8	0.0	.53	5.5	25.9
18	0.0	21.1	180	604.1	0.000	0.0	0.0	.90	7.7	25.9
19	0.0	17.0	142	404.3	.065	1.1	0.0	1.01	8.5	24.1
20	0.0	16.9	114	174.9	0.000	0.0	0.0	2.27	15.3	23.5
21	0.0	13.5	154	67.7	0.000	0.0	0.0	7.27	82.7	36.4
22	0.0	24.4	122	1.9	.080	0.0	I	R	R	R
23	0.0	872.2	201	1.2	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	9.346	GRAM/BHP HR
	CO	46.484	GRAM/BHP HR
	NO2	14.835	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.678	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

3-31-72 RUN 2 ENGINE 1-1 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL RATE LB/HR	FUEL RATE GM/HR	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.0	3.5	1579	0	2999	.310	13.91	42
2	1200	4.1	1	20.2	6.4	2903	0	282	.100	13.63	100
3	1200	16.5	4	18.6	6.8	3098	0	783	.100	12.71	230
4	1200	37.2	8	17.7	7.9	3593	0	1693	.130	13.77	1112
5	1200	51.8	12	16.6	9.1	4137	0	1736	.100	13.63	1675
6	1200	103.5	24	11.6	11.8	5334	0	1801	.100	13.48	3350
7	1200	155.2	35	6.6	18.2	8246	0	2044	.350	13.63	3200
8	1200	170.0	39	3.3	21.1	9553	0	1441	.420	13.18	3050
9	1200	190.5	44	.3	28.1	12737	0	2792	3.010	11.60	1975
10	1200	207.0	47	0.0	28.8	13064	0	3439	5.030	10.78	650
11	600	0.0	0	18.0	3.5	1597	0	3043	.250	13.48	53
12	1200	0.0	0	22.5	4.0	1796	0	55627	.310	6.13	14
13	2300	212.5	93	.8	57.6	26127	0	2510	5.140	11.24	900
14	2300	195.5	86	1.3	46.1	20929	0	1324	2.560	12.71	2075
15	2300	174.0	76	3.0	40.8	18507	0	283	.850	13.33	2125
16	2300	159.0	70	4.8	36.7	16629	0	202	.280	13.18	2500
17	2300	106.3	47	11.0	26.5	11998	0	167	.130	12.09	3700
18	2300	53.2	23	16.4	19.1	8673	0	223	.130	12.47	2850
19	2300	38.3	17	18.0	15.5	7026	0	241	.130	12.82	2325
20	2300	17.0	7	20.2	13.2	5997	0	298	.150	13.48	1250
21	2300	4.3	2	21.3	11.3	5135	0	322	.210	13.77	700
22	600	0.0	0	18.0	3.5	1597	0	2527	.390	13.48	56
23	2300	0.0	0	25.2	5.5	2486	0	22855	.250	3.95	11

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	32.6	68	1.5	.070	0.0	I	R	R	R
2	0.0	5.9	43	7.0	.060	.1	0.0	6.28	45.1	7.4
3	0.0	18.8	49	18.4	.060	.2	0.0	4.98	12.8	4.9
4	0.0	43.2	67	94.3	.050	.4	0.0	5.09	7.9	11.1
5	0.0	51.6	60	165.5	.030	.4	0.0	4.36	5.1	14.0
6	0.0	69.8	78	431.2	.060	1.4	0.0	2.95	3.3	18.2
7	0.0	118.8	411	617.7	0.000	0.0	0.0	3.35	11.6	17.4
8	0.0	100.2	590	703.8	.040	1.6	0.0	2.58	15.2	18.1
9	0.0	238.9	5201	560.9	0.000	0.0	0.0	5.49	119.5	12.9
10	0.0	278.1	8217	174.5	0.000	0.0	0.0	5.88	173.7	3.7
11	0.0	34.6	57	2.0	.070	0.0	I	R	R	R
12	0.0	832.5	94	.7	.120	0.0	I	R	R	R
13	0.0	394.4	16311	469.4	.025	2.3	0.0	4.24	175.3	5.0
14	0.0	179.9	7027	936.1	.055	4.7	0.0	2.10	82.1	10.9
15	0.0	36.8	2236	918.9	.035	2.7	0.0	.48	29.4	12.1
16	0.0	25.0	698	1023.9	.060	4.2	0.0	.36	10.0	14.7
17	0.0	16.4	257	1204.4	.060	2.8	0.0	.35	5.5	25.9
18	0.0	15.3	180	650.1	0.000	0.0	0.0	.66	7.7	27.9
19	0.0	13.0	142	418.0	.065	1.1	0.0	.78	8.5	24.9
20	0.0	13.1	133	182.2	0.000	0.0	0.0	1.76	17.9	24.5
21	0.0	11.8	155	85.2	0.000	0.0	0.0	6.34	83.5	45.8
22	0.0	28.6	89	2.1	.080	0.0	I	R	R	R
23	0.0	876.0	194	1.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	9.047	GRAM/BHP HR
	CO	46.644	GRAM/BHP HR
	NO2	14.774	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.678	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

4-03-72 RUN 1 ENGINE 1-1 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL RATE LB/HR	FUEL RATE GM/HR	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.2	3.5	1579	35	3400	.520	13.91	44
2	1200	4.1	1	20.3	6.4	2903	26	452	.100	14.05	70
3	1200	16.5	4	18.5	6.8	3098	43	896	.070	12.94	215
4	1200	37.2	8	17.5	7.9	3593	78	1982	.150	14.18	963
5	1200	51.7	12	16.5	9.1	4137	49	2013	.130	14.05	1587
6	1200	103.5	24	11.5	11.8	5334	95	1744	.070	13.48	3200
7	1200	155.0	35	6.5	18.2	8246	91	2268	.440	14.05	2750
8	1200	169.5	39	3.2	21.1	9553	67	1526	.490	13.63	2550
9	1200	190.0	43	.3	28.1	12737	62	3107	3.890	11.48	1563
10	1200	207.0	47	0.0	28.8	13064	36	3513	4.980	11.01	575
11	600	0.0	0	18.2	3.5	1597	55	4227	.280	13.48	50
12	1200	0.0	0	22.5	4.0	1796	145	62193	.350	5.50	12
13	2300	212.0	93	.8	57.6	26127	50	2739	5.290	11.01	663
14	2300	195.0	85	1.2	46.1	20929	49	1360	2.870	12.34	1662
15	2300	174.0	76	3.0	40.8	18507	36	299	.810	13.18	1688
16	2300	159.0	70	4.6	36.7	16629	24	174	.280	13.18	1800
17	2300	106.0	46	10.8	26.5	11998	19	195	.100	12.22	3250
18	2300	53.0	23	16.3	19.1	8673	36	251	.100	12.47	2150
19	2300	38.2	17	17.9	15.5	7026	26	285	.100	12.71	1925
20	2300	17.0	7	20.3	13.2	5997	22	366	.150	13.33	1000
21	2300	4.2	2	21.3	11.3	5135	39	394	.180	13.48	550
22	600	0.0	0	18.0	3.5	1597	47	2705	.250	13.48	53
23	2300	0.0	0	25.2	5.5	2486	40	22733	.150	3.45	11

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	.8	36.3	112	1.6	.070	0.0	R	R	R	R
2	1.2	9.3	41	4.8	.060	.1	1.2	9.78	43.7	5.0
3	2.2	21.2	33	16.9	.060	.2	.6	5.61	8.8	4.5
4	4.2	49.0	75	79.0	.050	.4	.5	5.77	8.8	9.3
5	3.1	57.9	76	151.6	.030	.4	.3	4.90	6.4	12.8
6	7.9	67.8	55	412.9	.060	1.4	.3	2.87	2.3	17.5
7	11.0	127.1	498	511.6	0.000	0.0	.3	3.59	14.1	14.4
8	9.7	102.2	662	566.6	.040	1.5	.3	2.64	17.1	14.6
9	10.9	252.4	6383	421.4	0.000	0.0	.3	5.81	147.0	9.7
10	6.2	280.8	8042	152.6	0.000	0.0	.1	5.94	170.0	3.2
11	1.3	47.6	64	1.9	.070	0.0	R	R	R	R
12	4.7	925.6	105	.6	.120	0.0	R	R	R	R
13	17.1	431.8	16845	346.7	.025	2.3	.2	4.65	181.4	3.7
14	14.4	185.4	7907	752.8	.055	4.7	.2	2.17	92.6	8.8
15	10.4	39.5	2160	739.6	.035	2.7	.1	.52	28.3	9.7
16	6.4	21.5	698	737.3	.060	4.2	.1	.31	10.0	10.6
17	4.1	19.0	196	1049.1	.060	2.8	.1	.41	4.2	22.6
18	5.3	17.3	139	491.5	0.000	0.0	.2	.75	6.0	21.2
19	3.1	15.6	111	349.8	.065	1.1	.2	.93	6.6	20.9
20	2.1	16.2	134	147.3	0.000	0.0	.3	2.18	18.1	19.8
21	3.2	14.8	136	68.4	0.000	0.0	1.7	7.96	73.4	36.9
22	1.2	30.8	58	2.0	.080	0.0	R	R	R	R
23	3.7	962.1	128	1.5	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	9.976	GRAM/BHP HR
	CO	49.157	GRAM/BHP HR
	NO2	12.114	GRAM/BHP HR
	ALDE	.221	GRAM/BHP HR
	BSFC	.679	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

4-03-72 RUN 2 ENGINE 1-1 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL RATE LB/HR	FUEL RATE GM/HR	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.0	3.5	1579	0	3951	.310	13.63	38
2	1200	4.1	1	20.2	6.4	2903	0	338	.070	13.63	59
3	1200	16.5	4	18.8	6.8	3098	0	784	.070	12.94	150
4	1200	37.2	8	17.5	7.9	3593	0	1862	.100	13.77	975
5	1200	51.7	12	16.5	9.1	4137	0	1846	.070	13.48	1737
6	1200	103.5	24	11.5	11.8	5334	0	1873	.070	13.77	3300
7	1200	155.0	35	6.5	18.2	8246	0	2050	.420	13.77	2800
8	1200	169.5	39	3.5	21.1	9553	0	1456	.520	13.35	2800
9	1200	190.0	43	.2	28.1	12737	0	2810	4.260	11.13	1500
10	1200	207.0	47	0.0	28.8	13064	0	3566	5.350	11.24	650
11	600	0.0	0	18.0	3.5	1597	0	3048	.440	13.48	49
12	1200	0.0	0	22.5	4.0	1796	0	60390	.470	5.96	12
13	2300	212.0	93	.8	57.6	26127	0	2899	5.030	11.24	788
14	2300	195.0	85	1.2	46.1	20929	0	1368	2.360	12.82	1675
15	2300	174.0	76	3.0	40.8	18507	0	283	.520	13.63	2007
16	2300	159.0	70	4.6	36.7	16629	0	213	.180	13.48	2345
17	2300	106.0	46	10.8	26.5	11998	0	221	.100	12.34	3720
18	2300	53.0	23	16.3	19.1	8673	0	278	.130	12.47	2650
19	2300	38.2	17	18.0	15.5	7026	0	287	.100	12.94	2230
20	2300	17.0	7	20.3	13.2	5997	0	369	.130	13.63	1182
21	2300	4.2	2	21.3	11.3	5135	0	377	.180	13.63	607
22	600	0.0	0	18.0	3.5	1597	0	2397	.640	13.48	54
23	2300	0.0	0	25.2	5.5	2486	0	23640	.350	3.95	11

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	43.5	69	1.4	.070	0.0	I	R	R	R
2	0.0	7.1	30	4.1	.060	.1	0.0	7.55	31.6	4.4
3	0.0	18.6	33	11.8	.060	.2	0.0	4.91	8.9	3.1
4	0.0	47.6	52	82.7	.050	.4	0.0	5.60	6.1	9.7
5	0.0	55.6	43	173.7	.030	.4	0.0	4.71	3.6	14.7
6	0.0	71.2	54	416.6	.060	1.4	0.0	3.01	2.3	17.6
7	0.0	117.4	486	532.5	0.000	0.0	0.0	3.32	13.7	15.0
8	0.0	99.2	716	633.6	.040	1.5	0.0	2.56	18.5	16.4
9	0.0	228.4	6994	404.8	0.000	0.0	0.0	5.26	161.1	9.3
10	0.0	274.9	8331	166.4	0.000	0.0	0.0	5.81	176.1	3.5
11	0.0	34.2	100	1.8	.070	0.0	I	R	R	R
12	0.0	870.0	137	.6	.120	0.0	I	R	R	R
13	0.0	457.4	16031	412.5	.025	2.3	0.0	4.93	172.7	4.4
14	0.0	187.0	6514	759.9	.055	4.7	0.0	2.19	76.3	8.9
15	0.0	36.9	1371	870.0	.035	2.7	0.0	.48	18.0	11.4
16	0.0	25.9	442	946.3	.060	4.2	0.0	.37	6.3	13.6
17	0.0	21.3	194	1189.0	.060	2.8	0.0	.46	4.2	25.6
18	0.0	19.1	180	604.3	0.000	0.0	0.0	.82	7.8	26.0
19	0.0	15.4	109	398.0	.065	1.1	0.0	.92	6.5	23.8
20	0.0	16.0	114	170.6	0.000	0.0	0.0	2.16	15.4	23.0
21	0.0	14.0	135	74.8	0.000	0.0	0.0	7.52	72.6	40.3
22	0.0	26.7	144	2.0	.080	0.0	I	R	R	R
23	0.0	881.8	264	1.3	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	9.443	GRAM/BHP HR
	CO	43.523	GRAM/BHP HR
	NO2	13.678	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.679	LB/BHP HR

APPENDIX C

EMISSION RESULTS FROM ENGINE 1-2

TABULAR FORM

ENGINE 1-2

NINE MODE FTP EMISSION RESULTS

CONCENTRATION BASIS

4-6-72 ENGINE 1-2 RUN-2 K =1.083 HUM = 101 GR/LB

	FEDERAL MODE	CONCENTRATION HC	CO	AS CO2	MEASURED NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
	1 IDLE	1136	1.420	11.660	80	1.066	1211	1.514	85	.036	43.612	.055	3.071
	2 16'HG	95	.670	13.780	1083	1.020	97	.683	1105	.089	8.623	.061	98.302
	3 10'HG	61	.210	13.280	2550	1.078	66	.226	2749	.257	16.900	.058	706.465
	4 16'HG	86	.790	13.790	1105	1.016	87	.802	1122	.089	7.773	.071	99.875
	5 19'HG	179	1.810	13.130	332	1.019	182	1.845	338	.047	8.574	.087	15.902
	6 16'HG	88	.740	13.800	1143	1.016	89	.752	1162	.089	7.961	.067	103.403
	7 3'HG	42	.340	13.340	2438	1.070	45	.364	2608	.283	12.714	.103	738.035
	8 16'HG	82	.760	13.670	1096	1.026	84	.779	1124	.089	7.485	.069	100.038
	9 C.T.	3027	1.870	4.340	123	1.697	5137	3.174	209	.021	107.877	.067	4.384
	SUM----------(CYCLE COMPOSITE)----------										221.519	.637	1869.474
CYCLE 2													
	1 IDLE	1136	1.420	11.660	80	1.066	1211	1.514	85	.036	43.612	.055	3.071
	2 16'HG	154	.890	13.560	1069	1.023	158	.911	1094	.089	14.024	.081	97.348
	3 10'HG	70	.230	13.050	2540	1.045	77	.252	2782	.257	19.701	.065	714.870
	4 16'HG	93	.770	13.620	1161	1.028	96	.792	1193	.089	8.509	.070	106.219
	5 19'HG	108	1.850	13.080	347	1.027	111	1.900	356	.047	5.212	.089	16.746
	6 16'HG	88	.820	13.570	1086	1.030	91	.845	1119	.089	8.068	.075	99.572
	7 3'HG	46	.460	13.140	2476	1.081	50	.497	2675	.283	14.066	.141	757.117
	8 16'HG	82	.850	13.490	1093	1.035	85	.880	1132	.089	7.557	.078	100.726
	9 C.T.	3685	2.310	4.660	161	1.480	5455	3.420	238	.021	114.559	.072	5.005
	SUM----------(CYCLE COMPOSITE)----------										235.308	.726	1900.674
CYCLE 3													
	1 IDLE	1120	1.470	11.590	144	1.071	1200	1.575	154	.036	43.196	.057	5.554
	2 16'HG	155	.920	13.470	1116	1.029	159	.946	1148	.089	14.189	.084	102.161
	3 10'HG	71	.300	13.060	2441	1.091	77	.327	2664	.257	19.913	.084	684.624
	4 16'HG	91	.790	13.550	1083	1.033	94	.816	1118	.089	8.362	.073	99.522
	5 19'HG	125	1.770	13.060	351	1.030	129	1.823	361	.047	6.050	.086	16.989
	6 16'HG	91	.920	13.460	1270	1.034	94	.952	1314	.089	8.377	.085	116.914
	7 3'HG	44	.440	12.940	2396	1.098	48	.483	2630	.283	13.671	.137	744.423
	8 16'HG	77	.750	13.220	1037	1.060	82	.795	1099	.089	7.265	.071	97.838
	9 C.T.	2818	1.870	4.140	151	1.786	5033	3.340	270	.021	105.695	.070	5.664
	SUM----------(CYCLE COMPOSITE)----------										226.719	.746	1873.689
CYCLE 4													
	1 IDLE	1120	1.470	11.590	144	1.071	1200	1.575	154	.036	43.196	.057	5.554
	2 16'HG	146	.840	13.430	1089	1.035	151	.870	1127	.089	13.451	.077	100.327
	3 10'HG	63	.230	13.000	2520	1.100	69	.253	2772	.257	17.808	.065	712.338
	4 16'HG	88	.810	13.460	1102	1.039	91	.841	1145	.089	8.135	.075	101.872
	5 19'HG	115	1.870	12.910	351	1.038	119	1.941	364	.047	5.610	.091	17.124
	6 16'HG	90	.780	13.430	1219	1.042	94	.813	1270	.089	8.345	.072	113.034
	7 3'HG	45	.410	13.050	2470	1.090	49	.447	2692	.283	13.880	.126	761.872
	8 16'HG	82	.870	13.470	1158	1.036	85	.901	1200	.089	7.562	.080	106.792
	9 C.T.	3290	2.080	4.430	194	1.607	5287	3.342	312	.021	111.025	.070	6.547
	SUM----------(CYCLE COMPOSITE)----------										229.014	.714	1925.460

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 228.414 .682 1885.074

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 227.866 .730 1899.574

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(228.414) + 0.65*(227.866) =	228.058	PPM
CO	0.35*(.682) + 0.65*(.730) =	.713	PERCENT
NO	0.35*(1885.074) + 0.65*(1899.574) =	1894.499	PPM
	CORRECTED NO =	2051.652	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

4-6-72 ENGINE 1-2 RUN-3 K =1.113 HUM = 113 GR/LB

	FEDERAL MODE	CONCENTRATION HC	CO	AS CO2	MEASURED NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
	1 IDLE	909	1.280	12.310	94	1.041	946	1.332	98	.036	34.059	.048	3.522
	2 16'HG	161	.710	13.740	1103	1.016	164	.722	1121	.089	14.561	.064	99.757
	3 10'HG	87	.270	13.210	2518	1.079	94	.291	2717	.257	24.124	.075	698.218
	4 16'HG	102	.790	13.800	1171	1.014	103	.801	1187	.089	9.202	.071	105.638
	5 19'HG	150	1.840	13.280	322	1.010	151	1.858	325	.047	7.118	.087	15.279
	6 16'HG	94	.780	13.630	1064	1.012	95	.790	1077	.089	8.470	.070	95.876
	7 3'HG	54	.420	13.350	2507	1.065	57	.447	2669	.283	16.271	.127	755.414
	8 16'HG	87	.790	13.740	1137	1.013	89	.805	1159	.089	7.890	.072	103.121
	9 C.T.	3793	2.170	4.720	133	1.464	5555	3.178	195	.021	116.647	.067	4.090
	SUM----------(CYCLE COMPOSITE)----------										238.342	.681	1880.916
CYCLE 2													
	1 IDLE	909	1.280	12.310	94	1.041	946	1.332	98	.036	34.059	.048	3.522
	2 16'HG	115	.800	13.650	1212	1.023	118	.818	1240	.089	10.470	.073	110.347
	3 10'HG	60	.250	13.170	2443	1.085	65	.271	2651	.257	16.736	.070	681.435
	4 16'HG	92	.870	13.590	1165	1.027	94	.893	1196	.089	8.406	.079	106.443
	5 19'HG	136	1.890	13.030	337	1.027	140	1.941	346	.047	6.563	.091	16.263
	6 16'HG	91	.780	13.600	1161	1.029	94	.803	1195	.089	8.336	.071	106.349
	7 3'HG	50	.410	13.280	2497	1.071	54	.439	2674	.283	15.154	.124	756.809
	8 16'HG	85	.850	13.470	1137	1.037	88	.881	1179	.089	7.843	.078	104.906
	9 C.T.	2984	1.740	4.230	128	1.742	5199	3.031	223	.021	109.174	.064	4.683
	SUM----------(CYCLE COMPOSITE)----------										216.741	.699	1890.757
CYCLE 3													
	1 IDLE	1345	1.510	11.810	136	1.034	1391	1.562	141	.036	50.086	.056	5.064
	2 16'HG	120	.900	13.450	1102	1.034	124	.930	1139	.089	11.038	.083	101.366
	3 10'HG	64	.260	13.030	2528	1.096	70	.285	2771	.257	18.028	.073	712.110
	4 16'HG	88	.790	13.540	1086	1.033	91	.816	1122	.089	8.094	.073	99.892
	5 19'HG	118	1.750	13.040	342	1.033	122	1.807	353	.047	5.727	.085	16.598
	6 16'HG	88	.720	13.630	1113	1.029	91	.741	1146	.089	8.063	.066	101.975
	7 3'HG	49	.540	13.090	2481	1.081	53	.584	2682	.283	14.991	.165	759.028
	8 16'HG	88	.890	13.520	1164	1.031	91	.918	1200	.089	8.077	.082	106.838
	9 C.T.	3575	2.100	4.660	159	1.515	5416	3.181	241	.021	113.738	.067	5.059
	SUM----------(CYCLE COMPOSITE)----------										237.842	.750	1907.930
CYCLE 4													
	1 IDLE	1345	1.510	11.810	136	1.034	1391	1.562	141	.036	50.086	.056	5.064
	2 16'HG	117	.910	13.420	1133	1.036	121	.942	1173	.089	10.784	.084	104.428
	3 10'HG	62	.250	13.030	2644	1.097	68	.274	2900	.257	17.474	.070	745.190
	4 16'HG	90	.860	13.470	1188	1.036	93	.891	1231	.089	8.298	.079	109.530
	5 19'HG	104	1.820	13.020	352	1.033	107	1.879	363	.047	5.047	.088	17.083
	6 16'HG	87	.740	13.500	1178	1.038	90	.768	1223	.089	8.040	.068	108.867
	7 3'HG	43	.360	13.060	2601	1.091	47	.393	2839	.283	13.280	.111	803.316
	8 16'HG	81	.780	13.440	1208	1.042	84	.813	1259	.089	7.511	.072	112.012
	9 C.T.	3623	2.210	4.670	192	1.497	5423	3.308	287	.021	113.875	.069	6.035
	SUM----------(CYCLE COMPOSITE)----------										234.396	.700	2011.524

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 227.542 .690 1885.837

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 236.119 .725 1959.727

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(227.542) + 0.65*(236.119) =	233.117	PPM
CO	0.35*(.690) + 0.65*(.725) =	.712	PERCENT
NO	0.35*(1885.837) + 0.65*(1959.727) =	1933.866	PPM
	CORRECTED NO =	2152.848	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

4-6-72 ENGINE 1-2 RUN-4 K =1.088 HUM = 103 GR/LB

	FEDERAL MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
	1 IDLE	1440	.970	11.160	88	1.098	1582	1.066	97	.036	56.945	.038	3.480
	2 16'HG	354	.640	13.750	1002	1.003	355	.642	1005	.089	31.610	.057	89.472
	3 10'HG	88	.200	13.090	2579	1.091	96	.218	2815	.257	24.684	.056	723.418
	4 16'HG	101	.760	13.670	1133	1.024	103	.778	1160	.089	9.205	.069	103.265
	5 19'HG	140	1.650	13.120	332	1.029	144	1.697	342	.047	6.768	.080	16.051
	6 16'HG	98	.660	13.720	1195	1.024	100	.676	1224	.089	8.934	.060	108.941
	7 3'HG	61	.430	13.310	2481	1.067	65	.459	2647	.283	18.418	.130	749.089
	8 16'HG	90	.710	13.670	1156	1.027	92	.729	1187	.089	8.224	.065	105.636
	9 C.T.	3163	1.850	4.240	124	1.690	5345	3.126	210	.021	112.240	.066	4.400
	SUM----------(CYCLE COMPOSITE)----------										277.029	.621	1903.753
CYCLE 2													
	1 IDLE	1440	.970	11.160	88	1.098	1582	1.066	97	.036	56.945	.038	3.480
	2 16'HG	145	.630	13.450	1564	1.042	151	.656	1629	.089	13.441	.058	144.979
	3 10'HG	81	.290	13.040	2486	1.092	88	.317	2716	.257	22.742	.081	697.992
	4 16'HG	102	.810	13.490	1126	1.035	106	.839	1166	.089	9.399	.075	103.755
	5 19'HG	153	1.870	12.920	322	1.034	158	1.934	333	.047	7.437	.091	15.652
	6 16'HG	97	.840	13.500	1137	1.034	100	.868	1176	.089	8.926	.077	104.622
	7 3'HG	53	.430	13.050	2547	1.088	58	.468	2772	.283	16.325	.132	784.524
	8 16'HG	86	.790	13.500	1273	1.037	89	.819	1320	.089	7.934	.073	117.445
	9 C.T.	2555	1.720	4.300	151	1.831	4678	3.149	276	.021	98.239	.066	5.806
	SUM----------(CYCLE COMPOSITE)----------										241.388	.692	1978.254
CYCLE 3													
	1 IDLE	1159	1.510	11.760	186	1.053	1221	1.590	196	.036	43.946	.057	7.053
	2 16'HG	127	.860	13.400	1165	1.038	132	.893	1209	.089	11.734	.079	107.641
	3 10'HG	66	.230	12.930	2703	1.105	73	.254	2988	.257	18.751	.065	767.956
	4 16'HG	92	.770	13.400	1258	1.044	96	.804	1314	.089	8.551	.072	116.926
	5 19'HG	145	1.720	12.880	372	1.043	151	1.795	388	.047	7.111	.084	18.243
	6 16'HG	93	.710	13.410	1230	1.046	97	.742	1286	.089	8.656	.066	114.480
	7 3'HG	53	.440	13.070	2546	1.086	58	.478	2766	.283	16.294	.135	782.747
	8 16'HG	87	.810	13.460	1194	1.039	90	.841	1240	.089	8.043	.075	110.385
	9 C.T.	2832	1.870	4.360	194	1.736	4916	3.246	337	.021	103.231	.068	7.072
	SUM----------(CYCLE COMPOSITE)----------										226.318	.702	2032.502
CYCLE 4													
	1 IDLE	1159	1.510	11.760	186	1.053	1221	1.590	196	.036	43.946	.057	7.053
	2 16'HG	149	.870	13.290	1434	1.044	156	.908	1497	.089	13.847	.081	133.270
	3 10'HG	75	.310	13.020	2427	1.094	82	.339	2655	.257	21.084	.087	682.273
	4 16'HG	94	.810	13.360	1143	1.046	98	.847	1195	.089	8.748	.075	106.374
	5 19'HG	150	1.800	12.820	415	1.045	157	1.880	433	.047	7.364	.088	20.373
	6 16'HG	89	.770	13.260	1530	1.055	94	.813	1614	.089	8.358	.072	143.690
	7 3'HG	49	.470	13.060	2540	1.086	53	.511	2759	.283	15.064	.144	780.862
	8 16'HG	81	.780	13.170	1178	1.062	86	.829	1252	.089	7.659	.074	111.391
	9 C.T.	2975	2.030	4.340	227	1.692	5035	3.435	384	.021	105.729	.072	8.067
	SUM----------(CYCLE COMPOSITE)----------										231.801	.752	1993.355

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 259.208 .657 1941.004

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 229.059 .727 2012.929

FOUR CYCLE COMPOSITE - REPORTED VALUES =

HC	0.35*(259.208) + 0.65*(229.059) =	239.611	PPM
CO	0.35*(.657) + 0.65*(.727) =	.702	PERCENT
NO	0.35*(1941.004) + 0.65*(2012.929) =	1987.755	PPM
	CORRECTED NO =	2163.376	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

ENGINE 1-2

NINE MODE FTP EMISSION RESULTS

BRAKE SPECIFIC BASIS

4-6-72 ENGINE 1-2 RUN-2 K = 1.07 HUM = 101 GR/LB

MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1														
1 IDLE	1136	1.420	11.66	80	14.307	3074	264	616	6	.232	61.1	143	1.3	0
2 16 HG	95	.670	13.78	1083	14.553	13284	94	1235	328	.077	7.2	95	25.3	38
3 10 HG	61	.210	13.28	2550	13.556	19227	93	602	1201	.147	13.7	88	176.5	76
4 16 HG	86	.790	13.79	1105	14.673	13284	84	1445	332	.077	6.5	111	25.6	38
5 19 HG	179	1.810	13.13	332	15.133	9788	125	2365	71	.057	7.1	135	4.1	11
6 16 HG	88	.740	13.80	1143	14.635	13284	86	1357	344	.077	6.6	104	26.5	38
7 3 HG	42	.340	13.34	2438	13.725	26904	89	1346	1587	.113	10.0	152	179.3	120
8 16 HG	82	.760	13.67	1096	14.519	13284	81	1405	333	.077	6.2	108	25.6	38
9 C.T.	3027	1.870	4.34	123	9.479	2883	994	1149	12	.143	142.2	164	1.8	0
SUM----------(CYCLE COMPOSITE)----------											7.0	30	12.6	
CYCLE 2														
1 IDLE	1136	1.420	11.66	80	14.307	3074	264	616	6	.232	61.1	143	1.3	0
2 16 HG	154	.890	13.56	1069	14.616	13284	151	1634	323	.077	11.6	126	24.8	38
3 10 HG	70	.230	13.05	2540	13.356	19227	109	669	1214	.147	16.0	98	178.5	76
4 16 HG	93	.770	13.62	1161	14.490	13284	92	1426	353	.077	7.1	110	27.2	38
5 19 HG	108	1.850	13.08	347	15.047	9788	76	2431	75	.057	4.3	139	4.3	11
6 16 HG	88	.820	13.57	1086	14.485	13284	87	1519	331	.077	6.7	117	25.5	38
7 3 HG	46	.460	13.14	2476	13.650	26904	98	1831	1620	.113	11.1	207	183.1	120
8 16 HG	82	.850	13.49	1093	14.429	13284	82	1581	334	.077	6.3	122	25.7	38
9 C.T.	3685	2.310	4.66	141	10.950	2883	1048	1229	14	.143	149.8	176	2.0	0
SUM----------(CYCLE COMPOSITE)----------											7.4	33	12.7	
CYCLE 3														
1 IDLE	1120	1.470	11.59	144	14.270	3074	261	640	10	.232	60.4	148	2.4	0
2 16 HG	155	.920	13.47	1116	14.557	13284	153	1696	338	.077	11.8	131	26.0	38
3 10 HG	71	.300	13.06	2441	13.437	19227	110	867	1160	.147	16.1	127	170.5	76
4 16 HG	91	.790	13.55	1083	14.438	13284	90	1468	331	.077	7.0	113	25.5	38
5 19 HG	125	1.770	13.06	351	14.965	9788	88	2339	76	.057	5.0	133	4.3	11
6 16 HG	91	.920	13.46	1270	14.478	13284	90	1705	387	.077	6.9	131	29.8	38
7 3 HG	44	.440	12.94	2396	13.428	26904	95	1781	1594	.113	10.8	201	180.1	120
8 16 HG	77	.750	13.22	1037	14.053	13284	79	1432	325	.077	6.1	110	25.1	38
9 C.T.	2818	1.870	4.14	151	9.053	2883	969	1203	16	.143	138.6	172	2.3	0
SUM----------(CYCLE COMPOSITE)----------											7.1	34	12.6	
CYCLE 4														
1 IDLE	1120	1.470	11.59	144	14.270	3074	261	640	10	.232	60.4	148	2.4	0
2 16 HG	146	.840	13.43	1089	14.428	13284	145	1562	333	.077	11.2	120	25.6	38
3 10 HG	63	.230	13.00	2520	13.298	19227	98	672	1210	.147	14.5	99	177.8	76
4 16 HG	88	.810	13.46	1102	14.365	13284	88	1513	338	.077	6.8	117	26.1	38
5 19 HG	115	1.870	12.91	351	14.904	9788	82	2481	77	.057	4.6	141	4.4	11
6 16 HG	90	.780	13.43	1219	14.307	13284	90	1463	376	.077	6.9	113	28.9	38
7 3 HG	45	.410	13.05	2470	13.509	26904	97	1649	1633	.113	10.9	186	184.6	120
8 16 HG	82	.870	13.47	1158	14.429	13284	82	1618	354	.077	6.3	125	27.3	38
9 C.T.	3290	2.080	4.43	194	10.063	2883	1018	1204	18	.143	145.6	172	2.6	0
SUM----------(CYCLE COMPOSITE)----------											7.2	33	12.9	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------											7.2	32	12.6	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------											7.1	34	12.7	

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(7.2) + 0.65(7.1) = 7.162 (MASS)
CO 0.35(32) + 0.65(34) = 32.8 (MASS)
NO2 0.35(12.6) + 0.65(12.7) = 12.704 (MASS)
CORRECTED NO2 = 13.569 (MASS)

4-6-72 ENGINE 1-2 RUN-3 K = 1.09 HUM = 113 GR/LB

	MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1															
	1 IDLE	909	1.280	12.31	94	14.572	3074	207	545	7	.232	48.0	127	1.5	0
	2 16 HG	161	.710	13.74	1103	14.624	13284	158	1303	333	.077	12.2	100	25.6	38
	3 10 HG	87	.270	13.21	2518	13.574	19227	133	773	1184	.147	19.6	114	174.1	76
	4 16 HG	102	.790	13.80	1171	14.700	13284	100	1442	351	.077	7.7	111	27.1	38
	5 19 HG	150	1.840	13.28	322	15.282	9788	104	2381	68	.057	5.9	136	3.9	11
	6 16 HG	94	.780	13.83	1064	14.712	13284	92	1423	319	.077	7.1	110	24.6	38
	7 3 HG	54	.420	13.35	2507	13.828	26904	113	1651	1619	.113	12.8	187	183.0	120
	8 16 HG	87	.790	13.74	1137	14.624	13284	85	1450	343	.077	6.6	112	26.4	38
	9 C.T.	3793	2.170	4.72	133	10.986	2883	1075	1150	12	.143	153.7	164	1.7	0
	SUM----------(CYCLE COMPOSITE)----------											7.4	31	12.6	
CYCLE 2															
	1 IDLE	909	1.280	12.31	94	14.572	3074	207	545	7	.232	48.0	127	1.5	0
	2 16 HG	115	.800	13.65	1212	14.574	13284	113	1473	367	.077	8.7	113	28.2	38
	3 10 HG	60	.250	13.17	2443	13.485	19227	92	720	1156	.147	13.6	106	170.0	76
	4 16 HG	92	.870	13.59	1165	14.559	13284	91	1603	353	.077	7.0	123	27.2	38
	5 19 HG	136	1.890	13.03	337	15.067	9788	95	2480	73	.057	5.4	141	4.1	11
	6 16 HG	91	.780	13.60	1161	14.478	13284	90	1446	354	.077	6.9	111	27.2	38
	7 3 HG	50	.410	13.28	2497	13.744	26904	106	1621	1623	.113	11.9	183	183.4	120
	8 16 HG	85	.850	13.47	1137	14.412	13284	85	1583	348	.077	6.5	122	26.8	38
	9 C.T.	2984	1.740	4.23	128	9.193	2883	1011	1102	13	.143	144.5	158	1.9	0
	SUM----------(CYCLE COMPOSITE)----------											6.8	32	12.7	
CYCLE 3															
	1 IDLE	1345	1.510	11.81	136	14.773	3074	302	635	9	.232	70.1	147	2.2	0
	2 16 HG	120	.900	13.45	1102	14.480	13284	119	1668	336	.077	9.2	128	25.8	38
	3 10 HG	64	.260	13.03	2528	13.359	19227	99	756	1208	.147	14.6	111	177.6	76
	4 16 HG	88	.790	13.54	1086	14.425	13284	88	1470	332	.077	6.7	113	25.6	38
	5 19 HG	118	1.750	13.04	342	14.917	9788	84	2320	75	.057	4.8	132	4.2	11
	6 16 HG	88	.720	13.63	1113	14.445	13284	87	1338	340	.077	6.7	103	26.2	38
	7 3 HG	49	.540	13.09	2481	13.683	26904	104	2145	1620	.113	11.8	242	183.0	120
	8 16 HG	88	.890	13.52	1164	14.505	13284	87	1646	354	.077	6.7	127	27.3	38
	9 C.T.	3575	2.100	4.66	159	10.621	2883	1048	1151	14	.143	149.9	165	2.0	0
	SUM----------(CYCLE COMPOSITE)----------											7.6	34	12.8	
CYCLE 4															
	1 IDLE	1345	1.510	11.81	136	14.773	3074	302	635	9	.232	70.1	147	2.2	0
	2 16 HG	117	.910	13.42	1133	14.456	13284	116	1689	346	.077	8.9	130	26.6	38
	3 10 HG	62	.250	13.03	2644	13.347	19227	96	727	1265	.147	14.2	107	185.9	76
	4 16 HG	90	.860	13.47	1188	14.427	13284	89	1600	363	.077	6.9	123	28.0	38
	5 19 HG	104	1.820	13.02	352	14.952	9788	74	2407	77	.057	4.2	137	4.4	11
	6 16 HG	87	.740	13.50	1178	14.334	13284	87	1385	362	.077	6.7	107	27.9	38
	7 3 HG	43	.360	13.06	2601	13.466	26904	93	1453	1725	.113	10.5	164	194.9	120
	8 16 HG	81	.780	13.44	1208	14.307	13284	81	1463	372	.077	6.3	113	28.7	38
	9 C.T.	3623	2.210	4.67	192	10.793	2883	1045	1192	17	.143	149.5	171	2.4	0
	SUM----------(CYCLE COMPOSITE)----------											7.5	32	13.5	

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 7.1 32 12.6

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 7.5 33 13.1

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(7.1) + 0.65(7.5) = 7.364 (MASS)
CO 0.35(32) + 0.65(33) = 32.7 (MASS)
NO2 0.35(12.6) + 0.65(13.1) = 12.960 (MASS)
CORRECTED NO2 = 14.120 (MASS)

4-6-72 ENGINE 1-2 RUN-4 K = 1.07 HUM = 103 GR/LB

MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1														
1 IDLE	1440	.970	11.16	88	13.685	3074	349	440	7	.232	81.0	102	1.5	0
2 16 HG	354	.640	13.75	1002	14.772	13284	344	1163	299	.077	26.5	90	23.0	38
3 10 HG	88	.200	13.09	2579	13.385	19227	137	580	1230	.147	20.1	85	180.8	76
4 16 HG	101	.760	13.67	1133	14.539	13284	100	1403	344	.077	7.7	108	26.5	38
5 19 HG	140	1.650	13.12	332	14.921	9788	99	2186	72	.057	5.7	125	4.1	11
6 16 HG	98	.660	13.72	1195	14.486	13284	97	1223	364	.077	7.5	94	28.0	38
7 3 HG	61	.430	13.31	2481	13.806	26904	128	1693	1605	.113	14.5	191	181.4	120
8 16 HG	90	.710	13.67	1156	14.477	13284	89	1316	352	.077	6.9	101	27.1	38
9 C.T.	3163	1.850	4.24	124	9.506	2883	1036	1133	12	.143	148.1	162	1.8	0
SUM----------(CYCLE COMPOSITE)----------											8.6	29	12.8	
CYCLE 2														
1 IDLE	1440	.970	11.16	88	13.685	3074	349	440	7	.232	81.0	102	1.5	0
2 16 HG	145	.630	13.45	1564	14.237	13284	146	1187	485	.077	11.3	91	37.3	38
3 10 HG	81	.290	13.04	2486	13.417	19227	125	839	1183	.147	18.4	123	173.9	76
4 16 HG	102	.810	13.49	1126	14.410	13284	102	1508	345	.077	7.8	116	26.5	38
5 19 HG	153	1.870	12.92	322	14.955	9788	108	2472	70	.057	6.2	141	4.0	11
6 16 HG	97	.840	13.50	1137	14.445	13284	96	1560	347	.077	7.4	120	26.7	38
7 3 HG	53	.430	13.05	2547	13.537	26904	114	1726	1681	.113	12.9	195	189.9	120
8 16 HG	86	.790	13.50	1273	14.383	13284	86	1474	390	.077	6.6	113	30.1	38
9 C.T.	2555	1.720	4.30	151	8.779	2883	906	1141	16	.143	129.6	163	2.4	0
SUM----------(CYCLE COMPOSITE)----------											7.6	31	13.3	
CYCLE 3														
1 IDLE	1159	1.510	11.76	186	14.522	3074	265	646	13	.232	61.5	150	3.0	0
2 16 HG	127	.860	13.40	1165	14.397	13284	127	1603	357	.077	9.7	123	27.5	38
3 10 HG	66	.230	12.93	2703	13.231	19227	104	675	1304	.147	15.2	99	191.7	76
4 16 HG	92	.770	13.40	1258	14.269	13284	92	1448	389	.077	7.1	111	29.9	38
5 19 HG	145	1.720	12.88	372	14.757	9788	104	2305	82	.057	5.9	131	4.7	11
6 16 HG	93	.710	13.41	1230	14.220	13284	94	1340	381	.077	7.2	103	29.4	38
7 3 HG	53	.440	13.07	2546	13.567	26904	114	1763	1676	.113	12.8	199	189.4	120
8 16 HG	87	.810	13.46	1194	14.364	13284	87	1513	367	.077	6.7	117	28.2	38
9 C.T.	2832	1.870	4.36	194	9.289	2883	949	1172	20	.143	135.7	168	2.9	0
SUM----------(CYCLE COMPOSITE)----------											7.1	32	13.7	
CYCLE 4														
1 IDLE	1159	1.510	11.76	186	14.522	3074	265	646	13	.232	61.5	150	3.0	0
2 16 HG	149	.870	13.29	1434	14.321	13284	149	1630	442	.077	11.5	126	34.0	38
3 10 HG	75	.310	13.02	2427	13.411	19227	116	898	1155	.147	17.1	132	169.8	76
4 16 HG	94	.810	13.36	1143	14.272	13284	94	1523	353	.077	7.3	117	27.2	38
5 19 HG	150	1.800	12.82	415	14.782	9788	107	2408	91	.057	6.1	137	5.2	11
6 16 HG	89	.770	13.26	1530	14.126	13284	90	1463	478	.077	7.0	113	36.8	38
7 3 HG	49	.470	13.06	2540	13.583	26904	105	1880	1670	.113	11.8	212	188.7	120
8 16 HG	81	.780	13.17	1178	14.037	13284	83	1491	370	.077	6.4	115	28.5	38
9 C.T.	2975	2.030	4.34	227	9.583	2883	967	1234	23	.143	138.2	176	3.2	0
SUM----------(CYCLE COMPOSITE)----------											7.2	34	13.4	

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 8.1 30 13.0

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 7.1 33 13.5

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(8.1) + 0.65(7.1) = 7.455 (MASS)
CO 0.35(30) + 0.65(33) = 32.2 (MASS)
NO2 0.35(13.0) + 0.65(13.5) = 13.342 (MASS)
CORRECTED NO2 = 14.304 (MASS)

ENGINE 1-2

EXPERIMENTAL 23 MODE EMISSION RESULTS

BRAKE SPECIFIC BASIS

PROJECT 11-2877-01 CONTROL TECHNOLOGY

4-07-72 RUN 1 ENGINE 1-2 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL RATE LB/HR	FUEL RATE GM/HR	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	550	0.0	0	18.5	6.8	3071	44	18687	1.090	9.64	43
2	1200	7.5	2	20.0	12.4	5643	46	8332	2.600	11.01	68
3	1200	30.0	7	19.0	14.1	6400	49	3384	2.360	11.48	114
4	1200	67.6	15	17.4	16.2	7353	50	2766	2.110	11.84	235
5	1200	93.9	21	16.4	18.1	8210	54	2803	1.870	11.24	420
6	1200	187.5	43	11.0	23.9	10832	37	2349	.470	12.34	2000
7	1200	281.0	64	1.2	33.9	15368	81	718	.130	11.24	1100
8	1200	308.0	70	1.0	36.0	16339	64	664	.130	11.36	1750
9	1200	345.0	79	.8	41.3	18720	78	2590	2.400	11.24	1400
10	1200	375.0	86	0.0	46.9	21292	92	2881	3.240	10.78	1100
11	550	0.0	0	18.5	6.8	3071	76	11068	1.300	10.25	46
12	1200	0.0	0	22.5	6.3	2840	79	51914	1.270	5.16	14
13	2300	370.0	162	.9	90.0	40824	82	3621	4.260	11.92	813
14	2300	340.0	149	1.5	75.7	34347	70	1888	3.100	12.47	1262
15	2300	303.0	133	3.4	70.1	31784	146	508	.390	13.48	2250
16	2300	278.0	122	5.3	62.2	28218	26	772	.310	13.48	2400
17	2300	185.0	81	10.5	46.6	21133	38	504	.130	12.94	2650
18	2300	92.5	41	16.0	33.6	15223	31	1468	.520	13.48	1300
19	2300	66.6	29	17.0	30.1	13640	41	1527	.670	13.48	950
20	2300	29.6	13	19.0	25.1	11394	83	1640	.970	13.18	525
21	2300	7.4	3	20.2	22.3	10124	32	2260	1.340	12.71	300
22	550	0.0	0	18.5	6.8	3071	43	19303	.890	10.25	44
23	2300	0.0	0	24.5	7.1	3239	76	27807	.420	2.81	8

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	2.3	455.5	537	3.4	.070	0.0	R	R	R	R
2	3.8	325.5	2052	8.8	.060	.1	2.2	189.95	1197.4	5.1
3	4.8	152.8	2152	17.0	.060	.4	.7	22.29	313.9	2.5
4	5.6	143.0	2203	40.3	.050	.8	.4	9.26	142.6	2.6
5	7.1	171.9	2316	85.5	.030	.6	.3	8.01	108.0	4.0
6	6.6	195.0	788	551.4	.060	2.6	.2	4.55	18.4	12.9
7	23.5	96.5	353	490.5	0.000	0.0	.4	1.50	5.5	7.6
8	19.5	93.8	371	821.4	.040	2.8	.3	1.33	5.3	11.7
9	22.7	348.9	6530	626.0	0.000	0.0	.3	4.43	82.8	7.9
10	29.7	428.7	9739	543.5	0.000	0.0	.3	5.00	113.7	6.3
11	4.0	268.5	637	3.7	.070	0.0	R	R	R	R
12	4.2	1268.5	627	1.2	.120	0.0	R	R	R	R
13	44.0	893.7	21237	665.7	.025	4.1	.3	5.52	131.1	4.1
14	32.9	411.4	13648	913.5	.055	8.2	.2	2.76	91.7	6.1
15	72.1	115.9	1799	1705.5	.035	4.6	.5	.87	13.6	12.9
16	11.4	157.2	1274	1621.4	.060	7.3	.1	1.29	10.5	13.3
17	13.2	81.2	423	1417.1	.060	4.9	.2	1.00	5.2	17.5
18	7.1	158.0	1130	464.4	0.000	0.0	.2	3.90	27.9	11.5
19	8.5	145.6	1291	300.8	.065	1.9	.3	4.99	44.3	10.3
20	14.3	130.5	1560	138.7	0.000	0.0	1.1	10.07	120.3	10.7
21	4.9	160.3	1920	70.6	0.000	0.0	1.5	49.46	592.4	21.8
22	2.2	453.5	422	3.5	.080	0.0	R	R	R	R
23	8.9	1498.3	457	1.4	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	11.979	GRAM/BHP HR
	CO	58.620	GRAM/BHP HR
	NO2	10.494	GRAM/BHP HR
	ALDE	.295	GRAM/BHP HR
	BSFC	.675	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

4-10-72 RUN 1 ENGINE 1-2 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL RATE LB/HR	FUEL RATE GM/HR	DRY CONCENTRATION ALDE.	HC	CO	CO2	NO
1	550	0.0	0	18.5	6.8	3071	32	18841	.930	10.78	40
2	1200	7.5	2	20.2	12.4	5643	31	8146	2.480	11.72	75
3	1200	30.0	7	19.3	14.1	6400	27	5077	2.140	11.72	122
4	1200	67.6	15	17.5	16.2	7353	48	3072	1.660	11.01	280
5	1200	93.9	21	16.4	18.1	8210	62	3064	1.450	10.89	475
6	1200	187.5	43	11.5	23.9	10832	35	2494	.350	11.36	2000
7	1200	281.0	64	3.0	33.9	15368	21	937	.100	11.01	1600
8	1200	308.0	70	1.2	36.0	16339	76	1105	.100	11.24	1850
9	1200	345.0	79	1.0	41.3	18720	40	3294	1.010	11.60	2100
10	1200	375.0	86	0.0	46.9	21292	33	4387	2.730	10.78	1100
11	550	0.0	0	18.5	6.8	3071	41	11003	1.200	9.64	47
12	1200	0.0	0	22.5	6.3	2840	98	68331	1.090	4.45	14
13	2300	370.0	162	.9	90.0	40824	57	4538	4.260	11.84	875
14	2300	340.0	149	1.7	75.7	34347	90	1930	.970	13.63	2375
15	2300	303.0	133	4.5	70.1	31784	90	786	.310	12.94	2400
16	2300	278.0	122	5.5	62.2	28218	26	514	.180	12.47	2650
17	2300	185.0	81	10.7	46.6	21133	41	642	.130	11.36	2850
18	2300	92.5	41	16.2	33.6	15223	32	1381	.350	11.01	1450
19	2300	66.6	29	17.4	30.1	13640	35	1497	.440	11.36	913
20	2300	29.6	13	19.1	25.1	11394	51	1557	.670	11.48	475
21	2300	7.4	3	20.4	22.3	10124	30	2507	1.120	11.24	250
22	550	0.0	0	18.5	6.8	3071	71	17970	.700	8.93	40
23	2300	0.0	0	24.7	7.1	3239	59	22490	.250	2.16	8

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	1.6	425.6	424	3.0	.070	0.0	R	R	R	R
2	2.5	306.1	1883	9.4	.060	.1	1.5	178.65	1098.7	5.5
3	2.6	226.2	1926	18.1	.060	.4	.4	32.99	280.9	2.6
4	5.9	174.1	1900	52.7	.050	.8	.4	11.27	123.0	3.4
5	8.8	198.9	1902	102.4	.030	.6	.4	9.27	88.6	4.8
6	6.8	225.9	640	601.4	.060	2.6	.2	5.27	14.9	14.0
7	6.2	128.6	277	728.6	0.000	0.0	.1	2.00	4.3	11.3
8	23.3	157.7	288	876.4	.040	2.8	.3	2.24	4.1	12.5
9	12.4	476.6	2952	1008.7	0.000	0.0	.2	6.05	37.4	12.8
10	11.0	669.7	8418	557.5	0.000	0.0	.1	7.82	98.2	6.5
11	2.3	283.0	623	4.0	.070	0.0	R	R	R	R
12	4.9	1568.1	505	1.0	.120	0.0	R	R	R	R
13	30.3	1119.2	21222	716.4	.025	4.1	.2	6.91	131.0	4.4
14	45.1	448.0	4549	1830.8	.055	8.2	.3	3.01	30.6	12.3
15	46.3	187.4	1493	1900.1	.035	4.6	.3	1.41	11.3	14.3
16	12.4	114.2	808	1954.6	.060	7.3	.1	.94	6.6	16.1
17	16.2	117.4	480	1730.7	.060	4.9	.2	1.45	5.9	21.4
18	9.1	182.9	936	637.3	0.000	0.0	.2	4.51	23.1	15.7
19	8.6	170.9	1015	345.8	.065	1.9	.3	5.86	34.8	11.9
20	10.3	144.2	1253	146.0	0.000	0.0	.8	11.12	96.7	11.3
21	5.3	201.3	1816	66.6	0.000	0.0	1.6	62.11	560.5	20.6
22	4.1	482.9	380	3.6	.080	0.0	R	R	R	R
23	8.9	1563.4	351	1.7	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	13.613	GRAM/BHP HR
	CO	41.614	GRAM/BHP HR
	NO2	13.282	GRAM/BHP HR
	ALDE	.289	GRAM/BHP HR
	BSFC	.675	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

4-10-72 RUN 2 ENGINE 1-2 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL RATE LB/HR	FUEL RATE GM/HR	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	550	0.0	0	18.5	6.8	3071	45	18878	.930	11.01	37
2	1200	7.5	2	20.2	12.4	5643	35	7942	2.210	12.34	89
3	1200	30.0	7	19.3	14.1	6400	32	4612	2.020	11.48	127
4	1200	67.6	15	17.5	16.2	7353	31	3088	1.800	11.48	330
5	1200	93.9	21	16.5	18.1	8210	39	3069	1.410	11.13	550
6	1200	187.5	43	11.5	23.9	10832	36	2501	.350	11.72	2100
7	1200	281.0	64	3.1	33.9	15368	40	656	.130	9.93	1800
8	1200	308.0	70	1.2	36.0	16339	72	823	.130	10.43	2150
9	1200	345.0	79	1.0	41.3	18720	45	2758	.610	10.55	2500
10	1200	375.0	86	0.0	46.9	21292	57	3112	2.690	9.37	1050
11	550	0.0	0	18.5	6.8	3071	50	11090	1.230	10.55	48
12	1200	0.0	0	22.5	6.3	2840	79	56207	.930	4.54	12
13	2300	370.0	162	.9	90.0	40824	44	3445	4.210	11.84	900
14	2300	340.0	149	1.7	75.7	34347	80	1818	1.270	13.48	2350
15	2300	303.0	133	4.5	70.1	31784	42	560	.250	12.82	2700
16	2300	278.0	122	5.6	62.2	28218	25	678	.150	11.92	2900
17	2300	185.0	81	10.7	46.6	21133	27	647	.130	11.24	3000
18	2300	92.5	41	16.2	33.6	15223	42	1331	.310	11.48	1450
19	2300	66.5	29	17.4	30.1	13640	63	1389	.420	11.60	1175
20	2300	29.6	13	19.2	25.1	11394	27	1559	.670	11.60	575
21	2300	7.4	3	20.4	22.3	10124	31	1791	1.050	11.84	300
22	550	0.0	0	18.5	6.8	3071	42	13611	.580	9.03	43
23	2300	0.0	0	24.7	7.1	3239	94	25613	.280	2.37	7

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	2.2	419.2	417	2.7	.070	0.0	R	R	R	R
2	2.8	292.1	1642	10.8	.060	.1	1.6	170.44	958.0	6.3
3	3.2	211.4	1871	19.4	.060	.4	.5	30.85	272.9	2.8
4	3.6	167.1	1967	59.3	.050	.8	.2	10.82	127.4	3.8
5	5.3	196.1	1820	116.7	.030	.6	.2	9.14	84.8	5.4
6	6.8	219.9	622	613.0	.060	2.6	.2	5.13	14.5	14.3
7	13.0	99.5	399	907.0	0.000	0.0	.2	1.55	6.2	14.1
8	23.7	126.4	403	1095.9	.040	2.8	.3	1.80	5.7	15.6
9	16.1	451.5	2017	1358.7	0.000	0.0	.2	5.73	25.6	17.2
10	21.1	535.7	9352	600.0	0.000	0.0	.2	6.25	109.1	7.0
11	2.6	264.2	592	3.8	.070	0.0	R	R	R	R
12	4.4	1439.1	481	1.0	.120	0.0	R	R	R	R
13	23.4	857.9	21176	744.0	.025	4.1	.1	5.29	130.7	4.6
14	39.5	418.3	5901	1794.6	.055	8.2	.3	2.81	39.6	12.1
15	21.8	135.7	1223	2170.6	.035	4.6	.2	1.02	9.2	16.4
16	12.4	157.6	704	2238.4	.060	7.3	.1	1.29	5.8	18.4
17	10.9	119.5	485	1840.8	.060	4.9	.1	1.47	6.0	22.7
18	11.6	169.9	800	614.6	0.000	0.0	.3	4.19	19.7	15.2
19	15.3	155.8	952	437.6	.065	1.9	.5	5.34	32.6	15.0
20	5.3	142.9	1241	175.1	0.000	0.0	.4	11.03	95.7	13.5
21	5.3	138.7	1643	77.2	0.000	0.0	1.6	42.81	507.0	23.8
22	2.6	381.0	328	3.9	.080	0.0	R	R	R	R
23	12.6	1591.8	352	1.3	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	12.680	GRAM/BHP HR
	CO	42.415	GRAM/BHP HR
	NO2	14.540	GRAM/BHP HR
	ALDE	.256	GRAM/BHP HR
	BSFC	.675	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

4-11-72 RUN 1 ENGINE 1-2 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL RATE LB/HR	FUEL RATE GM/HR	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	550	0.0	0	18.0	6.8	3071	0	18896	1.050	11.01	42
2	1200	7.6	2	20.2	12.4	5643	0	6317	2.360	11.48	85
3	1200	30.4	7	19.2	14.1	6400	0	3953	2.140	11.84	127
4	1200	68.5	16	17.6	16.2	7353	0	3391	1.870	12.22	270
5	1200	95.0	22	16.2	18.1	8210	0	3385	1.520	12.34	570
6	1200	190.0	43	11.0	23.9	10832	0	2858	.350	12.71	2150
7	1200	285.0	65	2.6	33.9	15368	0	776	.100	11.60	1700
8	1200	312.0	71	2.2	36.0	16339	0	1114	.150	12.22	2150
9	1200	350.0	80	2.1	41.3	18720	0	2705	1.270	12.47	2050
10	1200	380.0	87	0.0	46.9	21292	0	3629	3.150	11.36	950
11	550	0.0	0	18.0	6.8	3071	0	11133	1.120	11.13	48
12	1200	0.0	0	22.9	6.3	2840	0	63291	1.090	4.84	13
13	2300	370.0	162	1.9	90.0	40824	0	4137	4.400	11.72	850
14	2300	340.0	149	2.7	75.7	34347	0	1931	1.050	13.63	2400
15	2300	303.0	133	4.7	70.1	31784	0	848	.420	13.77	2600
16	2300	278.0	122	5.8	62.2	28218	0	724	.310	13.91	2900
17	2300	185.0	81	11.3	46.6	21133	0	579	.210	13.18	2800
18	2300	92.5	41	16.3	33.6	15223	0	1338	.470	11.92	1400
19	2300	66.6	29	17.7	30.1	13640	0	1505	.550	11.84	1000
20	2300	29.6	13	19.2	25.1	11394	0	1562	.770	11.72	525
21	2300	7.4	3	20.2	22.3	10124	0	2284	1.090	11.24	300
22	550	0.0	0	18.4	6.8	3071	0	16478	1.010	9.64	48
23	2300	0.0	0	24.7	7.1	3239	0	30705	.490	2.05	8

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	416.0	467	3.1	.070	0.0	I	R	R	R
2	0.0	246.3	1859	11.0	.060	.1	0.0	141.84	1070.5	6.3
3	0.0	176.0	1925	18.8	.060	.4	0.0	25.34	277.1	2.7
4	0.0	172.8	1925	45.7	.050	.8	0.0	11.04	123.0	2.9
5	0.0	195.7	1775	109.4	.030	.7	0.0	9.02	81.8	5.0
6	0.0	232.0	574	579.3	.060	2.6	0.0	5.34	13.2	13.3
7	0.0	101.2	264	736.5	0.000	0.0	0.0	1.55	4.0	11.3
8	0.0	145.9	397	934.4	.040	2.9	0.0	2.05	5.6	13.1
9	0.0	361.4	3428	909.4	0.000	0.0	0.0	4.52	42.9	11.4
10	0.0	519.6	9109	451.5	0.000	0.0	0.0	5.98	104.9	5.2
11	0.0	255.8	520	3.6	.070	0.0	I	R	R	R
12	0.0	1466.0	510	1.0	.120	0.0	I	R	R	R
13	0.0	1021.4	21946	696.8	.025	4.1	0.0	6.30	135.4	4.3
14	0.0	445.9	4898	1840.1	.055	8.2	0.0	2.99	32.9	12.4
15	0.0	188.9	1889	1922.0	.035	4.6	0.0	1.42	14.2	14.5
16	0.0	143.0	1236	1900.9	.060	7.3	0.0	1.17	10.2	15.6
17	0.0	91.0	667	1460.9	.060	4.9	0.0	1.12	8.2	18.0
18	0.0	162.6	1154	565.0	0.000	0.0	0.0	4.01	28.5	13.9
19	0.0	163.7	1208	361.1	.065	1.9	0.0	5.61	41.4	12.4
20	0.0	140.7	1401	157.0	0.000	0.0	0.0	10.86	108.1	12.1
21	0.0	184.1	1775	80.3	0.000	0.0	0.0	56.81	547.7	24.8
22	0.0	411.5	509	4.0	.080	0.0	I	R	R	R
23	0.0	1772.5	571	1.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	13.118	GRAM/BHP HR
	CO	44.556	GRAM/BHP HR
	NO2	12.815	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.674	LB/BHP HR

APPENDIX D

EMISSION RESULTS FROM ENGINE 2-2

TABULAR FORM

ENGINE 2-2

NINE MODE FTP EMISSION RESULTS

CONCENTRATION BASIS

4-14-72 ENGINE 2-2 RUN 2 K =1.120 HUM = 116 GR/LB

	FEDERAL MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
	1 IDLE	179	1.050	13.060	84	1.052	188	1.105	88	.036	6.782	.040	3.182
	2 16'HG	80	1.480	13.060	384	1.044	84	1.545	401	.089	7.435	.138	35.686
	3 10'HG	80	1.090	13.180	1206	1.050	84	1.144	1266	.257	21.585	.294	325.395
	4 16'HG	61	1.300	13.180	420	1.043	64	1.357	438	.089	5.665	.121	39.005
	5 19'HG	18	.250	13.440	157	1.067	19	.267	168	.047	.903	.013	7.876
	6 16'HG	57	1.300	13.180	435	1.044	59	1.357	454	.089	5.295	.121	40.411
	7 3'HG	102	1.230	13.060	1904	1.052	107	1.294	2003	.283	30.363	.366	566.774
	8 16'HG	58	1.450	13.060	420	1.047	61	1.518	440	.089	5.405	.135	39.141
	9 C.T.	1741	.882	5.750	73	1.796	3128	1.585	131	.021	65.682	.033	2.754
	SUM----------(CYCLE COMPOSITE)----------										149.114	1.260	1060.224
CYCLE 2													
	1 IDLE	166	1.010	12.820	90	1.074	178	1.084	97	.036	6.417	.039	3.479
	2 16'HG	75	1.410	12.470	406	1.094	82	1.542	444	.089	7.301	.137	39.525
	3 10'HG	80	1.120	12.590	1259	1.095	88	1.227	1379	.257	22.523	.315	354.452
	4 16'HG	35	1.380	12.690	435	1.081	38	1.491	470	.089	3.366	.133	41.838
	5 19'HG	9	.250	12.940	183	1.109	10	.277	203	.047	.469	.013	9.539
	6 16'HG	53	1.450	12.470	449	1.094	58	1.587	491	.089	5.161	.141	43.724
	7 3'HG	107	1.630	12.470	1800	1.082	116	1.764	1948	.283	32.765	.499	551.193
	8 16'HG	62	1.590	12.340	449	1.098	68	1.746	493	.089	6.061	.155	43.890
	9 C.T.	1857	.948	5.960	111	1.718	3191	1.629	191	.021	67.001	.034	4.005
	SUM----------(CYCLE COMPOSITE)----------										151.064	1.467	1091.643
CYCLE 3													
	1 IDLE	180	.970	12.710	143	1.083	195	1.050	155	.036	7.017	.038	5.575
	2 16'HG	86	1.590	12.590	449	1.076	93	1.711	483	.089	8.234	.152	42.992
	3 10'HG	93	1.200	12.710	1351	1.081	101	1.297	1461	.257	25.843	.333	375.417
	4 16'HG	73	1.520	12.590	493	1.080	79	1.641	532	.089	7.015	.146	47.377
	5 19'HG	26	.250	13.060	250	1.097	29	.274	274	.047	1.341	.013	12.894
	6 16'HG	66	1.550	12.590	508	1.079	71	1.673	548	.089	6.339	.149	48.791
	7 3'HG	118	1.380	12.470	1947	1.091	129	1.506	2125	.283	36.441	.426	601.283
	8 16'HG	79	1.470	12.590	538	1.081	85	1.589	582	.089	7.602	.141	51.773
	9 C.T.	1853	.803	5.750	168	1.779	3296	1.428	299	.021	69.208	.030	6.275
	SUM----------(CYCLE COMPOSITE)----------										169.042	1.429	1192.376
CYCLE 4													
	1 IDLE	180	.810	12.590	210	1.099	198	.890	231	.036	7.124	.032	8.311
	2 16'HG	92	1.520	12.590	523	1.078	99	1.639	564	.089	8.828	.146	50.183
	3 10'HG	91	1.270	12.590	1369	1.088	99	1.382	1490	.257	25.453	.355	382.907
	4 16'HG	71	1.590	12.470	552	1.087	77	1.728	600	.089	6.868	.154	53.393
	5 19'HG	22	.250	12.820	320	1.118	25	.280	358	.047	1.156	.013	16.816
	6 16'HG	62	1.520	12.290	552	1.105	69	1.680	610	.089	6.100	.150	54.308
	7 3'HG	114	1.410	12.230	1989	1.110	127	1.566	2209	.283	35.824	.443	625.041
	8 16'HG	71	1.520	12.220	582	1.111	79	1.688	646	.089	7.018	.150	57.524
	9 C.T.	1773	.770	5.500	217	1.859	3296	1.431	403	.021	69.217	.030	8.472
	SUM----------(CYCLE COMPOSITE)----------										167.586	1.473	1256.955
	AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------										150.089	1.364	1075.934
	AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------										168.314	1.451	1224.666

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(150.089) + 0.65*(168.314) =	161.935	PPM
CO	0.35*(1.364) + 0.65*(1.451) =	1.420	PERCENT
NO	0.35*(1075.934) + 0.65*(1224.666) =	1172.610	PPM
	CORRECTED NO =	1313.340	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

4-14-72 ENGINE 2-2 RUN 3 K =1.111 HUM = 112 GR/LB

FEDERAL MODE	CONCENTRATION HC	CO	AS CO2	MEASURED NO	DILUTION FACTOR	A U J U S T E D HC	CO	NO	WEIGHTING FACTOR	W E I G H T E D HC	CO	NO
CYCLE 1												
1 IDLE	184	.815	13.180	117	1.052	194	.857	123	.036	6.967	.031	4.430
2 16'HG	98	1.450	13.180	420	1.035	101	1.501	435	.089	9.027	.134	38.685
3 10'HG	102	1.160	13.480	1314	1.023	104	1.187	1345	.257	26.824	.305	345.559
4 16'HG	84	1.450	13.330	478	1.025	86	1.486	490	.089	7.663	.132	43.607
5 19'HG	35	.255	13.770	197	1.041	36	.265	205	.047	1.712	.012	9.634
6 16'HG	80	1.520	13.180	493	1.034	83	1.571	510	.089	7.360	.140	45.359
7 3'HG	125	1.410	13.180	1947	1.034	129	1.458	2014	.283	36.586	.413	569.866
8 16'HG	84	1.480	13.180	493	1.035	87	1.532	510	.089	7.737	.136	45.409
9 C.T.	1891	.760	6.820	80	1.569	2967	1.192	126	.021	62.302	.025	2.636
SUM----------(CYCLE COMPOSITE)----------										166.178	1.328	1105.184
CYCLE 2												
1 IDLE	180	.615	13.060	183	1.061	191	.865	194	.036	6.878	.031	6.992
2 16'HG	89	1.590	12.940	493	1.048	93	1.667	517	.089	8.304	.148	45.999
3 10'HG	89	1.160	13.100	1387	1.053	94	1.221	1460	.257	24.075	.314	375.189
4 16'HG	75	1.520	12.940	538	1.052	79	1.599	566	.089	7.023	.142	50.380
5 19'HG	31	.260	13.480	307	1.063	33	.266	326	.047	1.549	.012	15.340
6 16'HG	80	1.539	12.940	538	1.051	84	1.618	565	.089	7.483	.144	50.326
7 3'HG	116	1.450	12.820	1968	1.061	123	1.538	2087	.283	34.821	.435	590.748
8 16'HG	75	1.660	12.820	552	1.056	79	1.753	583	.089	7.049	.156	51.879
9 C.T.	1719	.660	6.300	116	1.709	2937	1.128	198	.021	61.678	.024	4.162
SUM----------(CYCLE COMPOSITE)----------										158.860	1.407	1191.016
CYCLE 3												
1 IDLE	180	.740	13.060	265	1.064	192	.788	282	.036	6.896	.028	10.153
2 16'HG	93	1.737	12.710	552	1.060	99	1.841	585	.089	8.774	.164	52.077
3 10'HG	95	1.230	12.940	1407	1.062	101	1.306	1494	.257	25.921	.336	383.902
4 16'HG	75	1.590	12.820	598	1.059	79	1.683	633	.089	7.067	.150	56.346
5 19'HG	31	.280	13.330	363	1.074	33	.301	390	.047	1.565	.014	18.320
6 16'HG	75	1.630	12.820	613	1.057	79	1.723	648	.089	7.057	.153	57.675
7 3'HG	116	1.450	12.940	2055	1.051	122	1.525	2161	.283	34.518	.431	611.495
8 16'HG	80	1.585	13.060	659	1.040	83	1.649	686	.089	7.407	.147	61.012
9 C.T.	1841	.930	6.130	129	1.689	3110	1.571	218	.021	65.311	.033	4.576
SUM----------(CYCLE COMPOSITE)----------										164.514	1.456	1255.558
CYCLE 4												
1 IDLE	184	.640	13.330	307	1.047	193	.670	321	.036	6.936	.024	11.572
2 16'HG	98	1.840	12.820	613	1.047	103	1.927	642	.089	9.134	.171	57.135
3 10'HG	102	1.230	13.060	1463	1.052	107	1.294	1539	.257	27.573	.333	395.488
4 16'HG	84	1.700	12.710	613	1.062	89	1.806	651	.089	7.941	.161	57.951
5 19'HG	31	.280	13.330	406	1.074	33	.301	436	.047	1.565	.014	20.490
6 16'HG	71	1.630	12.710	628	1.066	76	1.738	669	.089	6.736	.155	59.583
7 3'HG	116	1.450	12.710	2033	1.069	124	1.550	2174	.283	35.103	.439	615.210
8 16'HG	80	1.630	12.710	659	1.065	85	1.736	702	.089	7.585	.155	62.480
9 C.T.	1833	.700	6.470	136	1.648	3020	1.153	224	.021	63.429	.024	4.706
SUM----------(CYCLE COMPOSITE)----------										166.001	1.475	1284.615

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 162.519 1.368 1148.100

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 165.258 1.466 1270.087

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(162.519) + 0.65*(165.258) =	164.299	PPM
CO	0.35*(1.368) + 0.65*(1.466) =	1.431	PERCENT
NO	0.35*(1148.100) + 0.65*(1270.087) =	1227.391	PPM
	CORRECTED NO =	1363.516	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

4-14-72 ENGINE 2-2 RUN 4 K =1.096 HUM = 106 GR/LB

	FEDERAL MODE	CONCENTRATION HC	CO	AS CO2	MEASURED NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
	1 IDLE	180	.490	13.630	90	1.031	186	.505	93	.036	6.678	.018	3.339
	2 16'HG	90	1.230	13.910	464	.992	89	1.220	460	.089	7.943	.109	40.951
	3 10'HG	89	.930	13.910	1444	1.002	89	.932	1447	.257	22.919	.239	371.849
	4 16'HG	71	1.230	13.910	508	.993	71	1.221	504	.089	6.275	.109	44.897
	5 19'HG	27	.210	14.180	210	1.013	27	.213	213	.047	1.285	.010	9.998
	6 16'HG	66	1.270	13.910	493	.992	65	1.260	489	.089	5.827	.112	43.528
	7 3'HG	120	1.410	13.630	2011	1.002	120	1.413	2016	.283	34.043	.400	570.506
	8 16'HG	75	1.520	13.770	508	.992	74	1.508	504	.089	6.624	.134	44.869
	9 C.T.	1806	.640	5.390	125	1.893	3418	1.211	237	.021	71.788	.025	4.969
	SUM----------(CYCLE COMPOSITE)----------										163.383	1.157	1134.905
CYCLE 2													
	1 IDLE	191	1.050	13.480	130	1.020	195	1.071	133	.036	7.016	.039	4.775
	2 16'HG	97	1.550	13.480	449	1.010	98	1.565	453	.089	8.717	.139	40.351
	3 10'HG	198	1.160	13.480	1444	1.016	201	1.178	1467	.257	51.692	.303	376.988
	4 16'HG	80	1.520	13.480	493	1.012	81	1.538	499	.089	7.206	.137	44.409
	5 19'HG	31	.282	14.050	251	1.019	32	.287	256	.047	1.485	.014	12.026
	6 16'HG	75	1.480	13.330	493	1.025	77	1.517	505	.089	6.840	.135	44.959
	7 3'HG	125	1.840	13.180	1865	1.019	127	1.874	1900	.283	36.034	.530	537.620
	8 16'HG	85	1.660	13.330	524	1.017	86	1.689	533	.089	7.697	.150	47.448
	9 C.T.	1768	.670	5.770	188	1.809	3199	1.212	340	.021	67.173	.025	7.143
	SUM----------(CYCLE COMPOSITE)----------										193.860	1.472	1115.719
CYCLE 3													
	1 IDLE	175	.970	13.180	143	1.047	183	1.015	150	.036	6.594	.037	5.388
	2 16'HG	93	1.770	12.940	464	1.041	97	1.843	483	.089	8.619	.164	43.000
	3 10'HG	89	1.340	13.060	1388	1.049	93	1.405	1456	.257	23.988	.361	374.102
	4 16'HG	75	1.630	12.940	523	1.048	79	1.708	548	.089	6.995	.152	48.781
	5 19'HG	31	.300	13.630	265	1.050	33	.315	278	.047	1.529	.015	13.074
	6 16'HG	71	1.700	12.940	523	1.046	74	1.778	547	.089	6.608	.158	48.673
	7 3'HG	116	1.590	13.180	1947	1.028	119	1.635	2002	.283	33.759	.463	566.621
	8 16'HG	80	1.700	13.180	508	1.027	82	1.746	522	.089	7.313	.155	46.441
	9 C.T.	1788	.610	5.640	257	1.841	3292	1.123	473	.021	69.127	.024	9.936
	SUM----------(CYCLE COMPOSITE)----------										164.531	1.529	1156.015
CYCLE 4													
	1 IDLE	170	.770	13.180	170	1.055	179	.812	179	.036	6.454	.029	6.454
	2 16'HG	93	1.660	12.940	493	1.045	97	1.735	515	.089	8.653	.154	45.869
	3 10'HG	93	1.200	13.060	1482	1.054	98	1.264	1562	.257	25.186	.325	401.344
	4 16'HG	80	1.550	12.940	552	1.051	84	1.628	580	.089	7.480	.145	51.615
	5 19'HG	31	.250	13.480	279	1.063	33	.266	297	.047	1.549	.012	13.941
	6 16'HG	75	1.550	12.940	552	1.051	79	1.629	580	.089	7.016	.145	51.635
	7 3'HG	120	1.520	12.820	2055	1.058	127	1.608	2173	.283	35.918	.455	615.094
	8 16'HG	84	1.630	12.940	598	1.047	88	1.707	626	.089	7.829	.152	55.737
	9 C.T.	1740	.520	5.750	273	1.838	3198	.956	502	.021	67.159	.020	10.537
	SUM----------(CYCLE COMPOSITE)----------										167.244	1.438	1252.226

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 178.621 1.315 1125.312

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 165.888 1.483 1204.121

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(178.621) + 0.65*(165.888) =	170.344	PPM
CO	0.35*(1.315) + 0.65*(1.483) =	1.424	PERCENT
NO	0.35*(1125.312) + 0.65*(1204.121) =	1176.538	PPM
	CORRECTED NO =	1289.705	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

ENGINE 2-2

NINE MODE FTP EMISSION RESULTS

BRAKE SPECIFIC BASIS

4-14-72 ENGINE 2-2 RUN 2 K = 1.09 HUM = 116 GR/LB

MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1														
1 IDLE	179	1.050	13.06	84	14.303	2633	36	390	5	.232	8.3	91	1.2	0
2 16 HG	80	1.480	13.06	384	14.626	11672	69	2386	102	.077	5.3	184	7.8	24
3 10 HG	80	1.090	13.18	1206	14.356	17806	107	2731	497	.147	15.8	401	73.0	62
4 16 HG	61	1.300	13.18	420	14.546	11672	53	2107	112	.077	4.1	162	8.6	24
5 19 HG	18	.250	13.44	157	13.709	8749	12	322	33	.057	.7	18	1.9	3
6 16 HG	57	1.300	13.18	435	14.542	11672	49	2108	116	.077	3.8	162	8.9	24
7 3 HG	102	1.230	13.06	1904	14.400	24970	191	4308	1096	.113	21.6	487	123.9	103
8 16 HG	58	1.450	13.06	420	14.573	11672	50	2346	112	.077	3.9	181	8.6	24
9 C.T.	1741	.882	5.75	73	8.512	2706	598	566	8	.143	85.5	81	1.1	0
SUM----------(CYCLE COMPOSITE)----------											5.2	62	8.3	
CYCLE 2														
1 IDLE	166	1.010	12.82	90	14.009	2633	34	383	6	.232	7.8	89	1.3	0
2 16 HG	75	1.410	12.47	406	13.961	11672	68	2381	113	.077	5.2	183	8.7	24
3 10 HG	80	1.120	12.59	1259	13.796	17806	112	2920	539	.147	16.4	429	79.3	62
4 16 HG	35	1.380	12.69	435	14.108	11672	31	2306	119	.077	2.4	178	9.2	24
5 19 HG	9	.250	12.94	183	13.200	8749	6	335	40	.057	.4	19	2.3	3
6 16 HG	53	1.450	12.47	449	13.977	11672	48	2446	124	.077	3.7	188	9.6	24
7 3 HG	107	1.630	12.47	1800	14.216	24970	203	5784	1050	.113	22.9	654	118.6	103
8 16 HG	62	1.590	12.34	449	13.997	11672	56	2678	124	.077	4.3	206	9.6	24
9 C.T.	1857	.948	5.96	111	8.914	2706	609	581	11	.143	87.1	83	1.6	0
SUM----------(CYCLE COMPOSITE)----------											5.3	72	8.5	
CYCLE 3														
1 IDLE	180	.970	12.71	143	13.874	2633	37	372	9	.232	8.6	86	2.1	0
2 16 HG	86	1.590	12.59	449	14.273	11672	76	2627	122	.077	5.8	202	9.4	24
3 10 HG	93	1.200	12.71	1351	14.010	17806	128	3081	570	.147	18.8	453	83.8	62
4 16 HG	73	1.520	12.59	493	14.189	11672	65	2526	135	.077	5.0	194	10.4	24
5 19 HG	26	.250	13.06	250	13.338	8749	18	331	54	.057	1.0	19	3.1	3
6 16 HG	66	1.550	12.59	508	14.211	11672	59	2572	139	.077	4.5	198	10.7	24
7 3 HG	118	1.380	12.47	1947	13.977	24970	228	4980	1155	.113	25.7	563	130.5	103
8 16 HG	79	1.470	12.59	538	14.145	11672	70	2450	147	.077	5.4	189	11.3	24
9 C.T.	1853	.803	5.75	168	8.554	2706	633	513	18	.143	90.5	73	2.5	0
SUM----------(CYCLE COMPOSITE)----------											5.8	70	9.3	
CYCLE 4														
1 IDLE	180	.810	12.59	210	13.594	2633	38	317	14	.232	8.7	74	3.1	0
2 16 HG	92	1.520	12.59	523	14.209	11672	82	2522	143	.077	6.3	194	11.0	24
3 10 HG	91	1.270	12.59	1369	13.958	17806	125	3273	580	.147	18.4	481	85.2	62
4 16 HG	71	1.590	12.47	552	14.137	11672	63	2652	151	.077	4.9	204	11.7	24
5 19 HG	22	.250	12.82	320	13.094	8749	16	337	71	.057	.9	19	4.0	3
6 16 HG	62	1.520	12.29	552	13.877	11672	56	2583	154	.077	4.3	199	11.9	24
7 3 HG	114	1.410	12.23	1989	13.763	24970	223	5167	1198	.113	25.2	584	135.4	103
8 16 HG	71	1.520	12.22	582	13.817	11672	65	2594	163	.077	5.0	200	12.6	24
9 C.T.	1773	.770	5.50	217	8.185	2706	633	514	24	.143	90.5	74	3.4	0
SUM----------(CYCLE COMPOSITE)----------											5.8	72	9.8	

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 5.3 67 8.4

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 5.8 71 9.6

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(5.3) + 0.65(5.8) = 5.622 (MASS)
CO 0.35(67) + 0.65(71) = 69.3 (MASS)
NO2 0.35(8.4) + 0.65(9.6) = 9.142 (MASS)
CORRECTED NO2 = 10.001 (MASS)

4-14-72 ENGINE 2-2 RUN 3 K = 1.09 HUM = 112 GR/LB

	MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1															
	1 IDLE	184	.815	13.18	117	14.194	2633	37	305	7	.232	8.6	71	1.7	0
	2 16 HG	98	1.450	13.18	420	14.736	11672	84	2320	110	.077	6.5	179	8.5	24
	3 10 HG	102	1.160	13.48	1314	14.750	17806	133	2829	527	.147	19.5	416	77.4	62
	4 16 HG	84	1.450	13.33	478	14.871	11672	71	2299	125	.077	5.5	177	9.6	24
	5 19 HG	35	.255	13.77	197	14.063	8749	24	320	41	.057	1.3	18	2.3	3
	6 16 HG	80	1.520	13.18	493	14.786	11672	68	2424	129	.077	5.3	187	9.9	24
	7 3 HG	125	1.410	13.18	1947	14.725	24970	229	4830	1096	.113	25.9	546	123.9	103
	8 16 HG	84	1.480	13.18	493	14.751	11672	72	2366	130	.077	5.5	182	10.0	24
	9 C.T.	1891	.760	6.82	80	9.622	2706	574	432	7	.143	82.1	62	1.1	0
	SUM----------(CYCLE COMPOSITE)----------											5.6	65	8.6	
CYCLE 2															
	1 IDLE	180	.815	13.06	183	14.069	2633	36	308	11	.232	8.4	71	2.6	0
	2 16 HG	89	1.590	12.94	493	14.626	11672	77	2563	131	.077	5.9	197	10.1	24
	3 10 HG	89	1.160	13.10	1387	14.356	17806	119	2906	571	.147	17.5	427	84.0	62
	4 16 HG	75	1.520	12.94	538	14.541	11672	65	2465	143	.077	5.0	190	11.0	24
	5 19 HG	31	.250	13.48	307	13.763	8749	21	321	65	.057	1.2	18	3.7	3
	6 16 HG	80	1.539	12.94	538	14.565	11672	69	2491	143	.077	5.3	192	11.0	24
	7 3 HG	116	1.450	12.82	1968	14.395	24970	217	5081	1133	.113	24.6	574	128.1	103
	8 16 HG	75	1.660	12.82	552	14.561	11672	65	2688	147	.077	5.0	207	11.3	24
	9 C.T.	1719	.660	6.30	116	8.817	2706	570	409	12	.143	81.5	59	1.7	0
	SUM----------(CYCLE COMPOSITE)----------											5.4	68	9.3	
CYCLE 3															
	1 IDLE	180	.740	13.06	265	13.994	2633	37	281	17	.232	8.5	65	3.8	0
	2 16 HG	93	1.737	12.71	552	14.547	11672	81	2815	147	.077	6.2	217	11.3	24
	3 10 HG	95	1.230	12.94	1407	14.273	17806	128	3100	583	.147	18.8	456	85.7	62
	4 16 HG	75	1.590	12.82	598	14.491	11672	65	2587	160	.077	5.0	199	12.3	24
	5 19 HG	31	.280	13.33	363	13.643	8749	21	363	77	.057	1.2	21	4.4	3
	6 16 HG	75	1.630	12.82	613	14.531	11672	65	2645	163	.077	5.0	204	12.6	24
	7 3 HG	116	1.450	12.94	2055	14.515	24970	216	5039	1174	.113	24.4	569	132.6	103
	8 16 HG	80	1.585	13.06	659	14.731	11672	68	2537	173	.077	5.3	195	13.3	24
	9 C.T.	1841	.930	6.13	129	9.048	2706	595	562	13	.143	85.0	80	1.8	0
	SUM----------(CYCLE COMPOSITE)----------											5.6	71	9.8	
CYCLE 4															
	1 IDLE	184	.640	13.33	307	14.169	2633	37	240	19	.232	8.6	56	4.4	0
	2 16 HG	98	1.840	12.82	613	14.766	11672	84	2938	161	.077	6.4	226	12.4	24
	3 10 HG	102	1.230	13.06	1463	14.400	17806	136	3072	601	.147	20.0	452	88.3	62
	4 16 HG	84	1.700	12.71	613	14.501	11672	73	2764	164	.077	5.6	213	12.6	24
	5 19 HG	31	.280	13.33	406	13.643	8749	21	363	86	.057	1.2	21	4.9	3
	6 16 HG	71	1.630	12.71	628	14.417	11672	62	2666	169	.077	4.8	205	13.0	24
	7 3 HG	116	1.450	12.71	2033	14.285	24970	219	5120	1180	.113	24.7	579	133.3	103
	8 16 HG	80	1.630	12.71	659	14.426	11672	70	2664	177	.077	5.4	205	13.6	24
	9 C.T.	1833	.700	6.47	136	9.150	2706	585	418	13	.143	83.7	60	1.9	0
	SUM----------(CYCLE COMPOSITE)----------											5.7	71	10.0	
	AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------											5.5	66	9.0	
	AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------											5.6	71	9.9	

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(5.5) + 0.65(5.6) = 5.606 (MASS)
CO 0.35(66) + 0.65(71) = 69.4 (MASS)
NO2 0.35(9.0) + 0.65(9.9) = 9.577 (MASS)
CORRECTED NO2 = 10.420 (MASS)

4-14-72 ENGINE 2-2 RUN 4 K = 1.08 HUM = 106 GR/LB

MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1														
1 IDLE	180	.490	13.63	90	14.314	2633	36	182	5	.232	8.3	42	1.3	0
2 16 HG	90	1.230	13.91	464	15.237	11672	74	1903	118	.077	5.7	147	9.1	24
3 10 HG	89	.930	13.91	1444	14.936	17806	115	2240	572	.147	16.8	329	84.0	62
4 16 HG	71	1.230	13.91	508	15.217	11672	59	1906	129	.077	4.5	147	10.0	24
5 19 HG	27	.210	14.18	210	14.419	8749	18	257	42	.057	1.0	15	2.4	3
6 16 HG	66	1.270	13.91	493	15.251	11672	55	1963	125	.077	4.2	151	9.6	24
7 3 HG	120	1.410	13.63	2011	15.170	24970	213	4688	1099	.113	24.1	530	124.2	103
8 16 HG	75	1.520	13.77	508	15.371	11672	62	2332	128	.077	4.7	180	9.9	24
9 C.T.	1806	.640	5.39	125	7.980	2706	661	438	14	.143	94.6	63	2.0	0
SUM----------(CYCLE COMPOSITE)----------											5.8	56	8.9	
CYCLE 2														
1 IDLE	191	1.050	13.48	130	14.736	2633	37	379	8	.232	8.6	88	1.8	0
2 16 HG	97	1.550	13.48	449	15.135	11672	81	2415	115	.077	6.2	186	8.9	24
3 10 HG	198	1.160	13.48	1444	14.854	17806	256	2809	575	.147	37.7	413	84.5	62
4 16 HG	80	1.520	13.48	493	15.086	11672	67	2376	127	.077	5.1	183	9.8	24
5 19 HG	31	.282	14.05	251	14.365	8749	20	347	51	.057	1.2	20	2.9	3
6 16 HG	75	1.480	13.33	493	14.891	11672	63	2343	128	.077	4.9	180	9.9	24
7 3 HG	125	1.840	13.18	1865	15.155	24970	222	6124	1020	.113	25.1	692	115.3	103
8 16 HG	85	1.660	13.33	524	15.082	11672	71	2595	135	.077	5.5	200	10.4	24
9 C.T.	1768	.670	5.77	188	8.349	2706	619	439	20	.143	88.5	63	2.9	0
SUM----------(CYCLE COMPOSITE)----------											6.4	71	8.7	
CYCLE 3														
1 IDLE	175	.970	13.18	143	14.339	2633	35	360	9	.232	8.1	83	2.0	0
2 16 HG	93	1.770	12.94	464	14.810	11672	79	2818	121	.077	6.1	217	9.3	24
3 10 HG	89	1.340	13.06	1388	14.496	17806	118	3325	566	.147	17.4	489	83.2	62
4 16 HG	75	1.630	12.94	523	14.651	11672	65	2623	138	.077	5.0	202	10.7	24
5 19 HG	31	.300	13.63	265	13.963	8749	21	380	55	.057	1.2	22	3.1	3
6 16 HG	71	1.700	12.94	523	14.717	11672	61	2724	138	.077	4.7	210	10.6	24
7 3 HG	116	1.590	13.18	1947	14.895	24970	210	5384	1084	.113	23.7	608	122.4	103
8 16 HG	80	1.700	13.18	508	14.966	11672	67	2678	132	.077	5.2	206	10.1	24
9 C.T.	1788	.610	5.64	257	8.181	2706	639	408	28	.143	91.3	58	4.0	0
SUM----------(CYCLE COMPOSITE)----------											5.7	74	9.0	
CYCLE 4														
1 IDLE	170	.770	13.18	170	14.134	2633	34	290	11	.232	7.9	67	2.4	0
2 16 HG	93	1.660	12.94	493	14.700	11672	80	2662	130	.077	6.1	205	10.0	24
3 10 HG	93	1.200	13.06	1482	14.360	17806	125	3006	610	.147	18.3	442	89.7	62
4 16 HG	80	1.550	12.94	552	14.576	11672	69	2507	147	.077	5.3	193	11.3	24
5 19 HG	31	.250	13.48	279	13.763	8749	21	321	59	.057	1.2	18	3.4	3
6 16 HG	75	1.550	12.94	552	14.571	11672	65	2508	147	.077	5.0	193	11.3	24
7 3 HG	120	1.520	12.82	2055	14.470	24970	224	5299	1177	.113	25.3	599	133.0	103
8 16 HG	84	1.630	12.94	598	14.661	11672	72	2621	158	.077	5.6	202	12.2	24
9 C.T.	1740	.520	5.75	273	8.149	2706	624	349	30	.143	89.2	50	4.3	0
SUM----------(CYCLE COMPOSITE)----------											5.8	69	9.8	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------											6.1	64	8.8	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------											5.8	72	9.4	

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(6.1) + 0.65(5.8) = 5.881 (MASS)
CO 0.35(64) + 0.65(72) = 68.9 (MASS)
NO2 0.35(8.8) + 0.65(9.4) = 9.185 (MASS)
CORRECTED NO2 = 9.900 (MASS)

ENGINE 2-2

EXPERIMENTAL 23 MODE EMISSION RESULTS

BRAKE SPECIFIC BASIS

PROJECT 11-2877-01 CONTROL TECHNOLOGY

4-17-72 RUN 1 ENGINE 2-2 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL RATE LB/HR	FUEL RATE GM/HR	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	550	0.0	0	17.5	5.8	2631	40	3709	.740	14.53	44
2	1200	5.2	1	17.7	11.7	5289	18	187	.050	14.05	80
3	1200	20.8	5	16.8	14.1	6378	21	261	.150	14.42	152
4	1200	46.8	11	15.3	15.4	6981	32	626	.180	14.79	295
5	1200	65.0	15	14.5	17.1	7775	65	707	.150	15.09	500
6	1200	130.0	30	12.3	22.4	10170	23	2089	.520	15.43	1100
7	1200	195.0	45	7.0	27.2	12329	31	2982	.810	15.09	1775
8	1200	213.0	49	5.8	30.0	13608	35	3073	.930	14.94	1875
9	1200	239.0	55	3.4	32.1	14579	43	2863	1.050	14.66	2000
10	1200	260.0	59	0.0	48.5	22009	44	5275	10.030	8.60	125
11	550	0.0	0	17.5	5.8	2631	39	3310	.740	14.53	50
12	1200	0.0	0	22.8	5.8	2654	63	44273	.350	5.50	5
13	2300	310.0	136	.5	100.7	45659	66	4906	11.000	7.18	93
14	2300	285.0	125	3.4	62.7	28459	37	2268	.850	13.63	2300
15	2300	254.0	111	5.0	59.4	26957	43	2160	1.340	13.48	2250
16	2300	232.0	102	6.0	56.3	25515	49	2274	1.630	13.18	2000
17	2300	155.0	68	11.2	41.3	18711	63	1645	.930	13.63	1600
18	2300	77.5	34	15.5	31.9	14465	33	1589	1.090	13.48	800
19	2300	55.0	24	17.0	27.8	12624	35	1417	.930	13.48	590
20	2300	24.8	11	18.5	23.9	10859	28	1065	.700	13.63	380
21	2300	6.2	3	19.7	20.7	9385	24	696	.420	13.77	230
22	550	0.0	0	17.5	5.8	2654	27	3545	.490	13.06	43
23	2300	0.0	0	24.5	6.1	2758	62	25564	.070	2.37	3

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	1.4	62.4	251	2.5	.070	0.0	R	R	R	R
2	1.4	7.0	38	9.9	.060	.1	1.2	5.88	31.8	8.4
3	1.9	11.4	132	22.1	.060	.3	.4	2.40	27.9	4.7
4	3.2	29.1	169	45.5	.050	.5	.3	2.72	15.8	4.3
5	7.1	35.9	154	84.3	.030	.4	.5	2.42	10.4	5.7
6	3.1	131.4	661	229.8	.060	1.8	.1	4.43	22.3	7.7
7	5.1	227.0	1245	448.5	0.000	0.0	.1	5.09	28.0	10.1
8	6.4	258.5	1580	523.6	.040	1.9	.1	5.31	32.5	10.8
9	8.6	261.0	1933	605.2	0.000	0.0	.2	4.78	35.4	11.1
10	10.8	606.1	23276	47.7	0.000	0.0	.2	10.20	391.8	.8
11	1.4	55.8	252	2.8	.070	0.0	R	R	R	R
12	3.5	1143.1	183	.4	.120	0.0	R	R	R	R
13	34.6	1199.8	54339	75.1	.025	3.4	.3	8.84	400.3	.6
14	15.6	438.9	3323	1477.6	.055	6.9	.1	3.52	26.6	11.8
15	16.7	387.3	4853	1339.3	.035	3.9	.2	3.48	43.6	12.0
16	17.9	385.8	5587	1126.7	.060	6.1	.2	3.80	55.0	11.1
17	17.2	209.1	2387	675.0	.060	4.1	.3	3.08	35.2	9.9
18	6.9	156.0	2162	260.8	0.000	0.0	.2	4.60	63.7	7.7
19	6.5	122.9	1630	169.9	.065	1.6	.3	5.10	67.7	7.1
20	4.6	80.1	1064	94.9	0.000	0.0	.4	7.37	97.9	8.7
21	3.4	45.8	558	50.3	0.000	0.0	1.3	16.86	205.7	18.5
22	1.1	67.6	189	2.7	.080	0.0	R	R	R	R
23	7.3	1411.1	78	.5	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	11.914	GRAM/BHP HR
	CO	80.724	GRAM/BHP HR
	NO2	9.412	GRAM/BHP HR
	ALDE	.226	GRAM/BHP HR
	BSFC	.757	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

4-17-72 RUN 2 ENGINE 2-2 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL RATE LB/HR	FUEL RATE GM/HR	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	550	0.0	0	17.5	5.8	2631	32	3503	.890	13.18	42
2	1200	5.2	1	17.7	11.7	5289	21	168	.050	13.18	80
3	1200	20.8	5	16.7	14.1	6378	24	292	.150	13.33	152
4	1200	46.8	11	15.3	15.4	6981	33	597	.180	13.48	295
5	1200	65.0	15	14.6	17.1	7775	56	688	.180	13.63	500
6	1200	130.0	30	12.0	22.4	10170	24	2244	.520	13.91	1100
7	1200	195.0	45	7.0	27.2	12329	27	2780	.930	13.63	1775
8	1200	213.0	49	5.9	30.0	13608	27	2836	1.200	13.33	1875
9	1200	239.0	55	3.4	32.1	14579	43	2780	1.380	13.18	2000
10	1200	260.0	59	0.0	48.5	22009	43	5265	10.440	7.94	125
11	550	0.0	0	17.5	5.8	2631	33	3723	1.160	12.71	50
12	1200	0.0	0	22.8	5.8	2654	60	57007	.520	5.50	5
13	2300	310.0	136	.5	100.7	45659	36	4910	11.000	7.28	93
14	2300	285.0	125	3.4	62.7	28459	32	2223	1.340	13.77	2300
15	2300	254.0	111	5.0	59.4	26957	36	2050	1.380	13.63	2250
16	2300	232.0	102	6.2	56.3	25515	35	2109	1.660	13.48	2000
17	2300	155.0	68	11.2	41.3	18711	54	1533	.890	13.77	1600
18	2300	77.5	34	15.7	31.9	14465	57	1594	1.230	13.77	800
19	2300	55.8	24	17.0	27.8	12624	27	1307	1.010	13.77	590
20	2300	24.8	11	18.5	23.9	10859	24	933	.850	14.05	380
21	2300	6.2	3	19.7	20.7	9385	28	712	.310	13.77	230
22	550	0.0	0	17.5	5.8	2654	24	2930	.390	13.33	43
23	2300	0.0	0	24.5	6.1	2758	43	21453	.070	2.26	3

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	1.2	63.9	328	2.5	.070	0.0	R	R	R	R
2	1.8	6.7	40	10.6	.060	.1	1.5	5.66	33.9	8.9
3	2.5	13.8	143	23.9	.060	.3	.5	2.90	30.1	5.0
4	3.7	30.4	185	49.8	.050	.5	.3	2.84	17.3	4.7
5	6.8	38.5	204	93.0	.030	.4	.5	2.59	13.7	6.3
6	3.6	155.7	729	253.4	.060	1.8	.1	5.24	24.5	8.5
7	4.9	231.0	1561	489.6	0.000	0.0	.1	5.18	35.0	11.0
8	5.4	260.5	2227	571.8	.040	1.9	.1	5.35	45.8	11.7
9	9.1	273.1	2739	652.4	0.000	0.0	.2	5.00	50.2	11.9
10	10.8	612.9	24549	48.3	0.000	0.0	.2	10.32	413.2	.8
11	1.3	68.8	433	3.1	.070	0.0	R	R	R	R
12	2.9	1290.6	238	.4	.120	0.0	R	R	R	R
13	18.7	1194.4	54049	74.7	.025	3.4	.1	8.80	398.1	.6
14	13.0	412.5	5024	1417.4	.055	6.9	.1	3.31	40.3	11.4
15	13.7	363.2	4939	1323.5	.035	3.9	.1	3.27	44.4	11.9
16	12.5	350.6	5573	1103.6	.060	6.1	.1	3.45	54.9	10.9
17	14.6	193.6	2271	671.0	.060	4.1	.2	2.85	33.5	9.9
18	11.8	152.1	2371	253.4	0.000	0.0	.3	4.48	69.9	7.5
19	5.0	110.7	1727	165.8	.065	1.6	.2	4.53	70.7	6.8
20	3.8	67.6	1244	91.4	0.000	0.0	.4	6.22	114.5	8.4
21	4.0	47.2	415	50.6	0.000	0.0	1.5	17.39	153.0	18.7
22	1.0	55.5	149	2.7	.080	0.0	R	R	R	R
23	5.7	1322.0	87	.6	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	12.162	GRAM/BHP HR
	CO	85.280	GRAM/BHP HR
	NO2	9.347	GRAM/BHP HR
	ALDE	.182	GRAM/BHP HR
	BSFC	.756	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

4-18-72 RUN 1 ENGINE 2-2 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL RATE LB/HR	FUEL RATE GM/HR	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	550	0.0	0	17.5	5.8	2631	29	4535	1.120	13.33	36
2	1200	5.2	1	17.7	11.7	5289	25	180	.050	13.33	83
3	1200	20.8	5	16.8	14.1	6378	22	270	.100	13.63	131
4	1200	46.8	11	15.3	15.4	6981	35	712	.210	13.91	255
5	1200	65.0	15	14.7	17.1	7775	59	815	.210	14.05	360
6	1200	130.0	30	11.8	22.4	10170	34	2090	.640	14.05	813
7	1200	195.0	45	7.0	27.2	12329	32	3073	1.450	13.48	1100
8	1200	213.0	49	5.8	30.0	13608	34	2965	1.410	13.77	1225
9	1200	239.0	55	3.4	32.1	14579	43	2727	1.230	13.48	1500
10	1200	260.0	59	0.0	48.5	22009	42	5328	10.350	8.14	89
11	550	0.0	0	17.5	5.8	2631	38	4296	1.300	12.82	37
12	1200	0.0	0	22.8	5.8	2654	59	58984	.490	5.27	4
13	2300	310.0	136	.5	100.7	45659	29	5257	11.000	7.18	79
14	2300	285.0	125	3.4	62.7	28459	24	2609	1.590	12.94	1700
15	2300	254.0	111	4.9	59.4	26957	34	2440	1.660	12.94	1650
16	2300	232.0	102	6.2	56.3	25515	29	2504	2.020	12.94	1450
17	2300	155.0	68	11.0	41.3	18711	57	1868	1.120	13.18	1150
18	2300	77.5	34	15.5	31.9	14465	45	1815	1.480	13.06	538
19	2300	55.8	24	16.9	27.8	12624	27	1530	1.230	13.18	390
20	2300	24.8	11	18.5	23.9	10859	29	1133	1.160	13.18	250
21	2300	6.2	3	19.6	20.7	9385	34	6671	.640	13.48	175
22	550	0.0	0	17.5	5.8	2654	22	3560	1.010	13.06	36
23	2300	0.0	0	24.5	6.1	2758	43	23447	.150	1.95	2

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	1.1	80.0	399	2.1	.070	0.0	R	R	R	R
2	2.1	7.1	40	10.8	.060	.1	1.8	5.97	33.6	9.1
3	2.2	12.5	94	20.2	.060	.3	.5	2.64	19.7	4.3
4	3.8	35.0	209	41.6	.050	.5	.4	3.28	19.5	3.9
5	6.9	44.2	230	64.8	.030	.4	.5	2.97	15.5	4.4
6	5.0	142.7	882	184.1	.060	1.8	.2	4.80	29.7	6.2
7	5.6	248.6	2370	295.5	0.000	0.0	.1	5.58	53.2	6.6
8	6.4	260.7	2504	357.6	.040	1.9	.1	5.36	51.5	7.3
9	9.1	265.3	2418	484.6	0.000	0.0	.2	4.86	44.3	8.9
10	10.6	616.5	24189	34.1	0.000	0.0	.2	10.38	407.2	.6
11	1.5	77.7	475	2.3	.070	0.0	R	R	R	R
12	2.9	1342.5	225	.3	.120	0.0	R	R	R	R
13	15.2	1283.1	54238	63.8	.025	3.4	.1	9.45	399.5	.5
14	10.1	502.0	6180	1085.9	.055	6.9	.1	4.02	49.5	8.7
15	13.2	443.2	6090	994.8	.035	3.9	.1	3.98	54.7	8.9
16	10.5	420.1	6845	807.5	.060	6.1	.1	4.13	67.4	7.9
17	15.9	241.3	2922	493.1	.060	4.1	.2	3.55	43.0	7.3
18	9.5	178.4	2938	175.3	0.000	0.0	.3	5.26	86.6	5.2
19	5.1	132.6	2154	112.2	.065	1.6	.2	5.43	88.1	4.6
20	4.7	85.1	1761	62.4	0.000	0.0	.4	7.84	162.1	5.7
21	4.6	423.4	821	36.9	0.000	0.0	1.7	155.93	302.2	13.6
22	.9	65.5	375	2.2	.080	0.0	R	R	R	R
23	5.7	1454.9	188	.4	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	13.283	GRAM/BHP HR
	CO	95.013	GRAM/BHP HR
	NO2	6.885	GRAM/BHP HR
	ALDE	.177	GRAM/BHP HR
	BSFC	.756	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

4-18-72 RUN 2 ENGINE 2-2 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL RATE LB/HR	FUEL RATE GM/HR	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	550	0.0	0	17.4	5.8	2631	0	4410	.970	13.18	35
2	1200	5.2	1	17.0	11.7	5289	0	281	.070	13.18	100
3	1200	20.8	5	16.4	14.1	6378	0	360	.130	13.33	132
4	1200	46.8	11	15.3	15.4	6981	0	632	.180	13.77	230
5	1200	65.0	15	14.7	17.1	7775	0	723	.180	13.91	290
6	1200	130.0	30	11.4	22.4	10170	0	2380	.670	13.77	675
7	1200	195.0	45	7.0	27.2	12329	0	3064	1.230	13.33	1050
8	1200	213.0	49	6.3	30.0	13608	0	3236	1.450	13.18	1025
9	1200	239.0	55	4.2	32.1	14579	0	3179	1.590	13.06	1100
10	1200	260.0	59	0.0	48.5	22009	0	5797	10.560	7.94	83
11	550	0.0	0	17.5	5.8	2631	0	4408	1.380	12.71	35
12	1200	0.0	0	22.5	5.8	2654	0	58047	.490	5.50	5
13	2300	310.0	136	.9	100.7	45659	0	5729	11.000	7.28	83
14	2300	285.0	125	3.9	62.7	28459	0	2728	1.590	13.18	1700
15	2300	254.0	111	5.3	59.4	26957	0	2613	1.660	13.06	1650
16	2300	232.0	102	6.6	56.3	25515	0	2786	2.020	12.82	1350
17	2300	155.0	68	11.0	41.3	18711	0	1984	1.120	13.33	1150
18	2300	77.5	34	15.5	31.9	14465	0	1987	1.480	13.18	513
19	2300	55.8	24	17.0	27.8	12624	0	1645	1.230	13.33	380
20	2300	24.8	11	18.4	23.9	10859	0	1361	1.160	13.33	250
21	2300	6.2	3	19.5	20.7	9385	0	725	.640	13.77	185
22	550	0.0	0	17.6	5.8	2654	0	3613	1.010	12.94	39
23	2300	0.0	0	24.4	6.1	2758	0	24037	.150	2.32	2

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	79.5	353	2.1	.070	0.0	I	R	R	R
2	0.0	11.2	56	13.2	.060	.1	0.0	9.41	47.4	11.1
3	0.0	17.0	124	20.8	.060	.3	0.0	3.58	26.1	4.4
4	0.0	31.5	181	38.0	.050	.5	0.0	2.95	16.9	3.6
5	0.0	39.7	200	52.9	.030	.4	0.0	2.67	13.4	3.6
6	0.0	164.9	938	155.3	.060	1.8	0.0	5.55	31.6	5.2
7	0.0	254.1	2061	289.1	0.000	0.0	0.0	5.70	46.2	6.5
8	0.0	294.5	2665	309.7	.040	1.9	0.0	6.05	54.8	6.4
9	0.0	309.7	3128	355.7	0.000	0.0	0.0	5.67	57.3	6.5
10	0.0	668.7	24606	31.6	0.000	0.0	0.0	11.26	414.2	.5
11	0.0	79.8	505	2.1	.070	0.0	I	R	R	R
12	0.0	1305.9	223	.4	.120	0.0	I	R	R	R
13	0.0	1387.4	53814	66.3	.025	3.4	0.0	10.22	396.4	.5
14	0.0	516.1	6076	1067.8	.055	6.9	0.0	4.13	48.7	8.6
15	0.0	470.2	6034	985.7	.035	3.9	0.0	4.23	54.2	8.9
16	0.0	470.2	6886	756.4	.060	6.1	0.0	4.63	67.8	7.4
17	0.0	253.4	2890	487.7	.060	4.1	0.0	3.73	42.6	7.2
18	0.0	193.5	2910	165.6	0.000	0.0	0.0	5.70	85.8	4.9
19	0.0	141.1	2130	108.2	.065	1.6	0.0	5.77	87.2	4.4
20	0.0	101.0	1740	61.6	0.000	0.0	0.0	9.30	160.2	5.7
21	0.0	47.0	838	39.8	0.000	0.0	0.0	17.31	308.6	14.7
22	0.0	67.0	378	2.4	.080	0.0	I	R	R	R
23	0.0	1360.2	171	.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	13.336	GRAM/BHP HR
	CO	94.654	GRAM/BHP HR
	NO2	6.598	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.756	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

4-18-72 RUN 3 ENGINE 2-2 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL RATE LB/HR	FUEL RATE GM/HR	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	550	0.0	0	17.6	5.8	2631	0	3642	1.010	13.91	39
2	1200	5.2	1	17.2	11.7	5289	0	192	.070	13.63	98
3	1200	20.8	5	16.4	14.1	6378	0	282	.130	13.77	138
4	1200	46.8	11	15.3	15.4	6981	0	521	.180	14.05	250
5	1200	65.0	15	14.5	17.1	7775	0	555	.150	14.18	355
6	1200	130.0	30	11.4	22.4	10170	0	2094	.640	14.31	700
7	1200	195.0	45	7.0	27.2	12329	0	2907	1.230	13.91	1075
8	1200	213.0	49	6.3	30.0	13608	0	3023	1.450	13.77	1050
9	1200	239.0	55	4.2	32.1	14579	0	2963	1.340	13.77	1250
10	1200	260.0	59	0.0	48.5	22009	0	5757	10.480	8.43	100
11	550	0.0	0	17.6	5.8	2631	0	3744	1.230	13.33	34
12	1200	0.0	0	22.4	5.8	2654	0	58297	.520	5.96	5
13	2300	310.0	136	.9	100.7	45659	0	5078	11.000	7.09	81
14	2300	285.0	125	3.8	62.7	28459	0	2384	1.450	13.18	1850
15	2300	254.0	111	5.6	59.4	26957	0	2271	1.730	12.94	1600
16	2300	232.0	102	6.6	56.3	25515	0	2273	1.800	12.94	1550
17	2300	155.0	68	11.0	41.3	18711	0	1812	1.120	13.18	1250
18	2300	72.5	32	15.5	31.9	14465	0	1759	1.520	13.06	550
19	2300	55.8	24	17.0	27.8	12624	0	1531	1.340	13.18	410
20	2300	24.8	11	18.5	23.9	10859	0	1168	1.160	13.33	265
21	2300	6.2	3	19.4	20.7	9385	0	611	.640	13.63	190
22	550	0.0	0	17.5	5.8	2654	0	3273	.970	12.94	40
23	2300	0.0	0	24.3	6.1	2758	0	21979	.150	2.26	3

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	62.7	351	2.2	.070	0.0	I	R	R	R
2	0.0	7.4	55	12.5	.060	.1	0.0	6.22	45.9	10.5
3	0.0	12.9	120	20.9	.060	.3	0.0	2.72	25.3	4.4
4	0.0	25.4	178	40.6	.050	.5	0.0	2.38	16.6	3.8
5	0.0	30.0	164	63.7	.030	.4	0.0	2.02	11.0	4.3
6	0.0	140.5	867	155.9	.060	1.8	0.0	4.73	29.2	5.2
7	0.0	232.3	1985	285.2	0.000	0.0	0.0	5.21	44.6	6.4
8	0.0	265.0	2568	305.6	.040	1.9	0.0	5.45	52.8	6.3
9	0.0	280.4	2561	392.7	0.000	0.0	0.0	5.14	46.9	7.2
10	0.0	650.3	23911	37.5	0.000	0.0	0.0	10.95	402.5	.6
11	0.0	66.0	438	2.0	.070	0.0	I	R	R	R
12	0.0	1256.7	226	.3	.120	0.0	I	R	R	R
13	0.0	1246.7	54552	66.2	.025	3.4	0.0	9.18	401.8	.5
14	0.0	456.3	5606	1175.6	.055	6.9	0.0	3.66	44.9	9.4
15	0.0	411.0	6324	961.2	.035	3.9	0.0	3.70	56.9	8.6
16	0.0	387.4	6198	877.2	.050	6.1	0.0	3.81	61.0	8.6
17	0.0	234.1	2923	536.2	.060	4.1	0.0	3.45	43.1	7.9
18	0.0	172.4	3010	179.0	0.000	0.0	0.0	5.43	94.8	5.6
19	0.0	131.7	2329	117.1	.065	1.6	0.0	5.39	95.3	4.8
20	0.0	86.8	1742	65.4	0.000	0.0	0.0	8.00	160.4	6.0
21	0.0	40.0	847	41.3	0.000	0.0	0.0	14.74	311.8	15.2
22	0.0	61.0	365	2.5	.080	0.0	I	R	R	R
23	0.0	1315.5	181	.5	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	12.350	GRAM/BHP HR
	CO	93.422	GRAM/BHP HR
	NO2	7.118	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.756	LB/BHP HR

APPENDIX E

EMISSION RESULTS FROM ENGINE 1-3

TABULAR FORM

ENGINE 1-3

NINE MODE FTP EMISSION RESULTS

CONCENTRATION BASIS

4-24-72 ENGINE 1-3 RUN 1 K = .831 HUM = 36 GR/LB

	FEDERAL MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
	1 IDLE	423	.700	11.480	91	1.180	499	.826	107	.036	17.971	.030	3.866
	2 16'HG	102	.310	13.770	1059	1.033	105	.320	1094	.089	9.379	.029	97.373
	3 10'HG	87	.350	13.580	2573	1.047	91	.366	2694	.257	23.410	.094	692.347
	4 16'HG	55	.280	13.770	1229	1.038	57	.291	1276	.089	5.081	.026	113.536
	5 19'HG	26	.150	13.280	349	1.083	28	.163	378	.047	1.324	.008	17.772
	6 16'HG	49	.300	13.480	1211	1.060	52	.318	1283	.089	4.621	.028	114.215
	7 3'HG	33	.250	13.180	1473	1.087	36	.272	1601	.283	10.151	.077	453.086
	8 16'HG	39	.310	13.630	1229	1.049	41	.325	1289	.089	3.640	.029	114.704
	9 C.T.	1096	.170	5.680	94	2.087	2287	.355	196	.021	48.028	.007	4.119
	SUM----------(CYCLE COMPOSITE)----------										123.605	.328	1611.017
CYCLE 2													
	1 IDLE	423	.700	11.480	91	1.180	499	.826	107	.036	17.971	.030	3.866
	2 16'HG	349	.500	13.580	1134	1.021	356	.510	1157	.089	31.702	.045	103.008
	3 10'HG	71	.310	13.480	2697	1.057	75	.328	2852	.257	19.296	.084	732.979
	4 16'HG	35	.180	13.180	1241	1.090	38	.196	1352	.089	3.394	.017	120.344
	5 19'HG	13	.340	13.480	363	1.061	14	.361	385	.047	.648	.017	18.105
	6 16'HG	39	.220	13.060	1659	1.097	43	.241	1821	.089	3.809	.021	162.044
	7 3'HG	21	.270	13.180	1947	1.087	23	.294	2117	.283	6.461	.083	599.018
	8 16'HG	31	.350	13.480	1325	1.059	33	.371	1404	.089	2.923	.033	124.916
	9 C.T.	1143	.160	5.520	86	2.122	2425	.339	182	.021	50.925	.007	3.832
	SUM----------(CYCLE COMPOSITE)----------										137.129	.339	1868.111
CYCLE 3													
	1 IDLE	278	.520	11.840	90	1.169	325	.608	105	.036	11.703	.022	3.789
	2 16'HG	66	.390	13.480	1150	1.055	70	.411	1213	.089	6.196	.037	107.962
	3 10'HG	75	.400	13.480	2739	1.054	79	.421	2886	.257	20.310	.108	741.725
	4 16'HG	39	.380	13.480	1283	1.057	41	.402	1357	.089	3.670	.036	120.748
	5 19'HG	17	.440	13.180	363	1.081	18	.475	392	.047	.863	.022	18.436
	6 16'HG	39	.360	13.480	1313	1.058	41	.381	1389	.089	3.673	.034	123.662
	7 3'HG	21	.270	13.180	1968	1.087	23	.294	2140	.283	6.461	.083	605.479
	8 16'HG	35	.410	13.530	1313	1.053	37	.432	1382	.089	3.279	.038	123.027
	9 C.T.	1105	.240	5.860	74	2.021	2234	.485	150	.021	46.906	.010	3.141
	SUM----------(CYCLE COMPOSITE)----------										103.062	.391	1847.969
CYCLE 4													
	1 IDLE	278	.520	11.840	90	1.169	325	.608	105	.036	11.703	.022	3.789
	2 16'HG	92	.390	13.840	1217	1.026	94	.400	1248	.089	8.400	.036	111.115
	3 10'HG	75	.390	13.330	2791	1.066	80	.416	2974	.257	20.541	.107	764.417
	4 16'HG	39	.310	13.480	1313	1.060	41	.329	1392	.089	3.680	.029	123.888
	5 19'HG	22	.180	13.060	363	1.101	24	.198	400	.047	1.138	.009	18.779
	6 16'HG	53	.320	13.060	1301	1.092	58	.349	1421	.089	5.151	.031	126.453
	7 3'HG	61	.210	13.100	1988	1.093	67	.229	2172	.283	18.862	.065	614.711
	8 16'HG	31	.360	13.480	1369	1.059	33	.381	1450	.089	2.921	.034	129.017
	9 C.T.	1040	.210	5.800	75	2.063	2146	.433	155	.021	45.058	.009	3.249
	SUM----------(CYCLE COMPOSITE)----------										117.455	.342	1895.417

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 130.367 .333 1739.564

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 110.258 .366 1871.693

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(130.367) + 0.65*(110.258) =	117.296	PPM
CO	0.35*(.333) + 0.65*(.366) =	.355	PERCENT
NO	0.35*(1739.564) + 0.65*(1871.693) =	1825.448	PPM
	CORRECTED NO =	1516.638	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

4-25-72 ENGINE 1-3 RUN 2 K = .902 HUM = 51 GR/LB

	FEDERAL MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
	1 IDLE	449	.490	11.600	77	1.176	528	.576	91	.036	19.009	.021	3.260
	2 16'HG	114	.300	13.910	1054	1.022	117	.307	1078	.089	10.373	.027	95.902
	3 10'HG	107	.310	13.580	1867	1.047	112	.325	1955	.257	28.788	.083	502.317
	4 16'HG	71	.270	13.880	1241	1.029	73	.278	1277	.089	6.502	.025	113.649
	5 19'HG	37	.130	13.180	321	1.091	40	.142	350	.047	1.898	.007	16.467
	6 16'HG	61	.250	13.500	1152	1.059	65	.265	1220	.089	5.750	.024	108.587
	7 3'HG	43	.210	13.400	1738	1.070	46	.225	1860	.283	13.021	.064	526.282
	8 16'HG	50	.270	13.790	1247	1.037	52	.280	1293	.089	4.616	.025	115.119
	9 C.T.	1245	.190	6.030	87	1.941	2417	.369	169	.021	50.753	.008	3.547
	SUM----------(CYCLE COMPOSITE)----------										140.709	.283	1485.131
CYCLE 2													
	1 IDLE	449	.490	11.600	77	1.176	528	.576	91	.036	19.009	.021	3.260
	2 16'HG	71	.270	13.480	1117	1.059	75	.286	1183	.089	6.692	.025	105.282
	3 10'HG	84	.300	13.480	2647	1.057	89	.317	2797	.257	22.814	.081	718.916
	4 16'HG	53	.260	13.630	1277	1.049	56	.273	1340	.089	4.950	.024	119.269
	5 19'HG	26	.130	13.180	321	1.092	28	.142	351	.047	1.335	.007	16.482
	6 16'HG	49	.280	13.630	1187	1.049	51	.294	1245	.089	4.575	.026	110.818
	7 3'HG	35	.210	13.180	1876	1.088	38	.229	2042	.283	10.780	.065	577.819
	8 16'HG	49	.350	13.720	1313	1.040	51	.364	1365	.089	4.534	.032	121.482
	9 C.T.	1239	.190	6.290	93	1.877	2326	.357	175	.021	48.850	.007	3.667
	SUM----------(CYCLE COMPOSITE)----------										123.539	.289	1776.994
CYCLE 3													
	1 IDLE	416	.530	11.920	77	1.148	477	.608	88	.036	17.188	.022	3.181
	2 16'HG	82	.330	13.450	1438	1.058	87	.349	1522	.089	7.722	.031	135.420
	3 10'HG	75	.310	13.250	2656	1.075	81	.333	2856	.257	20.724	.086	733.915
	4 16'HG	49	.260	13.480	1229	1.061	52	.276	1304	.089	4.628	.025	116.082
	5 19'HG	26	.120	13.120	334	1.098	29	.132	367	.047	1.342	.006	17.233
	6 16'HG	50	.250	13.480	1344	1.062	53	.265	1427	.089	4.724	.024	126.981
	7 3'HG	33	.200	13.180	1841	1.089	36	.218	2005	.283	10.170	.062	567.344
	8 16'HG	44	.310	13.630	1274	1.048	46	.325	1335	.089	4.105	.029	118.857
	9 C.T.	1159	.180	5.960	108	1.986	2302	.357	214	.021	48.333	.008	4.504
	SUM----------(CYCLE COMPOSITE)----------										118.935	.291	1823.519
CYCLE 4													
	1 IDLE	416	.530	11.920	77	1.148	477	.608	88	.036	17.188	.022	3.181
	2 16'HG	78	.280	13.480	1170	1.058	83	.296	1238	.089	7.345	.026	110.176
	3 10'HG	79	.350	13.480	2655	1.055	83	.369	2802	.257	21.426	.095	720.060
	4 16'HG	53	.280	13.550	1298	1.055	56	.295	1369	.089	4.975	.026	121.848
	5 19'HG	26	.120	13.180	312	1.093	28	.131	341	.047	1.335	.006	16.026
	6 16'HG	46	.270	13.480	1232	1.061	49	.287	1307	.089	4.344	.025	116.351
	7 3'HG	33	.230	13.180	1925	1.088	36	.250	2094	.283	10.158	.071	592.563
	8 16'HG	42	.310	13.630	1259	1.048	44	.325	1320	.089	3.919	.029	117.476
	9 C.T.	1185	.200	6.020	109	1.960	2322	.392	214	.021	48.762	.008	4.485
	SUM----------(CYCLE COMPOSITE)----------										119.453	.309	1802.166

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 132.124 .286 1631.062

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 119.194 .300 1812.842

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(132.124) + 0.65*(119.194) =	123.720	PPM
CO	0.35*(.286) + 0.65*(.300) =	.295	PERCENT
NO	0.35*(1631.062) + 0.65*(1812.842) =	1749.219	PPM
	CORRECTED NO =	1578.167	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

4-25-72 ENGINE 1-3 RUN 3 K = .810 HUM = 32 GR/LB

	FEDERAL MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
	1 IDLE	374	.530	11.600	80	1.182	442	.626	95	.036	15.912	.023	3.404
	2 16'HG	104	.230	13.550	1100	1.052	109	.242	1158	.089	9.742	.022	103.035
	3 10'HG	93	.270	13.480	2606	1.057	98	.285	2755	.257	25.268	.073	708.053
	4 16'HG	57	.210	13.530	1188	1.059	60	.222	1258	.089	5.371	.020	111.934
	5 19'HG	37	.120	13.120	307	1.097	41	.132	337	.047	1.907	.006	15.826
	6 16'HG	46	.210	13.480	1223	1.063	49	.223	1301	.089	4.354	.020	115.755
	7 3'HG	41	.190	13.150	1738	1.091	45	.207	1896	.283	12.660	.059	536.664
	8 16'HG	40	.250	13.940	1260	1.028	41	.257	1295	.089	3.659	.023	115.254
	9 C.T.	1272	.180	5.860	97	1.980	2518	.356	192	.021	52.886	.007	4.033
	SUM----------(CYCLE COMPOSITE)----------										131.759	.252	1713.959
CYCLE 2													
	1 IDLE	374	.530	11.600	80	1.182	442	.626	95	.036	15.912	.023	3.404
	2 16'HG	66	.260	13.550	1117	1.054	70	.274	1178	.089	6.194	.024	104.826
	3 10'HG	73	.330	13.580	2723	1.049	77	.346	2856	.257	19.679	.089	734.041
	4 16'HG	41	.180	13.720	1277	1.047	43	.188	1337	.089	3.819	.017	118.950
	5 19'HG	17	.160	13.180	321	1.092	19	.175	351	.047	.873	.008	16.475
	6 16'HG	40	.180	13.630	1260	1.054	42	.190	1327	.089	3.751	.017	118.143
	7 3'HG	22	.240	13.180	1821	1.088	24	.261	1982	.283	6.776	.074	560.838
	8 16'HG	31	.350	13.720	1338	1.041	32	.364	1393	.089	2.872	.032	123.968
	9 C.T.	1156	.250	5.860	97	2.005	2317	.501	194	.021	48.663	.011	4.083
	SUM----------(CYCLE COMPOSITE)----------										108.538	.295	1784.728
CYCLE 3													
	1 IDLE	438	.480	12.220	90	1.121	491	.538	101	.036	17.678	.019	3.633
	2 16'HG	68	.300	13.480	1241	1.058	72	.317	1313	.089	6.404	.028	116.869
	3 10'HG	71	.300	13.480	2843	1.058	75	.317	3008	.257	19.303	.082	772.940
	4 16'HG	40	.230	13.550	1376	1.058	42	.243	1455	.089	3.766	.022	129.538
	5 19'HG	17	.140	13.180	363	1.093	19	.153	397	.047	.873	.007	18.645
	6 16'HG	37	.250	13.700	1284	1.046	39	.261	1343	.089	3.444	.023	119.510
	7 3'HG	22	.160	13.330	1925	1.079	24	.173	2078	.283	6.720	.049	588.014
	8 16'HG	31	.280	13.770	1351	1.040	32	.291	1405	.089	2.869	.026	125.038
	9 C.T.	1125	.170	5.890	102	2.017	2269	.343	206	.021	47.644	.007	4.320
	SUM----------(CYCLE COMPOSITE)----------										108.702	.263	1878.506
CYCLE 4													
	1 IDLE	438	.480	12.220	90	1.121	491	.538	101	.036	17.678	.019	3.633
	2 16'HG	74	.320	13.770	1206	1.035	77	.331	1248	.089	6.816	.029	111.089
	3 10'HG	74	.280	13.660	2791	1.045	77	.293	2916	.257	19.868	.075	749.332
	4 16'HG	49	.230	13.770	1289	1.040	51	.239	1341	.089	4.537	.021	119.347
	5 19'HG	18	.120	13.330	345	1.081	19	.130	373	.047	.915	.006	17.534
	6 16'HG	40	.280	13.660	1381	1.047	42	.293	1447	.089	3.729	.026	128.741
	7 3'HG	19	.160	13.400	2062	1.074	20	.172	2215	.283	5.775	.049	626.747
	8 16'HG	31	.270	13.770	1351	1.040	32	.281	1405	.089	2.870	.025	125.083
	9 C.T.	1108	.170	5.530	112	2.129	2359	.362	238	.021	49.531	.008	5.007
	SUM----------(CYCLE COMPOSITE)----------										111.719	.259	1886.511

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 120.148 .273 1749.344

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 110.210 .261 1882.509

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(120.148) + 0.65*(110.210) =	113.689	PPM
CO	0.35*(.273) + 0.65*(.261) =	.265	PERCENT
NO	0.35*(1749.344) + 0.65*(1882.509) =	1835.901	PPM
	CORRECTED NO =	1487.920	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

ENGINE 1-3

NINE MODE FTP EMISSION RESULTS

BRAKE SPECIFIC BASIS

4-24-72 ENGINE 1-3 RUN 1 K = .84 HUM = 36 GR/LB

MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1														
1 IDLE	423	.700	11.48	91	12.637	2115	76	237	5	.232	17.7	55	1.2	0
2 16 HG	102	.310	13.77	1059	14.190	9263	72	409	230	.077	5.5	31	17.7	22
3 10 HG	87	.350	13.58	2573	14.024	13518	91	681	823	.147	13.3	100	121.0	53
4 16 HG	55	.280	13.77	1229	14.109	9263	39	371	268	.077	3.0	29	20.6	22
5 19 HG	26	.150	13.28	349	13.458	6754	14	152	58	.057	.8	9	3.3	4
6 16 HG	49	.300	13.48	1211	13.833	9263	35	406	269	.077	2.7	31	20.7	22
7 3 HG	33	.250	13.18	1473	13.466	19613	52	736	712	.113	5.9	83	80.5	69
8 16 HG	39	.310	13.63	1229	13.982	9263	28	415	270	.077	2.1	32	20.8	22
9 C.T.	1096	.170	5.68	94	7.034	2261	380	110	10	.143	54.4	16	1.4	0
SUM----------(CYCLE COMPOSITE)----------											4.7	17	12.7	
CYCLE 2														
1 IDLE	423	.700	11.48	91	12.637	2115	76	237	5	.232	17.7	55	1.2	0
2 16 HG	349	.500	13.58	1134	14.457	9263	242	647	241	.077	18.6	50	18.6	22
3 10 HG	71	.310	13.48	2697	13.867	13518	75	610	873	.147	11.0	90	128.3	53
4 16 HG	35	.180	13.18	1241	13.398	9263	26	251	285	.077	2.0	19	21.9	22
5 19 HG	13	.340	13.48	363	13.834	6754	7	335	59	.057	.4	19	3.4	4
6 16 HG	39	.220	13.06	1659	13.322	9263	29	309	383	.077	2.3	24	29.5	22
7 3 HG	21	.270	13.18	1947	13.473	19613	33	794	941	.113	3.7	90	106.3	69
8 16 HG	31	.350	13.48	1325	13.863	9263	22	472	294	.077	1.7	36	22.6	22
9 C.T.	1143	.160	5.52	86	6.914	2261	404	106	9	.143	57.7	15	1.3	0
SUM----------(CYCLE COMPOSITE)----------											5.1	18	14.8	
CYCLE 3														
1 IDLE	278	.520	11.84	90	12.660	2115	50	175	5	.232	11.6	41	1.2	0
2 16 HG	66	.390	13.48	1150	13.941	9263	47	523	254	.077	3.6	40	19.5	22
3 10 HG	75	.400	13.48	2739	13.961	13518	78	782	880	.147	11.5	115	129.4	53
4 16 HG	39	.380	13.48	1283	13.902	9263	28	511	284	.077	2.2	39	21.9	22
5 19 HG	17	.440	13.18	363	13.638	6754	9	440	60	.057	.5	25	3.4	4
6 16 HG	39	.360	13.48	1313	13.882	9263	28	485	291	.077	2.2	37	22.4	22
7 3 HG	21	.270	13.18	1968	13.473	19613	33	794	951	.113	3.7	90	107.5	69
8 16 HG	35	.410	13.53	1313	13.978	9263	25	549	289	.077	1.9	42	22.2	22
9 C.T.	1105	.240	5.86	74	7.293	2261	370	150	8	.143	52.9	21	1.1	0
SUM----------(CYCLE COMPOSITE)----------											4.0	20	14.6	
CYCLE 4														
1 IDLE	278	.520	11.84	90	12.660	2115	50	175	5	.232	11.6	41	1.2	0
2 16 HG	92	.390	13.84	1217	14.329	9263	64	509	261	.077	4.9	39	20.1	22
3 10 HG	75	.390	13.33	2791	13.801	13518	79	772	908	.147	11.7	113	133.4	53
4 16 HG	39	.310	13.48	1313	13.832	9263	28	419	292	.077	2.2	32	22.5	22
5 19 HG	22	.180	13.06	363	13.264	6754	12	185	61	.057	.7	11	3.5	4
6 16 HG	53	.320	13.06	1301	13.437	9263	39	446	298	.077	3.0	34	22.9	22
7 3 HG	61	.210	13.10	1988	13.376	19613	97	622	968	.113	10.9	70	109.4	69
8 16 HG	31	.360	13.48	1369	13.873	9263	22	486	303	.077	1.7	37	23.4	22
9 C.T.	1040	.210	5.80	75	7.133	2261	356	134	8	.143	50.9	19	1.1	0
SUM----------(CYCLE COMPOSITE)----------											4.3	18	15.0	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------											4.9	17	13.8	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------											4.2	19	14.8	

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(4.9) + 0.65(4.2) = 4.422 (MASS)
CO 0.35(17) + 0.65(19) = 18.3 (MASS)
NO2 0.35(13.8) + 0.65(14.8) = 14.417 (MASS)
CORRECTED NO2 = 12.120 (MASS)

4-25-72 ENGINE 1-3 RUN 2 K = .91 HUM = 51 GR/LB

MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1														
1 IDLE	449	.490	11.60	77	12.575	2115	82	166	4	.232	18.9	39	1.0	0
2 16 HG	114	.300	13.91	1054	14.333	9263	80	392	226	.077	6.1	30	17.4	22
3 10 HG	107	.310	13.58	1847	14.006	13518	112	604	598	.147	16.4	89	87.9	53
4 16 HG	71	.270	13.88	1241	14.227	9263	50	355	268	.077	3.8	27	20.7	22
5 19 HG	37	.130	13.18	321	13.350	6754	20	133	54	.057	1.2	8	3.1	4
6 16 HG	61	.250	13.50	1152	13.816	9263	44	339	256	.077	3.4	26	19.7	22
7 3 HG	43	.210	13.40	1738	13.656	19613	67	609	829	.113	7.5	69	93.6	69
8 16 HG	50	.270	13.79	1247	14.114	9263	35	358	272	.077	2.7	28	20.9	22
9 C.T.	1245	.190	6.03	87	7.565	2261	402	115	9	.143	57.5	16	1.2	0
SUM----------(CYCLE COMPOSITE)----------											5.2	15	11.8	
CYCLE 2														
1 IDLE	449	.490	11.60	77	12.575	2115	82	166	4	.232	18.9	39	1.0	0
2 16 HG	71	.270	13.48	1117	13.827	9263	51	365	248	.077	4.0	28	19.1	22
3 10 HG	84	.300	13.48	2647	13.871	13518	88	591	856	.147	13.0	87	125.9	53
4 16 HG	53	.260	13.63	1277	13.947	9263	38	349	282	.077	2.9	27	21.7	22
5 19 HG	26	.130	13.18	321	13.338	6754	14	133	54	.057	.8	8	3.1	4
6 16 HG	49	.280	13.63	1187	13.963	9263	35	375	261	.077	2.7	29	20.1	22
7 3 HG	35	.210	13.18	1876	13.428	19613	55	620	910	.113	6.2	70	102.8	69
8 16 HG	49	.350	13.72	1313	14.123	9263	35	464	286	.077	2.7	36	22.0	22
9 C.T.	1239	.190	6.29	93	7.818	2261	387	111	9	.143	55.3	16	1.3	0
SUM----------(CYCLE COMPOSITE)----------											4.7	15	14.1	
CYCLE 3														
1 IDLE	416	.530	11.92	77	12.899	2115	74	176	4	.232	17.1	41	1.0	0
2 16 HG	82	.330	13.45	1438	13.869	9263	59	445	319	.077	4.6	34	24.6	22
3 10 HG	75	.310	13.25	2656	13.641	13518	80	621	874	.147	11.8	91	128.5	53
4 16 HG	49	.260	13.48	1229	13.793	9263	36	353	274	.077	2.7	27	21.1	22
5 19 HG	26	.120	13.12	334	13.268	6754	14	123	56	.057	.8	7	3.2	4
6 16 HG	50	.250	13.48	1344	13.784	9263	36	339	300	.077	2.8	26	23.1	22
7 3 HG	33	.200	13.18	1841	13.416	19613	52	591	894	.113	5.9	67	101.0	69
8 16 HG	44	.310	13.63	1274	13.988	9263	31	415	280	.077	2.4	32	21.6	22
9 C.T.	1159	.180	5.96	108	7.392	2261	383	111	11	.143	54.7	16	1.6	0
SUM----------(CYCLE COMPOSITE)----------											4.6	15	14.4	
CYCLE 4														
1 IDLE	416	.530	11.92	77	12.899	2115	74	176	4	.232	17.1	41	1.0	0
2 16 HG	78	.280	13.48	1170	13.844	9263	56	378	260	.077	4.3	29	20.0	22
3 10 HG	79	.350	13.48	2655	13.915	13518	83	687	856	.147	12.2	101	125.9	53
4 16 HG	53	.280	13.55	1298	13.887	9263	38	377	287	.077	2.9	29	22.1	22
5 19 HG	26	.120	13.18	312	13.328	6754	14	123	52	.057	.8	7	3.0	4
6 16 HG	46	.270	13.48	1232	13.800	9263	33	366	275	.077	2.6	28	21.1	22
7 3 HG	33	.230	13.18	1925	13.446	19613	52	678	932	.113	5.9	77	105.3	69
8 16 HG	42	.310	13.63	1259	13.985	9263	30	415	277	.077	2.3	32	21.3	22
9 C.T.	1185	.200	6.02	109	7.500	2261	386	122	11	.143	55.2	17	1.6	0
SUM----------(CYCLE COMPOSITE)----------											4.6	16	14.3	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------											5.0	15	12.9	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------											4.6	16	14.3	

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(5.0) + 0.65(4.6) = 4.712 (MASS)
CO 0.35(15) + 0.65(16) = 15.3 (MASS)
NO2 0.35(12.9) + 0.65(14.3) = 13.847 (MASS)
CORRECTED NO2 = 12.598 (MASS)

4-25-72 ENGINE 1-3 RUN 3 K = .62 HUM = 32 GR/LB

MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1														
1 IDLE	374	.530	11.60	80	12.534	2115	68	181	4	.232	15.8	42	1.0	0
2 16 HG	104	.230	13.55	1100	13.892	9263	75	310	244	.077	5.8	24	18.7	22
3 10 HG	93	.270	13.48	2606	13.850	13518	98	532	844	.147	14.4	78	124.1	53
4 16 HG	53	.210	13.53	1188	13.802	9263	41	285	265	.077	3.2	22	20.4	22
5 19 HG	37	.120	13.12	307	13.280	6754	20	123	52	.057	1.2	7	3.0	4
6 16 HG	46	.210	13.48	1223	13.740	9263	33	286	274	.077	2.6	22	21.1	22
7 3 HG	41	.190	13.15	1738	13.384	19613	65	562	846	.113	7.3	64	95.5	69
8 16 HG	40	.250	13.94	1260	14.233	9263	28	329	272	.077	2.2	25	21.0	22
9 C.T.	1272	.180	5.86	97	7.414	2261	419	111	10	.143	59.9	16	1.4	0
SUM----------(CYCLE COMPOSITE)----------											5.0	13	13.6	
CYCLE 2														
1 IDLE	374	.530	11.60	80	12.534	2115	68	181	4	.232	15.8	42	1.0	0
2 16 HG	66	.260	13.55	1117	13.881	9263	48	350	247	.077	3.7	27	19.1	22
3 10 HG	73	.330	13.58	2723	13.989	13518	76	654	874	.147	11.2	95	128.4	53
4 16 HG	41	.180	13.72	1277	13.944	9263	29	242	282	.077	2.3	19	21.7	22
5 19 HG	17	.160	13.18	321	13.358	6754	9	163	54	.057	.5	9	3.1	4
6 16 HG	40	.180	13.63	1260	13.853	9263	29	243	280	.077	2.2	19	21.5	22
7 3 HG	22	.240	13.18	1821	13.444	19613	35	707	882	.113	3.9	80	99.7	69
8 16 HG	31	.350	13.72	1338	14.103	9263	22	464	292	.077	1.7	36	22.5	22
9 C.T.	1156	.250	5.86	97	7.358	2261	384	155	10	.143	54.9	22	1.4	0
SUM----------(CYCLE COMPOSITE)----------											4.3	15	14.1	
CYCLE 3														
1 IDLE	438	.480	12.22	90	13.173	2115	76	156	5	.232	17.6	36	1.1	0
2 16 HG	68	.300	13.48	1241	13.853	9263	49	405	275	.077	3.8	31	21.2	22
3 10 HG	71	.300	13.48	2843	13.857	13518	75	591	921	.147	11.0	87	135.4	53
4 16 HG	40	.230	13.55	1376	13.823	9263	29	311	306	.077	2.2	24	23.6	22
5 19 HG	17	.140	13.18	363	13.338	6754	9	143	61	.057	.5	8	3.5	4
6 16 HG	37	.250	13.70	1284	13.990	9263	26	334	282	.077	2.0	26	21.7	22
7 3 HG	22	.160	13.33	1925	13.514	19613	34	469	928	.113	3.9	53	104.8	69
8 16 HG	31	.280	13.77	1351	14.083	9263	22	372	295	.077	1.7	29	22.7	22
9 C.T.	1125	.170	5.89	102	7.275	2261	378	107	11	.143	54.0	15	1.5	0
SUM----------(CYCLE COMPOSITE)----------											4.3	14	14.9	
CYCLE 4														
1 IDLE	438	.480	12.22	90	13.173	2115	76	156	5	.232	17.6	36	1.1	0
2 16 HG	74	.320	13.77	1206	14.170	9263	52	423	262	.077	4.0	33	20.2	22
3 10 HG	74	.280	13.66	2791	14.020	13518	77	545	893	.147	11.3	80	131.3	53
4 16 HG	49	.230	13.77	1289	14.053	9263	35	306	282	.077	2.7	24	21.7	22
5 19 HG	18	.120	13.33	345	13.469	6754	10	122	57	.057	.6	7	3.3	4
6 16 HG	40	.280	13.66	1381	13.983	9263	29	375	304	.077	2.2	29	23.4	22
7 3 HG	19	.160	13.40	2062	13.581	19613	30	467	989	.113	3.3	53	111.7	69
8 16 HG	31	.270	13.77	1351	14.073	9263	22	359	295	.077	1.7	28	22.7	22
9 C.T.	1108	.170	5.53	112	6.897	2261	392	113	12	.143	56.1	16	1.7	0
SUM----------(CYCLE COMPOSITE)----------											4.4	14	15.0	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------											4.6	14	13.9	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------											4.4	14	14.9	

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(4.6) + 0.65(4.4) = 4.449 (MASS)
CO 0.35(14) + 0.65(14) = 13.9 (MASS)
NO2 0.35(13.9) + 0.65(14.9) = 14.545 (MASS)
CORRECTED NO2 = 11.935 (MASS)

ENGINE 1-3

EXPERIMENTAL 23 MODE EMISSION RESULTS

BRAKE SPECIFIC BASIS

PROJECT 11-2877-01 CONTROL TECHNOLOGY

4-27-72 RUN 2 ENGINE 1-3 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL RATE LB/HR	FUEL RATE GM/HR	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.5	4.9	2228	35	7793	.520	11.72	24
2	1200	5.0	1	19.2	9.2	4155	32	1743	.280	13.18	130
3	1200	19.0	4	18.5	9.5	4314	40	1348	.150	13.18	215
4	1200	42.0	10	17.1	10.8	4892	63	1459	.130	13.06	380
5	1200	59.0	13	16.2	12.0	5424	62	1795	.100	13.06	505
6	1200	117.5	27	11.6	16.1	7283	75	2361	.100	13.33	1900
7	1200	176.0	40	3.4	23.9	10841	188	1465	.280	13.48	1600
8	1200	192.5	44	1.1	24.8	11261	49	1636	.390	13.48	1700
9	1200	216.0	49	.6	27.7	12560	38	2736	1.940	13.18	1275
10	1200	235.0	54	0.0	35.1	15931	31	4215	5.720	11.01	525
11	600	0.0	0	18.5	4.9	2228	41	4152	.610	12.59	31
12	1200	0.0	0	22.4	5.2	2375	51	58470	.210	3.56	3
13	2300	255.0	112	.5	66.0	29938	59	3358	5.240	11.84	600
14	2300	234.5	103	1.4	55.6	25220	26	2405	1.800	13.91	1800
15	2300	209.0	92	1.6	49.4	22388	28	396	.150	14.18	2500
16	2300	191.0	84	3.4	47.4	21503	20	278	.210	14.18	2250
17	2300	127.5	56	11.2	33.6	15249	31	1761	.520	14.18	2800
18	2300	64.0	28	15.5	24.1	10929	25	1248	.490	14.05	1438
19	2300	46.0	20	17.0	21.1	9566	40	855	.350	14.79	913
20	2300	20.0	9	18.4	18.0	8165	42	340	.210	14.05	440
21	2300	5.0	2	19.1	15.2	6902	21	226	.210	14.05	300
22	600	0.0	0	18.5	4.7	2127	29	4807	.280	12.47	28
23	2300	0.0	0	24.4	4.7	2134	67	20518	.100	2.70	2

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	1.3	133.3	180	1.4	.070	0.0	R	R	R	R
2	2.1	53.1	172	13.2	.060	.1	1.9	46.49	150.9	11.5
3	2.8	43.2	97	22.9	.060	.3	.6	9.95	22.4	5.3
4	5.0	53.5	96	46.3	.050	.5	.5	5.58	10.0	4.8
5	5.4	73.0	82	68.2	.030	.4	.4	5.41	6.1	5.1
6	8.6	125.8	108	336.2	.060	1.6	.3	4.69	4.0	12.5
7	31.6	114.2	441	414.1	0.000	0.0	.8	2.84	11.0	10.3
8	8.5	131.3	632	452.9	.040	1.8	.2	2.98	14.4	10.3
9	6.6	223.2	3197	345.4	0.000	0.0	.1	4.52	64.8	7.0
10	6.3	391.5	10732	161.9	0.000	0.0	.1	7.29	199.9	3.0
11	1.4	67.9	202	1.7	.070	0.0	R	R	R	R
12	2.7	1443.7	105	.3	.120	0.0	R	R	R	R
13	22.0	577.3	18195	342.4	.025	2.8	.2	5.17	162.9	3.1
14	9.0	380.3	5749	944.9	.055	5.6	.1	3.70	56.0	9.2
15	9.4	61.8	472	1293.1	.035	3.2	.1	.67	5.2	14.1
16	6.3	41.4	633	1114.1	.060	5.0	.1	.49	7.6	13.3
17	6.8	180.5	1077	952.9	.060	3.4	.1	3.23	19.3	17.1
18	4.1	93.0	738	355.7	0.000	0.0	.1	3.32	26.3	12.7
19	5.5	53.7	444	190.3	.065	1.3	.3	2.67	22.1	9.4
20	5.2	19.4	242	83.4	0.000	0.0	.6	2.21	27.7	9.5
21	2.2	10.9	205	48.1	0.000	0.0	1.0	5.00	93.6	22.0
22	1.0	77.3	91	1.5	.080	0.0	R	R	R	R
23	6.4	902.3	89	.3	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	12.562	GRAM/BHP HR
	CO	39.610	GRAM/BHP HR
	NO2	11.093	GRAM/BHP HR
	ALDE	.196	GRAM/BHP HR
	BSFC	.719	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

4-28-72 RUN 1 ENGINE 1-3 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL RATE LB/HR	FUEL RATE GM/HR	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.5	4.9	2228	25	8902	.470	11.72	24
2	1200	4.6	1	19.2	9.2	4155	28	1912	.180	13.33	147
3	1200	18.4	4	18.5	9.5	4314	31	1515	.130	13.06	225
4	1200	41.4	9	17.0	10.8	4892	50	1740	.100	13.18	385
5	1200	57.5	13	15.7	12.0	5424	71	1853	.100	13.18	620
6	1200	115.0	26	11.8	16.1	7283	53	2476	.100	13.48	1850
7	1200	172.5	39	4.2	23.9	10841	164	1522	.180	13.63	1725
8	1200	188.5	43	1.0	24.8	11261	61	1806	.280	13.63	1850
9	1200	211.5	48	.7	27.7	12560	90	2490	.640	13.63	1725
10	1200	230.0	53	0.0	35.1	15931	30	5148	5.720	11.24	663
11	600	0.0	0	18.5	4.9	2228	25	5063	.810	12.71	32
12	1200	0.0	0	22.5	5.2	2375	49	69318	.180	3.56	3
13	2300	250.0	109	.6	66.0	29938	37	3763	5.350	11.72	563
14	2300	230.0	101	1.5	55.6	25220	25	2281	1.010	14.18	2200
15	2300	205.0	90	1.8	49.4	22388	20	453	.150	14.05	2350
16	2300	187.5	82	3.5	47.4	21503	34	339	.210	13.91	2125
17	2300	125.0	55	11.0	33.6	15249	18	2097	.550	13.91	2750
18	2300	62.5	27	15.5	24.1	10929	18	1586	.580	13.77	1412
19	2300	45.0	20	16.9	21.1	9566	37	1133	.440	13.91	900
20	2300	20.0	9	18.3	18.0	8165	27	452	.250	13.91	470
21	2300	5.0	2	19.3	15.2	6902	15	225	.150	13.63	275
22	600	0.0	0	18.5	4.7	2127	38	5788	.210	12.22	29
23	2300	0.0	0	24.5	4.7	2134	44	21594	.130	2.93	3

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	.9	151.6	162	1.4	.070	0.0	R	R	R	R
2	1.8	58.0	110	14.8	.060	.1	1.7	55.17	104.9	14.1
3	2.1	49.0	85	24.2	.060	.3	.5	11.65	20.2	5.7
4	3.9	63.3	73	46.5	.050	.5	.4	6.69	7.8	4.9
5	6.2	74.6	81	82.9	.030	.4	.5	5.68	6.2	6.3
6	6.0	130.4	106	323.5	.060	1.6	.2	4.96	4.0	12.3
7	27.5	118.2	282	444.7	0.000	0.0	.7	3.00	7.2	11.3
8	10.4	144.3	452	490.8	.040	1.7	.2	3.35	10.5	11.4
9	16.7	215.4	1118	495.4	0.000	0.0	.3	4.46	23.1	10.3
10	5.8	469.3	10534	200.5	0.000	0.0	.1	8.93	200.4	3.8
11	.9	80.4	260	1.7	.070	0.0	R	R	R	R
12	2.3	1542.4	81	.2	.120	0.0	R	R	R	R
13	13.8	645.8	18545	320.5	.025	2.7	.1	5.90	169.4	2.9
14	9.0	373.1	3337	1194.7	.055	5.5	.1	3.70	33.1	11.9
15	6.7	71.1	476	1226.2	.035	3.1	.1	.79	5.3	13.7
16	11.0	51.5	644	1071.8	.060	4.9	.1	.63	7.8	13.1
17	4.0	218.0	1155	949.1	.060	3.3	.1	3.98	21.1	17.3
18	2.9	119.5	883	353.2	0.000	0.0	.1	4.36	32.2	12.9
19	5.3	74.9	588	197.6	.065	1.3	.3	3.80	29.8	10.0
20	3.4	26.0	290	89.7	0.000	0.0	.4	2.97	33.1	10.2
21	1.6	11.3	152	45.7	0.000	0.0	.7	5.15	69.2	20.9
22	1.3	94.8	69	1.6	.080	0.0	R	R	R	R
23	3.9	882.8	107	.3	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	13.685	GRAM/BHP HR
	CO	35.581	GRAM/BHP HR
	NO2	11.709	GRAM/BHP HR
	ALDE	.176	GRAM/BHP HR
	BSFC	.733	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

4-28-72 RUN 2 ENGINE 1-3 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL RATE LB/HR	FUEL RATE GM/HR	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.5	4.9	2228	27	9511	.440	9.64	25
2	1200	4.6	1	19.3	9.2	4155	23	1668	.210	11.92	135
3	1200	18.4	4	18.5	9.5	4314	31	1503	.130	12.09	215
4	1200	31.4	9	16.9	10.8	4892	44	1722	.100	11.92	325
5	1200	57.5	13	16.0	12.0	5424	68	1955	.100	12.59	580
6	1200	115.0	26	11.9	16.1	7283	85	2569	.070	12.59	1875
7	1200	172.5	39	4.3	23.9	10841	175	1677	.150	12.59	1688
8	1200	188.5	43	1.1	24.8	11261	51	1846	.250	12.59	1700
9	1200	211.5	48	.6	27.7	12560	57	2532	.740	12.82	1725
10	1200	230.0	53	0.0	35.1	15931	28	5053	5.500	10.55	588
11	600	0.0	0	18.5	4.9	2228	52	5692	.700	11.84	33
12	1200	0.0	0	22.5	5.2	2375	53	54941	.150	3.81	4
13	2300	250.0	109	.6	66.0	29938	32	4045	5.350	11.48	550
14	2300	230.0	101	1.6	55.6	25220	23	1762	.470	14.31	2550
15	2300	205.0	90	1.8	49.4	22388	30	339	.150	14.05	2300
16	2300	187.5	82	3.5	47.4	21503	27	396	.250	14.05	2187
17	2300	125.0	55	11.0	33.6	15249	30	2384	.550	14.05	2200
18	2300	62.5	27	15.5	24.1	10929	43	1775	.610	15.09	1125
19	2300	45.0	20	17.0	21.1	9566	37	1134	.440	14.05	688
20	2300	20.0	9	18.3	18.0	8165	28	510	.280	14.05	400
21	2300	5.0	2	19.2	15.2	6902	18	226	.150	13.91	230
22	600	0.0	0	18.5	4.7	2127	29	7253	.310	12.22	24
23	2300	0.0	0	24.5	4.7	2134	36	22570	.100	2.70	2

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	1.2	192.1	179	1.7	.070	0.0	R	R	R	R
2	1.7	56.4	143	15.1	.060	.1	1.6	53.63	136.4	14.4
3	2.4	52.4	92	24.9	.060	.3	.6	12.46	21.8	5.9
4	3.8	69.1	81	43.3	.050	.5	.4	7.31	8.6	4.6
5	6.2	82.3	85	81.1	.030	.4	.5	6.27	6.5	6.2
6	10.3	144.9	80	351.0	.060	1.6	.4	5.51	3.0	13.4
7	31.8	140.8	254	470.6	0.000	0.0	.8	3.57	6.5	11.9
8	9.5	159.6	437	488.0	.040	1.7	.2	3.71	10.1	11.3
9	11.1	230.3	1359	520.7	0.000	0.0	.2	4.76	28.1	10.8
10	5.9	486.3	10691	187.7	0.000	0.0	.1	9.25	203.4	3.6
11	1.9	96.7	240	1.9	.070	0.0	R	R	R	R
12	2.9	1380.0	75	.3	.120	0.0	R	R	R	R
13	12.2	702.6	18773	317.2	.025	2.7	.1	6.42	171.5	2.9
14	8.2	297.1	1601	1427.6	.055	5.5	.1	2.95	15.9	14.2
15	10.2	53.4	477	1201.0	.035	3.1	.1	.59	5.3	13.4
16	8.8	59.4	757	1088.8	.060	4.9	.1	.72	9.2	13.3
17	6.6	245.0	1142	750.6	.060	3.3	.1	4.47	20.9	13.7
18	6.3	122.2	848	257.1	0.000	0.0	.2	4.46	31.0	9.4
19	5.3	74.3	582	149.5	.065	1.3	.3	3.77	29.5	7.6
20	3.4	28.9	321	75.4	0.000	0.0	.4	3.30	36.7	8.6
21	1.9	11.1	149	37.4	0.000	0.0	.9	5.06	67.8	17.1
22	1.0	116.4	100	1.3	.080	0.0	R	R	R	R
23	3.3	952.3	85	.3	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	13.337	GRAM/BHP HR
	CO	32.310	GRAM/BHP HR
	NO2	11.679	GRAM/BHP HR
	ALDE	.190	GRAM/BHP HR
	BSFC	.733	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

5-01-72 RUN 1 ENGINE 1-3 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL RATE LB/HR	FUEL RATE GM/HR	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.8	4.9	2228	0	9084	.420	11.24	19
2	1200	4.6	1	19.2	9.2	4155	0	1686	.210	13.18	90
3	1200	18.4	4	18.5	9.5	4314	0	1348	.150	13.18	140
4	1200	41.4	9	16.9	10.8	4892	0	1458	.100	13.06	260
5	1200	57.5	13	15.8	12.0	5424	0	1683	.100	13.06	410
6	1200	115.0	26	12.0	16.1	7283	0	2473	.100	13.33	1400
7	1200	172.5	39	3.6	23.9	10841	0	1635	.280	13.48	1175
8	1200	188.5	43	1.6	24.8	11261	0	1632	.250	13.33	1275
9	1200	211.5	48	.6	27.7	12560	0	2552	1.160	13.33	1125
10	1200	230.0	53	0.0	35.1	15931	0	4674	5.780	10.89	363
11	600	0.0	0	18.9	4.9	2228	0	5213	.670	11.13	28
12	1200	0.0	0	22.4	5.2	2375	0	53167	.150	3.35	4
13	2300	250.0	109	.6	66.0	29938	0	3469	5.290	11.60	525
14	2300	230.0	101	1.4	55.6	25220	0	1994	.890	14.18	2100
15	2300	205.0	90	1.9	49.4	22388	0	396	.180	14.18	2250
16	2300	187.5	82	3.4	47.4	21503	0	396	.280	14.05	2100
17	2300	125.0	55	11.0	33.6	15249	0	2043	.660	13.91	2650
18	2300	62.5	27	15.5	24.1	10929	0	1421	.740	14.05	1350
19	2300	45.0	20	17.0	21.1	9566	0	1079	.520	14.18	850
20	2300	20.0	9	18.3	18.0	8165	0	681	.390	14.18	530
21	2300	5.0	2	19.3	15.2	6902	0	226	.180	14.05	270
22	600	0.0	0	18.8	4.7	2127	0	8569	.180	11.24	28
23	2300	0.0	0	24.5	4.7	2134	0	16911	.100	2.59	3

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	161.0	150	1.1	.070	0.0	I	R	R	R
2	0.0	51.7	130	9.2	.060	.1	0.0	49.15	123.7	8.7
3	0.0	43.2	97	14.9	.060	.3	0.0	10.27	23.1	3.5
4	0.0	53.6	74	31.7	.050	.5	0.0	5.67	7.9	3.4
5	0.0	68.5	82	55.4	.030	.4	0.0	5.21	6.3	4.2
6	0.0	131.7	108	247.5	.060	1.6	0.0	5.01	4.1	9.4
7	0.0	127.3	440	303.8	0.000	0.0	0.0	3.23	11.2	7.7
8	0.0	133.7	414	346.8	.040	1.7	0.0	3.11	9.6	8.1
9	0.0	217.3	1996	318.2	0.000	0.0	0.0	4.50	41.3	6.6
10	0.0	434.5	10854	111.9	0.000	0.0	0.0	8.27	206.5	2.1
11	0.0	94.2	245	1.7	.070	0.0	I	R	R	R
12	0.0	1431.9	82	.4	.120	0.0	I	R	R	R
13	0.0	602.5	18559	302.7	.025	2.7	0.0	5.50	169.5	2.8
14	0.0	329.3	2969	1151.5	.055	5.5	0.0	3.27	29.5	11.4
15	0.0	61.6	565	1161.4	.035	3.1	0.0	.69	6.3	12.9
16	0.0	59.3	846	1043.3	.060	4.9	0.0	.72	10.3	12.7
17	0.0	210.8	1376	908.1	.060	3.3	0.0	3.85	25.1	16.6
18	0.0	104.0	1094	328.0	0.000	0.0	0.0	3.80	40.0	12.0
19	0.0	69.7	679	182.3	.065	1.3	0.0	3.54	34.4	9.3
20	0.0	38.0	439	98.1	0.000	0.0	0.0	4.34	50.2	11.2
21	0.0	11.0	176	43.4	0.000	0.0	0.0	5.01	80.4	19.8
22	0.0	148.4	63	1.6	.080	0.0	I	R	R	R
23	0.0	823.6	98	.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	13.025	GRAM/BHP HR
	CO	36.063	GRAM/BHP HR
	NO2	10.802	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.733	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

5-01-72 RUN 2 ENGINE 1-3 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL RATE LB/HR	FUEL RATE GM/HR	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.7	4.9	2228	0	8799	.250	10.55	24
2	1200	4.6	1	19.2	9.2	4155	0	1568	.180	12.82	110
3	1200	18.4	4	18.5	9.5	4314	0	1345	.130	12.94	185
4	1200	41.4	9	16.8	10.8	4892	0	1510	.100	12.71	370
5	1200	57.5	13	15.8	12.0	5424	0	1678	.100	12.71	560
6	1200	115.0	26	12.0	16.1	7283	0	2355	.070	13.06	1825
7	1200	172.5	39	3.4	23.9	10841	0	1572	.250	13.06	1525
8	1200	188.5	43	1.6	24.8	11261	0	1572	.250	13.06	1625
9	1200	211.5	48	.6	27.7	12560	0	2374	1.160	12.94	1450
10	1200	230.0	53	0.0	35.1	15931	0	4553	5.960	10.55	450
11	600	0.0	0	18.8	4.9	2228	0	5558	.580	11.48	32
12	1200	0.0	0	22.4	5.2	2375	0	44261	.130	3.04	3
13	2300	250.0	109	.6	66.0	29938	0	3586	5.240	11.72	525
14	2300	230.0	101	1.4	55.6	25220	0	2056	.930	14.42	2200
15	2300	205.0	90	1.9	49.4	22388	0	454	.150	14.31	2400
16	2300	187.5	82	3.4	47.4	21503	0	454	.280	14.31	2225
17	2300	125.0	55	11.0	33.6	15249	0	2106	.640	14.31	2800
18	2300	62.5	27	15.6	24.1	10929	0	1479	.740	14.18	1350
19	2300	45.0	20	16.9	21.1	9566	0	1137	.550	14.31	975
20	2300	20.0	9	18.4	18.0	8165	0	625	.390	14.42	540
21	2300	5.0	2	19.3	15.2	6902	0	227	.180	14.31	290
22	600	0.0	0	18.8	4.7	2127	0	4989	.150	11.60	29
23	2300	0.0	0	24.5	4.7	2134	0	17371	.100	2.26	3

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	167.8	96	1.5	.070	0.0	I	R	R	R
2	0.0	49.5	115	11.5	.060	.1	0.0	47.12	109.2	11.0
3	0.0	43.9	86	20.1	.060	.3	0.0	10.45	20.4	4.8
4	0.0	57.0	76	46.4	.050	.5	0.0	6.03	8.1	4.9
5	0.0	70.1	84	77.7	.030	.4	0.0	5.34	6.4	5.9
6	0.0	128.3	77	330.2	.060	1.6	0.0	4.88	2.9	12.6
7	0.0	126.6	407	407.6	0.000	0.0	0.0	3.21	10.3	10.3
8	0.0	131.5	422	451.1	.040	1.7	0.0	3.05	9.8	10.5
9	0.0	208.0	2053	421.7	0.000	0.0	0.0	4.30	42.5	8.7
10	0.0	427.6	11305	140.3	0.000	0.0	0.0	8.14	215.1	2.7
11	0.0	98.1	207	1.9	.070	0.0	I	R	R	R
12	0.0	1383.6	82	.3	.120	0.0	I	R	R	R
13	0.0	619.9	18297	301.3	.025	2.7	0.0	5.66	167.1	2.8
14	0.0	333.3	3046	1184.2	.055	5.5	0.0	3.31	30.2	11.8
15	0.0	70.0	468	1229.8	.035	3.1	0.0	.78	5.2	13.7
16	0.0	66.7	831	1085.3	.060	4.9	0.0	.81	10.1	13.2
17	0.0	211.8	1300	935.0	.060	3.3	0.0	3.87	23.8	17.1
18	0.0	107.3	1084	325.1	0.000	0.0	0.0	3.92	39.6	11.9
19	0.0	72.7	710	206.8	.065	1.3	0.0	3.69	36.0	10.5
20	0.0	34.3	432	98.4	0.000	0.0	0.0	3.92	49.4	11.2
21	0.0	10.8	173	45.8	0.000	0.0	0.0	4.93	79.0	20.9
22	0.0	86.6	53	1.7	.080	0.0	I	R	R	R
23	0.0	904.7	105	.5	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	12.881	GRAM/BHP HR
	CO	35.318	GRAM/BHP HR
	NO2	11.626	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.733	LB/BHP HR

APPENDIX F

EMISSION RESULTS FROM ENGINE 2-3

TABULAR FORM

ENGINE 2-3

NINE MODE FTP EMISSION RESULTS

CONCENTRATION BASIS

5-12-72 2-3 RUN-1 K =1.129 RUN = 12[illegible] GM/LB

	FEDERAL MODE	CONCENTRATION HC	CONCENTRATION CO	CONCENTRATION CO2	AS MEASURED NO	DILUTION FACTOR	ADJUSTED HC	ADJUSTED CO	ADJUSTED NO	WEIGHTING FACTOR	WEIGHTED HC	WEIGHTED CO	WEIGHTED NO
CYCLE 1													
	1 IDLE	165	1.610	14.360	103	.945	156	1.522	97	.036	5.614	.055	3.504
	2 16"HG	69	.230	13.750	876	1.040	72	.234	911	.089	6.368	.021	81.099
	3 10"HG	44	.200	13.580	1340	1.056	46	.211	1415	.257	11.944	.054	363.759
	4 16"HG	39	.210	13.630	918	1.052	41	.221	966	.089	3.653	.020	85.989
	5 19"HG	31	.210	13.910	439	1.032	32	.217	453	.047	1.504	.010	21.296
	6 16"HG	44	.220	13.840	1060	1.036	46	.228	1098	.089	4.057	.020	97.727
	7 3"HG	106	1.580	14.310	1905	.953	101	1.505	1816	.283	28.589	.426	513.798
	8 16"HG	35	.270	13.770	1108	1.040	36	.281	1152	.089	3.239	.025	102.553
	9 C.T.	1862	1.470	7.150	102	1.465	2728	2.154	149	.021	57.294	.045	3.139
	SUM----------(CYCLE COMPOSITE)----------										122.282	.677	1272.863
CYCLE 2													
	1 IDLE	165	1.610	14.360	103	.945	156	1.522	97	.036	5.614	.055	3.504
	2 16"HG	56	.240	13.630	854	1.050	59	.252	897	.089	5.233	.022	79.801
	3 10"HG	44	.220	13.840	1606	1.036	46	.228	1664	.257	11.714	.059	427.559
	4 16"HG	39	.220	13.910	1089	1.031	40	.227	1123	.089	3.579	.020	99.939
	5 19"HG	27	.220	14.050	478	1.022	28	.225	488	.047	1.297	.011	22.958
	6 16"HG	35	.220	13.830	1054	1.040	36	.229	1096	.089	3.238	.020	97.520
	7 3"HG	107	1.700	14.310	2033	.949	102	1.614	1930	.283	28.744	.457	546.128
	8 16"HG	35	.280	14.050	1223	1.019	36	.285	1246	.089	3.175	.025	110.929
	9 C.T.	1857	1.530	8.890	129	1.244	2309	1.902	160	.021	48.493	.040	3.369
	SUM----------(CYCLE COMPOSITE)----------										111.086	.709	1391.707
CYCLE 3													
	1 IDLE	144	.740	14.760	90	.949	137	.702	85	.036	4.918	.025	3.073
	2 16"HG	61	.250	13.770	1037	1.039	63	.260	1077	.089	5.639	.023	95.857
	3 10"HG	44	.230	13.910	1677	1.030	45	.237	1728	.257	11.652	.061	444.081
	4 16"HG	39	.240	13.910	1145	1.030	40	.247	1180	.089	3.577	.022	105.004
	5 19"HG	26	.240	14.050	463	1.021	27	.245	473	.047	1.248	.012	22.224
	6 16"HG	39	.240	13.840	1164	1.036	40	.249	1205	.089	3.594	.022	107.280
	7 3"HG	106	1.590	14.350	2098	.950	101	1.511	1994	.283	28.505	.428	564.183
	8 16"HG	35	.280	13.910	1238	1.029	36	.288	1274	.089	3.206	.026	113.406
	9 C.T.	1731	1.290	9.070	125	1.252	2167	1.615	156	.021	45.500	.034	3.286
	SUM----------(CYCLE COMPOSITE)----------										107.837	.652	1458.393
CYCLE 4													
	1 IDLE	144	.740	14.760	90	.949	137	.702	85	.036	4.918	.025	3.073
	2 16"HG	61	.260	13.840	1025	1.033	63	.269	1059	.089	5.609	.024	94.242
	3 10"HG	45	.240	13.820	1618	1.037	46	.249	1677	.257	11.722	.064	431.061
	4 16"HG	44	.250	13.820	1071	1.036	46	.259	1110	.089	4.058	.023	98.776
	5 19"HG	30	.250	13.910	439	1.031	31	.258	453	.047	1.453	.012	21.268
	6 16"HG	44	.250	13.960	1119	1.026	45	.257	1224	.089	4.018	.023	108.938
	7 3"HG	98	1.440	14.420	2135	.951	93	1.370	2031	.283	26.377	.388	574.647
	8 16"HG	35	.280	14.050	1259	1.019	36	.285	1283	.089	3.175	.025	114.195
	9 C.T.	1809	1.390	9.010	96	1.244	2250	1.729	119	.021	47.247	.036	2.507
	SUM----------(CYCLE COMPOSITE)----------										108.577	.620	1448.706

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 116.684 .693 1332.285

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 108.207 .636 1453.550

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(116.684) + 0.65*(108.207) =	111.174	PPM
CO	0.35*(.693) + 0.65*(.636) =	.656	PERCENT
NO	0.35*(1332.285) + 0.65*(1453.550) =	1411.107	PPM
	CORRECTED NO =	1592.519	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

5-12-72 2-3 RUN-2 K =1.137 HUM = 124 GR/LB

	FEDERAL MODE	CONCENTRATION HC	CO	AS CO2	MEASURED NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
	1 IDLE	154	1.210	13.630	90	1.007	155	1.218	91	.036	5.582	.044	3.262
	2 16'HG	72	.210	12.820	784	1.115	80	.234	874	.089	7.146	.021	77.811
	3 10'HG	43	.210	12.710	1213	1.127	48	.237	1368	.257	12.459	.061	351.457
	4 16'HG	43	.210	12.710	881	1.127	48	.237	993	.089	4.315	.021	88.398
	5 19'HG	33	.210	13.060	386	1.098	36	.231	424	.047	1.704	.011	19.928
	6 16'HG	39	.210	12.710	919	1.128	44	.237	1036	.089	3.915	.021	92.242
	7 3'HG	97	1.540	13.470	1883	1.011	98	1.557	1903	.283	27.748	.441	538.656
	8 16'HG	35	.250	12.940	1005	1.107	39	.277	1112	.089	3.447	.025	98.983
	9 C.T.	1931	1.300	8.310	119	1.313	2535	1.707	156	.021	53.233	.036	3.281
	SUM----------(CYCLE COMPOSITE)----------										119.548	.680	1274.018
CYCLE 2													
	1 IDLE	154	1.210	13.630	90	1.007	155	1.218	91	.036	5.582	.044	3.262
	2 16'HG	62	.210	12.940	969	1.106	69	.232	1072	.089	6.102	.021	95.371
	3 10'HG	39	.210	12.920	1488	1.110	43	.233	1651	.257	11.122	.060	424.350
	4 16'HG	38	.210	12.820	1060	1.118	42	.235	1185	.089	3.782	.021	105.501
	5 19'HG	27	.210	12.940	449	1.109	30	.233	498	.047	1.407	.011	23.404
	6 16'HG	34	.210	12.820	905	1.119	38	.235	1012	.089	3.385	.021	90.104
	7 3'HG	102	1.570	13.330	1947	1.019	104	1.600	1985	.283	29.424	.453	561.647
	8 16'HG	31	.250	12.940	1164	1.107	34	.277	1289	.089	3.054	.025	114.681
	9 C.T.	1886	1.340	8.450	158	1.300	2451	1.742	205	.021	51.474	.037	4.312
	SUM----------(CYCLE COMPOSITE)----------										115.333	.691	1422.632
CYCLE 3													
	1 IDLE	161	1.450	13.630	156	.998	161	1.447	156	.036	5.784	.052	5.605
	2 16'HG	59	.210	12.940	1060	1.106	65	.232	1173	.089	5.808	.021	104.353
	3 10'HG	35	.210	12.820	1514	1.119	39	.235	1694	.257	10.062	.060	435.239
	4 16'HG	32	.210	12.820	986	1.119	36	.235	1103	.089	3.187	.021	98.185
	5 19'HG	25	.210	12.940	444	1.109	28	.233	493	.047	1.303	.011	23.148
	6 16'HG	33	.210	12.820	980	1.119	37	.235	1096	.089	3.286	.021	97.579
	7 3'HG	88	1.370	13.330	1870	1.028	90	1.408	1922	.283	25.592	.398	543.836
	8 16'HG	26	.250	12.940	1037	1.107	29	.277	1148	.089	2.563	.025	102.210
	9 C.T.	1837	1.240	8.450	157	1.312	2410	1.627	206	.021	50.603	.034	4.325
	SUM----------(CYCLE COMPOSITE)----------										108.188	.643	1414.480
CYCLE 4													
	1 IDLE	161	1.450	13.630	156	.998	161	1.447	156	.036	5.784	.052	5.605
	2 16'HG	44	.210	12.820	975	1.118	49	.235	1090	.089	4.377	.021	96.993
	3 10'HG	35	.210	12.710	1438	1.128	39	.237	1622	.257	10.148	.061	416.929
	4 16'HG	35	.210	12.710	1008	1.128	39	.237	1137	.089	3.514	.021	101.209
	5 19'HG	26	.210	12.940	463	1.109	29	.233	514	.047	1.355	.011	24.136
	6 16'HG	33	.210	12.820	1025	1.119	37	.235	1147	.089	3.286	.021	102.060
	7 3'HG	79	1.300	13.330	1885	1.031	81	1.340	1943	.283	23.048	.379	549.941
	8 16'HG	26	.250	12.820	1341	1.118	29	.279	1499	.089	2.586	.025	133.396
	9 C.T.	1737	1.050	8.300	146	1.355	2354	1.423	198	.021	49.427	.030	4.154
	SUM----------(CYCLE COMPOSITE)----------										103.526	.621	1434.424

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 117.440 .685 1348.325

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 105.857 .632 1424.452

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC 0.35*(117.440) + 0.65*(105.857) = 109.911 PPM
CO 0.35*(.685) + 0.65*(.632) = .651 PERCENT
NO 0.35*(1348.325) + 0.65*(1424.452) = 1397.807 PPM
CORRECTED NO = 1588.667 PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

5-12-72 2-3 RUN-3 K =1.133 HUM = 122 GR/LB

	FEDERAL MODE	CONCENTRATION HC	CO	AS CO2	MEASURED NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
	1 IDLE	182	1.050	13.330	80	1.032	188	1.084	83	.036	6.761	.039	2.972
	2 16'HG	79	.180	12.340	874	1.159	92	.209	1013	.089	8.146	.019	90.121
	3 10'HG	53	.180	12.340	1386	1.161	62	.209	1609	.257	15.817	.054	413.617
	4 16'HG	53	.180	12.160	821	1.178	62	.212	967	.089	5.557	.019	86.088
	5 19'HG	44	.180	12.340	391	1.162	51	.209	454	.047	2.403	.010	21.356
	6 16'HG	49	.180	12.220	881	1.173	57	.211	1033	.089	5.115	.019	91.963
	7 3'HG	109	1.420	12.710	2004	1.071	117	1.521	2146	.283	33.040	.430	607.445
	8 16'HG	48	.210	12.160	1217	1.177	57	.247	1433	.089	5.029	.022	127.511
	9 C.T.	1963	1.160	7.610	119	1.406	2761	1.631	167	.021	57.976	.034	3.515
	SUM----------(CYCLE COMPOSITE)----------										139.844	.645	1444.587
CYCLE 2													
	1 IDLE	182	1.050	13.330	80	1.032	188	1.084	83	.036	6.761	.039	2.972
	2 16'HG	62	.210	12.220	778	1.170	73	.246	910	.089	6.457	.022	81.021
	3 10'HG	45	.200	12.290	1539	1.166	52	.233	1794	.257	13.482	.060	461.071
	4 16'HG	44	.200	12.220	964	1.172	52	.234	1130	.089	4.591	.021	100.589
	5 19'HG	35	.200	12.220	458	1.173	41	.235	537	.047	1.930	.011	25.257
	6 16'HG	44	.200	11.920	1037	1.202	53	.240	1246	.089	4.705	.021	110.897
	7 3'HG	105	1.480	12.590	1834	1.079	113	1.596	1978	.283	32.050	.452	559.815
	8 16'HG	44	.230	12.220	1188	1.171	52	.269	1391	.089	4.586	.024	123.813
	9 C.T.	1841	1.200	8.050	100	1.363	2509	1.636	136	.021	52.695	.034	2.862
	SUM----------(CYCLE COMPOSITE)----------										127.257	.684	1468.298
CYCLE 3													
	1 IDLE	151	.900	13.480	90	1.029	155	.926	93	.036	5.593	.033	3.334
	2 16'HG	64	.210	12.090	897	1.182	76	.248	1061	.089	6.734	.022	94.387
	3 10'HG	44	.180	12.520	1446	1.146	50	.206	1656	.257	12.954	.053	425.717
	4 16'HG	43	.210	12.400	903	1.155	50	.243	1043	.089	4.421	.022	92.844
	5 19'HG	35	.210	12.470	380	1.150	40	.241	437	.047	1.891	.011	20.532
	6 16'HG	44	.210	12.470	1071	1.149	51	.241	1230	.089	4.498	.021	109.497
	7 3'HG	111	1.770	13.060	1897	1.031	114	1.825	1956	.283	32.385	.516	553.459
	8 16'HG	47	.250	12.940	1437	1.106	52	.276	1589	.089	4.624	.025	141.391
	9 C.T.	1888	1.230	8.320	145	1.321	2495	1.625	192	.021	52.387	.034	4.023
	SUM----------(CYCLE COMPOSITE)----------										125.488	.738	1445.184
CYCLE 4													
	1 IDLE	151	.900	13.480	90	1.029	155	.926	93	.036	5.593	.033	3.334
	2 16'HG	61	.210	12.650	1033	1.131	69	.238	1168	.089	6.140	.021	103.978
	3 10'HG	35	.190	12.400	1291	1.157	40	.220	1494	.257	10.407	.056	383.866
	4 16'HG	39	.190	12.710	1117	1.129	44	.214	1261	.089	3.918	.019	112.203
	5 19'HG	31	.160	12.710	410	1.131	35	.181	464	.047	1.647	.009	21.789
	6 16'HG	43	.190	12.650	1100	1.134	49	.215	1247	.089	4.338	.019	110.977
	7 3'HG	102	1.380	13.180	1877	1.037	106	1.431	1947	.283	29.939	.405	550.943
	8 16'HG	39	.230	12.780	1038	1.121	44	.258	1163	.089	3.890	.023	103.542
	9 C.T.	1842	1.090	8.440	92	1.321	2434	1.440	122	.021	51.109	.030	2.553
	SUM----------(CYCLE COMPOSITE)----------										116.982	.616	1393.184

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 133.551 .665 1456.442

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 121.235 .677 1419.184

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(133.551) + 0.65*(121.235) =	125.545	PPM
CO	0.35*(.665) + 0.65*(.677) =	.673	PERCENT
NO	0.35*(1456.442) + 0.65*(1419.184) =	1432.224	PPM
	CORRECTED NO =	1622.168	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

ENGINE 2-3

NINE MODE FTP EMISSION RESULTS

BRAKE SPECIFIC BASIS

5-12-72 2-3 RUN-1 K = 1.10 HUM = 120 GR/LB

MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1														
1 IDLE	165	1.610	14.36	103	16.148	1771	20	357	4	.232	4.5	83	.9	0
2 16 HG	69	.230	13.75	876	14.055	8308	44	275	172	.077	3.4	21	13.2	23
3 10 HG	44	.200	13.58	1340	13.828	12939	44	378	416	.147	6.5	56	61.2	48
4 16 HG	39	.210	13.63	918	13.882	8308	25	254	182	.077	1.9	20	14.0	23
5 19 HG	31	.210	13.91	439	14.153	5924	14	178	61	.057	.8	10	3.5	9
6 16 HG	44	.220	13.84	1060	14.108	8308	28	262	207	.077	2.2	20	16.0	23
7 3 HG	106	1.580	14.31	1905	16.004	21656	155	4319	856	.113	17.5	488	96.7	86
8 16 HG	35	.270	13.77	1108	14.078	8308	22	322	217	.077	1.7	25	16.7	23
9 C.T.	1862	1.470	7.15	102	10.631	1771	335	495	6	.143	47.9	71	.8	0
SUM----------(CYCLE COMPOSITE)----------											3.6	33	9.2	
CYCLE 2														
1 IDLE	165	1.610	14.36	103	16.148	1771	20	357	4	.232	4.5	83	.9	0
2 16 HG	56	.240	13.63	854	13.930	8308	36	289	169	.077	2.8	22	13.0	23
3 10 HG	44	.220	13.84	1606	14.108	12939	44	408	489	.147	6.4	60	71.9	48
4 16 HG	39	.220	13.91	1089	14.172	8308	25	261	212	.077	1.9	20	16.3	23
5 19 HG	27	.220	14.05	478	14.299	5924	12	184	66	.057	.7	10	3.7	9
6 16 HG	35	.220	13.80	1054	14.058	8308	22	263	207	.077	1.7	20	15.9	23
7 3 HG	107	1.700	14.31	2033	16.126	21656	155	4612	906	.113	17.5	521	102.4	86
8 16 HG	35	.280	14.05	1223	14.368	8308	22	327	235	.077	1.7	25	18.1	23
9 C.T.	1857	1.530	8.89	129	12.426	1771	286	440	6	.143	40.9	63	.9	0
SUM----------(CYCLE COMPOSITE)----------											3.2	34	10.0	
CYCLE 3														
1 IDLE	144	.740	14.76	90	15.656	1771	18	169	3	.232	4.1	39	.8	0
2 16 HG	61	.250	13.77	1037	14.086	8308	39	298	203	.077	3.0	23	15.6	23
3 10 HG	44	.230	13.91	1677	14.188	12939	43	424	508	.147	6.4	62	74.6	48
4 16 HG	39	.240	13.91	1145	14.192	8308	25	284	223	.077	1.9	22	17.1	23
5 19 HG	26	.240	14.05	463	14.318	5924	12	201	64	.057	.7	11	3.6	9
6 16 HG	39	.240	13.84	1164	14.122	8308	25	285	227	.077	1.9	22	17.5	23
7 3 HG	106	1.590	14.35	2098	16.054	21656	154	4332	940	.113	17.4	490	106.2	86
8 16 HG	35	.280	13.91	1238	14.228	8308	22	330	240	.077	1.7	25	18.5	23
9 C.T.	1731	1.290	9.07	125	12.229	1771	271	377	6	.143	38.7	54	.9	0
SUM----------(CYCLE COMPOSITE)----------											3.1	31	10.5	
CYCLE 4														
1 IDLE	144	.740	14.76	90	15.656	1771	18	169	3	.232	4.1	39	.8	0
2 16 HG	61	.260	13.84	1025	14.166	8308	39	308	200	.077	3.0	24	15.4	23
3 10 HG	44	.240	13.82	1618	14.108	12939	44	445	493	.147	6.4	65	72.4	48
4 16 HG	44	.250	13.82	1071	14.118	8308	28	297	209	.077	2.2	23	16.1	23
5 19 HG	30	.250	13.91	439	14.192	5924	14	211	61	.057	.8	12	3.5	9
6 16 HG	44	.250	13.96	1193	14.258	8308	28	294	231	.077	2.1	23	17.8	23
7 3 HG	98	1.440	14.42	2135	15.966	21656	144	3945	961	.113	16.2	446	108.6	86
8 16 HG	35	.280	14.05	1259	14.368	8308	22	327	242	.077	1.7	25	18.6	23
9 C.T.	1809	1.390	9.01	96	12.354	1771	280	403	5	.143	40.1	58	.7	0
SUM----------(CYCLE COMPOSITE)----------											3.1	29	10.4	

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 3.4 33 9.6

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 3.1 30 10.5

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(3.4) + 0.65(3.1) = 3.220 (MASS)
CO 0.35(33) + 0.65(30) = 31.2 (MASS)
NO2 0.35(9.6) + 0.65(10.5) = 10.154 (MASS)
CORRECTED NO2 = 11.161 (MASS)

5-12-72 2-3 RUN-2 K = 1.10 HUM = 124 GR/LB

MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1														
1 IDLE	154	1.210	13.63	90	15.006	1771	20	288	4	.232	4.6	67	.8	0
2 16 HG	72	.210	12.82	784	13.108	8308	49	269	165	.077	3.8	21	12.7	23
3 10 HG	43	.210	12.71	1213	12.966	12939	46	423	402	.147	6.8	62	59.1	48
4 16 HG	43	.210	12.71	881	12.966	8308	30	272	187	.077	2.3	21	14.4	23
5 19 HG	33	.210	13.06	386	13.306	5924	16	189	57	.057	.9	11	3.3	9
6 16 HG	39	.210	12.71	919	12.962	8308	27	272	196	.077	2.1	21	15.1	23
7 3 HG	97	1.540	13.47	1883	15.115	21656	150	4457	896	.113	17.0	504	101.2	86
8 16 HG	35	.250	12.94	1005	13.228	8308	24	317	210	.077	1.8	24	16.1	23
9 C.T.	1931	1.300	8.31	119	11.695	1771	316	398	6	.143	45.2	57	.9	0
SUM----------(CYCLE COMPOSITE)----------											3.5	32	9.2	
CYCLE 2														
1 IDLE	154	1.210	13.63	90	15.006	1771	20	288	4	.232	4.6	67	.8	0
2 16 HG	62	.210	12.94	969	13.217	8308	42	267	202	.077	3.2	21	15.6	23
3 10 HG	39	.210	12.92	1488	13.172	12939	41	417	485	.147	6.1	61	71.3	48
4 16 HG	38	.210	12.82	1060	13.071	8308	26	270	224	.077	2.0	21	17.2	23
5 19 HG	27	.210	12.94	449	13.179	5924	13	191	67	.057	.7	11	3.8	9
6 16 HG	34	.210	12.82	905	13.067	8308	23	270	191	.077	1.8	21	14.7	23
7 3 HG	102	1.570	13.33	1947	15.010	21656	159	4576	933	.113	18.0	517	105.4	86
8 16 HG	31	.250	12.94	1164	13.223	8308	21	317	243	.077	1.6	24	18.7	23
9 C.T.	1886	1.340	8.45	158	11.827	1771	305	405	8	.143	43.6	58	1.1	0
SUM----------(CYCLE COMPOSITE)----------											3.4	33	10.2	
CYCLE 3														
1 IDLE	161	1.450	13.63	156	15.254	1771	20	340	6	.232	4.7	79	1.4	0
2 16 HG	59	.210	12.94	1060	13.214	8308	40	267	221	.077	3.1	21	17.0	23
3 10 HG	35	.210	12.82	1514	13.068	12939	37	420	498	.147	5.5	62	73.2	48
4 16 HG	32	.210	12.82	986	13.065	8308	22	270	208	.077	1.7	21	16.0	23
5 19 HG	25	.210	12.94	444	13.177	5924	12	191	66	.057	.7	11	3.8	9
6 16 HG	33	.210	12.82	980	13.066	8308	23	270	207	.077	1.7	21	15.9	23
7 3 HG	88	1.370	13.33	1870	14.795	21656	139	4051	909	.113	15.7	458	102.7	86
8 16 HG	26	.250	12.94	1037	13.218	8308	18	317	216	.077	1.4	24	16.7	23
9 C.T.	1837	1.240	8.45	157	11.674	1771	301	380	8	.143	43.0	54	1.1	0
SUM----------(CYCLE COMPOSITE)----------											3.2	31	10.2	
CYCLE 4														
1 IDLE	161	1.450	13.63	156	15.254	1771	20	340	6	.232	4.7	79	1.4	0
2 16 HG	44	.210	12.82	975	13.078	8308	30	269	206	.077	2.3	21	15.8	23
3 10 HG	35	.210	12.71	1438	12.958	12939	38	424	477	.147	5.5	62	70.1	48
4 16 HG	35	.210	12.71	1008	12.958	8308	24	272	215	.077	1.9	21	16.5	23
5 19 HG	26	.210	12.94	463	13.178	5924	13	191	69	.057	.7	11	3.9	9
6 16 HG	33	.210	12.82	1025	13.066	8308	23	270	216	.077	1.7	21	16.7	23
7 3 HG	79	1.300	13.33	1885	14.715	21656	126	3865	921	.113	14.2	437	104.1	86
8 16 HG	26	.250	12.82	1341	13.098	8308	18	320	282	.077	1.4	25	21.7	23
9 C.T.	1737	1.050	8.30	146	11.226	1771	296	335	8	.143	42.3	48	1.1	0
SUM----------(CYCLE COMPOSITE)----------											3.1	30	10.3	

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 3.4 33 9.7

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 3.1 30 10.3

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(3.4) + 0.65(3.1) = 3.230 (MASS)
CO 0.35(33) + 0.65(30) = 31.1 (MASS)
NO2 0.35(9.7) + 0.65(10.3) = 10.071 (MASS)
CORRECTED NO2 = 11.114 (MASS)

5-12-72 2-3 RUN-3 K = 1.10 HUM = 122 GR/LB

MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1														
1 IDLE	182	1.050	13.33	80	14.577	1771	24	258	3	.232	5.5	60	.7	0
2 16 HG	79	.180	12.34	874	12.605	8308	56	240	191	.077	4.3	18	14.7	23
3 10 HG	53	.180	12.34	1386	12.577	12939	59	374	473	.147	8.7	55	69.6	48
4 16 HG	53	.180	12.16	821	12.397	8308	38	244	183	.077	3.0	19	14.1	23
5 19 HG	44	.180	12.34	391	12.568	5924	22	171	61	.057	1.3	10	3.5	9
6 16 HG	49	.180	12.22	881	12.453	8308	35	243	195	.077	2.7	19	15.0	23
7 3 HG	109	1.420	12.71	2004	14.248	21656	179	4360	1011	.113	20.2	493	114.3	86
8 16 HG	48	.210	12.16	1217	12.422	8308	35	284	270	.077	2.7	22	20.8	23
9 C.T.	1963	1.160	7.61	119	10.890	1771	345	381	6	.143	49.3	54	.9	0
SUM----------(CYCLE COMPOSITE)----------											4.0	31	10.4	
CYCLE 2														
1 IDLE	182	1.050	13.33	80	14.577	1771	24	258	3	.232	5.5	60	.7	0
2 16 HG	62	.210	12.22	778	12.497	8308	45	282	172	.077	3.4	22	13.2	23
3 10 HG	45	.200	12.29	1539	12.539	12939	50	417	527	.147	7.4	61	77.5	48
4 16 HG	44	.200	12.22	964	12.468	8308	32	269	213	.077	2.4	21	16.4	23
5 19 HG	35	.200	12.22	458	12.458	5924	18	192	72	.057	1.0	11	4.1	9
6 16 HG	44	.200	11.92	1037	12.168	8308	32	276	235	.077	2.5	21	18.1	23
7 3 HG	105	1.480	12.59	1834	14.183	21656	173	4565	930	.113	19.6	516	105.1	86
8 16 HG	44	.230	12.22	1188	12.498	8308	32	309	262	.077	2.4	24	20.2	23
9 C.T.	1841	1.200	8.05	100	11.238	1771	313	382	5	.143	44.8	55	.7	0
SUM----------(CYCLE COMPOSITE)----------											3.7	32	10.5	
CYCLE 3														
1 IDLE	151	.900	13.48	90	14.543	1771	20	221	4	.232	4.6	51	.8	0
2 16 HG	64	.210	12.09	897	12.369	8308	46	285	200	.077	3.6	22	15.4	23
3 10 HG	44	.180	12.52	1446	12.748	12939	48	369	487	.147	7.1	54	71.6	48
4 16 HG	43	.210	12.40	903	12.656	8308	30	278	197	.077	2.3	21	15.2	23
5 19 HG	35	.210	12.47	380	12.718	5924	18	198	59	.057	1.0	11	3.3	9
6 16 HG	44	.210	12.47	1071	12.728	8308	31	277	232	.077	2.4	21	17.9	23
7 3 HG	111	1.770	13.06	1897	14.950	21656	174	5179	912	.113	19.6	585	103.1	86
8 16 HG	47	.250	12.94	1437	13.241	8308	32	317	299	.077	2.5	24	23.0	23
9 C.T.	1888	1.230	8.32	145	11.589	1771	312	380	7	.143	44.6	54	1.1	0
SUM----------(CYCLE COMPOSITE)----------											3.6	35	10.3	
CYCLE 4														
1 IDLE	151	.900	13.48	90	14.543	1771	20	221	4	.232	4.6	51	.8	0
2 16 HG	61	.210	12.65	1033	12.926	8308	42	273	220	.077	3.3	21	17.0	23
3 10 HG	35	.190	12.40	1291	12.628	12939	39	393	439	.147	5.7	58	64.6	48
4 16 HG	39	.190	12.71	1117	12.942	8308	27	246	238	.077	2.1	19	18.3	23
5 19 HG	31	.160	12.71	410	12.903	5924	15	148	62	.057	.9	8	3.6	9
6 16 HG	43	.190	12.65	1100	12.886	8308	30	247	235	.077	2.3	19	18.1	23
7 3 HG	102	1.380	13.18	1877	14.670	21656	163	4115	920	.113	18.4	465	103.9	86
8 16 HG	39	.230	12.78	1038	13.052	8308	27	296	219	.077	2.1	23	16.9	23
9 C.T.	1842	1.090	8.44	92	11.519	1771	306	339	5	.143	43.7	48	.7	0
SUM----------(CYCLE COMPOSITE)----------											3.4	29	10.0	

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 3.8 32 10.5

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 3.5 32 10.2

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(3.8) + 0.65(3.5) = 3.625 (MASS)
CO 0.35(32) + 0.65(32) = 31.9 (MASS)
NO2 0.35(10.5) + 0.65(10.2) = 10.290 (MASS)
CORRECTED NO2 = 11.334 (MASS)

ENGINE 2-3

EXPERIMENTAL 23 MODE EMISSION RESULTS

BRAKE SPECIFIC BASIS

PROJECT 11-2877-01 CONTROL TECHNOLOGY

5-11-72 RUN 1 ENGINE 2-3 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.5	4.3		25	3349	1.010	13.62	47
2	1200	4.4	1	19.1	7.5		27	955	.150	13.15	100
3	1200	17.6	4	18.8	7.9		44	1457	.150	12.90	215
4	1200	39.6	9	17.3	9.2		77	1788	.130	12.55	470
5	1200	55.0	13	16.2	10.0		75	1952	.130	12.35	600
6	1200	110.0	25	9.8	15.2		76	1336	.130	12.10	913
7	1200	165.0	38	6.4	20.1		86	2027	.210	13.40	2000
8	1200	180.4	41	4.7	21.8		64	1914	.350	13.25	2200
9	1200	202.4	46	1.7	24.2		87	2144	.250	13.63	2500
10	1200	220.0	50	0.0	31.6		55	3955	5.030	10.80	450
11	600	0.0	0	18.6	4.3		32	3509	1.550	12.73	48
12	1200	0.0	0	23.0	4.1		166	73417	.640	6.28	6
13	2300	235.0	103	1.8	50.9		57	2453	1.450	13.77	2300
14	2300	216.2	95	3.4	47.8		58	1821	1.160	13.77	2100
15	2300	192.7	84	5.3	43.4		56	1648	1.160	13.63	2050
16	2300	176.2	77	6.8	39.5		38	1698	.630	13.63	2100
17	2300	117.5	51	11.2	27.9		60	560	.210	12.71	2100
18	2300	58.8	26	16.6	19.2		59	560	.220	12.71	850
19	2300	42.3	19	17.8	16.5		65	470	.220	12.59	525
20	2300	18.8	8	19.4	14.3		38	358	.200	12.47	290
21	2300	4.7	2	20.7	12.1		25	308	.200	12.59	169
22	600	0.0	0	18.5	4.3		33	3617	.770	13.33	37
23	2300	0.0	0	24.9	4.2		81	43892	.420	4.45	4

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	.7	43.5	265	2.0	.070	0.0	R	R	R	R
2	1.5	24.3	77	8.4	.060	.1	1.5	24.16	76.7	8.4
3	2.6	39.7	83	19.5	.060	.2	.6	9.88	20.5	4.8
4	5.4	57.9	85	50.5	.050	.5	.6	6.40	9.4	5.6
5	5.8	69.9	94	71.4	.030	.4	.5	5.57	7.5	5.7
6	9.2	74.6	147	169.1	.060	1.5	.4	2.97	5.8	6.7
7	12.3	133.8	280	438.5	0.000	0.0	.3	3.55	7.4	11.6
8	9.9	137.1	506	523.1	.040	1.6	.2	3.33	12.3	12.7
9	14.7	166.8	393	645.6	0.000	0.0	.3	3.61	8.5	14.0
10	10.5	349.0	8965	131.8	0.000	0.0	.2	6.94	178.4	2.6
11	.9	46.6	416	2.1	.070	0.0	R	R	R	R
12	4.6	952.0	168	.3	.120	0.0	R	R	R	R
13	18.3	366.4	4375	1140.6	.025	2.6	.2	3.56	42.5	11.1
14	18.1	261.3	3362	1000.4	.055	5.2	.2	2.76	35.5	10.6
15	16.0	217.1	3087	896.6	.035	3.0	.2	2.57	36.6	10.6
16	10.3	210.7	1579	865.2	.060	4.6	.1	2.73	20.5	11.2
17	12.7	54.6	414	680.4	.060	3.1	.2	1.06	8.0	13.2
18	8.6	37.5	298	189.0	0.000	0.0	.3	1.46	11.6	7.3
19	8.1	27.3	258	101.3	.065	1.2	.4	1.47	13.9	5.5
20	4.2	18.2	206	49.1	0.000	0.0	.5	2.21	25.0	6.0
21	2.3	13.2	173	24.0	0.000	0.0	1.1	6.39	84.0	11.6
22	.9	48.6	209	1.7	.080	0.0	R	R	R	R
23	3.6	899.0	174	.3	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	10.274	GRAM/BHP HR
	CO	28.372	GRAM/BHP HR
	NO2	10.530	GRAM/BHP HR
	ALDE	.272	GRAM/BHP HR
	BSFC	.655	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

5-15-72 RUN 1 ENGINE 2-3 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.5	3.8		39	3071	.930	13.91	44
2	1200	4.5	1	19.1	7.2		40	729	.150	13.06	98
3	1200	17.9	4	18.7	7.7		48	1122	.150	13.06	185
4	1200	40.3	9	17.4	9.0		93	1459	.150	13.06	420
5	1200	56.0	13	16.2	10.1		67	1850	.150	12.94	750
6	1200	112.0	26	14.0	11.3		63	1287	.150	12.71	1025
7	1200	168.0	38	15.5	21.0		83	1698	.350	13.91	2000
8	1200	184.0	42	4.0	22.7		76	1641	.470	13.77	2200
9	1200	206.0	47	2.5	24.2		79	1983	.350	14.05	2450
10	1200	224.0	51	0.0	26.7		64	3748	5.790	10.77	600
11	600	0.0	0	19.3	3.8		50	3074	1.480	13.48	48
12	1200	0.0	0	23.0	3.7		131	62755	.580	6.30	6
13	2300	235.0	103	2.5	49.8		52	2108	1.590	13.48	2350
14	2300	216.0	95	4.3	45.5		58	1593	1.450	13.48	2250
15	2300	192.5	84	6.7	40.3		55	1880	1.590	13.48	2200
16	2300	176.0	77	7.9	36.9		53	1585	.550	13.77	2850
17	2300	117.5	51	11.5	27.6		46	505	.220	12.94	2350
18	2300	58.8	26	16.7	18.5		57	471	.210	12.82	1325
19	2300	42.3	19	18.0	16.4		60	415	.210	12.82	850
20	2300	18.8	8	19.8	12.0		36	286	.180	12.82	400
21	2300	4.7	2	20.8	10.1		36	235	.180	12.71	217
22	600	0.0	0	18.8	2.8		40	2606	.880	13.48	47
23	2300	0.0	0	25.0	3.9		85	35661	.440	4.84	4

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	1.0	34.6	212	1.7	.070	0.0	R	R	R	R
2	2.1	17.9	75	8.0	.060	.1	2.1	17.52	72.8	7.8
3	2.7	29.5	80	16.1	.060	.2	.7	7.21	19.5	3.9
4	6.2	44.4	92	42.5	.050	.5	.7	4.83	10.0	4.6
5	5.0	63.9	105	86.1	.030	.4	.4	5.00	8.2	6.7
6	5.3	50.6	119	133.8	.060	1.5	.2	1.98	4.7	5.2
7	11.9	112.3	468	439.3	0.000	0.0	.3	2.93	12.2	11.4
8	11.7	117.4	679	522.4	.040	1.7	.3	2.79	16.2	12.4
9	12.8	148.9	531	610.9	0.000	0.0	.3	3.16	11.3	13.0
10	9.8	267.7	8355	142.3	0.000	0.0	.2	5.23	163.2	2.8
11	1.2	34.4	334	1.8	.070	0.0	R	R	R	R
12	3.6	792.1	148	.3	.120	0.0	R	R	R	R
13	16.5	311.5	4746	1152.9	.025	2.6	.2	3.03	46.1	11.2
14	17.1	218.0	4007	1022.0	.055	5.2	.2	2.30	42.4	10.8
15	14.4	225.3	3849	875.2	.035	3.0	.2	2.67	45.7	10.4
16	13.3	183.1	1283	1093.0	.060	4.6	.2	2.38	16.7	14.2
17	9.5	47.8	421	739.6	.060	3.1	.2	.93	8.2	14.4
18	8.0	30.3	273	283.0	0.000	0.0	.3	1.18	10.6	11.0
19	7.3	23.5	241	160.2	.065	1.2	.4	1.27	13.0	8.6
20	3.2	11.9	152	55.4	0.000	0.0	.4	1.45	18.4	6.7
21	2.8	8.4	129	25.7	0.000	0.0	1.3	4.06	62.8	12.5
22	.8	22.9	156	1.4	.080	0.0	R	R	R	R
23	3.6	707.4	176	.3	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	8.410	GRAM/BHP HR
	CO	30.073	GRAM/BHP HR
	NO2	11.308	GRAM/BHP HR
	ALDE	.254	GRAM/BHP HR
	BSFC	.614	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

5-16-72 RUN 1 ENGINE 2-3 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.8	3.9		50	3872	1.090	13.91	41
2	1200	4.5	1	19.2	7.9		42	841	.130	12.94	91
3	1200	17.9	4	19.0	8.0		69	1231	.130	12.71	145
4	1200	40.3	9	17.5	9.1		63	1786	.130	12.47	370
5	1200	56.0	13	16.3	10.3		73	1894	.130	12.22	688
6	1200	112.0	26	11.1	15.6		78	1396	.130	12.47	1000
7	1200	168.0	38	6.3	20.5		83	1804	.280	13.48	1750
8	1200	184.0	42	4.5	22.5		67	1802	.490	13.18	1950
9	1200	206.0	47	3.0	24.2		67	1927	.390	14.05	2300
10	1200	224.0	51	0.0	32.7		42	3697	5.900	10.89	650
11	600	0.0	0	19.4	3.6		41	3414	1.300	13.63	45
12	1200	0.0	0	23.0	3.6		155	64831	.490	6.30	6
13	2300	235.0	103	2.6	50.3		52	2168	1.770	13.48	2100
14	2300	216.0	95	4.4	46.2		54	1707	1.450	13.48	2150
15	2300	192.5	84	6.4	41.7		63	1820	1.380	13.48	2050
16	2300	176.0	77	7.7	35.8		29	1528	.520	13.77	2350
17	2300	117.5	51	11.8	27.1		59	504	.170	12.82	2050
18	2300	58.8	26	16.8	18.1		47	493	.170	12.82	1025
19	2300	42.3	19	18.0	16.6		58	436	.170	12.71	688
20	2300	18.8	8	19.9	12.4		33	280	.160	12.71	290
21	2300	4.7	2	20.9	11.3		27	241	.160	12.71	192
22	600	0.0	0	18.7	3.6		42	3114	.810	13.48	38
23	2300	0.0	0	24.9	3.8		93	40380	.440	4.84	3

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	1.2	44.2	251	1.6	.070	0.0	R	R	R	R
2	2.5	23.0	72	8.3	.060	.1	2.4	22.46	70.1	8.1
3	4.2	34.6	74	13.5	.060	.2	1.0	8.46	18.0	3.3
4	4.4	57.5	85	39.6	.050	.5	.5	6.25	9.2	4.3
5	5.9	70.7	98	85.2	.030	.4	.5	5.53	7.7	6.7
6	9.4	77.7	146	184.8	.060	1.5	.4	3.04	5.7	7.2
7	12.0	120.5	378	388.1	0.000	0.0	.3	3.14	9.8	10.1
8	10.7	132.8	730	477.2	.040	1.7	.3	3.16	17.4	11.3
9	10.9	144.4	590	572.1	0.000	0.0	.2	3.07	12.5	12.2
10	7.8	319.6	10304	186.6	0.000	0.0	.2	6.25	201.3	3.6
11	.9	36.1	277	1.6	.070	0.0	R	R	R	R
12	4.1	788.0	120	.2	.120	0.0	R	R	R	R
13	16.5	319.8	5275	1028.5	.025	2.6	.2	3.11	51.3	10.0
14	16.3	237.1	4069	991.5	.055	5.2	.2	2.51	43.0	10.5
15	17.2	228.6	3502	855.1	.035	3.0	.2	2.71	41.5	10.1
16	7.0	172.0	1182	878.0	.060	4.6	.1	2.23	15.3	11.4
17	12.0	47.5	324	641.2	.060	3.1	.2	.92	6.3	12.5
18	6.4	31.1	217	214.7	0.000	0.0	.2	1.21	8.4	8.3
19	7.3	25.4	200	132.8	.065	1.2	.4	1.37	10.8	7.2
20	3.1	12.2	141	42.0	0.000	0.0	.4	1.48	17.1	5.1
21	2.3	9.5	128	25.3	0.000	0.0	1.1	4.63	62.2	12.3
22	1.0	34.4	181	1.4	.080	0.0	R	R	R	R
23	3.7	740.0	163	.2	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	8.730	GRAM/BHP HR
	CO	29.615	GRAM/BHP HR
	NO2	10.260	GRAM/BHP HR
	ALDE	.261	GRAM/BHP HR
	BSFC	.630	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

5-16-72 RUN 2 ENGINE 2-3 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.5	3.7	14.5	0	3141	1.050	14.31	36
2	1200	4.5	1	19.3	7.1	16.4	0	673	.150	12.94	79
3	1200	17.9	4	18.9	7.3	16.4	0	1121	.150	12.94	125
4	1200	40.3	9	17.4	8.7	16.3	0	1794	.150	12.94	420
5	1200	56.0	13	16.1	10.5	16.4	0	1790	.130	12.71	725
6	1200	112.0	26	11.2	13.4	16.5	0	1565	.150	12.59	1250
7	1200	168.0	38	6.5	20.8	15.1	0	1693	.310	13.63	1900
8	1200	184.0	42	4.9	21.5	15.0	0	1865	.440	13.63	2000
9	1200	206.0	47	3.1	23.2	14.9	0	1864	.390	13.63	2450
10	1200	224.0	51	0.0	32.1	12.1	0	3628	5.840	10.55	600
11	600	0.0	0	19.2	3.3	13.9	0	3699	1.870	13.06	45
12	1200	0.0	0	23.0	3.7	14.3	0	64268	.870	6.82	5
13	2300	235.0	103	2.6	50.5	14.1	0	2171	1.800	13.63	2250
14	2300	216.0	95	4.5	45.9	14.2	0	1884	1.730	13.63	2150
15	2300	192.5	84	6.5	41.2	14.2	0	1998	1.550	13.77	2100
16	2300	176.0	77	7.4	39.3	14.6	0	1818	.650	14.05	2350
17	2300	117.5	51	12.1	25.8	16.2	0	561	.210	13.06	2600
18	2300	58.8	26	16.9	16.4	16.3	0	460	.210	13.06	1200
19	2300	42.3	19	18.1	15.8	16.3	0	404	.210	13.06	788
20	2300	18.8	8	19.8	13.1	16.3	0	281	.160	13.06	400
21	2300	4.7	2	20.9	11.3	16.3	0	224	.160	13.06	225
22	600	0.0	0	18.6	3.7	14.4	0	2843	1.050	13.77	45
23	2300	0.0	0	24.9	3.6	20.2	0	34963	.470	5.96	5

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	33.3	225	1.3	.070	0.0	I	R	R	R
2	0.0	16.5	74	6.4	.060	.1	0.0	16.08	72.4	6.2
3	0.0	28.1	76	10.4	.060	.2	0.0	6.88	18.6	2.5
4	0.0	53.1	90	41.3	.050	.5	0.0	5.77	9.7	4.5
5	0.0	65.7	96	88.3	.030	.4	0.0	5.13	7.5	6.9
6	0.0	74.0	143	196.3	.060	1.5	0.0	2.89	5.6	7.7
7	0.0	113.5	420	422.6	0.000	0.0	0.0	2.96	10.9	11.0
8	0.0	127.3	607	453.5	.040	1.7	0.0	3.03	14.4	10.8
9	0.0	138.3	584	603.4	0.000	0.0	0.0	2.94	12.4	12.8
10	0.0	315.1	10248	173.0	0.000	0.0	0.0	6.16	200.2	3.4
11	0.0	36.7	375	1.5	.070	0.0	I	R	R	R
12	0.0	755.9	207	.2	.120	0.0	I	R	R	R
13	0.0	317.9	5324	1093.8	.025	2.6	0.0	3.09	51.7	10.6
14	0.0	252.5	4683	956.4	.055	5.2	0.0	2.67	49.5	10.1
15	0.0	240.9	3774	840.5	.035	3.0	0.0	2.86	44.8	10.0
16	0.0	217.5	1571	933.8	.060	4.6	0.0	2.82	20.4	12.1
17	0.0	49.4	373	759.1	.060	3.1	0.0	.96	7.2	14.8
18	0.0	25.7	236	222.1	0.000	0.0	0.0	1.00	9.2	8.6
19	0.0	21.8	229	141.1	.065	1.2	0.0	1.18	12.4	7.6
20	0.0	12.6	145	59.7	0.000	0.0	0.0	1.53	17.7	7.3
21	0.0	8.7	125	28.8	0.000	0.0	0.0	4.21	60.6	14.0
22	0.0	31.3	233	1.6	.080	0.0	I	R	R	R
23	0.0	568.2	154	.3	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	8.194	GRAM/BHP HR
	CO	33.247	GRAM/BHP HR
	NO2	10.667	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.620	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

5-17-72 RUN 1 ENGINE 2-3 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.7	4.4	14.5	0	3857	1.050	13.48	38
2	1200	4.5	1	19.2	7.7	16.4	0	785	.210	12.94	95
3	1200	17.9	4	18.8	7.8	16.5	0	1120	.150	12.82	130
4	1200	40.3	9	17.4	9.4	16.4	0	1792	.150	12.82	480
5	1200	56.0	13	16.5	10.0	16.4	0	1848	.150	12.82	625
6	1200	112.0	26	10.3	15.4	16.8	0	1508	.150	12.47	1075
7	1200	168.0	38	6.2	20.5	15.2	0	1807	.390	13.63	1950
8	1200	184.0	42	4.9	21.8	15.2	0	1695	.390	13.63	2100
9	1200	206.0	47	2.8	23.8	15.0	0	1751	.250	13.77	2550
10	1200	224.0	51	0.0	32.7	12.4	0	3682	5.400	10.89	670
11	600	0.0	0	19.2	4.3	13.9	0	3636	1.660	13.06	45
12	1200	0.0	0	23.0	4.2	15.1	0	64950	.440	6.56	4
13	2300	235.0	103	2.6	50.5	14.3	0	2105	1.450	13.48	2400
14	2300	216.0	95	4.6	45.9	14.4	0	1762	1.340	13.48	2200
15	2300	192.5	84	6.4	40.6	14.5	0	1817	1.160	13.48	2050
16	2300	176.0	77	7.5	38.4	14.9	0	1528	.490	13.77	2350
17	2300	117.5	51	11.7	27.3	16.6	0	448	.170	12.71	2050
18	2300	58.8	26	16.6	19.0	16.5	0	481	.180	12.71	1100
19	2300	42.3	19	17.8	16.7	16.6	0	414	.170	12.71	688
20	2300	18.8	8	19.8	13.6	16.6	0	297	.160	12.71	320
21	2300	4.7	2	21.0	11.6	16.6	0	224	.160	12.71	182
22	600	0.0	0	18.8	4.1	14.5	0	3400	.930	13.48	40
23	2300	0.0	0	24.9	4.0	20.7	0	39026	.420	5.50	5

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	51.5	283	1.7	.070	0.0	I	R	R	R
2	0.0	20.8	112	8.4	.060	.1	0.0	20.31	109.7	8.2
3	0.0	30.4	82	11.7	.060	.2	0.0	7.43	20.1	2.9
4	0.0	58.0	98	51.6	.050	.5	0.0	6.30	10.7	5.6
5	0.0	63.8	105	71.6	.030	.4	0.0	4.99	8.2	5.6
6	0.0	82.6	166	195.5	.060	1.5	0.0	3.23	6.5	7.6
7	0.0	118.5	517	424.5	0.000	0.0	0.0	3.09	13.5	11.1
8	0.0	118.0	548	485.3	.040	1.7	0.0	2.81	13.0	11.5
9	0.0	132.9	383	642.6	0.000	0.0	0.0	2.82	8.1	13.7
10	0.0	327.9	9715	198.1	0.000	0.0	0.0	6.41	189.8	3.9
11	0.0	46.9	432	1.9	.070	0.0	I	R	R	R
12	0.0	912.8	125	.2	.120	0.0	I	R	R	R
13	0.0	318.6	4432	1205.8	.025	2.6	0.0	3.10	43.1	11.7
14	0.0	244.9	3760	1014.7	.055	5.2	0.0	2.59	39.8	10.7
15	0.0	225.8	2913	846.1	.035	3.0	0.0	2.68	34.6	10.0
16	0.0	184.8	1197	943.7	.060	4.6	0.0	2.40	15.5	12.2
17	0.0	42.9	329	651.9	.060	3.1	0.0	.83	6.4	12.7
18	0.0	32.0	242	242.8	0.000	0.0	0.0	1.24	9.4	9.4
19	0.0	24.2	201	133.6	.065	1.2	0.0	1.31	10.9	7.2
20	0.0	14.1	154	50.6	0.000	0.0	0.0	1.72	18.7	6.1
21	0.0	9.1	132	24.7	0.000	0.0	0.0	4.43	63.9	12.0
22	0.0	42.6	236	1.7	.080	0.0	I	R	R	R
23	0.0	716.0	156	.3	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	9.368	GRAM/BHP HR
	CO	27.867	GRAM/BHP HR
	NO2	10.725	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.642	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

5-17-72 RUN 2 ENGINE 2-3 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.8	4.1	14.3	39	3531	1.120	13.91	38
2	1200	4.5	1	19.2	7.4	16.4	52	898	.130	13.18	93
3	1200	17.9	4	18.7	8.0	16.4	56	1460	.130	13.18	180
4	1200	40.3	9	17.5	8.8	16.3	60	1906	.130	12.94	370
5	1200	56.0	13	16.7	9.6	16.4	78	2018	.150	12.94	575
6	1200	112.0	26	10.4	14.8	16.7	78	1624	.150	12.82	1125
7	1200	168.0	38	5.5	20.8	15.1	81	1808	.280	13.77	2000
8	1200	184.0	42	4.5	21.7	15.0	68	1923	.440	13.77	2050
9	1200	206.0	47	2.8	23.7	14.9	65	2092	.350	13.77	2450
10	1200	224.0	51	0.0	32.7	12.2	41	4096	5.840	10.78	660
11	600	0.0	0	19.2	3.9	13.9	46	4096	1.840	13.06	41
12	1200	0.0	0	23.0	3.8	13.6	128	75952	.810	6.73	6
13	2300	235.0	103	2.6	49.9	14.0	55	2386	1.800	12.94	2200
14	2300	216.0	95	4.6	45.2	14.1	61	2158	1.730	12.94	2000
15	2300	192.5	84	6.5	42.2	14.2	59	1927	1.480	12.94	2050
16	2300	176.0	77	7.7	37.9	14.9	39	1577	.520	13.18	2500
17	2300	117.5	51	12.1	26.3	16.3	57	618	.180	13.18	2300
18	2300	58.8	26	17.1	17.6	16.4	44	516	.170	13.06	950
19	2300	42.3	19	18.0	16.3	16.5	55	477	.170	12.94	700
20	2300	18.8	8	19.7	13.3	16.5	39	348	.160	13.06	400
21	2300	4.7	2	20.8	11.5	16.4	28	281	.160	13.06	220
22	600	0.0	0	18.9	3.8	14.5	37	3744	.930	13.63	41
23	2300	0.0	0	24.8	3.8	18.6	98	42105	.420	5.27	4

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	1.0	42.4	272	1.5	.070	0.0	R	R	R	R
2	2.8	22.5	66	7.7	.060	.1	2.7	22.01	64.3	7.5
3	3.3	39.5	71	16.2	.060	.2	.8	9.67	17.4	4.0
4	3.9	57.1	79	36.8	.050	.5	.4	6.20	8.5	4.0
5	5.5	66.1	99	62.5	.030	.4	.4	5.16	7.8	4.9
6	8.6	83.0	155	190.9	.060	1.5	.3	3.24	6.1	7.5
7	11.7	120.1	376	441.1	0.000	0.0	.3	3.13	9.8	11.5
8	10.0	131.3	607	464.5	.040	1.7	.2	3.12	14.4	11.0
9	10.6	156.6	529	609.0	0.000	0.0	.2	3.33	11.2	12.9
10	7.7	356.8	10277	190.9	0.000	0.0	.2	6.97	200.8	3.7
11	1.1	47.0	426	1.6	.070	0.0	R	R	R	R
12	3.1	856.9	185	.2	.120	0.0	R	R	R	R
13	18.0	360.5	5493	1103.4	.025	2.6	.2	3.50	53.4	10.7
14	18.1	297.2	4813	914.6	.055	5.2	.2	3.14	50.9	9.7
15	16.7	252.3	3915	891.2	.035	3.0	.2	2.99	46.4	10.6
16	10.5	195.8	1304	1030.0	.060	4.6	.1	2.54	16.9	13.4
17	10.8	54.8	323	677.5	.060	3.1	.2	1.07	6.3	13.2
18	5.8	31.1	207	189.7	0.000	0.0	.2	1.21	8.0	7.4
19	6.7	26.7	192	130.3	.065	1.2	.4	1.44	10.4	7.0
20	3.8	15.9	148	60.6	0.000	0.0	.5	1.93	17.9	7.4
21	2.4	11.0	127	28.7	0.000	0.0	1.1	5.35	61.7	13.9
22	.9	42.8	215	1.6	.080	0.0	R	R	R	R
23	3.7	726.2	146	.2	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	9.406	GRAM/BHP HR
	CO	33.104	GRAM/BHP HR
	NO2	10.644	GRAM/BHP HR
	ALDE	.259	GRAM/BHP HR
	BSFC	.627	LB/BHP HR

APPENDIX G

ENGINE 2-3

COMPARISON OF 1972 TO 1973 CALIFORNIA

CONFIGURATION EMISSION RATES

ENGINE 2-3

EXPERIMENTAL 23 MODE RESULTS
(Army Lab Tests)

1973 CALIFORNIA VERSION OF ENGINE

1972 RETEST OF 1972 STANDARD ENGINE

PROJECT 11-2877-01 CONTROL TECHNOLOGY

5-24-72 RUN 1 1973 CALIFORNIA VERSION OF ENGINE 2-3 PER MANUF. SPECS.

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.0	4.7	15.0	0	3390	.580	13.48	35
2	1200	4.3	1	19.2	7.9	15.6	0	632	.130	13.77	98
3	1200	17.2	4	18.5	8.4	15.6	0	993	.130	13.77	155
4	1200	38.7	9	17.1	10.1	15.8	0	1184	.130	13.63	220
5	1200	53.8	12	16.4	10.9	15.8	0	1296	.130	13.63	290
6	1200	107.5	25	10.6	15.9	16.1	0	1348	.130	13.18	725
7	1200	161.0	37	6.4	21.7	14.5	0	2388	.770	14.05	1100
8	1200	177.0	40	5.0	22.7	14.5	0	2272	.640	14.05	1275
9	1200	197.8	45	3.0	24.6	14.5	0	2214	.890	13.77	1350
10	1200	215.0	49	0.0	32.5	12.5	0	3803	5.240	11.24	750
11	600	0.0	0	18.2	4.7	14.1	0	3398	1.300	13.06	41
12	1200	0.0	0	22.7	3.8	15.0	0	65277	.580	7.00	5
13	2300	256.0	112	.1	64.8	12.1	0	3238	6.250	10.66	775
14	2300	235.5	103	3.3	51.2	13.6	0	2400	2.520	12.94	1250
15	2300	209.9	92	5.3	48.5	13.5	0	2348	2.780	12.94	1175
16	2300	192.0	84	6.8	46.5	13.6	0	2345	2.600	12.94	1075
17	2300	128.0	56	10.3	31.2	15.6	0	360	.150	13.48	1600
18	2300	64.0	28	15.9	21.4	15.8	0	203	.150	13.48	800
19	2300	46.0	20	17.8	18.3	15.8	0	146	.130	13.48	460
20	2300	21.0	9	19.2	15.4	15.9	0	118	.100	13.48	270
21	2300	5.0	2	20.5	12.7	16.2	0	76	.100	13.63	156
22	600	0.0	0	18.0	4.7	15.2	0	2649	.580	13.18	37
23	2300	0.0	0	24.8	3.9	31.7	0	23872	.150	3.95	4

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	49.7	172	1.7	.070	0.0	I	R	R	R
2	0.0	16.3	68	8.4	.060	.1	0.0	16.61	69.0	8.5
3	0.0	27.0	71	14.0	.060	.2	0.0	6.88	18.2	3.6
4	0.0	38.9	86	24.0	.050	.4	0.0	4.40	9.8	2.7
5	0.0	46.4	94	34.4	.030	.4	0.0	3.77	7.6	2.8
6	0.0	72.3	141	129.1	.060	1.5	0.0	2.94	5.7	5.3
7	0.0	155.9	1016	238.4	0.000	0.0	0.0	4.24	27.6	6.5
8	0.0	157.0	893	292.5	.040	1.6	0.0	3.88	22.1	7.2
9	0.0	166.0	1348	336.1	0.000	0.0	0.0	3.67	29.8	7.4
10	0.0	333.0	9269	218.1	0.000	0.0	0.0	6.78	188.7	4.4
11	0.0	48.8	377	2.0	.070	0.0	I	R	R	R
12	0.0	787.1	141	.2	.120	0.0	I	R	R	R
13	0.0	552.3	21533	438.8	.025	2.8	0.0	4.93	192.1	3.9
14	0.0	355.2	7534	614.2	.055	5.7	0.0	3.44	73.0	6.0
15	0.0	323.4	7735	537.3	.035	3.2	0.0	3.52	84.2	5.8
16	0.0	313.5	7023	477.2	.060	5.0	0.0	3.73	83.5	5.7
17	0.0	37.3	314	550.1	.060	3.4	0.0	.67	5.6	9.8
18	0.0	14.4	215	188.7	0.000	0.0	0.0	.51	7.7	6.7
19	0.0	8.9	160	93.0	.065	1.3	0.0	.44	7.9	4.6
20	0.0	6.1	104	46.0	0.000	0.0	0.0	.66	11.3	5.0
21	0.0	3.2	85	21.7	0.000	0.0	0.0	1.45	38.6	9.9
22	0.0	39.8	176	1.8	.080	0.0	I	R	R	R
23	0.0	651.0	83	.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	8.843	GRAM/BHP HR
	CO	70.608	GRAM/BHP HR
	NO2	6.042	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.678	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY
5-23-72 RUN 2 1973 CALIFORNIA VERSION OF ENGINE 2-3 PER MANUF. SPECS.

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.5	4.7	15.8	0	4150	.210	12.94	29
2	1200	4.3	1	19.4	7.9	16.5	0	560	.100	12.94	55
3	1200	17.2	4	18.3	8.4	16.6	0	941	.100	12.94	85
4	1200	38.7	9	16.8	10.1	16.6	0	1210	.100	12.94	161
5	1200	53.8	12	15.8	10.9	16.5	0	1434	.100	12.94	270
6	1200	107.5	25	10.3	15.9	16.4	0	1255	.100	12.94	620
7	1200	161.0	37	6.3	21.7	14.7	0	2212	.470	14.05	1125
8	1200	177.0	40	5.0	22.7	14.7	0	2212	.470	14.05	1313
9	1200	197.8	45	3.0	24.6	14.5	0	2272	.770	13.91	1375
10	1200	215.0	49	0.0	32.5	12.5	0	3897	5.240	11.48	750
11	600	0.0	0	18.3	4.7	14.8	0	2780	.930	13.63	41
12	1200	0.0	0	22.8	3.8	16.9	0	50087	.280	6.82	6
13	2300	256.0	112	.1	64.8	12.2	0	4051	6.020	11.01	775
14	2300	235.5	103	3.4	51.2	13.4	0	3212	2.970	12.94	1075
15	2300	209.9	92	5.4	48.5	13.5	0	2978	2.780	12.94	1063
16	2300	192.0	84	6.8	46.5	13.7	0	1716	2.360	13.18	1000
17	2300	128.0	56	10.4	31.2	15.5	0	988	.150	13.77	1125
18	2300	64.0	28	15.8	21.4	15.9	0	220	.150	13.63	420
19	2300	46.0	20	17.6	18.3	15.9	0	192	.130	13.63	230
20	2300	21.0	9	19.3	15.4	16.0	0	113	.100	13.63	115
21	2300	5.0	2	20.4	12.7	16.4	0	76	.100	13.63	68
22	600	0.0	0	17.5	4.7	15.5	0	2987	.280	13.48	18
23	2300	0.0	0	24.8	3.9	29.5	0	26022	.150	4.27	3

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	64.5	66	1.5	.070	0.0	I	R	R	R
2	0.0	15.4	56	5.0	.060	.1	0.0	15.70	56.6	5.1
3	0.0	27.3	59	8.2	.060	.2	0.0	6.95	14.9	2.1
4	0.0	41.9	70	18.5	.050	.4	0.0	4.74	7.9	2.1
5	0.0	54.0	76	33.8	.030	.4	0.0	4.40	6.2	2.7
6	0.0	68.8	111	112.8	.060	1.5	0.0	2.80	4.5	4.6
7	0.0	147.5	633	249.1	0.000	0.0	0.0	4.01	17.2	6.8
8	0.0	154.7	664	304.7	.040	1.6	0.0	3.82	16.4	7.5
9	0.0	170.0	1164	341.7	0.000	0.0	0.0	3.76	25.8	7.6
10	0.0	336.3	9134	214.9	0.000	0.0	0.0	6.85	185.9	4.4
11	0.0	39.5	267	1.9	.070	0.0	I	R	R	R
12	0.0	703.6	79	.3	.120	0.0	I	R	R	R
13	0.0	683.0	20501	433.8	.025	2.8	0.0	6.09	182.9	3.9
14	0.0	459.8	8588	510.9	.055	5.7	0.0	4.46	83.3	5.0
15	0.0	408.6	7705	484.0	.035	3.2	0.0	4.45	83.8	5.3
16	0.0	230.3	6400	445.7	.060	5.0	0.0	2.74	76.1	5.3
17	0.0	99.7	306	377.1	.060	3.4	0.0	1.78	5.5	6.7
18	0.0	15.4	213	98.0	0.000	0.0	0.0	.55	7.6	3.5
19	0.0	11.5	158	46.0	.065	1.3	0.0	.57	7.9	2.3
20	0.0	5.7	103	19.4	0.000	0.0	0.0	.62	11.1	2.1
21	0.0	3.2	85	9.4	0.000	0.0	0.0	1.45	38.6	4.3
22	0.0	44.8	85	.9	.080	0.0	I	R	R	R
23	0.0	655.6	76	.2	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	8.921	GRAM/BHP HR
	CO	68.623	GRAM/BHP HR
	NO2	5.088	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.678	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

5-25-72 RUN 1 1973 CALIFORNIA VERSION OF ENGINE 2-3 PER MANUF. SPECS.

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.3	4.7	14.9	0	4861	.770	13.33	35
2	1200	4.3	1	19.3	7.9	15.7	0	1071	.130	13.63	130
3	1200	17.2	4	18.5	8.4	15.7	0	1098	.130	13.48	127
4	1200	38.7	9	17.3	10.1	15.7	0	1659	.130	13.33	255
5	1200	53.8	12	16.2	10.9	16.2	0	1909	.130	13.18	380
6	1200	107.5	25	10.8	15.9	16.1	0	1849	.130	12.94	840
7	1200	161.0	37	6.4	21.7	14.6	0	2713	.640	13.48	1225
8	1200	177.0	40	5.0	22.7	14.5	0	2798	.610	13.48	1400
9	1200	197.8	45	3.1	24.6	14.4	0	2713	.930	13.18	1450
10	1200	215.0	49	0.0	32.5	12.5	0	4618	5.140	10.78	825
11	600	0.0	0	18.3	4.7	14.8	0	4053	.770	12.82	39
12	1200	0.0	0	22.9	3.8	13.1	0	89066	.470	6.05	3
13	2300	256.0	112	.1	64.8	12.0	0	5488	6.020	10.78	800
14	2300	235.5	103	3.4	51.2	13.3	0	4240	3.060	12.71	1150
15	2300	209.9	92	5.5	48.5	13.4	0	3891	2.780	12.82	1225
16	2300	192.0	84	6.7	46.5	13.4	0	3888	2.690	12.82	1125
17	2300	128.0	56	10.6	31.2	15.5	0	1521	.180	13.48	1800
18	2300	64.0	28	16.0	21.4	15.7	0	832	.180	13.33	900
19	2300	46.0	20	17.5	18.3	15.7	0	642	.180	13.48	600
20	2300	21.0	9	19.5	15.4	15.7	0	405	.130	13.48	300
21	2300	5.0	2	20.5	12.7	15.8	0	135	.130	13.33	179
22	600	0.0	0	18.3	4.7	14.6	0	3389	.850	13.18	39
23	2300	0.0	0	24.8	3.9	25.3	0	37482	.180	4.27	5

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	70.3	225	1.7	.070	0.0	I	R	R	R
2	0.0	27.8	68	11.2	.060	.1	0.0	28.35	69.5	11.4
3	0.0	30.5	73	11.8	.060	.2	0.0	7.76	18.6	3.0
4	0.0	55.5	88	28.3	.050	.4	0.0	6.28	9.9	3.2
5	0.0	70.2	97	46.4	.030	.4	0.0	5.71	7.9	3.8
6	0.0	100.6	143	151.7	.060	1.5	0.0	4.10	5.8	6.2
7	0.0	185.4	883	277.8	0.000	0.0	0.0	5.04	24.0	7.6
8	0.0	200.7	884	333.4	.040	1.6	0.0	4.96	21.9	8.2
9	0.0	210.5	1458	373.5	0.000	0.0	0.0	4.66	32.3	8.3
10	0.0	416.2	9358	246.9	0.000	0.0	0.0	8.47	190.5	5.0
11	0.0	61.1	234	2.0	.070	0.0	I	R	R	R
12	0.0	982.1	105	.1	.120	0.0	I	R	R	R
13	0.0	929.8	20603	450.0	.025	2.8	0.0	8.29	183.8	4.0
14	0.0	608.3	8869	547.8	.055	5.7	0.0	5.90	86.0	5.3
15	0.0	534.8	7719	559.0	.035	3.2	0.0	5.82	84.0	6.1
16	0.0	515.8	7209	495.5	.060	5.0	0.0	6.13	85.7	5.9
17	0.0	155.8	373	612.3	.060	3.4	0.0	2.78	6.6	10.9
18	0.0	59.4	259	213.1	0.000	0.0	0.0	2.12	9.3	7.6
19	0.0	38.8	220	120.5	.065	1.3	0.0	1.93	10.9	6.0
20	0.0	20.7	134	50.9	0.000	0.0	0.0	2.25	14.6	5.5
21	0.0	5.8	112	25.3	0.000	0.0	0.0	2.63	51.2	11.6
22	0.0	49.8	252	1.9	.080	0.0	I	R	R	R
23	0.0	808.8	78	.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	12.506	GRAM/BHP HR
	CO	73.085	GRAM/BHP HR
	NO2	6.339	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.678	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

5-26-72 RUN 1 ENGINE 2-3 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	19.2	4.0	14.5	0	4258	1.010	13.63	35
2	1200	4.7	1	19.6	7.5	15.0	0	1022	.420	14.18	90
3	1200	19.0	4	19.3	7.9	15.0	0	1531	.280	14.18	150
4	1200	42.0	10	18.4	9.2	15.2	0	2773	.210	14.05	510
5	1200	59.0	13	17.0	10.0	15.2	0	2910	.150	13.91	925
6	1200	118.0	27	10.2	15.2	15.7	0	1907	.130	13.06	1300
7	1200	176.0	40	6.0	20.1	15.1	0	2291	.150	14.05	2075
8	1200	193.0	44	4.5	21.8	15.1	0	2378	.280	14.05	2100
9	1200	216.0	49	2.8	24.2	15.0	0	2439	.210	14.31	2400
10	1200	235.0	54	0.0	31.6	12.4	0	4431	5.410	11.72	460
11	600	0.0	0	19.5	4.3	13.7	0	4701	2.360	13.48	40
12	1200	0.0	0	23.4	4.1	12.8	0	79887	1.230	7.37	6
13	2300	240.0	105	2.9	50.9	14.5	0	2449	1.270	13.77	2500
14	2300	221.0	97	4.0	47.8	14.4	0	2107	1.380	13.63	2200
15	2300	197.0	86	5.5	43.4	14.6	0	1734	1.200	13.63	2100
16	2300	180.0	79	7.4	39.5	14.7	0	1764	.850	14.05	2200
17	2300	120.0	53	11.3	27.9	16.5	0	438	.180	13.18	2300
18	2300	60.0	26	16.6	19.2	16.5	0	472	.180	13.18	1500
19	2300	43.0	19	18.2	16.5	16.4	0	360	.180	13.33	875
20	2300	19.0	8	20.0	14.3	16.3	0	282	.150	13.48	425
21	2300	4.8	2	21.2	12.1	16.1	0	192	.150	13.63	250
22	600	0.0	0	19.2	4.3	14.1	0	3593	1.590	13.63	44
23	2300	0.0	0	25.1	4.2	11.4	0	36038	.350	6.13	8

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	51.3	246	1.4	.070	0.0	I	R	R	R
2	0.0	23.6	196	6.9	.060	.1	0.0	22.01	182.8	6.4
3	0.0	37.5	139	12.2	.060	.3	0.0	8.65	31.9	2.8
4	0.0	79.6	122	48.6	.050	.5	0.0	8.30	12.7	5.1
5	0.0	92.0	96	97.1	.030	.4	0.0	6.82	7.1	7.2
6	0.0	98.3	135	222.4	.060	1.6	0.0	3.65	5.0	8.2
7	0.0	144.8	191	435.3	0.000	0.0	0.0	3.60	4.8	10.8
8	0.0	161.4	384	473.3	.040	1.8	0.0	3.66	8.7	10.7
9	0.0	181.3	315	592.4	0.000	0.0	0.0	3.67	6.4	12.0
10	0.0	361.4	8914	124.6	0.000	0.0	0.0	6.73	166.0	2.3
11	0.0	56.2	570	1.6	.070	0.0	I	R	R	R
12	0.0	895.6	279	.2	.120	0.0	I	R	R	R
13	0.0	369.9	3875	1253.7	.025	2.6	0.0	3.52	36.9	11.9
14	0.0	300.1	3971	1040.5	.055	5.3	0.0	3.10	41.0	10.8
15	0.0	227.5	3181	914.8	.035	3.0	0.0	2.64	36.9	10.6
16	0.0	209.6	2041	868.0	.060	4.7	0.0	2.66	25.9	11.0
17	0.0	41.4	343	721.0	.060	3.2	0.0	.79	6.5	13.7
18	0.0	30.7	236	323.5	0.000	0.0	0.0	1.17	9.0	12.3
19	0.0	19.9	201	160.5	.065	1.2	0.0	1.06	10.7	8.5
20	0.0	13.4	144	67.0	0.000	0.0	0.0	1.61	17.3	8.1
21	0.0	7.6	121	33.0	0.000	0.0	0.0	3.63	57.3	15.7
22	0.0	45.0	402	1.8	.080	0.0	I	R	R	R
23	0.0	680.9	134	.5	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	9.417	GRAM/BHP HR
	CO	31.051	GRAM/BHP HR
	NO2	10.765	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.635	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

5-30-72 RUN 1 ENGINE 2-3 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.5	4.7	14.7	0	3400	.930	13.48	39
2	1200	4.3	1	19.5	7.9	15.5	0	480	.210	13.77	84
3	1200	17.2	4	19.0	8.4	15.6	0	845	.180	13.48	147
4	1200	38.7	9	18.0	10.1	15.8	0	1745	.150	13.48	500
5	1200	53.8	12	16.4	10.9	16.1	0	1825	.150	13.18	813
6	1200	107.5	25	10.3	15.9	16.9	0	1284	.150	12.47	950
7	1200	161.0	37	5.5	21.7	15.4	0	1694	.180	13.77	2212
8	1200	177.0	40	3.6	22.7	15.4	0	1720	.210	13.63	2250
9	1200	197.8	45	2.5	24.6	15.2	0	1862	.280	13.63	2450
10	1200	215.0	49	0.0	32.5	12.4	0	3693	5.780	10.89	435
11	600	0.0	0	19.2	4.7	13.9	0	3823	2.210	13.06	43
12	1200	0.0	0	23.3	3.8	9.4	0	60880	1.010	7.37	6
13	2300	256.0	112	2.9	64.8	14.4	0	2221	1.380	13.63	2650
14	2300	235.5	103	4.4	51.2	14.6	0	1908	1.300	13.77	2400
15	2300	209.9	92	6.0	48.5	14.7	0	1564	1.230	13.63	2200
16	2300	192.0	84	7.5	46.5	15.0	0	1589	.520	14.05	2650
17	2300	128.0	56	11.2	31.2	16.7	0	402	.180	13.18	2350
18	2300	64.0	28	16.7	21.4	16.4	0	473	.180	13.48	1500
19	2300	46.0	20	18.2	18.3	16.4	0	366	.180	13.48	925
20	2300	21.0	9	19.9	15.4	16.2	0	339	.150	13.77	525
21	2300	5.0	2	21.2	12.7	16.1	0	201	.130	13.91	250
22	600	0.0	0	18.7	4.7	14.5	0	3027	1.450	13.91	42
23	2300	0.0	0	25.0	3.9	21.5	0	31268	.350	6.13	7

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	46.6	269	1.9	.070	0.0	I	R	R	R
2	0.0	12.3	109	7.1	.060	.1	0.0	12.56	111.0	7.3
3	0.0	23.4	101	13.6	.060	.2	0.0	5.96	25.6	3.5
4	0.0	57.6	100	54.8	.050	.4	0.0	6.52	11.3	6.2
5	0.0	67.1	111	99.2	.030	.4	0.0	5.46	9.1	8.1
6	0.0	72.7	171	178.4	.060	1.5	0.0	2.96	7.0	7.3
7	0.0	117.9	253	511.5	0.000	0.0	0.0	3.21	6.9	13.9
8	0.0	126.6	312	549.5	.040	1.6	0.0	3.13	7.7	13.6
9	0.0	147.4	448	643.9	0.000	0.0	0.0	3.26	9.9	14.2
10	0.0	320.0	10117	125.1	0.000	0.0	0.0	6.51	205.9	2.5
11	0.0	51.5	602	1.9	.070	0.0	I	R	R	R
12	0.0	715.8	240	.2	.120	0.0	I	R	R	R
13	0.0	428.5	5379	1697.7	.025	2.8	0.0	3.82	48.0	15.1
14	0.0	290.6	3998	1213.2	.055	5.7	0.0	2.82	38.8	11.8
15	0.0	228.9	3636	1069.0	.035	3.2	0.0	2.49	39.6	11.6
16	0.0	227.5	1504	1259.9	.060	5.0	0.0	2.71	17.9	15.0
17	0.0	42.4	384	824.0	.060	3.4	0.0	.76	6.9	14.7
18	0.0	33.5	257	352.3	0.000	0.0	0.0	1.19	9.2	12.6
19	0.0	22.2	220	186.1	.065	1.3	0.0	1.10	10.9	9.2
20	0.0	16.9	151	87.1	0.000	0.0	0.0	1.84	16.5	9.5
21	0.0	8.2	107	33.9	0.000	0.0	0.0	3.75	49.0	15.5
22	0.0	40.8	394	1.9	.080	0.0	I	R	R	R
23	0.0	575.8	130	.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	7.791	GRAM/BHP HR
	CO	30.540	GRAM/BHP HR
	NO2	12.646	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.678	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

5-30-72 RUN 2 ENGINE 2-3 STATIONARY DYNAMOMETER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.5	4.7	14.4	0	4229	1.410	14.05	39
2	1200	4.3	1	19.6	7.9	14.7	0	1193	.580	14.18	98
3	1200	17.2	4	19.0	8.4	15.0	0	1418	.310	14.18	170
4	1200	38.7	9	18.0	10.1	15.2	0	2263	.180	14.05	580
5	1200	53.8	12	16.5	10.9	16.0	0	1909	.130	13.18	775
6	1200	107.5	25	10.2	15.9	16.9	0	1314	.100	12.71	988
7	1200	161.0	37	5.6	21.7	15.3	0	1893	.130	13.91	2175
8	1200	177.0	40	4.0	22.7	15.3	0	1921	.150	13.91	2100
9	1200	197.0	45	2.7	24.6	15.1	0	2037	.180	14.05	2500
10	1200	215.0	49	0.0	32.5	12.6	0	4066	5.960	13.33	625
11	600	0.0	0	19.2	4.7	13.8	0	4058	2.400	13.06	43
12	1200	0.0	0	23.3	3.8	14.1	0	65380	1.160	7.56	6
13	2300	256.0	112	2.9	64.8	14.2	0	2477	1.660	13.33	2400
14	2300	235.5	103	4.0	51.2	14.3	0	2048	1.550	13.33	2200
15	2300	209.9	92	5.9	48.5	14.4	0	1821	1.450	13.48	2000
16	2300	192.0	84	7.5	46.5	14.6	0	1819	1.050	13.77	2200
17	2300	128.0	56	11.5	31.2	16.5	0	398	.180	12.94	2100
18	2300	64.0	28	16.7	21.4	16.4	0	421	.180	12.94	1225
19	2300	46.0	20	18.0	18.3	16.4	0	392	.150	12.94	750
20	2300	21.0	9	20.0	15.4	16.2	0	309	.150	13.33	370
21	2300	5.0	2	21.3	12.7	16.1	0	186	.130	13.33	195
22	600	0.0	0	18.7	4.7	14.3	0	4151	1.520	13.33	34
23	2300	0.0	0	25.0	3.9	21.6	0	34334	.350	5.75	6

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	56.2	378	1.7	.070	0.0	I	R	R	R
2	0.0	28.9	284	7.9	.060	.1	0.0	29.44	289.0	8.0
3	0.0	36.9	163	14.7	.060	.2	0.0	9.39	41.5	3.7
4	0.0	71.4	115	60.7	.050	.4	0.0	8.07	13.0	6.9
5	0.0	70.2	97	94.7	.030	.4	0.0	5.71	7.9	7.7
6	0.0	73.2	113	182.8	.060	1.5	0.0	2.98	4.6	7.4
7	0.0	130.8	181	498.9	0.000	0.0	0.0	3.55	4.9	13.6
8	0.0	138.9	219	504.3	.040	1.6	0.0	3.44	5.4	12.5
9	0.0	157.5	281	641.7	0.000	0.0	0.0	3.50	6.2	14.3
10	0.0	304.8	9025	155.5	0.000	0.0	0.0	6.20	183.7	3.2
11	0.0	53.4	645	1.9	.070	0.0	I	R	R	R
12	0.0	728.9	261	.2	.120	0.0	I	R	R	R
13	0.0	477.7	6468	1537.0	.025	2.8	0.0	4.26	57.7	13.7
14	0.0	315.4	4823	1125.1	.055	5.7	0.0	3.06	46.8	10.9
15	0.0	264.8	4260	965.6	.035	3.2	0.0	2.88	46.3	10.5
16	0.0	255.8	2982	1026.9	.060	5.0	0.0	3.04	35.5	12.2
17	0.0	42.8	391	749.8	.060	3.4	0.0	.76	7.0	13.4
18	0.0	31.0	268	299.6	0.000	0.0	0.0	1.11	9.6	10.7
19	0.0	24.8	192	157.4	.065	1.3	0.0	1.23	9.5	7.8
20	0.0	16.0	156	63.4	0.000	0.0	0.0	1.74	17.0	6.9
21	0.0	7.9	112	27.6	0.000	0.0	0.0	3.61	51.2	12.6
22	0.0	57.4	424	1.6	.080	0.0	I	R	R	R
23	0.0	637.1	131	.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	8.422	GRAM/BHP HR
	CO	38.529	GRAM/BHP HR
	NO2	11.315	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.678	LB/BHP HR

ENGINE 2-3

9 MODE FTP

1973 CALIFORNIA VERSION OF ENGINE RESULTS

CONCENTRATION RESULTS

CALIFORNIA ARB MASS RESULTS

5-31-72 73 VERSION ENGINE 2-3 RUN-1 ARMY LAB K = .989 HUM = 72 GR/LB

	FEDERAL MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
	1 IDLE	228	.530	13.530	77	1.033	235	.547	80	.036	8.476	.020	2.863
	2 16'HG	39	.160	13.330	542	1.078	42	.172	584	.089	3.741	.015	51.996
	3 10'HG	28	.160	13.480	1218	1.067	30	.171	1300	.257	7.678	.044	333.981
	4 16'HG	17	.190	13.480	643	1.067	18	.203	686	.089	1.614	.018	61.044
	5 19'HG	17	.120	13.500	265	1.068	18	.128	283	.047	.853	.006	13.300
	6 16'HG	22	.160	13.460	612	1.069	24	.171	654	.089	2.093	.015	58.228
	7 3'HG	97	2.280	13.250	1546	1.000	97	2.281	1547	.283	27.461	.645	437.676
	8 16'HG	30	.150	12.940	837	1.111	33	.167	930	.089	2.967	.015	82.786
	9 C.T.	955	.440	7.410	85	1.674	1599	.737	142	.021	33.574	.015	2.988
	SUM----------(CYCLE COMPOSITE)----------										88.458	.794	1044.862
CYCLE 2													
	1 IDLE	228	.530	13.530	77	1.033	235	.547	80	.036	8.476	.020	2.863
	2 16'HG	35	.180	13.180	582	1.090	38	.196	634	.089	3.394	.017	56.438
	3 10'HG	30	.150	13.180	1140	1.091	33	.164	1244	.257	8.414	.042	319.717
	4 16'HG	30	.150	13.020	505	1.105	33	.166	558	.089	2.949	.015	49.644
	5 19'HG	16	.130	13.450	242	1.072	17	.139	259	.047	.806	.007	12.187
	6 16'HG	17	.130	12.820	410	1.124	19	.146	461	.089	1.700	.013	41.005
	7 3'HG	107	2.190	13.450	1488	.989	106	2.166	1472	.283	29.949	.613	416.492
	8 16'HG	35	.160	13.140	612	1.094	38	.175	669	.089	3.407	.016	59.571
	9 C.T.	908	.450	6.910	59	1.787	1622	.804	105	.021	34.068	.017	2.214
	SUM----------(CYCLE COMPOSITE)----------										93.164	.759	960.132
CYCLE 3													
	1 IDLE	75	.580	13.480	77	1.047	79	.607	81	.036	2.827	.022	2.902
	2 16'HG	53	.200	13.400	552	1.070	57	.214	590	.089	5.045	.019	52.544
	3 10'HG	35	.150	12.480	628	1.151	40	.173	723	.257	10.357	.044	185.840
	4 16'HG	35	.150	12.820	439	1.121	39	.168	492	.089	3.492	.015	43.806
	5 19'HG	35	.130	13.200	251	1.090	38	.142	274	.047	1.793	.007	12.859
	6 16'HG	30	.130	12.940	468	1.112	33	.145	521	.089	2.970	.013	46.325
	7 3'HG	106	2.060	13.300	1605	1.004	106	2.068	1611	.283	30.113	.585	455.961
	8 16'HG	35	.200	13.480	752	1.065	37	.213	801	.089	3.317	.019	71.264
	9 C.T.	867	.440	7.850	68	1.610	1396	.708	109	.021	29.313	.015	2.299
	SUM----------(CYCLE COMPOSITE)----------										89.227	.739	873.799
CYCLE 4													
	1 IDLE	75	.580	13.480	77	1.047	79	.607	81	.036	2.827	.022	2.902
	2 16'HG	26	.210	13.180	613	1.089	28	.229	668	.089	2.520	.020	59.421
	3 10'HG	21	.180	12.960	1069	1.109	23	.200	1186	.257	5.986	.051	304.729
	4 16'HG	16	.140	12.710	425	1.133	18	.159	482	.089	1.613	.014	42.858
	5 19'HG	13	.130	13.140	224	1.097	14	.143	246	.047	.670	.007	11.548
	6 16'HG	17	.130	12.940	522	1.113	19	.145	581	.089	1.685	.013	51.726
	7 3'HG	89	2.080	13.180	1501	1.013	90	2.107	1520	.283	25.511	.596	430.239
	8 16'HG	26	.150	13.330	678	1.079	28	.162	732	.089	2.498	.014	65.135
	9 C.T.	828	.430	7.730	67	1.640	1358	.705	110	.021	28.523	.015	2.308
	SUM----------(CYCLE COMPOSITE)----------										71.833	.753	970.865

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 90.811 .776 1002.497

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 80.530 .746 922.332

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(90.811) + 0.65*(80.530) =	84.128	PPM
CO	0.35*(.776) + 0.65*(.746) =	.756	PERCENT
NO	0.35*(1002.497) + 0.65*(922.332) =	950.390	PPM
	CORRECTED NO =	939.785	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

5-31-72 73 VERSION ENGINE 2-3 RUN-2 ARMY LAB K =1.004 HUM = 76 GR/LB

	FEDERAL MODE	CONCENTRATION HC	CO	AS CO2	MEASURED NO	DILUTION FACTOR	A D J U S T E D HC	CO	NO	WEIGHTING FACTOR	W E I G H T E D HC	CO	NO
CYCLE 1													
	1 IDLE	98	.460	13.770	90	1.028	101	.473	93	.036	3.627	.017	3.331
	2 16'HG	43	.250	13.630	592	1.051	45	.263	622	.089	4.021	.023	55.355
	3 10'HG	31	.160	12.710	612	1.131	35	.181	692	.257	9.009	.046	177.847
	4 16'HG	25	.160	12.940	405	1.111	28	.178	450	.089	2.473	.016	40.059
	5 19'HG	18	.150	13.480	228	1.068	19	.160	244	.047	.904	.008	11.447
	6 16'HG	13	.150	13.060	420	1.103	14	.165	463	.089	1.276	.015	41.220
	7 3'HG	89	2.310	13.630	1631	.974	87	2.251	1589	.283	24.542	.637	449.752
	8 16'HG	26	.210	13.630	720	1.054	27	.221	759	.089	2.438	.020	67.511
	9 C.T.	833	.460	7.430	88	1.694	1411	.779	149	.021	29.633	.016	3.131
	SUM----------(CYCLE COMPOSITE)----------										77.921	.798	849.652
CYCLE 2													
	1 IDLE	98	.460	13.770	90	1.028	101	.473	93	.036	3.627	.017	3.331
	2 16'HG	40	.210	13.770	586	1.042	42	.219	610	.089	3.709	.019	54.334
	3 10'HG	31	.160	13.180	890	1.091	34	.175	971	.257	8.690	.045	249.490
	4 16'HG	26	.150	13.180	464	1.092	28	.164	507	.089	2.526	.015	45.079
	5 19'HG	26	.140	13.480	230	1.068	28	.150	246	.047	1.305	.007	11.544
	6 16'HG	22	.160	13.480	568	1.067	23	.171	606	.089	2.090	.015	53.962
	7 3'HG	102	2.160	13.770	1482	.969	99	2.094	1436	.283	27.978	.592	406.505
	8 16'HG	35	.220	13.670	754	1.049	37	.231	791	.089	3.269	.021	70.419
	9 C.T.	831	.430	7.780	95	1.631	1355	.701	155	.021	28.455	.015	3.253
	SUM----------(CYCLE COMPOSITE)----------										81.649	.746	897.917
CYCLE 3													
	1 IDLE	281	1.140	13.770	90	.990	278	1.129	89	.036	10.017	.041	3.208
	2 16'HG	44	.210	13.770	567	1.041	46	.219	591	.089	4.078	.019	52.556
	3 10'HG	13	.160	12.740	552	1.130	15	.181	624	.257	3.775	.046	160.279
	4 16'HG	18	.150	13.180	405	1.092	20	.164	442	.089	1.750	.015	39.373
	5 19'HG	12	.150	13.630	251	1.057	13	.159	265	.047	.596	.007	12.470
	6 16'HG	13	.150	13.330	517	1.081	14	.162	559	.089	1.250	.014	49.720
	7 3'HG	89	1.430	13.580	1521	1.008	90	1.441	1533	.283	25.378	.408	433.700
	8 16'HG	25	.210	13.770	784	1.043	26	.219	818	.089	2.321	.019	72.777
	9 C.T.	831	.430	7.720	103	1.642	1364	.706	169	.021	28.649	.015	3.551
	SUM----------(CYCLE COMPOSITE)----------										77.813	.585	827.633
CYCLE 4													
	1 IDLE	281	1.140	13.770	90	.990	278	1.129	89	.036	10.017	.041	3.208
	2 16'HG	80	.250	13.480	597	1.059	85	.265	632	.089	7.540	.024	56.271
	3 10'HG	26	.210	13.480	1117	1.065	28	.224	1190	.257	7.117	.057	305.772
	4 16'HG	21	.180	13.220	508	1.088	23	.196	552	.089	2.033	.017	49.170
	5 19'HG	21	.150	13.770	251	1.046	22	.157	262	.047	1.032	.007	12.335
	6 16'HG	26	.210	13.750	663	1.044	27	.219	692	.089	2.417	.020	61.629
	7 3'HG	98	2.470	13.480	1314	.978	96	2.417	1286	.283	27.134	.684	363.812
	8 16'HG	34	.250	13.770	780	1.041	35	.260	812	.089	3.149	.023	72.252
	9 C.T.	794	.430	7.050	95	1.785	1417	.768	170	.021	29.766	.016	3.561
	SUM----------(CYCLE COMPOSITE)----------										90.205	.889	928.011

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 79.785 .772 873.784

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 84.009 .737 877.822

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(79.785) + 0.65*(84.009) =	82.531	PPM
CO	0.35*(.772) + 0.65*(.737) =	.749	PERCENT
NO	0.35*(873.784) + 0.65*(877.822) =	876.409	PPM
	CORRECTED NO =	879.549	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

5-30-72 73 VERSION ENGINE 2-4 RUN-1 ARMY LAB K =1.063 HUM = 94 GR/LB

	FEDERAL MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
	1 IDLE	296	.370	12.710	62	1.097	325	.406	68	.036	11.692	.015	2.449
	2 16'HG	63	.180	12.940	588	1.107	70	.199	651	.089	6.207	.018	57.933
	3 10'HG	45	.150	12.940	1357	1.110	51	.166	1506	.257	13.121	.043	387.063
	4 16'HG	35	.210	13.180	710	1.088	38	.229	773	.089	3.390	.020	68.773
	5 19'HG	26	.310	13.200	288	1.093	28	.336	312	.047	1.324	.016	14.666
	6 16'HG	34	.150	13.060	645	1.101	37	.165	710	.089	3.331	.015	63.194
	7 3'HG	116	2.600	12.740	1338	1.024	119	2.661	1370	.283	33.604	.753	387.601
	8 16'HG	36	.160	13.200	747	1.089	39	.174	813	.089	3.488	.016	72.379
	9 C.T.	965	.400	7.300	78	1.697	1638	.679	132	.021	34.399	.014	2.780
	SUM----------(CYCLE COMPOSITE)----------										110.557	.909	1056.840
CYCLE 2													
	1 IDLE	296	.370	12.710	62	1.097	325	.406	68	.036	11.692	.015	2.449
	2 16'HG	58	.150	13.480	612	1.065	62	.160	652	.089	5.496	.014	57.997
	3 10'HG	41	.140	13.630	1326	1.055	43	.148	1399	.257	11.116	.038	359.520
	4 16'HG	35	.150	13.480	671	1.067	37	.160	716	.089	3.323	.014	63.705
	5 19'HG	28	.130	13.770	298	1.046	29	.136	312	.047	1.376	.006	14.647
	6 16'HG	34	.150	13.500	653	1.065	36	.160	696	.089	3.223	.014	61.910
	7 3'HG	114	2.600	13.180	1344	.993	113	2.582	1335	.283	32.034	.731	377.666
	8 16'HG	31	.150	13.630	705	1.055	33	.158	744	.089	2.912	.014	66.223
	9 C.T.	1041	.380	7.710	79	1.607	1673	.611	127	.021	35.126	.013	2.666
	SUM----------(CYCLE COMPOSITE)----------										106.300	.859	1006.782
CYCLE 3													
	1 IDLE	165	.440	13.910	83	1.013	167	.446	84	.036	6.020	.016	3.028
	2 16'HG	36	.150	13.480	597	1.067	38	.160	626	.089	3.418	.014	55.725
	3 10'HG	34	.150	13.630	1412	1.055	36	.158	1490	.257	9.220	.041	382.908
	4 16'HG	31	.150	13.630	633	1.055	33	.158	668	.089	2.912	.014	59.460
	5 19'HG	26	.130	13.720	330	1.050	27	.136	346	.047	1.283	.006	16.281
	6 16'HG	31	.130	13.460	622	1.069	33	.139	665	.089	2.951	.012	59.202
	7 3'HG	114	2.380	13.180	1428	1.000	114	2.381	1429	.283	32.277	.674	404.316
	8 16'HG	35	.160	13.520	725	1.063	37	.170	771	.089	3.312	.015	68.604
	9 C.T.	907	.360	7.670	82	1.642	1489	.591	135	.021	31.279	.012	2.828
	SUM----------(CYCLE COMPOSITE)----------										92.671	.805	1052.353
CYCLE 4													
	1 IDLE	165	.440	13.910	83	1.013	167	.446	84	.036	6.020	.016	3.028
	2 16'HG	38	.150	13.770	597	1.044	40	.157	623	.089	3.532	.014	55.482
	3 10'HG	34	.150	13.910	1357	1.034	35	.155	1403	.257	9.036	.040	360.645
	4 16'HG	31	.150	13.910	695	1.034	32	.155	719	.089	2.854	.014	63.980
	5 19'HG	26	.130	14.050	295	1.025	27	.133	302	.047	1.253	.006	14.215
	6 16'HG	27	.130	13.800	689	1.044	28	.136	719	.089	2.508	.012	63.995
	7 3'HG	113	2.600	13.480	1362	.973	110	2.530	1325	.283	31.116	.716	375.047
	8 16'HG	35	.150	13.960	700	1.030	36	.155	721	.089	3.210	.014	64.191
	9 C.T.	910	.350	7.810	98	1.617	1471	.566	158	.021	30.899	.012	3.328
	SUM----------(CYCLE COMPOSITE)----------										90.426	.844	1003.910

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 108.428 .884 1031.811

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 91.549 .824 1028.132

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(108.428) + 0.65*(91.549) =	97.457	PPM
CO	0.35*(.884) + 0.65*(.824) =	.845	PERCENT
NO	0.35*(1031.811) + 0.65*(1028.132) =	1029.419	PPM
	CORRECTED NO =	1094.218	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

5-30-72 73 VERSION ENGINE 2-3 RUN-1 ARMY LAB K = 1.05 HUM = 94 GR/LB

MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1														
1 IDLE	296	.370	12.71	62	13.400	1907	45	106	3	.232	10.6	25	.7	0
2 16 HG	63	.180	12.94	588	13.188	8127	42	224	120	.077	3.2	17	9.3	23
3 10 HG	46	.150	12.94	1357	13.140	12530	47	289	430	.147	7.0	42	63.2	48
4 16 HG	35	.210	13.18	710	13.428	8127	23	257	143	.077	1.8	20	11.0	23
5 19 HG	26	.310	13.20	288	13.538	6061	13	280	43	.057	.7	16	2.4	10
6 16 HG	34	.150	13.06	645	13.247	8127	23	186	131	.077	1.7	14	10.1	23
7 3 HG	116	2.600	12.74	1338	15.465	19567	159	6645	562	.113	17.9	751	63.5	85
8 16 HG	36	.160	13.20	747	13.399	8127	24	196	150	.077	1.8	15	11.6	23
9 C.T.	965	.400	7.30	78	8.742	1907	227	176	6	.143	32.5	25	.8	0
SUM----------(CYCLE COMPOSITE)----------											3.2	38	7.1	
CYCLE 2														
1 IDLE	296	.370	12.71	62	13.400	1907	45	106	3	.232	10.6	25	.7	0
2 16 HG	58	.150	13.48	612	13.693	8127	37	180	121	.077	2.9	14	9.3	23
3 10 HG	41	.140	13.63	1326	13.814	12530	40	257	399	.147	5.9	38	58.7	48
4 16 HG	35	.150	13.48	671	13.668	8127	22	180	132	.077	1.7	14	10.2	23
5 19 HG	28	.130	13.77	298	13.930	6061	13	114	43	.057	.7	7	2.5	10
6 16 HG	34	.150	13.50	653	13.687	8127	22	180	129	.077	1.7	14	9.9	23
7 3 HG	114	2.600	13.18	1344	15.903	19567	151	6462	549	.113	17.1	730	62.0	85
8 16 HG	31	.150	13.63	705	13.813	8127	20	178	138	.077	1.5	14	10.6	23
9 C.T.	1041	.380	7.71	79	9.214	1907	233	159	5	.143	33.3	23	.8	0
SUM----------(CYCLE COMPOSITE)----------											3.1	36	6.8	
CYCLE 3														
1 IDLE	165	.440	13.91	83	14.528	1907	23	117	4	.232	5.4	27	.8	0
2 16 HG	36	.150	13.48	587	13.669	8127	23	180	116	.077	1.8	14	8.9	23
3 10 HG	34	.150	13.63	1412	13.817	12530	33	275	425	.147	4.9	40	62.5	48
4 16 HG	31	.150	13.63	633	13.813	8127	20	178	124	.077	1.5	14	9.5	23
5 19 HG	26	.130	13.72	330	13.878	6061	12	115	48	.057	.7	7	2.7	10
6 16 HG	31	.130	13.46	622	13.623	8127	20	157	123	.077	1.5	12	9.5	23
7 3 HG	114	2.380	13.18	1428	15.683	19567	154	5998	592	.113	17.4	678	66.8	85
8 16 HG	35	.160	13.52	725	13.718	8127	22	191	143	.077	1.7	15	11.0	23
9 C.T.	907	.360	7.67	82	9.010	1907	207	154	6	.143	29.6	22	.8	0
SUM----------(CYCLE COMPOSITE)----------											2.7	34	7.1	
CYCLE 4														
1 IDLE	165	.440	13.91	83	14.528	1907	23	117	4	.232	5.4	27	.8	0
2 16 HG	38	.150	13.77	597	13.961	8127	24	176	115	.077	1.8	14	8.9	23
3 10 HG	34	.150	13.91	1357	14.097	12530	33	269	400	.147	4.8	40	58.9	48
4 16 HG	31	.150	13.91	695	14.093	8127	19	175	133	.077	1.5	13	10.2	23
5 19 HG	26	.130	14.05	295	14.208	6061	12	112	42	.057	.7	6	2.4	10
6 16 HG	27	.130	13.80	689	13.959	8127	17	153	133	.077	1.3	12	10.3	23
7 3 HG	113	2.600	13.48	1362	16.202	19567	147	6343	546	.113	16.7	717	61.7	85
8 16 HG	35	.150	13.96	700	14.148	8127	22	174	133	.077	1.7	13	10.3	23
9 C.T.	910	.350	7.81	98	9.143	1907	205	147	7	.143	29.3	21	1.0	0
SUM----------(CYCLE COMPOSITE)----------											2.6	36	6.8	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------											3.2	37	7.0	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------											2.6	35	7.0	

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(3.2) + 0.65(2.6) = 2.825 (MASS)
CO 0.35(37) + 0.65(35) = 35.8 (MASS)
NO2 0.35(7.0) + 0.65(7.0) = 6.979 (MASS)
CORRECTED NO2 = 7.346 (MASS)

5-31-72 73 VERSION ENGINE 2-3 RUN-1 ARMY LAB K = .99 HUM = 72 GR/LB

	MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1															
	1 IDLE	228	.530	13.53	77	14.306	1907	33	143	3	.232	7.6	33	.8	0
	2 16 HG	39	.160	13.33	542	13.532	8127	25	194	108	.077	1.9	15	8.3	23
	3 10 HG	28	.160	13.48	1218	13.670	12530	28	296	371	.147	4.1	44	54.5	48
	4 16 HG	17	.190	13.48	643	13.688	8127	11	228	127	.077	.8	18	9.8	23
	5 19 HG	17	.120	13.50	265	13.638	6061	8	108	39	.057	.5	6	2.2	10
	6 16 HG	22	.160	13.46	612	13.644	8127	14	193	121	.077	1.1	15	9.3	23
	7 3 HG	97	2.280	13.25	1546	15.635	19567	131	5764	642	.113	14.8	651	72.6	85
	8 16 HG	30	.150	12.94	837	13.122	8127	20	188	172	.077	1.5	14	13.3	23
	9 C.T.	955	.440	7.41	85	8.881	1907	221	191	6	.143	31.7	27	.9	0
	SUM----------(CYCLE COMPOSITE)----------											2.7	34	7.1	
CYCLE 2															
	1 IDLE	228	.530	13.53	77	14.306	1907	33	143	3	.232	7.6	33	.8	0
	2 16 HG	35	.180	13.18	582	13.398	8127	23	221	117	.077	1.8	17	9.0	23
	3 10 HG	30	.150	13.18	1140	13.362	12530	30	284	355	.147	4.5	42	52.2	48
	4 16 HG	30	.150	13.02	505	13.202	8127	20	187	103	.077	1.5	14	7.9	23
	5 19 HG	16	.130	13.45	242	13.597	6061	8	117	36	.057	.4	7	2.0	10
	6 16 HG	17	.130	12.82	410	12.968	8127	12	165	85	.077	.9	13	6.6	23
	7 3 HG	107	2.190	13.45	1488	15.756	19567	144	5494	614	.113	16.2	621	69.3	85
	8 16 HG	35	.160	13.14	612	13.338	8127	23	197	124	.077	1.8	15	9.5	23
	9 C.T.	908	.450	6.91	59	8.341	1907	224	208	4	.143	32.1	30	.6	0
	SUM----------(CYCLE COMPOSITE)----------											2.8	33	6.5	
CYCLE 3															
	1 IDLE	75	.580	13.48	77	14.141	1907	11	158	3	.232	2.5	37	.8	0
	2 16 HG	53	.200	13.40	552	13.657	8127	34	240	109	.077	2.6	19	8.4	23
	3 10 HG	35	.150	12.48	628	12.668	12530	37	300	206	.147	5.5	44	30.3	48
	4 16 HG	35	.150	12.82	439	13.008	8127	24	189	91	.077	1.8	15	7.0	23
	5 19 HG	35	.130	13.20	251	13.368	6061	17	119	38	.057	1.0	7	2.2	10
	6 16 HG	30	.130	12.94	468	13.102	8127	20	163	96	.077	1.5	13	7.4	23
	7 3 HG	106	2.060	13.30	1605	15.474	19567	145	5262	674	.113	16.4	595	76.1	85
	8 16 HG	35	.200	13.48	752	13.718	8127	22	239	148	.077	1.7	18	11.4	23
	9 C.T.	867	.440	7.85	68	9.226	1907	194	184	5	.143	27.7	26	.7	0
	SUM----------(CYCLE COMPOSITE)----------											2.5	32	6.0	
CYCLE 4															
	1 IDLE	75	.580	13.48	77	14.141	1907	11	158	3	.232	2.5	37	.8	0
	2 16 HG	26	.210	13.18	613	13.418	8127	17	257	123	.077	1.3	20	9.5	23
	3 10 HG	21	.180	12.96	1069	13.163	12530	22	346	338	.147	3.2	51	49.7	48
	4 16 HG	16	.140	12.71	425	12.867	8127	11	179	89	.077	.8	14	6.9	23
	5 19 HG	13	.130	13.14	224	13.284	6061	6	120	34	.057	.4	7	1.9	10
	6 16 HG	17	.130	12.94	522	13.088	8127	11	163	108	.077	.9	13	8.3	23
	7 3 HG	89	2.080	13.18	1501	15.356	19567	122	5354	635	.113	13.8	605	71.8	85
	8 16 HG	26	.150	13.33	678	13.508	8127	17	182	135	.077	1.3	14	10.4	23
	9 C.T.	828	.430	7.73	67	9.054	1907	188	183	5	.143	26.9	26	.7	0
	SUM----------(CYCLE COMPOSITE)----------											2.1	33	6.6	
	AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------											2.7	33	6.8	
	AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------											2.3	32	6.3	

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(2.7) + 0.65(2.3) = 2.454 (MASS)
CO 0.35(33) + 0.65(32) = 32.7 (MASS)
NO2 0.35(6.8) + 0.65(6.3) = 6.482 (MASS)
CORRECTED NO2 = 6.416 (MASS)

5-31-72 73 VERSION ENGINE 2-3 RUN-2 ARMY LAB K = 1.00 HUM = 76 GR/LB

MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1														
1 IDLE	98	.460	13.77	90	14.336	1907	14	124	4	.232	3.3	29	.9	0
2 16 HG	43	.250	13.63	592	13.926	8127	27	295	115	.077	2.1	23	8.8	23
3 10 HG	31	.160	12.71	612	12.903	12530	33	314	197	.147	4.8	46	29.0	48
4 16 HG	25	.160	12.94	405	13.127	8127	17	200	83	.077	1.3	15	6.4	23
5 19 HG	18	.150	13.48	228	13.649	6061	9	135	34	.057	.5	8	1.9	10
6 16 HG	13	.150	13.06	420	13.224	8127	9	186	86	.077	.7	14	6.6	23
7 3 HG	89	2.310	13.63	1631	16.036	19567	117	5694	661	.113	13.3	643	74.7	85
8 16 HG	26	.210	13.63	720	13.868	8127	16	249	140	.077	1.3	19	10.8	23
9 C.T.	833	.460	7.43	88	8.790	1907	195	202	6	.143	27.9	29	.9	0
SUM----------(CYCLE COMPOSITE)----------											2.3	34	5.8	
CYCLE 2														
1 IDLE	98	.460	13.77	90	14.336	1907	14	124	4	.232	3.3	29	.9	0
2 16 HG	40	.210	13.77	586	14.023	8127	25	246	113	.077	1.9	19	8.7	23
3 10 HG	31	.160	13.18	890	13.373	12530	31	303	277	.147	4.6	45	40.7	48
4 16 HG	26	.150	13.18	464	13.358	8127	17	184	94	.077	1.3	14	7.2	23
5 19 HG	26	.140	13.48	230	13.648	6061	12	126	34	.057	.7	7	1.9	10
6 16 HG	22	.160	13.48	568	13.664	8127	14	192	112	.077	1.1	15	8.6	23
7 3 HG	102	2.160	13.77	1482	16.040	19567	134	5323	600	.113	15.2	601	67.8	85
8 16 HG	35	.220	13.67	754	13.928	8127	22	259	146	.077	1.7	20	11.2	23
9 C.T.	831	.430	7.78	95	9.107	1907	188	182	7	.143	26.9	26	.9	0
SUM----------(CYCLE COMPOSITE)----------											2.3	32	6.1	
CYCLE 3														
1 IDLE	281	1.140	13.77	90	15.213	1907	38	289	4	.232	8.8	67	.9	0
2 16 HG	44	.210	13.77	567	14.028	8127	28	246	109	.077	2.1	19	8.4	23
3 10 HG	13	.160	12.74	552	12.914	12530	14	314	178	.147	2.0	46	26.1	48
4 16 HG	18	.150	13.18	405	13.349	8127	12	184	82	.077	.9	14	6.3	23
5 19 HG	12	.150	13.63	251	13.793	6061	6	133	37	.057	.3	8	2.1	10
6 16 HG	13	.150	13.33	517	13.494	8127	8	182	103	.077	.7	14	8.0	23
7 3 HG	89	1.430	13.58	1521	15.106	19567	125	3742	654	.113	14.1	423	73.9	85
8 16 HG	25	.210	13.77	784	14.007	8127	16	246	151	.077	1.2	19	11.6	23
9 C.T.	831	.430	7.72	103	9.047	1907	189	183	7	.143	27.1	26	1.0	0
SUM----------(CYCLE COMPOSITE)----------											2.4	26	5.7	
CYCLE 4														
1 IDLE	281	1.140	13.77	90	15.213	1907	38	289	4	.232	8.8	67	.9	0
2 16 HG	80	.250	13.48	597	13.816	8127	51	297	117	.077	3.9	23	9.0	23
3 10 HG	26	.210	13.48	1117	13.718	12530	26	387	339	.147	3.8	57	49.8	48
4 16 HG	21	.180	13.22	508	13.423	8127	14	220	102	.077	1.1	17	7.9	23
5 19 HG	21	.150	13.77	251	13.943	6061	10	132	36	.057	.6	8	2.1	10
6 16 HG	26	.210	13.75	663	13.988	8127	16	246	128	.077	1.3	19	9.8	23
7 3 HG	98	2.470	13.48	1314	16.056	19567	129	6081	532	.113	14.6	687	60.1	85
8 16 HG	34	.250	13.77	780	14.057	8127	21	292	150	.077	1.6	22	11.5	23
9 C.T.	794	.430	7.05	95	8.338	1907	196	199	7	.143	28.0	28	1.0	0
SUM----------(CYCLE COMPOSITE)----------											2.6	38	6.3	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------											2.3	33	6.0	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------											2.5	32	6.0	

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(2.3) + 0.65(2.5) = 2.435 (MASS)
CO 0.35(33) + 0.65(32) = 32.7 (MASS)
NO2 0.35(6.0) + 0.65(6.0) = 5.995 (MASS)
CORRECTED NO2 = 6.012 (MASS)

ENGINE 2-3

EXPERIMENTAL 23 MODE RESULTS

1972 STANDARD ENGINE

1973 CALIFORNIA VERSION OF ENGINE

PROJECT 11-2877-01 CONTROL TECHNOLOGY

6-15-72 RUN 1 1972 VERSION OF ENGINE 2-3 PER MANUF. SPECS.

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.2	4.2	15.2	0	2093	.740	13.48	50
2	1200	4.6	1	19.8	6.5	15.7	0	914	.100	13.77	54
3	1200	18.4	4	19.0	7.5	15.5	0	424	.180	14.05	126
4	1200	41.4	9	17.4	8.5	15.7	0	1095	.130	13.77	345
5	1200	57.5	13	16.5	10.2	15.9	0	1441	.130	13.48	765
6	1200	115.0	26	9.2	15.5	17.2	0	812	.130	12.82	888
7	1200	172.5	39	5.2	21.0	15.5	0	1333	.150	13.91	2188
8	1200	188.6	43	3.4	22.5	15.5	0	1380	.280	13.91	2138
9	1200	211.6	48	1.1	24.2	15.2	0	1474	.390	14.05	2400
10	1200	230.0	53	0.0	32.2	12.6	0	2858	5.610	11.13	950
11	600	0.0	0	18.5	4.0	14.6	0	2275	1.520	13.33	53
12	1200	0.0	0	22.2	3.7	16.0	0	51707	.700	7.65	11
13	2300	260.0	114	0.0	64.5	12.1	0	3118	6.500	10.25	1000
14	2300	239.2	105	3.0	51.0	13.5	0	2435	2.970	12.82	1500
15	2300	213.2	93	4.4	44.5	14.5	0	1865	1.380	13.48	2400
16	2300	195.0	85	5.8	42.0	14.6	0	1726	1.300	13.33	2200
17	2300	130.0	57	9.4	31.2	16.8	0	554	.150	12.71	1700
18	2300	65.0	28	15.7	19.8	16.8	0	532	.150	12.82	1363
19	2300	46.8	20	17.2	17.0	16.8	0	418	.150	12.82	766
20	2300	20.8	9	19.6	13.0	16.4	0	228	.150	13.18	285
21	2300	5.2	2	21.0	10.7	16.3	0	197	.130	13.33	165
22	600	0.0	0	18.0	3.6	15.1	0	1834	.670	13.63	47
23	2300	0.0	0	24.0	4.0	17.8	0	30068	.350	8.68	8

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	27.6	197	2.2	.070	0.0	I	R	R	R
2	0.0	19.3	43	3.8	.060	.1	0.0	18.36	40.6	3.6
3	0.0	10.1	87	10.0	.060	.3	0.0	2.41	20.6	2.4
4	0.0	30.1	72	31.5	.050	.5	0.0	3.19	7.6	3.3
5	0.0	48.5	88	85.4	.030	1.1	0.0	1.35	2.5	2.4
6	0.0	43.8	142	159.1	.060	1.6	0.0	1.67	5.4	6.1
7	0.0	89.5	203	487.5	0.000	0.0	0.0	2.27	5.2	12.4
8	0.0	98.3	403	505.6	.040	1.7	0.0	2.28	9.3	11.7
9	0.0	110.9	593	599.6	0.000	0.0	0.0	2.29	12.3	12.4
10	0.0	245.2	9722	270.6	0.000	0.0	0.0	4.67	185.0	5.1
11	0.0	27.4	369	2.1	.070	0.0	I	R	R	R
12	0.0	641.8	176	.5	.120	0.0	I	R	R	R
13	0.0	534.7	22515	569.3	.025	2.8	0.0	4.70	197.7	5.0
14	0.0	351.4	8656	718.5	.055	5.8	0.0	3.35	82.6	6.9
15	0.0	250.3	3740	1068.9	.035	3.3	0.0	2.68	40.1	11.4
16	0.0	222.1	3380	940.0	.060	5.1	0.0	2.60	39.6	11.0
17	0.0	60.7	332	618.5	.060	3.4	0.0	1.07	5.8	10.9
18	0.0	36.7	209	312.1	0.000	0.0	0.0	1.29	7.3	11.0
19	0.0	24.8	180	150.7	.065	1.3	0.0	1.21	8.8	7.4
20	0.0	10.1	134	41.8	0.000	0.0	0.0	1.11	14.7	4.6
21	0.0	7.1	95	19.7	0.000	0.0	0.0	3.11	41.5	8.7
22	0.0	20.7	153	1.8	.080	0.0	I	R	R	R
23	0.0	453.2	107	.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	6.726	GRAM/BHP HR
	CO	56.555	GRAM/BHP HR
	NO2	8.535	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.610	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

6-16-72 RUN 1 1972 VERSION OF ENGINE 2-3 PER MANUF. SPECS.

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.1	4.0	15.5	0	2166	.580	12.94	43
2	1200	4.6	1	19.6	7.3	16.0	0	355	.130	13.63	63
3	1200	18.4	4	18.5	7.6	16.2	0	618	.130	13.33	140
4	1200	41.4	9	17.3	8.7	16.3	0	1146	.130	13.18	365
5	1200	57.5	13	16.0	9.9	16.5	0	1300	.130	12.94	570
6	1200	115.0	26	9.0	16.3	16.7	0	773	.130	12.94	875
7	1200	172.5	39	4.7	20.7	15.5	0	1130	.130	13.91	1925
8	1200	188.6	43	3.0	22.7	15.5	0	1289	.180	13.91	2050
9	1200	211.6	48	1.5	24.6	15.2	0	1484	.470	13.91	2150
10	1200	230.0	53	0.0	32.0	12.6	0	2711	5.500	11.13	900
11	600	0.0	0	18.7	3.6	14.1	0	2402	2.500	13.06	48
12	1200	0.0	0	22.4	4.0	15.9	0	50691	.930	7.56	9
13	2300	260.0	114	0.0	65.0	14.7	0	3410	6.440	10.43	938
14	2300	239.2	105	2.6	50.2	13.6	0	2406	2.690	13.06	1550
15	2300	213.2	93	4.3	45.0	14.5	0	1662	1.300	13.63	2387
16	2300	195.0	85	5.2	42.6	14.6	0	1547	1.270	13.63	2225
17	2300	130.0	57	9.2	31.5	16.7	0	437	.130	12.94	1625
18	2300	65.0	28	15.4	19.9	16.7	0	538	.150	12.82	1300
19	2300	46.8	20	17.0	17.2	16.6	0	409	.130	12.82	700
20	2300	20.8	9	19.1	13.3	16.5	0	242	.100	13.33	305
21	2300	5.2	2	20.5	11.5	16.4	0	188	.100	13.18	155
22	600	0.0	0	18.4	3.7	15.2	0	1726	.770	13.48	51
23	2300	0.0	0	24.1	3.9	17.7	0	40794	.390	7.56	11

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	28.6	155	1.9	.070	0.0	I	R	R	R
2	0.0	8.5	63	5.0	.060	.1	0.0	8.11	60.0	4.8
3	0.0	15.8	67	11.8	.060	.3	0.0	3.75	15.9	2.8
4	0.0	33.7	77	35.6	.050	.5	0.0	3.56	8.2	3.8
5	0.0	44.2	89	64.4	.030	.4	0.0	3.37	6.8	4.9
6	0.0	43.5	148	163.4	.060	1.6	0.0	1.66	5.6	6.2
7	0.0	75.0	174	424.0	0.000	0.0	0.0	1.90	4.4	10.8
8	0.0	93.3	263	492.9	.040	1.7	0.0	2.17	6.1	11.4
9	0.0	114.0	729	548.2	0.000	0.0	0.0	2.36	15.1	11.3
10	0.0	232.9	9542	256.6	0.000	0.0	0.0	4.43	181.6	4.9
11	0.0	24.8	522	1.6	.070	0.0	I	R	R	R
12	0.0	678.3	251	.4	.120	0.0	I	R	R	R
13	0.0	584.2	22285	533.2	.025	2.8	0.0	5.13	195.7	4.7
14	0.0	342.6	7738	732.8	.055	5.8	0.0	3.27	73.9	7.0
15	0.0	224.7	3551	1071.8	.035	3.3	0.0	2.41	38.0	11.5
16	0.0	198.6	3293	948.2	.060	5.1	0.0	2.33	38.6	11.1
17	0.0	47.6	286	587.8	.060	3.4	0.0	.84	5.0	10.3
18	0.0	37.3	210	299.1	0.000	0.0	0.0	1.31	7.4	10.5
19	0.0	24.5	158	139.6	.065	1.3	0.0	1.20	7.7	6.8
20	0.0	10.8	91	45.4	0.000	0.0	0.0	1.19	9.9	5.0
21	0.0	7.4	79	20.2	0.000	0.0	0.0	3.24	34.8	8.9
22	0.0	20.1	181	2.0	.080	0.0	I	R	R	R
23	0.0	599.9	116	.5	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	7.291	GRAM/BHP HR
	CO	55.839	GRAM/BHP HR
	NO2	8.658	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.632	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

6-13-72 RUN 1 1973 CALIFORNIA VERSION OF ENGINE 2-3 PER MANUF. SPECS.

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.5	4.7	15.9	0	3503	.550	12.71	35
2	1200	4.0	1	19.2	7.9	16.2	0	292	.130	13.33	64
3	1200	17.0	4	18.5	8.4	16.4	0	269	.130	12.94	88
4	1200	39.0	9	16.4	10.1	16.6	0	67	.130	12.94	182
5	1200	54.0	12	15.0	10.9	16.4	0	953	.130	12.94	340
6	1200	108.0	25	9.5	15.9	16.2	0	919	.150	12.94	810
7	1200	161.0	37	5.5	21.7	14.9	0	1063	.670	13.48	1375
8	1200	177.0	40	3.5	22.7	14.9	0	974	.740	13.63	1500
9	1200	198.0	45	2.7	24.6	14.8	0	995	.670	13.48	1700
10	1200	222.0	51	0.0	32.5	12.3	0	3004	5.780	11.01	750
11	600	0.0	0	18.5	4.7	15.3	0	2165	.850	12.94	44
12	1200	0.0	0	22.0	3.8	17.2	0	52436	.470	6.64	8
13	2300	250.0	109	0.0	64.8	12.2	0	2978	6.020	10.66	865
14	2300	236.0	103	3.0	51.2	12.8	0	2508	4.540	11.72	825
15	2300	210.0	92	4.9	48.5	13.6	0	2194	2.480	12.94	1400
16	2300	192.0	84	6.0	46.5	13.7	0	2282	2.280	12.94	1512
17	2300	128.0	56	10.0	31.2	15.9	0	528	.180	13.18	1575
18	2300	64.0	28	15.3	21.4	15.8	0	489	.210	13.33	825
19	2300	46.0	20	15.6	18.3	16.2	0	230	.150	13.18	360
20	2300	21.0	9	18.7	15.4	16.1	0	157	.130	13.33	215
21	2300	5.0	2	20.5	12.7	16.1	0	135	.130	13.18	150
22	600	0.0	0	18.0	4.7	15.6	0	2478	.610	13.06	44
23	2300	0.0	0	24.7	3.9	17.2	0	37922	.420	7.94	9

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	54.9	174	1.8	.070	0.0	I	R	R	R
2	0.0	7.8	70	5.6	.060	.1	0.0	8.50	76.3	6.2
3	0.0	7.8	76	8.5	.060	.2	0.0	2.01	19.7	2.2
4	0.0	2.4	92	21.2	.050	.4	0.0	.26	10.3	2.4
5	0.0	35.8	99	42.4	.030	.4	0.0	2.90	8.0	3.4
6	0.0	50.3	166	147.1	.060	1.5	0.0	2.04	6.7	6.0
7	0.0	73.4	934	315.2	0.000	0.0	0.0	2.00	25.4	8.6
8	0.0	69.3	1064	354.4	.040	1.6	0.0	1.71	26.3	8.8
9	0.0	77.9	1060	442.0	0.000	0.0	0.0	1.72	23.4	9.8
10	0.0	259.1	10071	214.8	0.000	0.0	0.0	5.11	198.6	4.2
11	0.0	33.0	261	2.2	.070	0.0	I	R	R	R
12	0.0	731.6	132	.4	.120	0.0	I	R	R	R
13	0.0	515.6	21053	497.2	.025	2.7	0.0	4.71	192.3	4.5
14	0.0	352.8	12900	385.3	.055	5.7	0.0	3.41	124.8	3.7
15	0.0	308.6	7047	653.8	.035	3.2	0.0	3.36	76.6	7.1
16	0.0	311.5	6288	685.6	.060	5.0	0.0	3.70	74.8	8.2
17	0.0	55.7	384	551.7	.060	3.4	0.0	.99	6.8	9.8
18	0.0	35.0	303	195.7	0.000	0.0	0.0	1.25	10.8	7.0
19	0.0	14.3	188	74.3	.065	1.3	0.0	.71	9.4	3.7
20	0.0	8.2	136	37.0	0.000	0.0	0.0	.89	14.8	4.0
21	0.0	5.8	114	21.5	0.000	0.0	0.0	2.66	51.9	9.8
22	0.0	38.0	189	2.2	.080	0.0	I	R	R	R
23	0.0	552.0	124	.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	7.984	GRAM/BHP HR
	CO	79.529	GRAM/BHP HR
	NO2	6.349	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.680	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

6-13-72 RUN 2 1973 CALIFORNIA VERSION OF ENGINE 2-3 PER MANUF. SPECS.

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.5	4.7	15.2	0	3162	.930	13.06	40
2	1200	4.0	1	19.2	7.9	15.6	0	215	.130	13.91	73
3	1200	17.0	4	18.5	8.4	16.1	0	474	.130	13.77	116
4	1200	39.0	9	16.5	10.1	16.2	0	822	.130	13.48	250
5	1200	54.0	12	15.2	10.9	16.3	0	1033	.130	13.18	400
6	1200	108.0	25	10.0	15.9	16.4	0	1011	.130	13.18	830
7	1200	161.0	37	5.6	21.7	14.9	0	1394	.640	13.77	1425
8	1200	177.0	40	3.5	22.7	15.0	0	1269	.610	13.77	1500
9	1200	198.0	45	2.9	24.6	14.8	0	1452	.580	13.91	1725
10	1200	222.0	51	0.0	32.5	12.5	0	3089	5.240	11.24	775
11	600	0.0	0	18.3	4.7	14.8	0	2719	1.300	13.06	42
12	1200	0.0	0	22.0	3.8	9.0	0	55420	.470	6.64	6
13	2300	252.0	110	0.0	64.8	12.3	0	2862	5.780	10.89	900
14	2300	236.0	103	3.3	51.2	13.1	0	2503	3.790	12.22	875
15	2300	210.0	92	5.0	48.5	13.7	0	2242	2.360	13.18	1425
16	2300	192.0	84	6.0	46.5	13.8	0	2170	2.180	13.18	1563
17	2300	128.0	56	10.0	31.2	16.0	0	455	.150	13.33	1625
18	2300	64.0	28	15.2	21.4	16.1	0	382	.150	13.18	680
19	2300	46.0	20	16.9	18.3	16.3	0	225	.130	13.18	350
20	2300	21.0	9	18.9	15.4	16.2	0	124	.100	13.33	154
21	2300	5.0	2	20.5	12.7	16.4	0	101	.070	13.18	98
22	600	0.0	0	12.9	4.7	15.4	0	2928	.700	12.94	38
23	2300	0.0	0	23.9	3.9	18.7	0	35258	.350	7.75	9

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	47.1	280	2.0	.070	0.0	I	R	R	R
2	0.0	5.5	67	6.1	.060	.1	0.0	5.99	73.2	6.7
3	0.0	12.9	72	10.5	.060	.2	0.0	3.33	18.5	2.7
4	0.0	27.5	88	27.8	.050	.4	0.0	3.09	9.9	3.1
5	0.0	38.1	97	49.0	.030	.4	0.0	3.09	7.8	4.0
6	0.0	54.4	141	148.2	.060	1.5	0.0	2.20	5.7	6.0
7	0.0	94.3	875	320.1	0.000	0.0	0.0	2.56	23.8	8.7
8	0.0	90.1	875	353.5	.040	1.6	0.0	2.23	21.6	8.7
9	0.0	110.7	893	436.7	0.000	0.0	0.0	2.45	19.7	9.7
10	0.0	271.2	9294	225.9	0.000	0.0	0.0	5.35	183.2	4.5
11	0.0	39.6	383	2.0	.070	0.0	I	R	R	R
12	0.0	755.0	129	.3	.120	0.0	I	R	R	R
13	0.0	496.2	20239	518.0	.025	2.8	0.0	4.50	183.4	4.7
14	0.0	357.5	10935	414.9	.055	5.7	0.0	3.46	105.8	4.0
15	0.0	312.8	6653	660.2	.035	3.2	0.0	3.40	72.3	7.2
16	0.0	293.8	5963	702.4	.060	5.0	0.0	3.49	70.9	8.4
17	0.0	47.7	317	564.5	.060	3.4	0.0	.85	5.7	10.1
18	0.0	27.7	220	163.9	0.000	0.0	0.0	.99	7.9	5.8
19	0.0	14.0	163	72.3	.065	1.3	0.0	.69	8.1	3.6
20	0.0	6.4	105	26.5	0.000	0.0	0.0	.70	11.4	2.9
21	0.0	4.4	61	14.1	0.000	0.0	0.0	2.00	28.1	6.4
22	0.0	44.8	216	1.9	.080	0.0	I	R	R	R
23	0.0	536.5	108	.5	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	8.105	GRAM/BHP HR
	CO	73.193	GRAM/BHP HR
	NO2	6.527	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.679	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY
6-15-72 RUN 1 1973 CALIFORNIA VERSION OF ENGINE 2-3 PER MANUF. SPECS.

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.8	4.2	15.7	0	3947	.640	13.18	37
2	1200	4.3	1	19.5	7.4	15.9	0	407	.100	14.05	60
3	1200	17.2	4	19.4	7.5	15.6	0	815	.130	14.18	60
4	1200	38.7	9	16.7	9.5	16.4	0	889	.130	13.48	219
5	1200	53.8	12	15.5	10.8	16.4	0	957	.100	13.48	280
6	1200	107.5	25	10.5	15.9	16.3	0	1036	.100	13.48	735
7	1200	161.0	37	5.4	22.5	15.0	0	1339	.700	13.91	1275
8	1200	177.0	40	3.4	23.2	15.1	0	1215	.640	14.05	1438
9	1200	197.8	45	2.6	24.2	14.8	0	1604	.490	14.42	1775
10	1200	222.0	51	0.0	32.2	12.6	0	3323	5.140	11.72	763
11	600	0.0	0	18.3	4.3	15.1	0	3400	.930	13.48	43
12	1200	0.0	0	22.0	3.8	17.3	0	53928	.470	6.64	7
13	2300	258.0	113	0.0	66.5	12.4	0	3179	5.720	11.13	963
14	2300	235.0	103	3.0	53.0	13.4	0	2926	3.240	12.71	1150
15	2300	209.9	92	4.7	47.0	13.9	0	2917	1.940	13.63	1688
16	2300	192.0	84	5.9	44.5	14.0	0	2715	1.840	13.63	1675
17	2300	128.0	56	9.8	32.5	16.0	0	934	.130	13.48	1537
18	2300	64.0	28	15.5	21.2	16.1	0	574	.150	13.48	838
19	2300	46.0	20	17.0	18.5	16.1	0	377	.100	13.48	500
20	2300	21.0	9	19.0	15.2	16.2	0	202	.070	13.33	245
21	2300	5.0	2	20.2	12.2	16.2	0	200	.050	13.48	129
22	600	0.0	0	18.0	3.8	15.6	0	2481	.470	13.33	43
23	2300	0.0	0	24.0	4.0	17.8	0	33506	.310	8.43	7

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	52.9	173	1.6	.070	0.0	I	R	R	R
2	0.0	9.6	48	4.8	.060	.1	0.0	9.80	48.6	4.8
3	0.0	19.3	62	4.7	.060	.2	0.0	4.90	15.8	1.2
4	0.0	28.0	83	22.8	.050	.4	0.0	3.16	9.3	2.6
5	0.0	34.3	72	33.3	.030	.4	0.0	2.79	5.9	2.7
6	0.0	54.6	106	128.6	.060	1.5	0.0	2.22	4.3	5.2
7	0.0	92.7	979	293.0	0.000	0.0	0.0	2.52	26.6	8.0
8	0.0	86.4	919	339.1	.040	1.6	0.0	2.14	22.7	8.4
9	0.0	116.9	721	429.2	0.000	0.0	0.0	2.59	16.0	9.5
10	0.0	282.3	8821	215.1	0.000	0.0	0.0	5.57	173.9	4.2
11	0.0	45.0	248	1.9	.070	0.0	I	R	R	R
12	0.0	743.5	131	.3	.120	0.0	I	R	R	R
13	0.0	558.5	20301	561.5	.025	2.8	0.0	4.94	179.7	5.0
14	0.0	433.1	9687	565.1	.055	5.7	0.0	4.21	94.1	5.5
15	0.0	392.1	5267	753.0	.035	3.2	0.0	4.27	57.3	8.2
16	0.0	348.1	4766	713.1	.060	5.0	0.0	4.14	56.7	8.5
17	0.0	100.5	283	549.1	.060	3.4	0.0	1.79	5.0	9.8
18	0.0	40.3	213	195.3	0.000	0.0	0.0	1.44	7.6	7.0
19	0.0	23.2	124	102.3	.065	1.3	0.0	1.15	6.2	5.1
20	0.0	10.4	73	41.8	0.000	0.0	0.0	1.13	7.9	4.5
21	0.0	8.2	41	17.5	0.000	0.0	0.0	3.73	18.8	8.0
22	0.0	30.4	116	1.7	.080	0.0	I	R	R	R
23	0.0	502.8	94	.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	8.569	GRAM/BHP HR
	CO	64.484	GRAM/BHP HR
	NO2	6.960	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.672	LB/BHP HR

APPENDIX H

ENGINE 2-3

EFFECT OF TIMING ON EMISSIONS

(23 MODE MASS RESULTS)

ENGINE 2-3

EFFECT OF TIMING ON EMISSIONS

TABULAR DATA

PROJECT 11-2877-01 CONTROL TECHNOLOGY

6-16-72 RUN 3 1972 VERSION OF ENGINE 2-3 TIMING 25 BTDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	750	0.0	0	20.0	3.8	13.5	0	13943	.640	11.84	58
2	1200	5.0	1	20.6	5.7	15.6	0	9639	.350	12.71	68
3	1200	20.0	5	19.5	6.9	15.6	0	1355	.180	13.77	163
4	1200	46.0	11	18.0	8.0	15.7	0	2170	.130	13.63	1075
5	1200	64.0	15	16.5	9.8	15.9	0	2305	.100	13.33	2262
6	1200	128.0	29	10.1	14.8	17.0	0	2009	.100	12.47	3150
7	1200	192.0	44	6.0	20.5	15.3	0	2342	.130	13.77	4200
8	1200	210.0	48	4.0	21.2	14.9	0	2462	.520	13.77	3200
9	1200	236.0	54	1.8	24.5	14.8	0	2397	.520	13.33	3000
10	1200	256.0	58	.3	32.2	12.6	0	3878	5.560	10.55	1675
11	750	0.0	0	20.8	3.6	14.4	0	3234	1.520	13.06	71
12	1200	0.0	0	22.4	3.7	19.3	0	33600	1.090	8.93	13
13	2300	266.0	116	.4	64.2	12.1	0	3640	6.570	10.25	1387
14	2300	245.0	107	2.4	50.0	13.8	0	2457	2.480	12.94	2175
15	2300	218.0	95	4.4	44.5	14.5	0	2092	1.450	13.33	3500
16	2300	200.0	88	5.8	41.2	14.6	0	2022	1.340	13.33	3550
17	2300	133.0	58	10.1	29.8	16.6	0	1064	.210	12.71	4200
18	2300	67.0	29	15.7	19.0	16.6	0	1024	.210	12.71	2650
19	2300	48.0	21	17.7	15.5	16.4	0	841	.180	12.94	1350
20	2300	21.0	9	20.0	13.2	16.4	0	1121	.180	12.94	520
21	2300	5.0	2	21.2	9.2	16.4	0	9244	.210	12.09	113
22	750	0.0	0	20.2	3.6	15.1	0	3729	.890	13.18	44
23	2300	0.0	0	24.1	4.2	17.4	0	55463	.470	6.73	8

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	173.2	161	2.4	.070	0.0	I	R	R	R
2	0.0	177.7	130	4.2	.060	.1	0.0	155.55	114.1	3.6
3	0.0	30.1	81	12.0	.060	.3	0.0	6.59	17.7	2.6
4	0.0	56.3	68	92.7	.050	.5	0.0	5.36	6.5	8.8
5	0.0	75.0	66	244.4	.030	.4	0.0	5.13	4.5	16.7
6	0.0	105.6	106	549.7	.060	1.8	0.0	3.61	3.6	18.8
7	0.0	154.1	173	917.4	0.000	0.0	0.0	3.51	3.9	20.9
8	0.0	162.9	695	702.8	.040	1.9	0.0	3.40	14.5	14.6
9	0.0	189.1	828	785.6	0.000	0.0	0.0	3.51	15.4	14.6
10	0.0	343.3	9943	492.3	0.000	0.0	0.0	5.87	170.0	8.4
11	0.0	35.4	336	2.6	.070	0.0	I	R	R	R
12	0.0	421.5	276	.6	.120	0.0	I	R	R	R
13	0.0	616.9	22491	780.6	.025	2.9	0.0	5.30	193.1	6.7
14	0.0	355.7	7253	1045.4	.055	5.9	0.0	3.31	67.6	9.7
15	0.0	281.7	3944	1564.8	.035	3.3	0.0	2.95	41.3	16.4
16	0.0	254.0	3401	1481.0	.060	5.3	0.0	2.90	38.8	16.9
17	0.0	110.4	440	1447.0	.060	3.5	0.0	1.89	7.6	24.8
18	0.0	67.8	281	582.3	0.000	0.0	0.0	2.31	9.6	19.8
19	0.0	44.8	194	238.7	.065	1.4	0.0	2.13	9.2	11.4
20	0.0	50.7	165	78.1	0.000	0.0	0.0	5.52	17.9	8.5
21	0.0	291.7	134	11.8	0.000	0.0	0.0	133.23	61.1	5.4
22	0.0	42.2	203	1.7	.080	0.0	I	R	R	R
23	0.0	829.0	142	.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	8.010	GRAM/BHP HR
	CO	54.573	GRAM/BHP HR
	NO2	14.589	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.582	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

6-16-72 RUN 2 1972 VERSION OF ENGINE 2-3 TIMING 16 BTDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	735	0.0	0	19.8	3.8	15.5	0	2487	.640	13.48	41
2	1200	5.0	1	21.0	5.9	15.8	0	1779	.210	13.77	58
3	1200	20.0	5	19.2	7.2	15.6	0	815	.150	14.05	130
4	1200	45.0	10	18.0	8.3	15.6	0	1943	.130	13.91	900
5	1200	63.0	14	16.5	9.9	15.8	0	2166	.100	13.77	1600
6	1200	126.0	29	10.4	15.1	14.6	0	1819	.100	13.18	2800
7	1200	189.0	43	6.4	19.9	15.2	0	2155	.180	14.31	3300
8	1200	207.0	47	4.3	21.4	15.4	0	2014	.150	14.05	3850
9	1200	232.0	53	2.0	23.7	15.3	0	2014	.150	14.05	4150
10	1200	252.0	58	.1	32.3	12.6	0	3607	5.670	11.01	1500
11	735	0.0	0	20.3	3.7	14.8	0	2159	1.090	13.63	52
12	1200	0.0	0	22.4	3.8	16.1	0	40248	.890	8.60	11
13	2300	265.0	116	.3	66.0	11.9	0	6005	6.640	10.09	1275
14	2300	244.0	107	2.7	49.5	14.3	0	2309	1.700	13.48	2750
15	2300	217.0	95	4.5	44.0	14.6	0	2056	1.380	13.33	3300
16	2300	199.0	87	6.2	41.6	14.7	0	1999	1.230	13.48	3400
17	2300	133.0	58	10.0	29.7	16.7	0	973	.150	12.59	3650
18	2300	66.0	29	15.9	19.5	16.8	0	929	.150	12.71	2300
19	2300	48.0	21	17.6	16.7	16.7	0	750	.150	12.71	1450
20	2300	21.0	9	20.1	12.6	16.5	0	426	.150	12.94	470
21	2300	5.0	2	21.1	9.4	16.6	0	1678	.150	12.71	155
22	735	0.0	0	19.9	3.5	15.4	0	2087	.670	13.18	48
23	2300	0.0	0	24.0	4.4	17.5	0	51730	.470	6.73	7

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	29.8	155	1.7	.070	0.0	I	R	R	R
2	0.0	33.6	80	3.6	.060	.1	0.0	29.43	70.2	3.2
3	0.0	18.6	69	9.9	.060	.3	0.0	4.08	15.2	2.2
4	0.0	51.4	69	79.0	.050	.5	0.0	5.00	6.8	7.7
5	0.0	69.1	64	169.3	.030	.4	0.0	4.80	4.5	11.8
6	0.0	92.6	103	473.0	.060	1.7	0.0	3.21	3.6	16.4
7	0.0	132.3	223	672.5	0.000	0.0	0.0	3.06	5.2	15.6
8	0.0	135.7	204	861.6	.040	1.9	0.0	2.87	4.3	18.2
9	0.0	150.3	226	1028.5	0.000	0.0	0.0	2.84	4.3	19.4
10	0.0	310.1	9847	428.2	0.000	0.0	0.0	5.39	171.0	7.4
11	0.0	24.3	247	1.9	.070	0.0	I	R	R	R
12	0.0	513.3	229	.5	.120	0.0	I	R	R	R
13	0.0	1037.3	23170	731.2	.025	2.9	0.0	8.94	199.7	6.3
14	0.0	336.5	5003	1330.2	.055	5.9	0.0	3.15	46.8	12.4
15	0.0	275.1	3730	1466.0	.035	3.3	0.0	2.90	39.3	15.4
16	0.0	253.1	3144	1428.6	.060	5.2	0.0	2.90	36.1	16.4
17	0.0	102.1	318	1271.7	.060	3.5	0.0	1.75	5.5	21.8
18	0.0	63.4	207	521.4	0.000	0.0	0.0	2.19	7.2	18.0
19	0.0	43.9	177	281.9	.065	1.4	0.0	2.09	8.4	13.4
20	0.0	18.5	132	67.9	0.000	0.0	0.0	2.02	14.3	7.4
21	0.0	54.9	99	16.8	0.000	0.0	0.0	25.09	45.3	7.7
22	0.0	23.6	153	1.8	.080	0.0	I	R	R	R
23	0.0	834.4	153	.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	7.908	GRAM/BHP HR
	CO	48.339	GRAM/BHP HR
	NO2	14.621	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.593	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

6-19-72 RUN 2 ENG. 2-3, 1972 VERSION, TIMING 4 ATDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	680	0.0	0	16.6	5.5	15.3	0	921	.440	14.05	78
2	1200	3.6	1	18.5	7.6	15.4	0	233	.180	14.53	93
3	1200	14.5	3	18.0	7.9	16.1	0	387	.130	13.77	107
4	1200	33.0	8	16.1	9.6	16.2	0	664	.100	13.48	227
5	1200	46.0	11	15.4	10.5	16.4	0	721	.100	13.63	300
6	1200	91.0	21	18.0	17.1	16.1	0	282	.100	13.91	570
7	1200	137.0	31	4.6	21.5	15.2	0	534	.150	14.66	1150
8	1200	149.0	34	3.0	22.9	15.1	0	677	.310	14.53	1200
9	1200	167.0	38	1.7	24.5	15.1	0	774	.390	14.53	1350
10	1200	182.0	42	.3	32.1	12.6	0	2214	5.450	11.60	630
11	680	0.0	0	17.3	5.1	14.9	0	1055	.640	14.53	82
12	1200	0.0	0	20.9	5.8	15.9	0	25491	.700	11.01	19
13	2300	222.0	97	.7	64.3	12.1	0	2716	6.310	10.55	590
14	2300	204.0	89	2.6	50.5	13.6	0	1805	2.870	12.94	963
15	2300	182.0	80	4.4	44.5	14.4	0	883	1.340	13.77	1438
16	2300	167.0	73	5.1	43.2	14.4	0	840	1.410	13.63	1300
17	2300	111.0	49	8.8	31.6	16.4	0	120	.070	12.94	975
18	2300	56.0	25	16.0	19.3	16.4	0	181	.100	12.94	720
19	2300	40.0	18	17.4	17.5	16.6	0	136	.100	12.94	425
20	2300	18.0	8	19.2	13.0	16.4	0	72	.100	13.18	200
21	2300	44.0	19	20.7	10.5	16.1	0	104	.070	13.48	102
22	680	0.0	0	16.5	4.8	15.5	0	440	.180	13.77	83
23	2300	0.0	0	23.6	5.7	17.4	0	27427	.390	8.93	12

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	15.8	152	4.4	.070	0.0	I	R	R	R
2	0.0	5.4	85	7.2	.060	.0	0.0	6.63	103.4	8.7
3	0.0	9.9	68	9.2	.060	.2	0.0	3.00	20.4	2.8
4	0.0	21.2	64	24.1	.050	.4	0.0	2.81	8.5	3.2
5	0.0	24.9	70	34.4	.030	.3	0.0	2.37	6.6	3.3
6	0.0	15.6	112	104.6	.060	1.2	0.0	.75	5.4	5.0
7	0.0	35.1	199	250.5	0.000	0.0	0.0	1.12	6.4	8.0
8	0.0	47.1	436	277.6	.040	1.4	0.0	1.38	12.8	8.2
9	0.0	57.3	584	332.1	0.000	0.0	0.0	1.50	15.3	8.7
10	0.0	186.7	9281	176.3	0.000	0.0	0.0	4.49	223.2	4.2
11	0.0	16.0	196	4.1	.070	0.0	I	R	R	R
12	0.0	470.3	261	1.1	.120	0.0	I	R	R	R
13	0.0	462.5	21700	333.5	.025	2.4	0.0	4.76	223.2	3.4
14	0.0	258.6	8305	457.8	.055	4.9	0.0	2.89	93.0	5.1
15	0.0	117.3	3595	633.8	.035	2.8	0.0	1.47	45.1	8.0
16	0.0	108.8	3690	559.2	.060	4.4	0.0	1.49	50.5	7.6
17	0.0	13.3	156	356.3	.060	2.9	0.0	.27	3.2	7.3
18	0.0	12.1	135	160.3	0.000	0.0	0.0	.49	5.5	6.5
19	0.0	8.3	123	85.8	.065	1.1	0.0	.47	7.0	4.9
20	0.0	3.2	90	29.5	0.000	0.0	0.0	.41	11.4	3.7
21	0.0	3.7	50	12.0	0.000	0.0	0.0	.19	2.6	.6
22	0.0	6.9	57	4.3	.080	0.0	I	R	R	R
23	0.0	587.9	169	.8	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	6.227	GRAM/BHP HR
	CO	66.561	GRAM/BHP HR
	NO2	6.234	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.786	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

6-19-72 RUN 1 1972 VERS. ENG. 2-3 TIM. 12 ATDC DIST. VAC. CONNECTED

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	560	0.0	0	13.0	5.0	16.6	0	15110	.280	11.72	69
2	1200	2.4	1	18.0	7.5	16.2	0	147	.100	13.63	75
3	1200	10.0	2	17.5	8.3	16.3	0	149	.100	13.48	81
4	1200	22.0	5	16.2	10.0	16.5	0	199	.100	13.18	122
5	1200	31.0	7	14.6	10.6	16.5	0	223	.100	13.18	152
6	1200	61.0	14	6.8	18.8	15.4	0	144	.100	14.18	620
7	1200	92.0	21	3.1	22.5	15.3	0	207	.180	14.05	795
8	1200	100.0	23	2.6	23.0	15.2	0	215	.150	14.18	880
9	1200	112.0	26	1.4	25.2	14.9	0	454	.490	14.18	913
10	1200	122.0	28	.3	32.5	12.6	0	1933	5.400	11.24	400
11	560	0.0	0	14.5	4.6	14.6	0	1621	1.090	13.77	77
12	1200	0.0	0	20.7	5.2	16.8	0	28946	.610	9.37	9
13	2300	174.0	76	.6	64.8	12.1	0	2067	6.370	10.55	300
14	2300	160.0	70	2.7	47.5	14.5	0	455	.850	14.05	810
15	2300	143.0	63	3.5	46.6	14.2	0	642	1.380	13.91	720
16	2300	131.0	57	4.4	45.3	14.3	0	577	1.270	13.91	660
17	2300	87.0	38	7.7	35.8	15.3	0	133	.100	14.18	735
18	2300	44.0	19	15.0	20.5	16.3	0	111	.070	13.18	420
19	2300	31.0	14	16.5	18.8	16.5	0	88	.070	13.18	280
20	2300	14.0	6	18.3	15.5	16.4	0	58	.070	13.18	155
21	2300	3.4	1	19.7	13.2	16.3	0	37	.050	13.48	90
22	560	0.0	0	13.5	4.8	15.5	0	678	.210	13.91	91
23	2300	0.0	0	23.4	5.5	12.4	0	29273	.350	8.75	12

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	253.6	95	3.8	.070	0.0	I	R	R	R
2	0.0	3.6	50	6.2	.060	.0	0.0	6.61	91.2	11.2
3	0.0	4.1	56	7.5	.060	.1	0.0	1.81	24.5	3.3
4	0.0	6.8	69	13.9	.050	.3	0.0	1.35	13.7	2.8
5	0.0	8.1	73	18.3	.030	.2	0.0	1.14	10.3	2.6
6	0.0	8.6	121	122.8	.060	.8	0.0	.62	8.6	8.8
7	0.0	14.8	260	189.0	0.000	0.0	0.0	.70	12.4	9.0
8	0.0	15.6	220	212.4	.040	.9	0.0	.68	9.6	9.3
9	0.0	35.3	769	235.3	0.000	0.0	0.0	1.38	30.0	9.2
10	0.0	169.3	9553	116.3	0.000	0.0	0.0	6.07	342.7	4.2
11	0.0	22.5	306	3.6	.070	0.0	I	R	R	R
12	0.0	530.3	226	.5	.120	0.0	I	R	R	R
13	0.0	354.8	22083	170.9	.025	1.9	0.0	4.66	289.8	2.2
14	0.0	65.6	2475	387.7	.055	3.9	0.0	.94	35.3	5.5
15	0.0	88.4	3838	329.1	.035	2.2	0.0	1.41	61.3	5.3
16	0.0	77.8	3459	295.5	.060	3.4	0.0	1.36	60.3	5.2
17	0.0	15.1	229	277.2	.060	2.3	0.0	.40	6.0	7.3
18	0.0	7.8	99	97.8	0.000	0.0	0.0	.40	5.1	5.1
19	0.0	5.6	91	59.8	.065	.9	0.0	.41	6.7	4.4
20	0.0	3.1	75	27.3	0.000	0.0	0.0	.50	12.2	4.5
21	0.0	1.6	45	13.2	0.000	0.0	0.0	1.09	30.0	8.9
22	0.0	10.4	65	4.6	.080	0.0	I	R	R	R
23	0.0	607.2	147	.8	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	8.494	GRAM/BHP HR
	CO	67.687	GRAM/BHP HR
	NO2	5.565	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	1.049	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

6-16-72 RUN 4 1972 VERS. ENG. 2-3 TIM. 12 ATDC DIST. VAC. DISSCON.

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	535	0.0	0	13.8	5.0	15.4	0	871	.420	13.77	90
2	1200	3.0	1	13.3	12.5	16.9	0	118	.050	12.94	91
3	1200	10.0	2	12.0	13.0	16.9	0	56	.050	12.94	119
4	1200	23.0	5	11.5	13.8	16.9	0	43	.050	12.94	127
5	1200	33.0	8	8.5	17.3	16.3	0	37	.050	13.33	320
6	1200	65.0	15	6.3	19.8	15.2	0	126	.130	14.31	735
7	1200	98.0	22	3.0	23.3	21.1	0	179	.130	14.31	975
8	1200	107.0	24	2.2	24.5	15.0	0	315	.390	14.18	938
9	1200	120.0	27	.9	25.4	14.8	0	426	.550	14.18	938
10	1200	130.0	30	0.0	31.6	12.6	0	1802	5.290	11.48	400
11	535	0.0	0	0.0	5.2	20.8	0	1020	.550	13.91	90
12	1200	0.0	0	21.0	5.5	11.8	0	34011	.520	9.03	14
13	2300	178.0	78	.4	65.5	11.9	0	2343	6.710	10.25	220
14	2300	164.0	72	2.6	51.2	13.6	0	1555	2.600	12.94	500
15	2300	146.0	64	3.3	47.2	14.2	0	798	1.450	13.63	780
16	2300	134.0	59	4.5	46.0	14.3	0	694	1.270	13.63	720
17	2300	89.0	39	7.8	36.0	15.2	0	167	.100	14.05	680
18	2300	45.0	20	9.5	29.5	16.7	0	118	.050	12.94	270
19	2300	32.0	14	11.1	27.5	16.8	0	96	.050	12.94	235
20	2300	14.0	6	14.4	22.5	16.6	0	73	.050	12.94	180
21	2300	4.0	2	16.5	17.5	16.5	0	53	.050	13.06	110
22	535	0.0	0	14.2	4.0	15.4	0	543	.210	13.91	98
23	2300	0.0	0	23.2	5.5	18.1	0	25237	.310	8.93	15

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	13.8	135	4.8	.070	0.0	I	R	R	R
2	0.0	5.1	44	13.2	.060	.0	0.0	7.48	64.3	19.3
3	0.0	2.5	46	17.9	.060	.1	0.0	1.11	20.1	7.8
4	0.0	2.1	49	20.4	.050	.3	0.0	.39	9.3	3.9
5	0.0	2.2	59	62.3	.030	.2	0.0	.29	7.9	8.3
6	0.0	7.8	163	151.6	.060	.9	0.0	.53	11.0	10.2
7	0.0	13.1	192	236.6	0.000	0.0	0.0	.58	8.6	10.6
8	0.0	24.0	600	236.9	.040	1.0	0.0	.98	24.5	9.7
9	0.0	33.2	866	242.7	0.000	0.0	0.0	1.21	31.6	8.9
10	0.0	152.4	9036	112.3	0.000	0.0	0.0	5.13	304.2	3.8
11	0.0	16.5	180	4.8	.070	0.0	I	R	R	R
12	0.0	655.2	202	.9	.120	0.0	I	R	R	R
13	0.0	404.8	23421	126.2	.025	1.9	0.0	5.19	300.5	1.6
14	0.0	230.2	7771	245.6	.055	4.0	0.0	3.20	108.2	3.4
15	0.0	112.6	4137	365.7	.035	2.2	0.0	1.76	64.7	5.7
16	0.0	96.7	3576	333.2	.060	3.5	0.0	1.65	60.9	5.7
17	0.0	19.2	233	260.2	.060	2.3	0.0	.49	6.0	6.7
18	0.0	12.1	104	92.3	0.000	0.0	0.0	.61	5.3	4.7
19	0.0	9.2	97	74.9	.065	.9	0.0	.66	6.9	5.3
20	0.0	5.7	79	46.9	0.000	0.0	0.0	.93	12.9	7.7
21	0.0	3.2	61	22.1	0.000	0.0	0.0	1.82	34.9	12.6
22	0.0	6.9	54	4.1	.080	0.0	I	R	R	R
23	0.0	535.2	133	1.1	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	8.585	GRAM/BHP HR
	CO	85.680	GRAM/BHP HR
	NO2	5.414	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	1.132	LB/BHP HR

ENGINE 2-3

EFFECT OF TIMING ON EMISSIONS

GRAPHED RESULTS

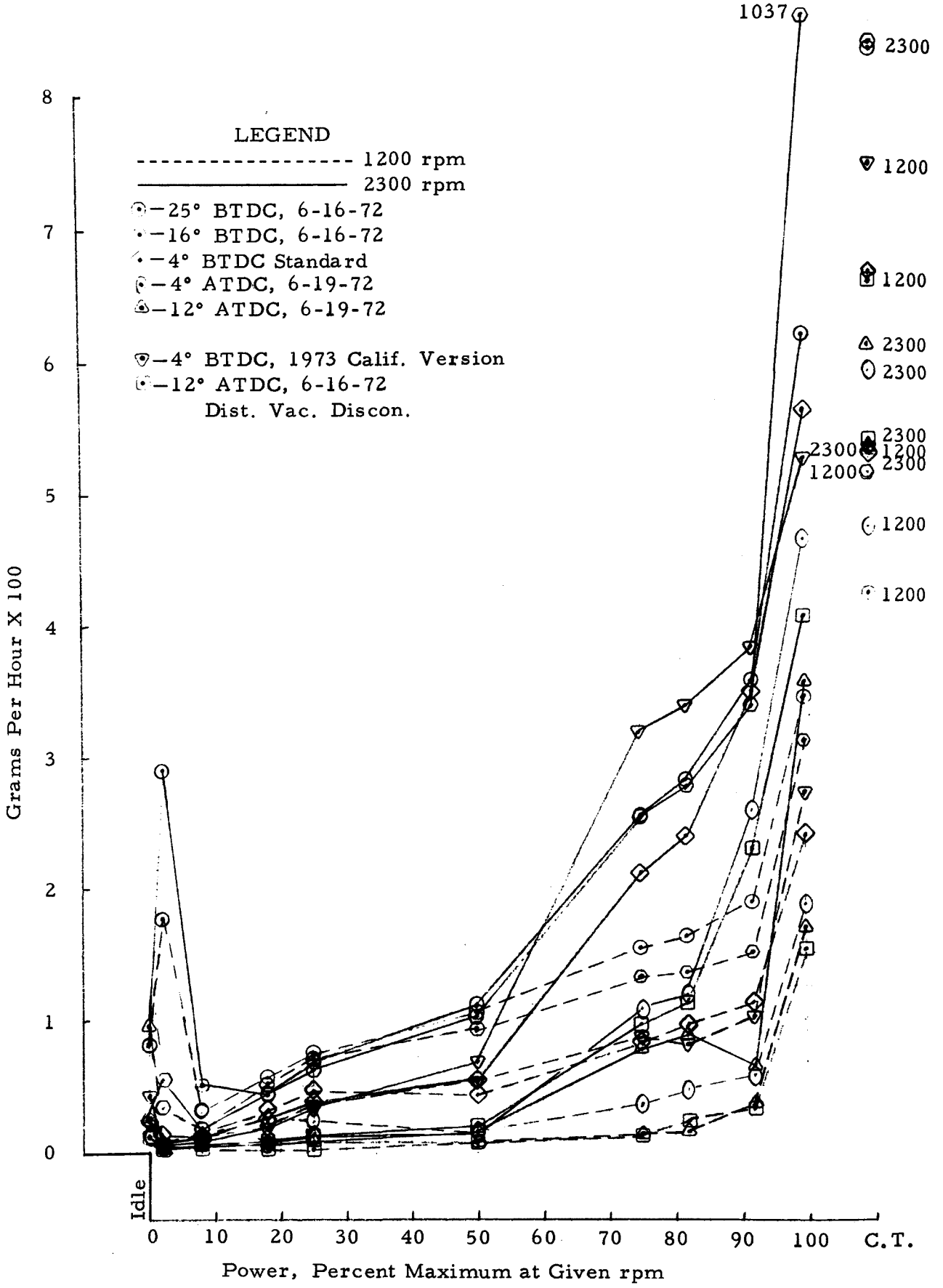


FIGURE H-1. EFFECT OF POWER ON HC EMISSION RATE

ENGINE 2-3, 23 MODE TEST

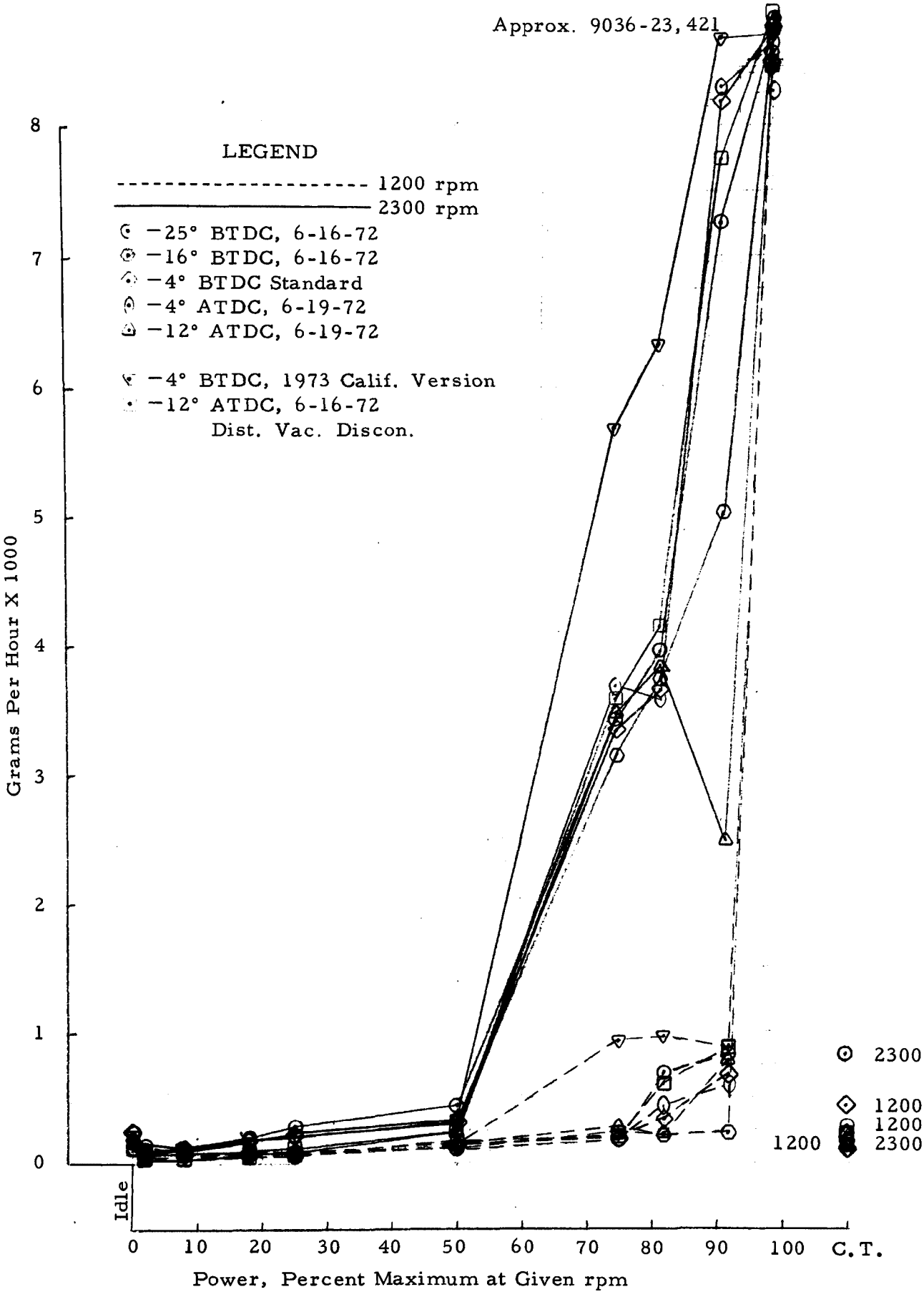


FIGURE H-2. EFFECT OF POWER ON CO EMISSION RATE
ENGINE 2-3, 23 MODE TEST

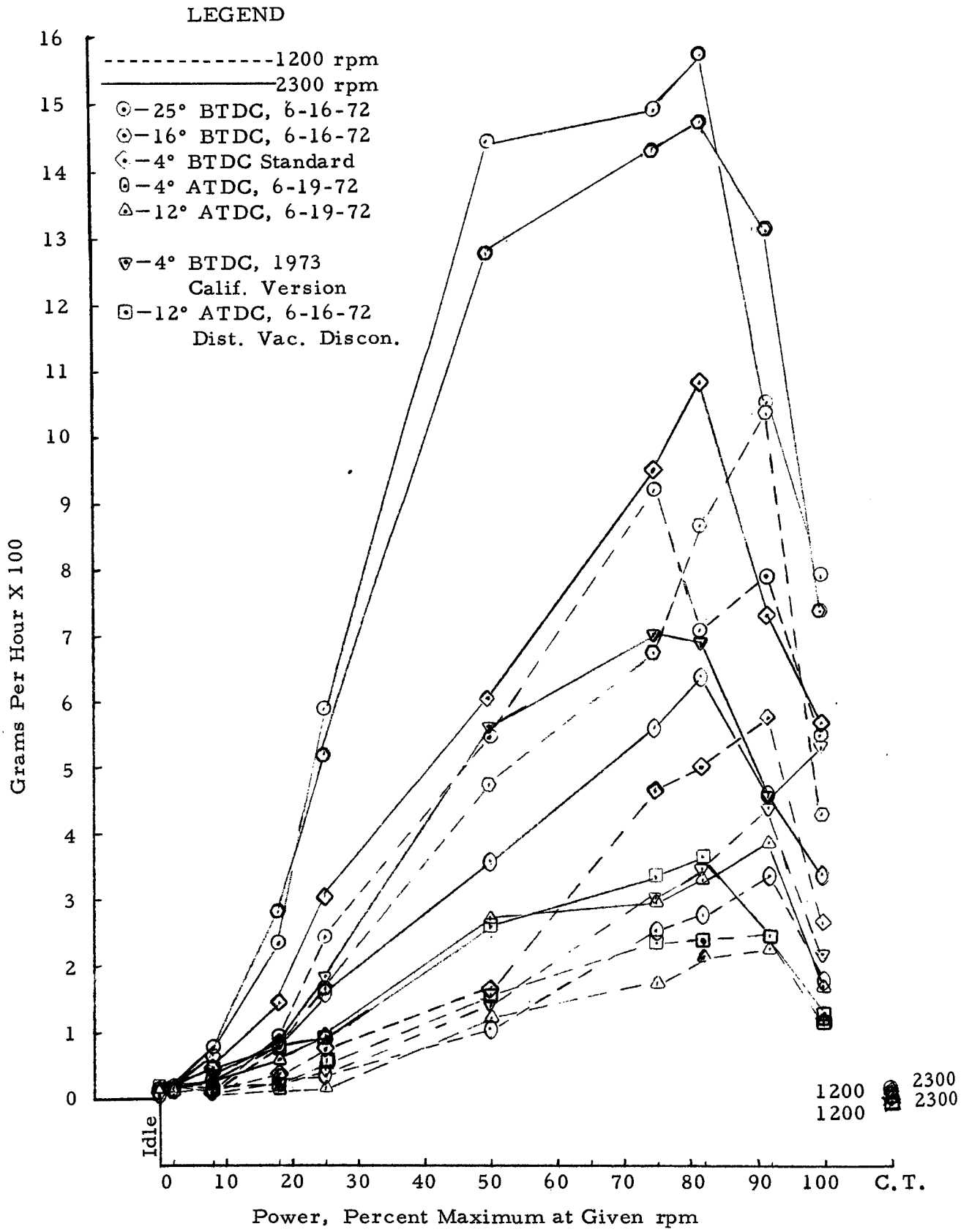


FIGURE H-3. EFFECT OF POWER ON NO_x (AS NO_2) EMISSION RATE

ENGINE 2-3, 23 MODE TEST

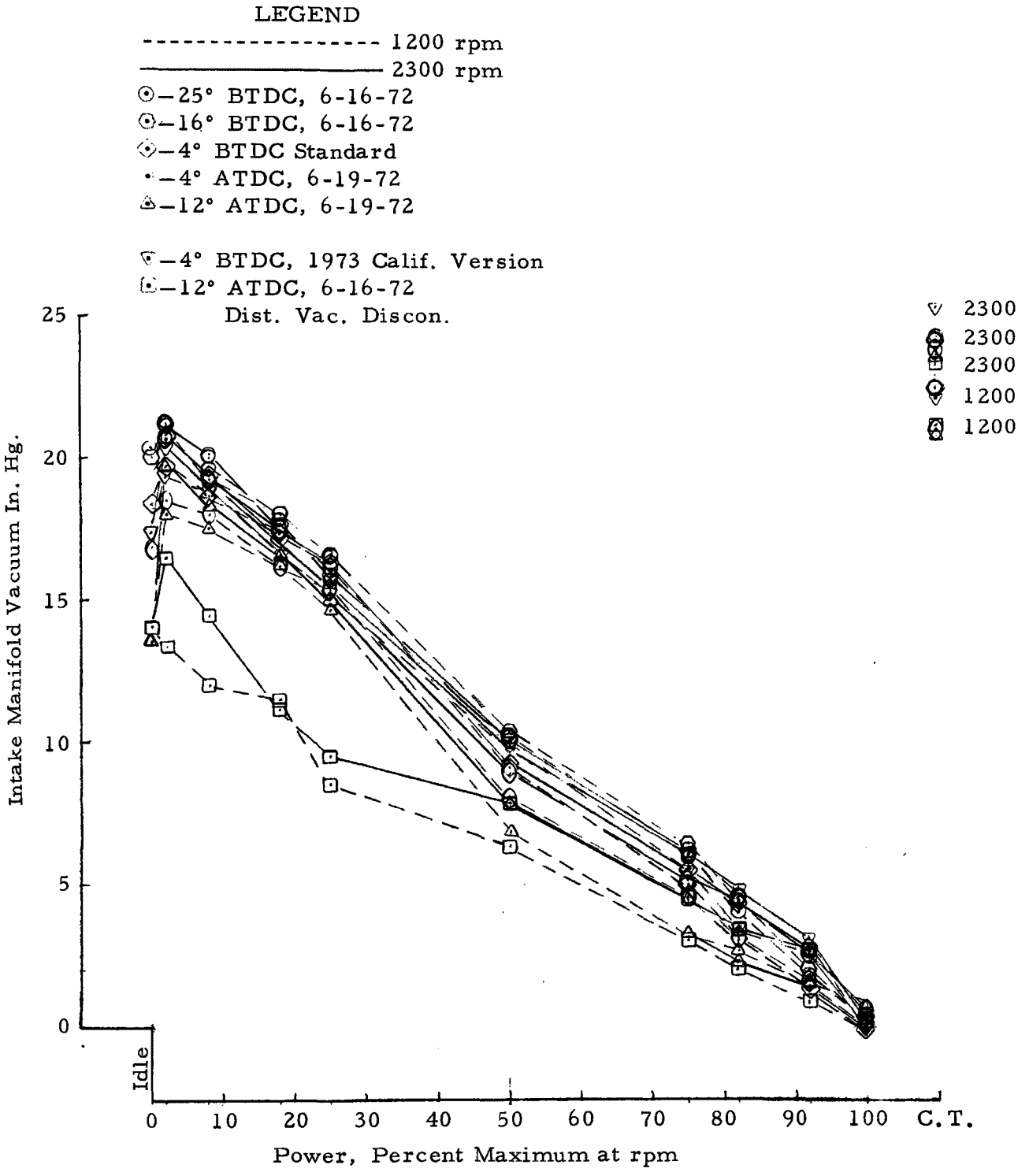


FIGURE H-4. MANIFOLD VACUUM AS A FUNCTION OF POWER

ENGINE 2-3, 23 MODE TEST

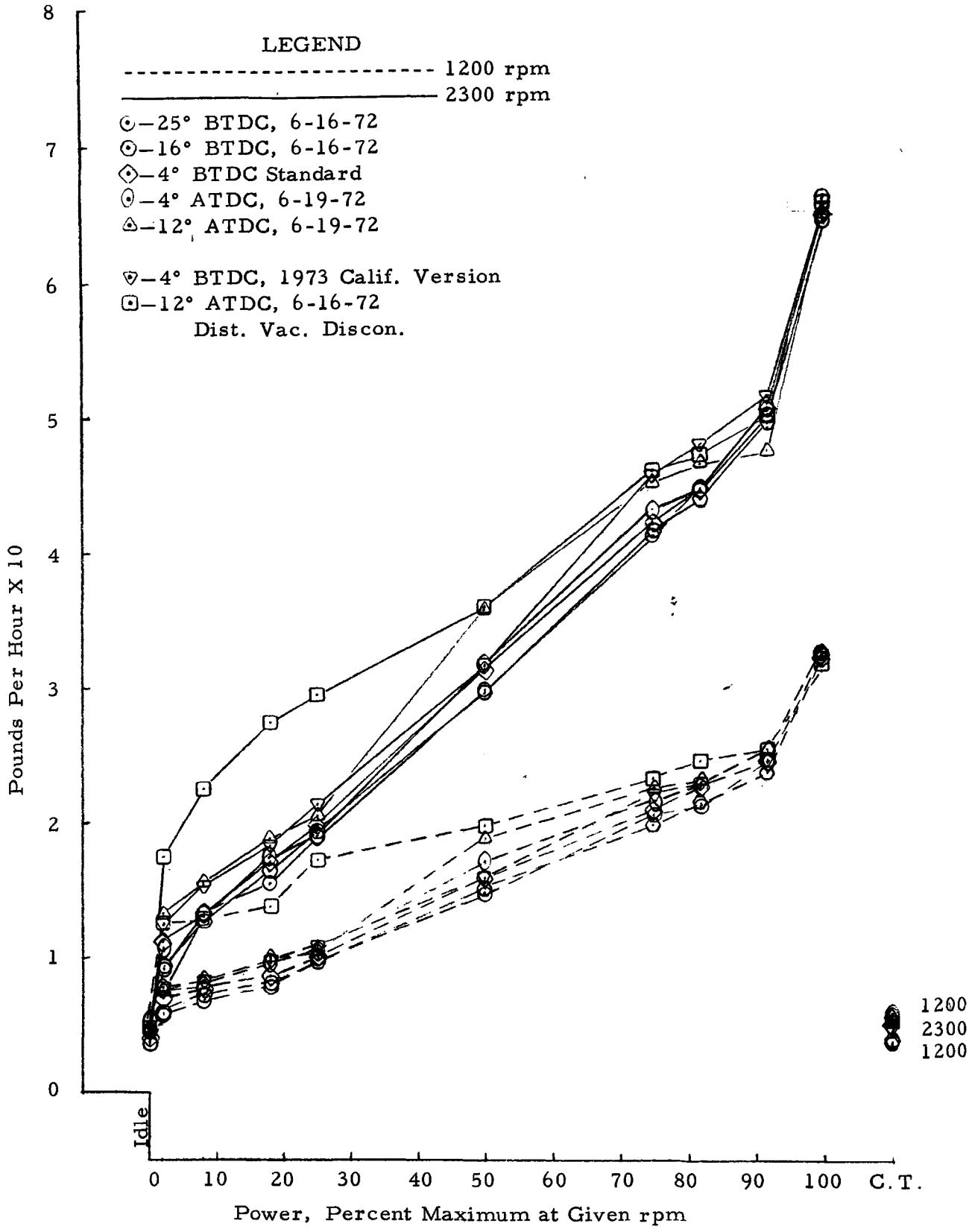


FIGURE H-5. FUEL CONSUMPTION AS A FUNCTION OF POWER

ENGINE 2-3, 23 MODE TEST

APPENDIX I

ENGINE 2-3

EFFECT OF AIR-FUEL RATIO ON EMISSIONS

(23 MODE MASS RESULTS)

ENGINE 2-3

EFFECT OF AIR-FUEL RATIO ON EMISSIONS

TABULAR DATA

PROJECT 11-2877-01 CONTROL TECHNOLOGY

6-20-72 RUN 1 ENG. 2-3, PER MAN. SPECS., CARB. JETS .080 RODS .051

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	680	0.0	0	18.0	3.5	14.9	0	2775	1.300	13.06	32
2	1200	4.3	1	19.5	6.8	14.5	0	939	1.200	13.77	63
3	1200	17.0	4	18.8	8.0	14.3	0	1370	1.520	13.77	91
4	1200	39.0	9	18.2	8.8	14.4	0	1851	1.270	13.77	161
5	1200	54.0	12	17.1	9.5	14.4	0	2165	1.160	13.91	420
6	1200	108.0	25	12.2	14.3	15.2	0	1811	.180	14.05	1412
7	1200	162.0	37	7.0	23.2	12.7	0	2826	4.880	11.72	410
8	1200	177.0	40	5.4	27.5	11.6	0	3421	7.620	9.64	102
9	1200	199.0	45	3.8	30.5	11.4	0	3569	8.010	9.37	99
10	1200	216.0	49	.3	36.5	11.0	0	4717	9.060	8.75	177
11	680	0.0	0	18.3	3.3	14.5	0	2444	1.840	12.94	34
12	1200	0.0	0	22.8	3.5	16.1	0	56775	.970	6.73	3
13	2300	256.0	112	.6	71.4	11.1	0	3701	9.060	8.84	305
14	2300	236.0	103	2.7	67.7	10.6	0	3926	10.440	8.14	89
15	2300	210.0	92	4.9	60.0	10.8	0	3779	10.030	8.54	152
16	2300	192.0	84	6.7	50.3	12.1	0	3121	6.440	10.43	510
17	2300	128.0	56	11.7	30.0	14.5	0	1705	1.120	13.63	2087
18	2300	64.0	28	17.0	19.8	14.7	0	1560	.740	13.77	1313
19	2300	46.0	20	18.6	16.5	14.7	0	1192	.810	13.77	550
20	2300	20.0	9	20.3	13.5	14.8	0	763	.610	13.48	305
21	2300	5.0	2	21.7	10.8	14.8	0	712	.640	13.48	134
22	680	0.0	0	18.5	3.4	14.7	0	2515	1.480	12.59	48
23	2300	0.0	0	24.7	3.6	17.3	0	43437	.470	7.37	7

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	30.1	285	1.2	.070	0.0	I	R	R	R
2	0.0	19.2	496	4.3	.060	.1	0.0	19.57	505.2	4.4
3	0.0	32.2	722	7.1	.060	.2	0.0	8.29	185.9	1.8
4	0.0	48.5	673	14.0	.050	.4	0.0	5.45	75.5	1.6
5	0.0	61.0	661	39.3	.030	.4	0.0	4.95	53.5	3.2
6	0.0	81.5	164	211.1	.060	1.5	0.0	3.30	6.6	8.6
7	0.0	176.2	6145	84.8	0.000	0.0	0.0	4.76	166.0	2.3
8	0.0	242.4	10908	24.1	.040	1.6	0.0	5.99	269.7	.6
9	0.0	278.4	12621	25.6	0.000	0.0	0.0	6.12	277.6	.6
10	0.0	427.2	16574	53.4	0.000	0.0	0.0	8.66	335.8	1.1
11	0.0	24.3	370	1.1	.070	0.0	I	R	R	R
12	0.0	673.8	233	.1	.120	0.0	I	R	R	R
13	0.0	656.0	32442	179.5	.025	2.8	0.0	5.85	289.4	1.6
14	0.0	635.4	34134	47.7	.055	5.7	0.0	6.15	330.3	.5
15	0.0	542.8	29102	72.7	.035	3.2	0.0	5.90	316.4	.8
16	0.0	414.5	17274	224.8	.060	5.0	0.0	4.93	205.4	2.7
17	0.0	155.5	2063	632.1	.060	3.4	0.0	2.77	36.8	11.3
18	0.0	95.5	915	266.8	0.000	0.0	0.0	3.41	32.7	9.5
19	0.0	60.7	833	93.0	.065	1.3	0.0	3.01	41.4	4.6
20	0.0	33.0	533	43.8	0.000	0.0	0.0	3.77	60.8	5.0
21	0.0	24.6	446	15.3	0.000	0.0	0.0	11.23	203.8	7.0
22	0.0	27.1	322	1.7	.080	0.0	I	R	R	R
23	0.0	582.2	127	.3	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	9.840	GRAM/BHP HR
	CO	218.548	GRAM/BHP HR
	NO2	3.264	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.720	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

6-21-72 RUN 2 ENG. 2-3, PER MAN. SPECS., CARB. JETS .075 RODS .038

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.3	3.8	14.4	0	2487	.770	13.33	37
2	1200	4.5	1	19.7	6.8	15.2	0	750	.420	14.31	66
3	1200	18.0	4	19.2	7.8	15.0	0	722	.490	14.31	88
4	1200	41.0	9	18.1	8.5	14.9	0	1822	.350	14.66	420
5	1200	57.0	13	17.3	10.0	14.8	0	1923	.420	14.66	560
6	1200	113.0	26	12.4	15.0	14.8	0	2068	.420	14.79	1650
7	1200	170.0	39	7.2	25.5	13.6	0	2390	2.920	13.48	713
8	1200	185.0	42	5.1	22.7	13.6	0	2275	2.780	13.63	875
9	1200	208.0	48	3.3	24.5	13.6	0	2219	2.870	13.63	975
10	1200	226.0	52	.3	32.5	12.1	0	3080	6.640	10.89	575
11	600	0.0	0	19.0	3.8	14.8	0	1995	.930	14.18	45
12	1200	0.0	0	22.5	4.0	16.3	0	46413	.640	7.94	8
13	2300	258.0	113	.6	66.5	11.7	0	3240	7.340	9.64	710
14	2300	237.0	104	3.0	53.3	12.9	0	2531	4.540	11.72	830
15	2300	212.0	93	5.2	47.5	13.1	0	2401	4.120	12.09	1025
16	2300	194.0	85	6.3	44.5	13.2	0	2353	3.660	12.34	1050
17	2300	129.0	56	11.7	29.4	14.8	0	1616	.470	14.05	2700
18	2300	65.0	28	16.8	19.5	14.6	0	1649	.810	14.05	1687
19	2300	46.0	20	18.5	16.4	14.7	0	1675	.610	14.05	975
20	2300	21.0	9	21.6	12.4	18.0	0	766	.440	14.18	330
21	2300	5.0	2	22.3	10.2	14.8	0	629	.470	14.18	127
22	600	0.0	0	18.3	3.5	15.3	0	1720	.490	13.33	45
23	2300	0.0	0	24.5	3.8	17.1	0	41937	.390	7.75	7

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	29.9	187	1.5	.070	0.0	I	R	R	R
2	0.0	15.6	177	4.6	.060	.1	0.0	15.20	171.9	4.4
3	0.0	17.2	235	6.9	.060	.2	0.0	4.18	57.3	1.7
4	0.0	46.2	179	35.4	.050	.5	0.0	4.94	19.2	3.8
5	0.0	57.1	252	55.2	.030	.4	0.0	4.39	19.3	4.2
6	0.0	91.2	374	241.8	.060	1.5	0.0	3.53	14.5	9.4
7	0.0	166.1	4100	164.4	0.000	0.0	0.0	4.28	105.6	4.2
8	0.0	140.8	3475	179.8	.040	1.7	0.0	3.33	82.2	4.3
9	0.0	147.5	3853	215.1	0.000	0.0	0.0	3.10	81.1	4.5
10	0.0	254.5	11085	157.8	0.000	0.0	0.0	4.93	214.7	3.1
11	0.0	22.5	212	1.7	.070	0.0	I	R	R	R
12	0.0	636.9	177	.4	.120	0.0	I	R	R	R
13	0.0	564.8	25846	410.9	.025	2.8	0.0	5.00	228.8	3.6
14	0.0	370.5	13427	403.4	.055	5.7	0.0	3.57	129.4	3.9
15	0.0	314.4	10901	445.7	.035	3.2	0.0	3.39	117.4	4.8
16	0.0	292.6	9192	433.4	.060	5.1	0.0	3.44	108.2	5.1
17	0.0	146.8	862	814.2	.060	3.4	0.0	2.60	15.3	14.4
18	0.0	97.1	963	329.7	0.000	0.0	0.0	3.41	33.8	11.6
19	0.0	84.0	618	162.4	.065	1.3	0.0	4.17	30.7	8.1
20	0.0	29.3	340	41.9	0.000	0.0	0.0	3.19	37.0	4.6
21	0.0	19.8	299	13.3	0.000	0.0	0.0	9.03	136.3	6.1
22	0.0	19.5	112	1.7	.080	0.0	I	R	R	R
23	0.0	586.1	110	.3	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	8.129	GRAM/BHP HR
	CO	103.020	GRAM/BHP HR
	NO2	6.146	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.642	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

6-21-72 RUN 1 ENG. 2-3, PER MAN. SPECS., CARB. JETS .068 RODS .038

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.0	3.5	16.3	0	6045	.440	12.47	28
2	1200	4.3	1	18.8	6.6	17.2	0	456	.100	13.18	46
3	1200	17.0	4	18.5	7.3	17.3	0	572	.130	12.34	68
4	1200	39.0	9	15.1	9.3	18.8	0	1232	.130	12.22	71
5	1200	54.0	12	12.8	10.8	18.5	0	1237	.130	13.33	76
6	1200	108.0	25	6.6	17.0	17.3	0	557	.130	13.48	315
7	1200	162.0	37	2.3	21.4	17.1	0	575	.130	13.63	770
8	1200	177.0	40	1.4	22.3	16.7	0	599	.150	13.91	1150
9	1200	199.0	45	.8	23.8	16.1	0	750	.180	14.53	1675
10	1200	216.0	49	.3	30.5	13.3	0	2435	4.790	12.47	763
11	600	0.0	0	18.0	3.4	14.9	0	3433	.930	14.66	44
12	1200	0.0	0	22.9	3.8	16.0	0	61553	.440	7.18	10
13	2300	250.0	109	.6	62.8	12.4	0	2825	5.900	10.66	900
14	2300	230.0	101	2.4	46.7	14.8	0	1305	.810	13.77	2600
15	2300	205.0	90	3.0	42.5	16.0	0	404	.180	13.18	2300
16	2300	188.0	82	3.9	40.7	16.0	0	416	.210	13.18	2175
17	2300	125.0	55	7.3	32.4	17.3	0	187	.150	12.22	975
18	2300	63.0	28	11.3	23.0	19.7	0	413	.180	10.66	145
19	2300	45.0	20	14.6	18.5	19.8	0	572	.180	10.66	147
20	2300	20.0	9	17.9	13.6	19.4	0	771	.150	10.78	80
21	2300	5.0	2	19.8	11.3	20.0	0	4288	.210	9.03	62
22	600	0.0	0	17.0	3.3	16.3	0	4670	.390	11.72	54
23	2300	0.0	0	24.7	3.1	18.0	0	47167	.350	6.13	5

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	71.0	104	1.1	.070	0.0	I	R	R	R
2	0.0	10.2	45	3.4	.060	.1	0.0	10.42	46.2	3.5
3	0.0	15.1	69	5.9	.060	.2	0.0	3.89	17.9	1.5
4	0.0	41.7	89	8.0	.050	.4	0.0	4.68	10.0	.9
5	0.0	44.6	95	9.1	.030	.4	0.0	3.62	7.7	.7
6	0.0	31.4	148	59.0	.060	1.5	0.0	1.27	6.0	2.4
7	0.0	40.4	184	179.6	0.000	0.0	0.0	1.09	5.0	4.9
8	0.0	42.9	217	273.5	.040	1.6	0.0	1.06	5.4	6.8
9	0.0	54.7	265	406.1	0.000	0.0	0.0	1.20	5.8	8.9
10	0.0	192.5	7648	200.2	0.000	0.0	0.0	3.90	155.0	4.1
11	0.0	33.2	182	1.4	.070	0.0	I	R	R	R
12	0.0	770.2	111	.4	.120	0.0	I	R	R	R
13	0.0	477.8	20157	505.4	.025	2.7	0.0	4.36	184.1	4.6
14	0.0	187.9	2356	1243.0	.055	5.5	0.0	1.87	23.4	12.3
15	0.0	58.2	523	1098.5	.035	3.1	0.0	.65	5.8	12.2
16	0.0	57.2	583	992.5	.060	4.9	0.0	.69	7.1	12.1
17	0.0	22.2	359	384.0	.060	3.3	0.0	.41	6.6	7.0
18	0.0	39.6	349	46.2	0.000	0.0	0.0	1.43	12.6	1.7
19	0.0	44.1	280	37.7	.065	1.3	0.0	2.24	14.2	1.9
20	0.0	43.2	170	14.9	0.000	0.0	0.0	4.93	19.4	1.7
21	0.0	227.3	225	10.9	0.000	0.0	0.0	103.81	102.7	5.0
22	0.0	55.6	94	2.1	.080	0.0	I	R	R	R
23	0.0	592.4	89	.2	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	7.171	GRAM/BHP HR
	CO	32.014	GRAM/BHP HR
	NO2	8.779	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.642	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

6-20-72 RUN 2 ENG. 2-3, PER MAN. SPECS., CARB. JETS .064 RODS .038

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.0	2.8	16.4	0	6473	.210	12.34	28
2	1200	4.0	1	15.3	7.3	23.7	0	24387	.310	6.21	3
3	1200	16.0	4	11.0	9.6	23.8	0	62888	.180	2.26	1
4	1200	36.0	8	7.0	13.6	21.4	0	3137	.210	9.64	20
5	1200	50.0	11	5.5	15.5	20.4	0	670	.150	10.55	38
6	1200	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
7	1200	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
8	1200	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
9	1200	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
10	1200	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
11	600	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
12	1200	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
13	2300	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
14	2300	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
15	2300	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
16	2300	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
17	2300	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
18	2300	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
19	2300	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
20	2300	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
21	2300	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
22	600	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
23	2300	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	62.3	41	.9	.070	0.0	I	R	R	R
2	0.0	901.4	231	.4	.060	.1	0.0	986.27	253.2	.4
3	0.0	3137.3	181	.2	.060	.2	0.0	858.19	49.6	.1
4	0.0	190.4	257	4.0	.050	.4	0.0	23.15	31.3	.5
5	0.0	43.8	198	8.2	.030	.3	0.0	3.83	17.3	.7
6	0.0	0.0	0	0.0	.060	0.0	0.0	0.00	0.0	0.0
7	0.0	0.0	0	0.0	0.000	0.0	0.0	0.00	0.0	0.0
8	0.0	0.0	0	0.0	.040	0.0	0.0	0.00	0.0	0.0
9	0.0	0.0	0	0.0	0.000	0.0	0.0	0.00	0.0	0.0
10	0.0	0.0	0	0.0	0.000	0.0	0.0	0.00	0.0	0.0
11	0.0	0.0	0	0.0	.070	0.0	0.0	0.00	0.0	0.0
12	0.0	0.0	0	0.0	.120	0.0	0.0	0.00	0.0	0.0
13	0.0	0.0	0	0.0	.025	0.0	0.0	0.00	0.0	0.0
14	0.0	0.0	0	0.0	.055	0.0	0.0	0.00	0.0	0.0
15	0.0	0.0	0	0.0	.035	0.0	0.0	0.00	0.0	0.0
16	0.0	0.0	0	0.0	.060	0.0	0.0	0.00	0.0	0.0
17	0.0	0.0	0	0.0	.060	0.0	0.0	0.00	0.0	0.0
18	0.0	0.0	0	0.0	0.000	0.0	0.0	0.00	0.0	0.0
19	0.0	0.0	0	0.0	.065	0.0	0.0	0.00	0.0	0.0
20	0.0	0.0	0	0.0	0.000	0.0	0.0	0.00	0.0	0.0
21	0.0	0.0	0	0.0	0.000	0.0	0.0	0.00	0.0	0.0
22	0.0	0.0	0	0.0	.080	0.0	0.0	0.00	0.0	0.0
23	0.0	0.0	0	0.0	.060	0.0	0.0	0.00	0.0	0.0

CYCLE COMPOSITE

HC	250.458	GRAM/BHP HR
CO	45.165	GRAM/BHP HR
NO2	.534	GRAM/BHP HR
ALDE	0.000	GRAM/BHP HR
BSFC	2.290	LB/BHP HR

ENGINE 2-3

EFFECT OF AIR-FUEL RATIO ON EMISSIONS

GRAPHED RESULTS

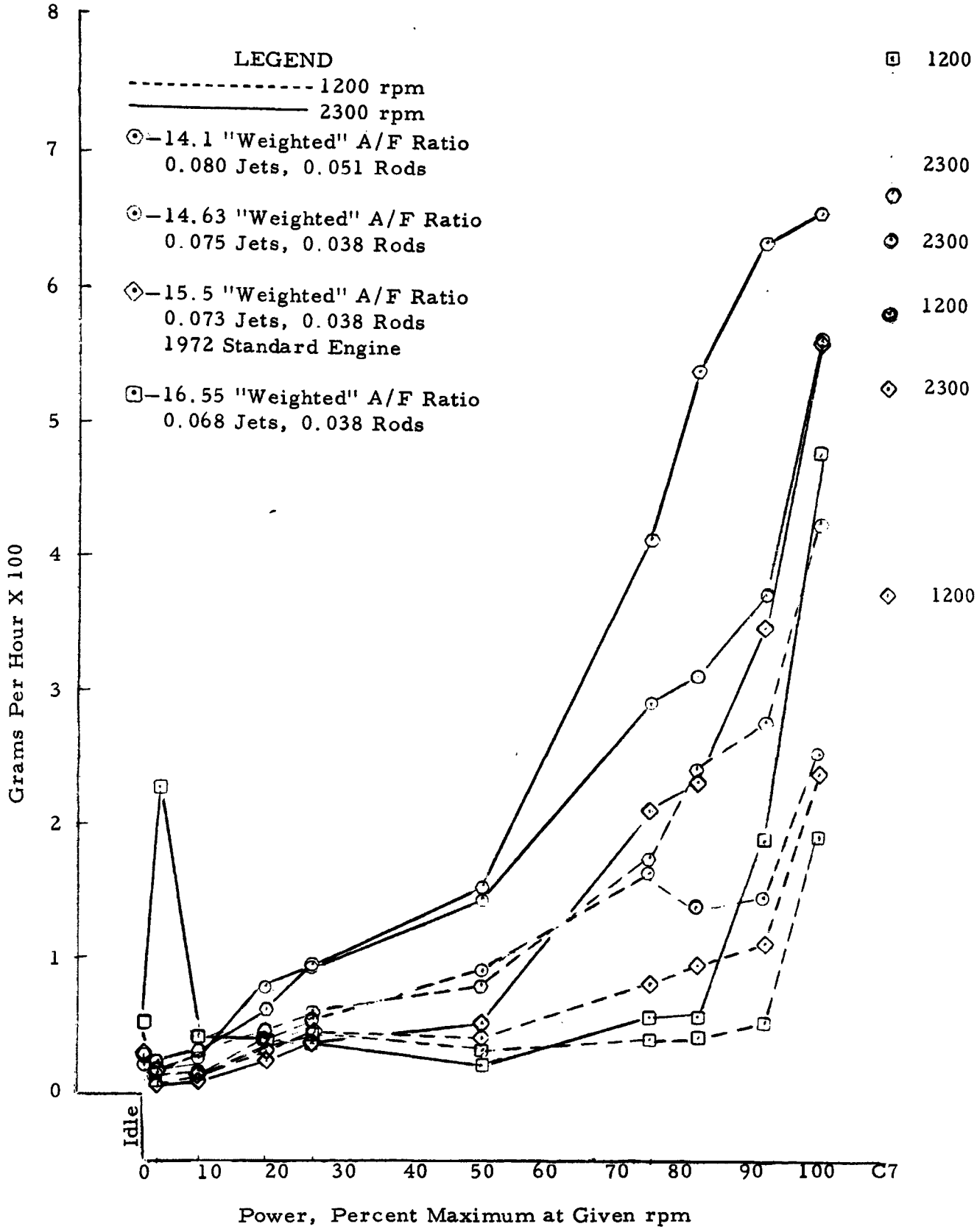


FIGURE I-1. EFFECT OF POWER ON HC EMISSION RATE
ENGINE 2-3, 23 MODE TEST

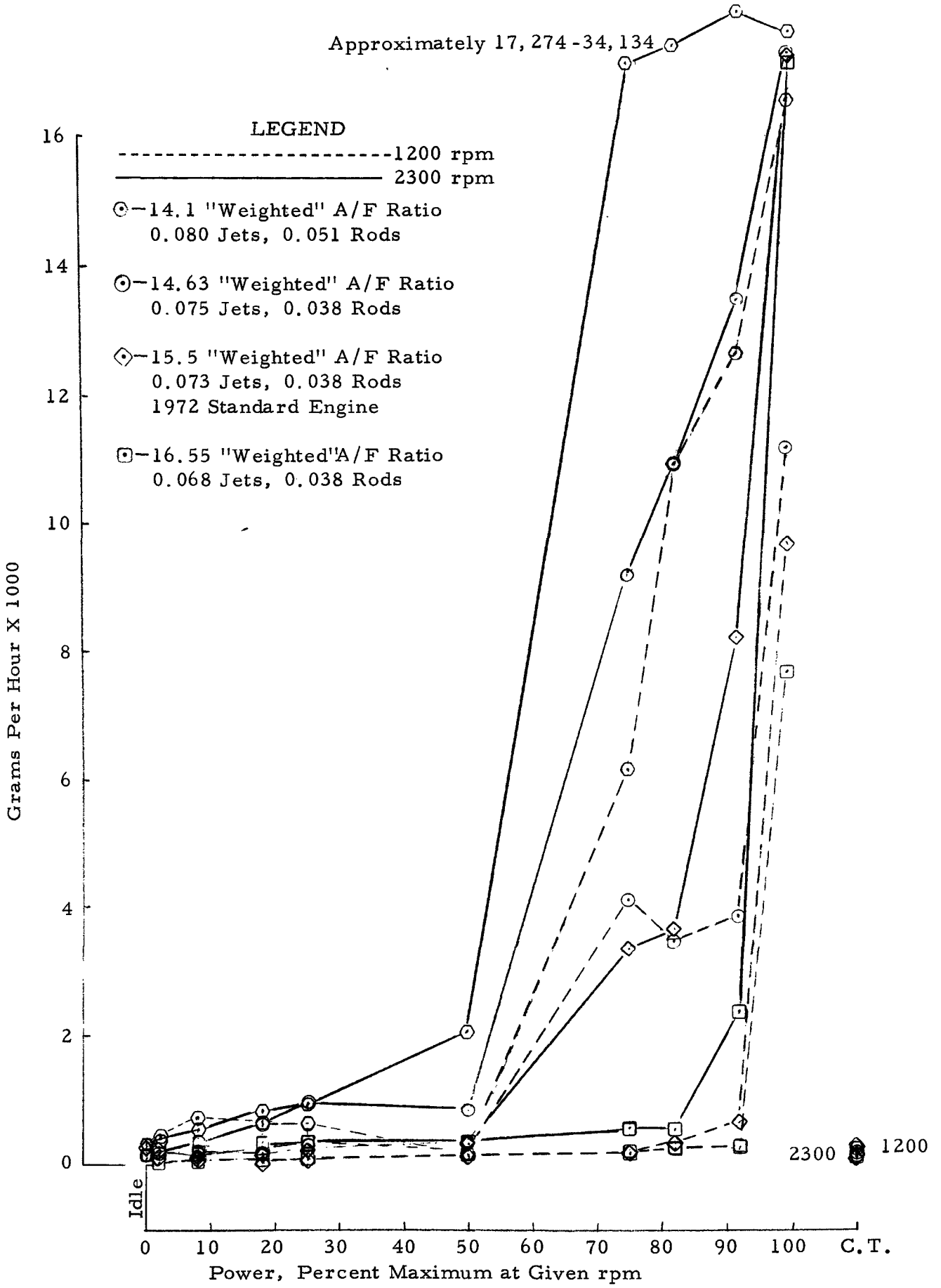


FIGURE I-2. EFFECT OF POWER ON CO EMISSION RATE
ENGINE 2-3, 23 MODE TEST

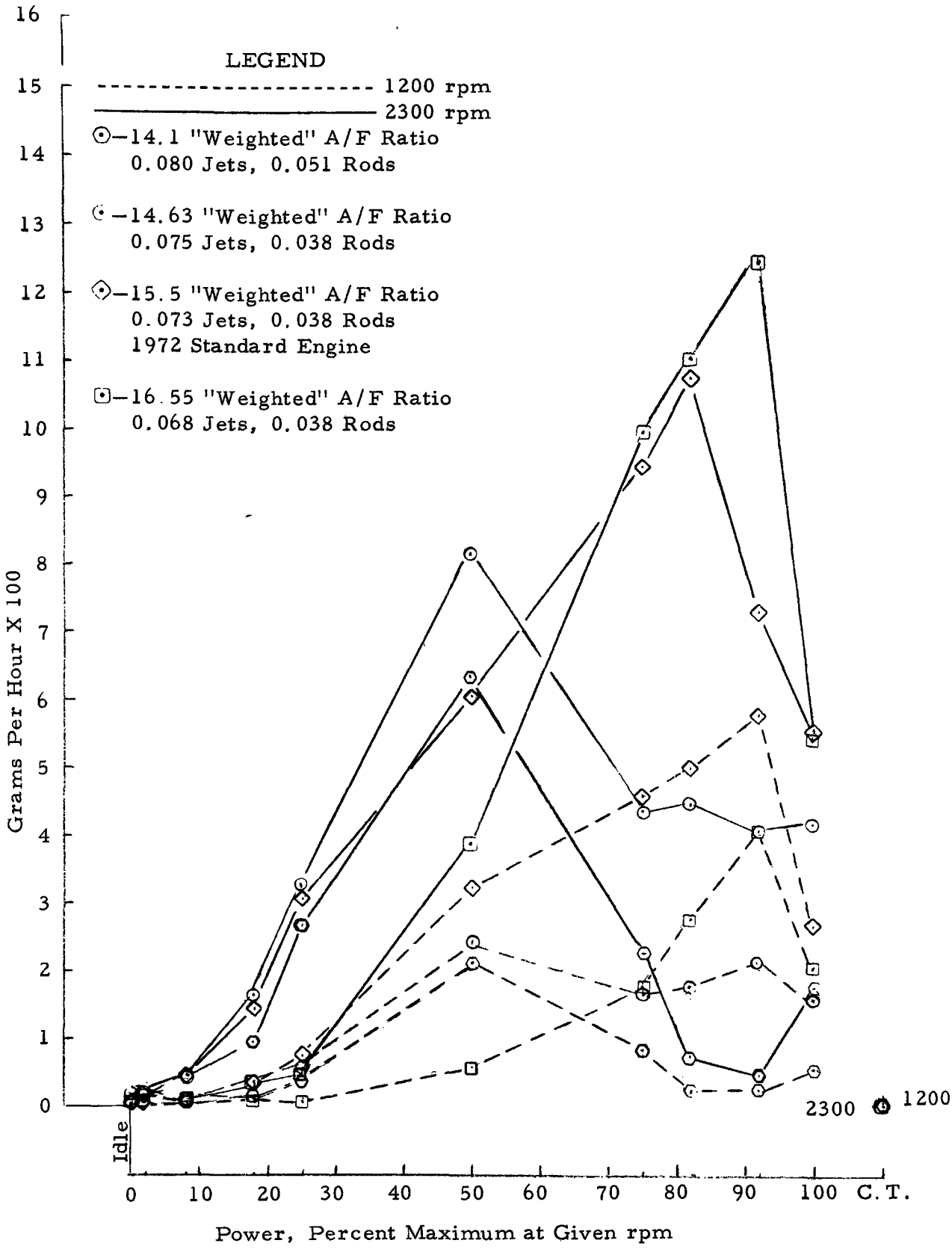


FIGURE I-3. EFFECT OF POWER ON NO_x (AS NO_2) EMISSION RATE
ENGINE 2-3, 23 MODE TEST

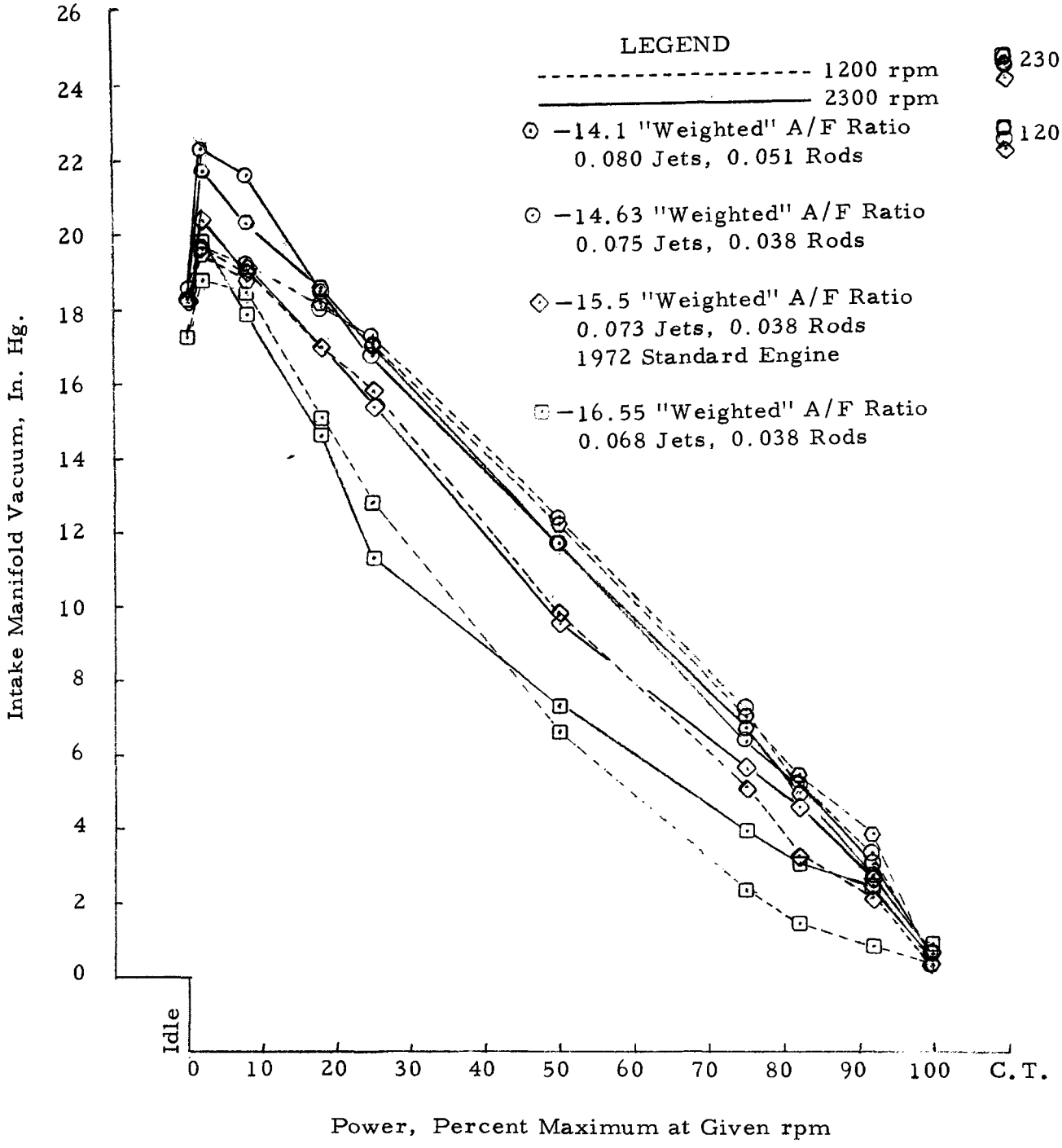


FIGURE I-4. MANIFOLD VACUUM AS A FUNCTION OF POWER
ENGINE 2-3, 23-MODE TEST

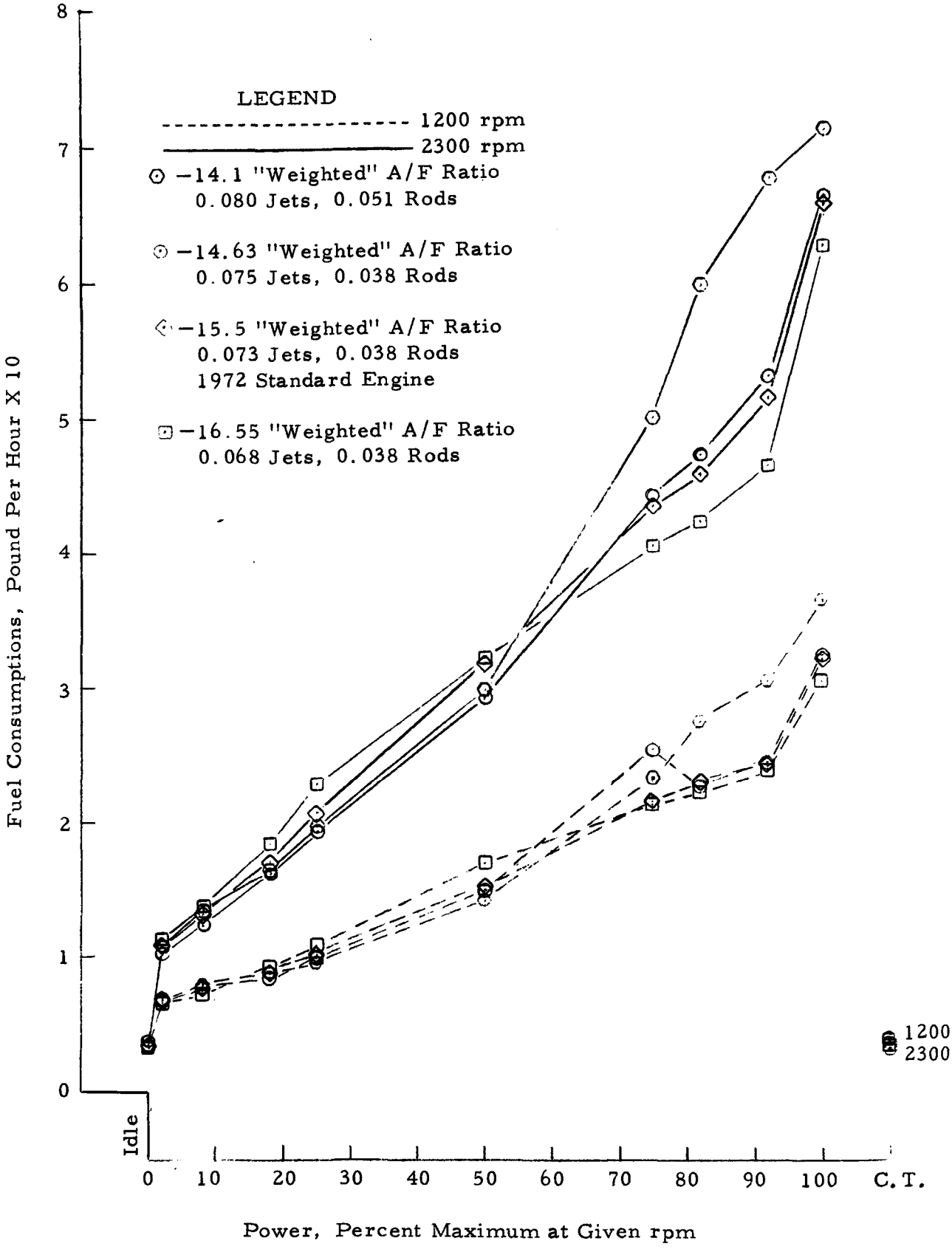


FIGURE I-5. FUEL CONSUMPTION AS A FUNCTION OF POWER
ENGINE 2-3, 23-MODE TEST

APPENDIX J

ENGINE 2-3

EFFECT OF EXHAUST MANIFOLD AIR INJECTION ON EMISSIONS

(23 MODE MASS RESULTS)

ENGINE 2-3

EFFECT OF EXHAUST MANIFOLD AIR INJECTION

TABULAR DATA

PROJECT 11-2877-01 CONTROL TECHNOLOGY

6-23-72 RUN 2 ENG. 2-3, 1972 VERSION, 25 BTDC W/AIR INJECTION

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	21.0	5.5	24.1	0	714	.100	8.75	49
2	1200	5.0	1	20.6	5.8	23.9	0	693	.130	8.84	61
3	1200	20.0	5	20.0	7.0	23.4	0	705	.130	9.03	81
4	1200	46.0	11	18.0	9.4	21.9	0	1450	.100	9.64	620
5	1200	64.0	15	15.8	10.6	20.7	0	1778	.100	10.43	1462
6	1200	128.0	29	9.7	14.8	20.0	0	1759	.100	10.66	2037
7	1200	192.0	44	5.4	21.0	17.6	0	2038	.150	12.47	2950
8	1200	210.0	48	4.3	22.3	17.4	0	1956	.250	12.47	3000
9	1200	236.0	54	1.9	24.4	17.0	0	1903	.440	12.47	3000
10	1200	256.0	58	.3	33.2	13.9	0	3649	5.400	9.78	1125
11	600	0.0	0	21.2	5.8	21.3	0	494	1.700	8.93	61
12	1200	0.0	0	21.0	5.8	21.6	0	713	1.700	8.75	52
13	2300	262.0	115	.6	64.2	12.9	0	3370	5.900	9.50	1262
14	2300	241.0	106	2.3	49.9	14.6	0	1984	2.360	12.09	1862
15	2300	215.0	94	4.3	42.4	15.7	0	936	1.050	12.71	2800
16	2300	197.0	86	5.3	40.5	16.1	0	808	.810	12.47	2750
17	2300	131.0	57	9.7	28.2	19.2	0	1022	.150	11.13	3050
18	2300	66.0	29	15.6	20.5	20.9	0	996	.150	10.09	2025
19	2300	47.0	21	17.5	16.6	21.9	0	840	.150	9.64	1200
20	2300	21.0	9	19.8	13.0	23.9	0	973	.130	8.68	340
21	2300	5.0	2	21.4	9.9	22.7	0	4555	.130	10.43	100
22	600	0.0	0	20.5	3.8	22.8	0	710	.130	9.93	58
23	2300	0.0	0	23.7	5.5	28.4	0	47498	.210	2.11	3

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	20.0	56	4.6	.070	0.0	I	R	R	R
2	0.0	20.2	76	5.9	.060	.1	0.0	17.66	66.9	5.2
3	0.0	24.3	90	9.3	.060	.3	0.0	5.31	19.8	2.0
4	0.0	62.5	87	88.8	.050	.5	0.0	5.95	8.3	8.4
5	0.0	79.8	91	218.0	.030	.4	0.0	5.46	6.2	14.9
6	0.0	108.0	124	415.3	.060	1.8	0.0	3.69	4.2	14.2
7	0.0	151.4	225	727.5	0.000	0.0	0.0	3.45	5.1	16.6
8	0.0	153.2	396	780.1	.040	1.9	0.0	3.19	8.2	16.3
9	0.0	160.8	751	841.5	0.000	0.0	0.0	2.98	13.9	15.6
10	0.0	353.5	10567	361.8	0.000	0.0	0.0	6.04	180.7	6.2
11	0.0	12.2	846	5.0	.070	0.0	I	R	R	R
12	0.0	17.8	859	4.3	.120	0.0	I	R	R	R
13	0.0	623.7	22054	775.6	.025	2.9	0.0	5.44	192.2	6.8
14	0.0	306.6	7366	955.5	.055	5.8	0.0	2.90	69.8	9.1
15	0.0	129.9	2945	1290.5	.035	3.3	0.0	1.38	31.3	13.7
16	0.0	111.2	2250	1255.4	.060	5.2	0.0	1.29	26.1	14.6
17	0.0	114.8	341	1138.0	.060	3.4	0.0	2.00	5.9	19.8
18	0.0	89.6	272	604.6	0.000	0.0	0.0	3.10	9.4	20.9
19	0.0	64.0	231	303.8	.065	1.3	0.0	3.11	11.2	14.8
20	0.0	64.4	174	74.7	0.000	0.0	0.0	7.01	18.9	8.1
21	0.0	185.7	107	13.5	0.000	0.0	0.0	84.81	48.9	6.2
22	0.0	12.1	45	3.3	.080	0.0	I	R	R	R
23	0.0	1676.1	150	.3	.060	0.0	I	R	R	R

CYCLE COMPOSITE

HC	6.743	GRAM/BHP HR
CO	53.858	GRAM/BHP HR
NO2	13.006	GRAM/BHP HR
ALDE	0.000	GRAM/BHP HR
BSFC	.613	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

6-30-72 RUN 1 ENG. 2-3, 1972 VERSION, TIMING 16 BTDC W/AIR INJECTION

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	19.0	3.0	16.0	0	8996	.640	12.82	39
2	1200	6.0	1	20.8	5.9	16.0	0	3674	.350	13.77	64
3	1200	20.0	5	19.1	7.4	16.3	0	1073	.180	13.77	166
4	1200	45.0	10	18.1	8.6	16.1	0	2164	.130	14.05	900
5	1200	63.0	14	16.5	9.9	16.2	0	2423	.100	13.63	1750
6	1200	126.0	29	10.5	14.9	16.5	0	2248	.100	13.33	3300
7	1200	189.0	43	5.5	20.8	15.4	0	2552	.350	14.18	3150
8	1200	207.0	47	3.8	22.2	15.3	0	2449	.700	14.31	3350
9	1200	232.0	53	1.8	24.1	15.2	0	2526	.700	13.91	3200
10	1200	252.0	58	.2	31.9	12.9	0	4127	5.560	11.13	1475
11	600	0.0	0	19.5	2.9	14.7	0	5016	1.660	13.48	54
12	1200	0.0	0	23.5	2.7	16.5	0	58739	.440	6.91	9
13	2300	260.0	114	.4	63.2	12.7	0	3723	5.900	10.78	1550
14	2300	239.0	105	2.8	49.2	14.4	0	2337	1.940	13.18	2650
15	2300	213.0	93	4.8	45.0	14.4	0	2278	2.080	12.94	3250
16	2300	195.0	85	6.1	42.2	14.4	0	2307	2.020	13.06	3300
17	2300	130.0	57	10.5	30.1	16.3	0	1039	.180	13.18	5150
18	2300	65.0	28	16.0	19.5	16.4	0	898	.180	13.06	3250
19	2300	47.0	21	17.9	16.1	16.5	0	653	.160	13.18	1838
20	2300	21.0	9	19.6	13.4	16.6	0	404	.150	13.18	788
21	2300	5.0	2	21.2	11.0	16.6	0	337	.150	13.18	325
22	600	0.0	0	19.0	2.8	16.3	0	4803	.580	13.48	625
23	2300	0.0	0	25.2	2.9	20.6	0	49169	.350	4.64	9

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	85.3	123	1.2	.070	0.0	I	R	R	R
2	0.0	67.9	131	3.9	.060	.1	0.0	49.51	95.3	2.9
3	0.0	25.6	87	13.2	.060	.3	0.0	5.60	19.0	2.9
4	0.0	58.6	71	81.0	.050	.5	0.0	5.70	6.9	7.9
5	0.0	77.9	65	186.7	.030	.4	0.0	5.41	4.5	13.0
6	0.0	111.3	100	542.3	.060	1.7	0.0	3.87	3.5	18.8
7	0.0	162.9	451	667.4	0.000	0.0	0.0	3.77	10.4	15.5
8	0.0	161.6	933	734.2	.040	1.9	0.0	3.42	19.7	15.5
9	0.0	185.8	1040	781.4	0.000	0.0	0.0	3.50	19.6	14.7
10	0.0	349.2	9502	414.3	0.000	0.0	0.0	6.06	165.0	7.2
11	0.0	42.2	282	1.5	.070	0.0	I	R	R	R
12	0.0	544.0	82	.3	.120	0.0	I	R	R	R
13	0.0	625.8	20036	865.1	.025	2.8	0.0	5.50	176.0	7.6
14	0.0	339.6	5696	1278.8	.055	5.8	0.0	3.25	54.4	12.2
15	0.0	304.9	5625	1444.4	.035	3.3	0.0	3.27	60.3	15.5
16	0.0	288.5	5101	1369.7	.060	5.1	0.0	3.38	59.7	16.0
17	0.0	105.4	369	1733.9	.060	3.4	0.0	1.85	6.5	30.5
18	0.0	59.6	241	716.0	0.000	0.0	0.0	2.09	8.5	25.2
19	0.0	35.5	198	331.9	.065	1.3	0.0	1.73	9.6	16.1
20	0.0	18.4	138	118.9	0.000	0.0	0.0	2.00	15.0	12.9
21	0.0	12.6	113	40.3	0.000	0.0	0.0	5.75	51.7	18.4
22	0.0	42.0	102	18.1	.080	0.0	I	R	R	R
23	0.0	652.9	94	.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	7.938	GRAM/BHP HR
	CO	54.975	GRAM/BHP HR
	NO2	15.922	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.588	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

6-23-72 RUN 1 ENG. 2-3, 1972 VERSION, WITH FACT. AIR INJECTION

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	680	0.0	0	18.0	3.8	22.6	0	1628	.100	9.14	25
2	1200	4.0	1	19.6	7.0	23.4	0	433	.020	8.93	44
3	1200	18.0	4	18.6	8.5	22.6	0	651	.020	9.25	125
4	1200	40.0	9	17.5	9.3	22.2	0	1022	.020	9.37	345
5	1200	55.0	13	16.7	10.2	21.5	0	1156	.020	9.78	430
6	1200	110.0	25	10.3	14.9	20.0	0	1111	.020	10.78	875
7	1200	165.0	38	5.5	21.0	18.1	0	999	.070	11.84	1412
8	1200	180.0	41	4.2	22.3	17.7	0	947	.130	12.22	1537
9	1200	202.0	46	2.3	23.6	17.1	0	958	.150	12.22	1850
10	1200	220.0	50	.3	32.2	13.9	0	1596	4.120	11.01	835
11	680	0.0	0	18.5	3.5	21.4	0	723	.210	9.64	37
12	1200	0.0	0	22.7	3.3	28.2	0	39097	.130	2.99	3
13	2300	246.0	108	.6	66.1	12.9	0	2643	5.560	10.55	875
14	2300	226.0	99	3.1	48.3	15.2	0	532	.810	13.48	2000
15	2300	202.0	88	4.8	43.7	15.7	0	195	.470	13.48	1850
16	2300	185.0	81	5.9	41.9	15.6	0	121	.440	13.48	1500
17	2300	123.0	54	10.5	28.9	18.9	0	343	.150	11.36	1787
18	2300	62.0	27	15.5	20.1	20.8	0	548	.150	10.25	1188
19	2300	44.0	19	17.2	17.5	21.8	0	491	.130	9.64	730
20	2300	20.0	9	18.9	14.8	23.2	0	412	.130	8.93	330
21	2300	5.0	2	21.0	10.7	24.9	0	259	.100	8.48	100
22	680	0.0	0	18.0	3.5	22.0	0	1090	.180	9.50	35
23	2300	0.0	0	24.5	3.3	32.9	0	58597	.050	.13	2

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	29.8	37	1.5	.070	0.0	I	R	R	R
2	0.0	15.3	14	5.2	.060	.1	0.0	16.73	15.6	5.7
3	0.0	26.9	17	17.1	.060	.2	0.0	6.54	4.1	4.2
4	0.0	45.4	18	50.9	.050	.5	0.0	4.97	2.0	5.6
5	0.0	53.9	19	66.6	.030	.4	0.0	4.29	1.5	5.3
6	0.0	68.8	25	179.9	.060	1.5	0.0	2.74	1.0	7.2
7	0.0	79.2	112	371.9	0.000	0.0	0.0	2.10	3.0	9.9
8	0.0	77.0	213	414.8	.040	1.6	0.0	1.87	5.2	10.1
9	0.0	82.3	260	527.4	0.000	0.0	0.0	1.78	5.6	11.4
10	0.0	152.5	7950	264.8	0.000	0.0	0.0	3.03	158.2	5.3
11	0.0	11.6	68	2.0	.070	0.0	I	R	R	R
12	0.0	832.5	56	.2	.120	0.0	I	R	R	R
13	0.0	483.9	20565	531.9	.025	2.7	0.0	4.49	190.9	4.9
14	0.0	81.3	2499	1014.2	.055	5.4	0.0	.82	25.3	10.2
15	0.0	27.6	1347	871.5	.035	3.1	0.0	.31	15.2	9.9
16	0.0	16.6	1212	679.4	.060	4.9	0.0	.20	15.0	8.4
17	0.0	38.9	344	673.9	.060	3.2	0.0	.72	6.4	12.5
18	0.0	47.8	264	343.8	0.000	0.0	0.0	1.76	9.7	12.7
19	0.0	39.7	212	195.9	.065	1.3	0.0	2.06	11.0	10.2
20	0.0	30.4	194	80.8	0.000	0.0	0.0	3.47	22.1	9.2
21	0.0	14.6	114	18.7	0.000	0.0	0.0	6.67	52.0	8.6
22	0.0	17.7	59	1.9	.080	0.0	I	R	R	R
23	0.0	1452.3	25	.1	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	9.186	GRAM/BHP HR
	CO	33.763	GRAM/BHP HR
	NO2	9.138	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.647	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

6-26-72 RUN 3 ENG. 2-3, 1972 VERSION, TIMING 4 ATDC W/AIR INJECTION

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	16.5	5.2	21.7	0	216	.130	9.78	65
2	1200	3.0	1	18.8	5.4	22.9	0	144	.130	9.37	81
3	1200	14.0	3	18.3	8.3	22.7	0	196	.130	9.37	73
4	1200	31.0	7	16.6	9.2	21.8	0	418	.130	9.93	204
5	1200	43.0	10	16.2	10.0	21.4	0	438	.130	10.09	245
6	1200	86.0	20	9.8	15.5	19.9	0	292	.100	11.01	425
7	1200	129.0	29	5.5	20.5	17.3	0	513	.150	12.34	915
8	1200	141.0	32	3.4	22.6	17.3	0	1049	.150	12.34	1063
9	1200	158.0	36	2.7	25.2	16.8	0	2351	.310	12.59	1075
10	1200	172.0	39	.2	32.2	13.9	0	572	3.010	12.47	555
11	600	0.0	0	17.2	5.3	20.6	0	92	.130	10.55	88
12	1200	0.0	0	20.3	6.4	23.9	0	3403	.150	8.54	28
13	2300	210.0	92	.5	64.7	13.0	0	726	5.190	11.24	505
14	2300	193.0	85	3.2	48.0	15.1	0	45	.420	14.05	1287
15	2300	172.0	75	4.7	44.4	15.4	0	19	.150	14.05	1100
16	2300	158.0	69	6.0	41.6	15.7	0	19	.130	13.77	1000
17	2300	105.0	46	9.7	29.7	19.3	0	50	.100	11.24	840
18	2300	53.0	23	15.9	19.3	21.2	0	114	.100	10.25	550
19	2300	38.0	17	17.2	17.2	22.3	0	120	.100	9.37	350
20	2300	17.0	7	19.2	14.0	24.1	0	87	.100	8.75	130
21	2300	4.0	2	21.0	10.7	25.2	0	88	.100	8.43	62
22	600	0.0	0	16.5	6.0	21.8	0	132	.100	9.78	75
23	2300	0.0	0	23.2	6.2	51.0	0	26819	.150	1.15	2

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	5.1	62	5.1	.070	0.0	I	R	R	R
2	0.0	3.7	68	7.0	.060	.0	0.0	5.41	98.6	10.2
3	0.0	7.7	104	9.6	.060	.2	0.0	2.42	32.5	3.0
4	0.0	17.3	108	27.9	.050	.4	0.0	2.44	15.3	3.9
5	0.0	19.3	116	35.9	.030	.3	0.0	1.97	11.8	3.7
6	0.0	18.4	127	89.1	.060	1.2	0.0	.94	6.5	4.5
7	0.0	38.0	225	225.2	0.000	0.0	0.0	1.29	7.6	7.6
8	0.0	85.3	247	287.1	.040	1.3	0.0	2.65	7.7	8.9
9	0.0	204.6	545	310.6	0.000	0.0	0.0	5.67	15.1	8.6
10	0.0	53.7	5716	173.2	0.000	0.0	0.0	1.37	145.4	4.4
11	0.0	2.1	59	6.6	.070	0.0	I	R	R	R
12	0.0	109.4	97	3.0	.120	0.0	I	R	R	R
13	0.0	129.1	18644	298.2	.025	2.3	0.0	1.40	202.7	3.2
14	0.0	6.7	1276	643.0	.055	4.6	0.0	.08	15.1	7.6
15	0.0	2.8	430	517.9	.035	2.6	0.0	.04	5.7	6.9
16	0.0	2.6	356	450.6	.060	4.2	0.0	.04	5.2	6.5
17	0.0	5.9	240	331.2	.060	2.8	0.0	.13	5.2	7.2
18	0.0	9.6	171	154.3	0.000	0.0	0.0	.41	7.4	6.6
19	0.0	9.8	166	95.6	.065	1.1	0.0	.59	10.0	5.7
20	0.0	6.2	145	30.9	0.000	0.0	0.0	.83	19.5	4.2
21	0.0	5.0	115	11.7	0.000	0.0	0.0	2.84	65.5	6.7
22	0.0	3.6	56	6.9	.080	0.0	I	R	R	R
23	0.0	1894.2	214	.5	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	6.646	GRAM/BHP HR
	CO	32.118	GRAM/BHP HR
	NO2	6.506	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.811	LB/BHP HR

ENGINE 2-3

EFFECT OF EXHAUST MANIFOLD AIR INJECTION

GRAPHED RESULTS

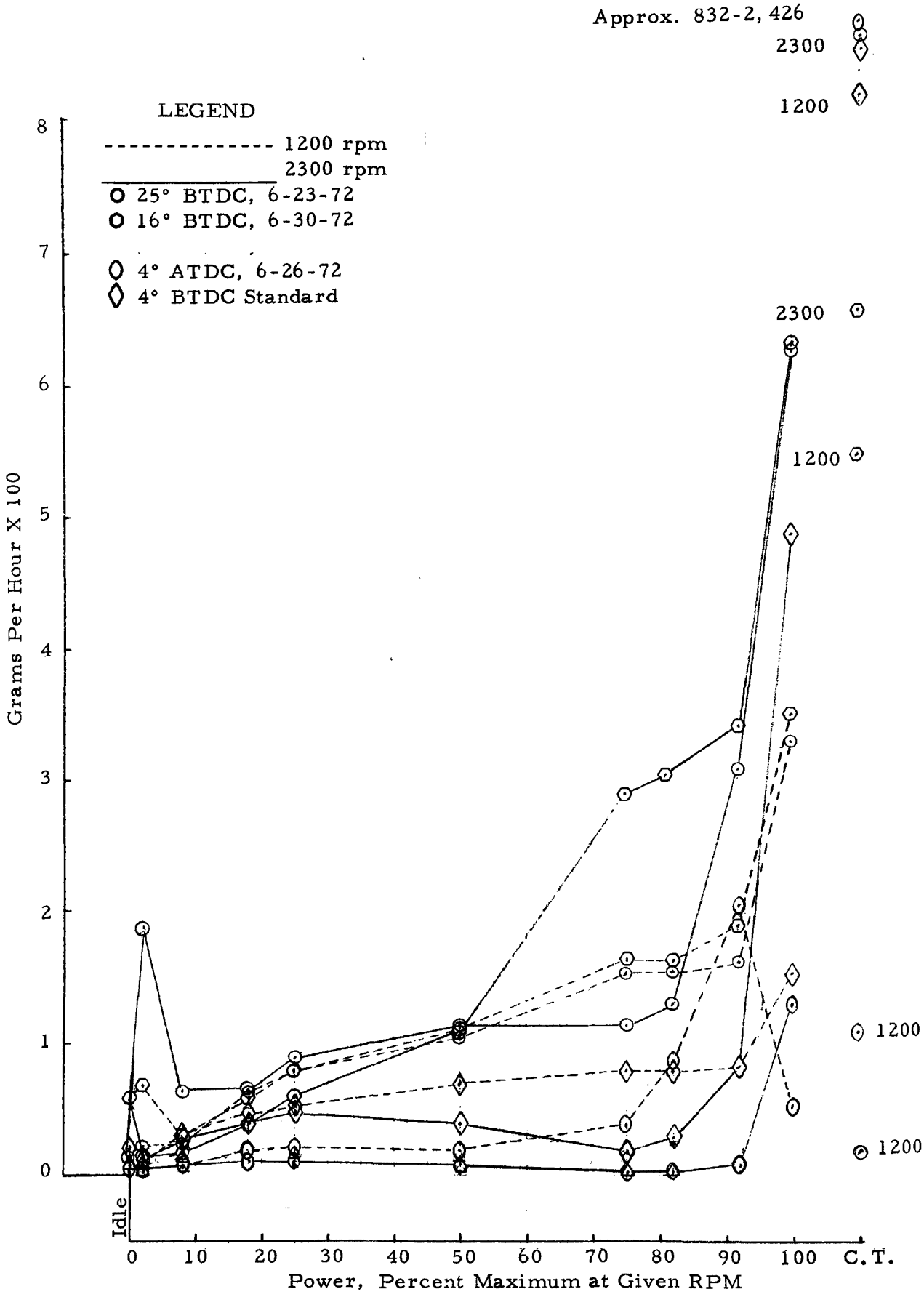


FIGURE J-1. EFFECT OF POWER ON HC EMISSION RATE - AIR INJECTION ENGINE 2-3, 23 MODE TEST

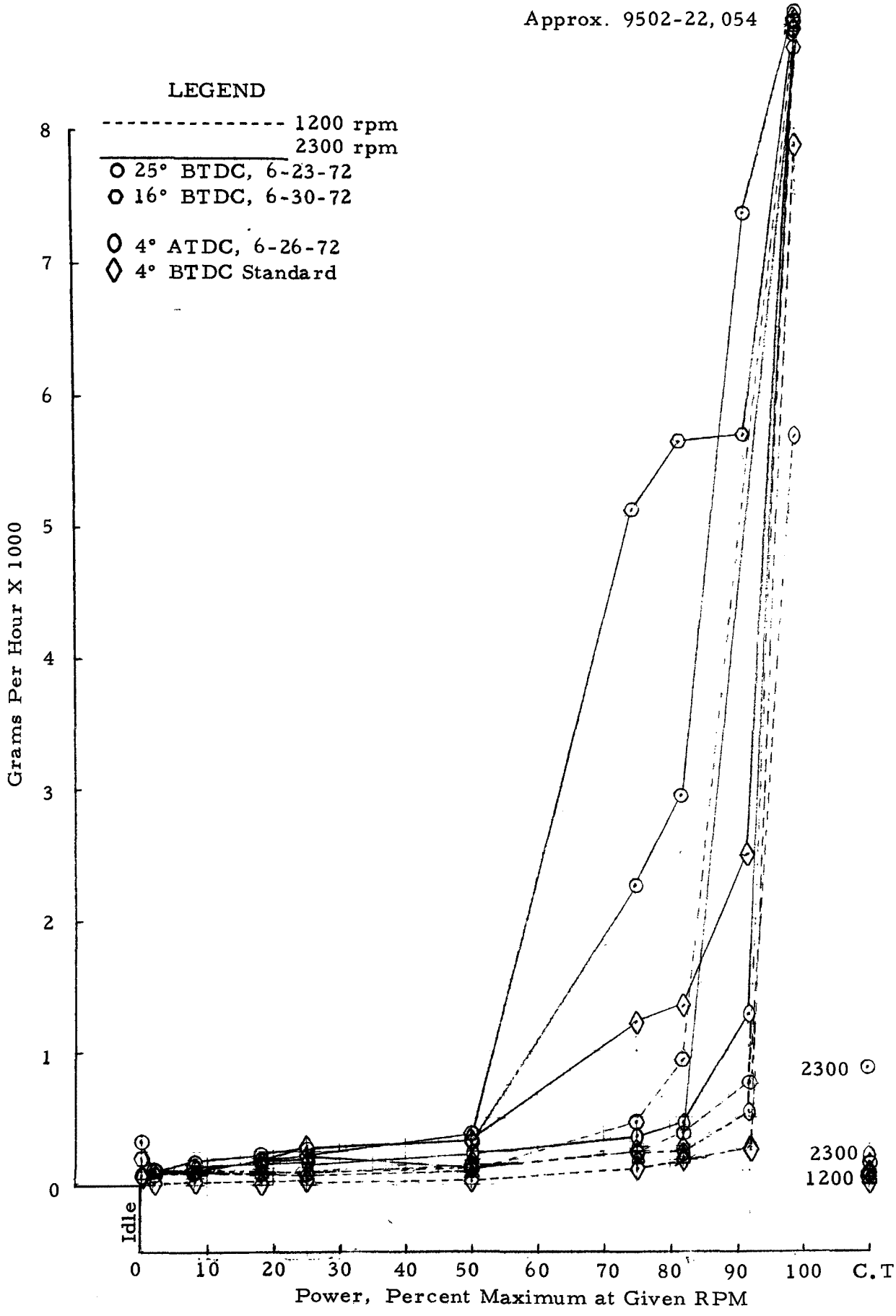


FIGURE J-2. EFFECT OF POWER ON CO EMISSION RATE - AIR INJECTION ENGINE 2-3, 23 MODE TEST

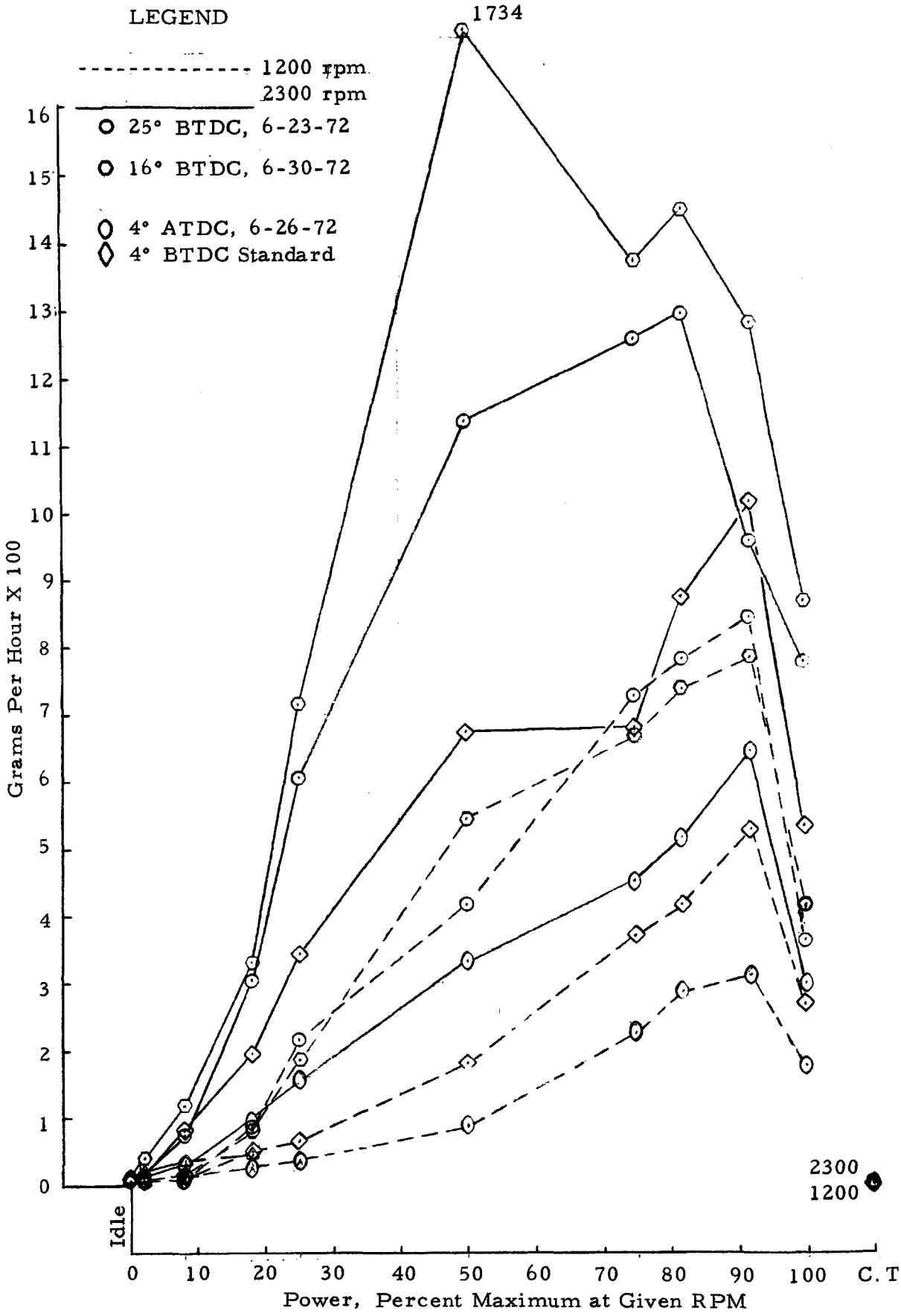


FIGURE J-3. EFFECT OF POWER ON NO_x (AS NO_2) EMISSION RATE - AIR INJECTION
ENGINE 2-3, 23 MODE TEST

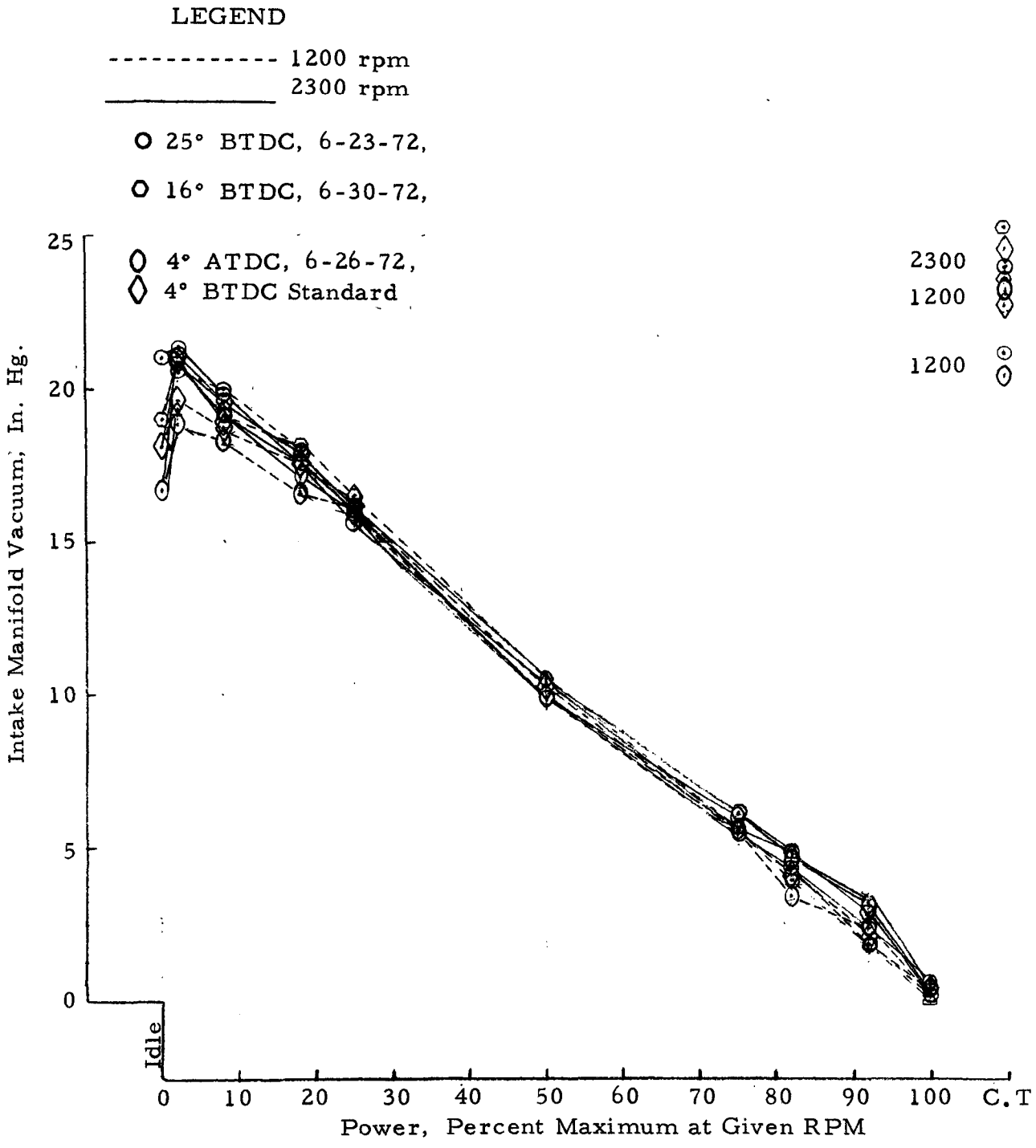


FIGURE J-4. MANIFOLD VACUUM AS A FUNCTION OF POWER
ENGINE 2-3, 23 MODE TEST

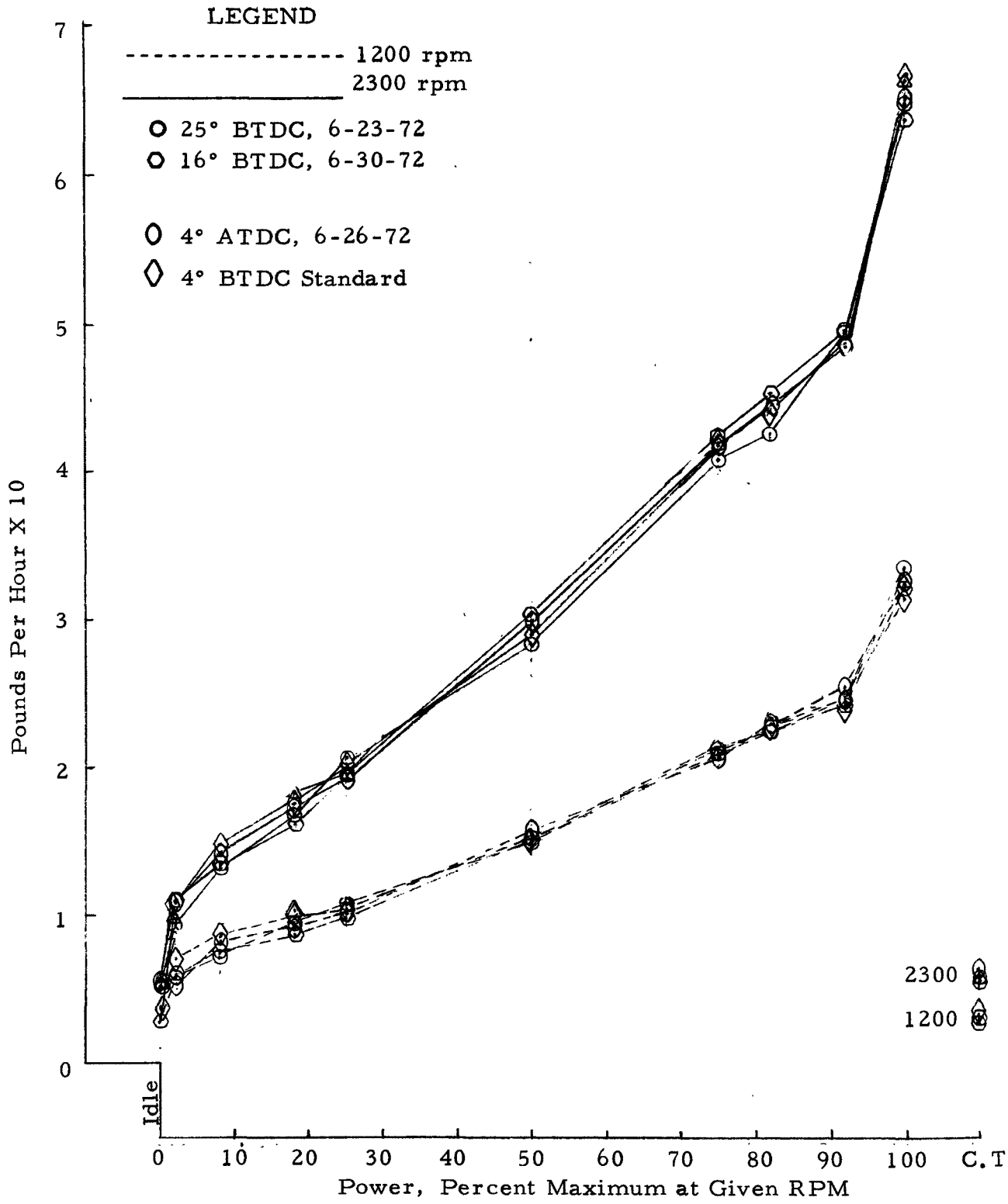


FIGURE J-5. FUEL CONSUMPTION AS A FUNCTION OF POWER
ENGINE 2-3, 23 MODE TEST

APPENDIX K

ENGINE 2-3

EFFECT OF FACTORY EGR ON EMISSIONS

(23 MODE MASS RESULTS)

ENGINE 2-3

EFFECT OF FACTORY EGR ON EMISSIONS

TABULAR DATA

PROJECT 11-2877-01 CONTROL TECHNOLOGY

6-27-72 RUN 3 ENG. 2-3, 1972 VERSION, TIMING 25 BTDC W/EGR

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	20.9	5.5	42.7	0	834	.150	4.45	74
2	1200	5.0	1	18.8	7.0	47.2	0	1920	.150	3.95	41
3	1200	20.0	5	14.0	8.7	45.8	0	9498	.150	3.35	34
4	1200	46.0	11	11.3	10.5	47.9	0	3571	.100	3.68	99
5	1200	64.0	15	10.0	11.5	48.2	0	2383	.100	3.81	122
6	1200	128.0	29	6.6	14.7	45.0	0	822	.070	4.36	134
7	1200	192.0	44	3.7	20.5	42.9	0	782	.130	4.45	2650
8	1200	210.0	48	3.0	22.0	42.9	0	771	.130	4.45	3500
9	1200	236.0	54	1.4	25.4	40.6	0	816	.310	4.64	3300
10	1200	256.0	58	.3	31.8	33.5	0	1432	2.250	3.50	1325
11	600	0.0	0	20.9	5.5	44.2	0	812	.310	4.19	77
12	1200	0.0	0	21.0	6.0	48.1	0	644	.180	3.95	76
13	2300	264.0	116	.6	63.8	12.6	0	1409	6.130	10.66	1425
14	2300	243.0	106	2.5	50.3	13.8	0	1149	3.060	13.06	1725
15	2300	216.0	95	4.0	44.0	14.3	0	1108	1.940	13.48	2300
16	2300	198.0	87	4.8	42.2	14.4	0	1130	1.940	13.33	2100
17	2300	132.0	58	8.1	30.0	15.8	0	724	.210	13.91	1350
18	2300	66.0	29	13.1	20.4	16.4	0	460	.180	13.48	435
19	2300	48.0	21	14.2	18.4	16.4	0	461	.180	13.18	295
20	2300	21.0	9	16.4	15.0	16.3	0	1150	.250	13.43	136
21	2300	5.0	2	17.6	12.7	16.6	0	3249	.310	12.71	80
22	600	0.0	0	20.8	5.6	15.3	0	454	.280	14.18	90
23	2300	0.0	0	23.5	5.8	20.2	0	26053	.580	7.46	9

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	44.4	161	13.2	.070	0.0	I	R	R	R
2	0.0	142.1	224	10.2	.060	.1	0.0	124.34	196.2	8.9
3	0.0	842.3	269	10.0	.060	.3	0.0	184.33	58.8	2.2
4	0.0	411.1	233	37.7	.050	.5	0.0	39.11	22.1	3.6
5	0.0	299.7	254	51.1	.030	.4	0.0	20.49	17.4	3.5
6	0.0	121.5	209	65.6	.060	1.8	0.0	4.16	7.1	2.2
7	0.0	156.1	524	1756.3	0.000	0.0	0.0	3.56	11.9	40.0
8	0.0	165.3	563	2489.9	.040	1.9	0.0	3.44	11.7	51.9
9	0.0	186.8	1434	2508.7	0.000	0.0	0.0	3.46	26.6	46.5
10	0.0	350.6	11124	1076.7	0.000	0.0	0.0	5.99	190.2	18.4
11	0.0	44.2	341	13.9	.070	0.0	I	R	R	R
12	0.0	41.8	236	16.4	.120	0.0	I	R	R	R
13	0.0	240.9	21165	808.7	.025	2.9	0.0	2.08	183.1	7.0
14	0.0	161.5	8687	804.9	.055	5.9	0.0	1.52	81.6	7.6
15	0.0	142.4	5036	981.3	.035	3.3	0.0	1.51	53.2	10.4
16	0.0	140.6	4876	867.6	.060	5.2	0.0	1.62	56.2	10.0
17	0.0	69.4	407	429.7	.060	3.5	0.0	1.20	7.0	7.4
18	0.0	31.0	245	97.5	0.000	0.0	0.0	1.07	8.5	3.4
19	0.0	28.7	226	61.0	.065	1.4	0.0	1.36	10.8	2.9
20	0.0	56.5	248	22.2	0.000	0.0	0.0	6.14	27.0	2.4
21	0.0	140.3	270	11.5	0.000	0.0	0.0	64.06	123.5	5.2
22	0.0	7.9	99	5.2	.080	0.0	I	R	R	R
23	0.0	643.9	290	.7	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	6.920	GRAM/BHP HR
	CO	62.334	GRAM/BHP HR
	NO2	10.827	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.639	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

6-28-72 RUN 1 ENG. 2-3, 16 BTDC W/EGR, DIST. VAC. FOR SIGNAL

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.5	4.9	15.2	0	6197	.770	12.94	40
2	1200	5.0	1	15.0	8.2	15.9	0	37057	.470	9.25	19
3	1200	20.0	5	13.4	9.0	15.7	0	18653	.440	11.84	48
4	1200	45.0	10	10.9	11.0	15.8	0	7996	.280	12.94	105
5	1200	63.0	14	9.2	12.6	15.7	0	3034	.210	13.77	164
6	1200	125.0	29	6.0	16.5	15.1	0	1873	.280	14.31	375
7	1200	188.0	43	3.7	20.4	15.0	0	2299	.440	14.18	2075
8	1200	205.0	47	3.1	21.7	15.1	0	2270	.390	14.18	2450
9	1200	230.0	53	1.8	23.8	14.9	0	2384	.580	14.05	2950
10	1200	250.0	57	.3	31.8	12.7	0	3865	5.500	11.13	1212
11	600	0.0	0	18.5	5.0	14.2	0	4334	1.870	13.33	71
12	1200	0.0	0	23.1	5.1	15.1	0	61702	.670	7.23	23
13	2300	264.0	116	.5	63.0	12.5	0	3780	6.020	10.66	1350
14	2300	243.0	106	2.9	48.2	14.2	0	2342	1.940	13.48	2300
15	2300	216.0	95	4.2	43.1	14.3	0	2212	2.020	13.33	1737
16	2300	198.0	87	4.9	41.3	14.3	0	2083	1.940	13.33	1350
17	2300	132.0	58	8.1	29.8	14.3	0	2170	2.020	13.33	1325
18	2300	66.0	29	13.0	20.0	15.5	0	1273	.550	13.63	820
19	2300	48.0	21	14.6	15.3	16.2	0	620	.180	13.63	275
20	2300	21.0	9	16.5	14.5	16.2	0	774	.210	13.48	145
21	2300	5.0	2	18.0	16.5	16.2	0	1799	.250	13.18	75
22	600	0.0	0	18.5	4.8	15.7	0	3654	.390	13.06	31
23	2300	0.0	0	24.7	5.0	18.1	0	40805	.420	7.56	9

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	96.1	241	2.1	.070	0.0	I	R	R	R
2	0.0	1026.6	263	1.8	.060	.1	0.0	898.66	230.2	1.5
3	0.0	538.3	257	4.6	.060	.3	0.0	117.80	56.1	1.0
4	0.0	284.6	201	12.4	.050	.5	0.0	27.68	19.6	1.2
5	0.0	121.4	170	21.8	.030	.4	0.0	8.44	11.8	1.5
6	0.0	94.8	286	63.1	.060	1.7	0.0	3.32	10.0	2.2
7	0.0	143.2	554	429.3	0.000	0.0	0.0	3.33	12.9	10.0
8	0.0	151.0	524	541.1	.040	1.9	0.0	3.22	11.2	11.6
9	0.0	173.1	851	711.1	0.000	0.0	0.0	3.29	16.2	13.5
10	0.0	327.7	9418	341.2	0.000	0.0	0.0	5.74	164.9	6.0
11	0.0	62.9	548	3.4	.070	0.0	I	R	R	R
12	0.0	1014.5	223	1.2	.120	0.0	I	R	R	R
13	0.0	633.3	20372	750.9	.025	2.9	0.0	5.48	176.2	6.5
14	0.0	327.2	5473	1066.5	.055	5.9	0.0	3.07	51.4	10.0
15	0.0	277.7	5123	724.3	.035	3.3	0.0	2.94	54.2	7.7
16	0.0	252.1	4743	542.5	.060	5.2	0.0	2.91	54.7	6.3
17	0.0	188.4	3543	382.0	.060	3.5	0.0	3.26	61.3	6.6
18	0.0	80.7	704	172.6	0.000	0.0	0.0	2.79	24.4	6.0
19	0.0	31.0	182	45.7	.065	1.4	0.0	1.48	8.7	2.2
20	0.0	37.0	203	23.0	0.000	0.0	0.0	4.02	22.0	2.5
21	0.0	98.9	278	13.8	0.000	0.0	0.0	45.18	126.8	6.3
22	0.0	57.6	124	1.6	.080	0.0	I	R	R	R
23	0.0	767.3	160	.6	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	14.054	GRAM/BHP HR
	CO	62.467	GRAM/BHP HR
	NO2	7.008	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.623	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

6-27-72 RUN 2 ENG. 2-3, 4 BTDC W/EGR, DIST. VAC. FOR SIGNAL

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	13.9	8.3	16.8	0	11990	.550	11.36	21
2	1200	4.0	1	13.4	8.6	17.5	0	11070	.440	11.13	20
3	1200	17.0	4	9.9	11.1	17.5	0	3348	.310	12.22	34
4	1200	39.0	9	7.7	13.7	15.3	0	621	.210	13.77	82
5	1200	54.0	12	6.9	15.0	15.3	0	323	.210	14.05	41
6	1200	108.0	25	5.2	17.2	15.4	0	368	.180	14.05	340
7	1200	162.0	37	3.6	19.6	15.3	0	504	.180	14.18	1012
8	1200	177.0	40	2.7	21.3	15.2	0	589	.490	13.91	1775
9	1200	199.0	45	1.8	22.7	15.1	0	760	.550	13.91	1887
10	1200	216.0	49	.3	29.7	12.8	0	1348	5.350	11.13	770
11	600	0.0	0	14.2	8.2	16.2	0	10923	.670	11.72	25
12	1200	0.0	0	14.1	8.3	16.4	0	11007	.610	11.48	23
13	2300	249.0	106	.5	61.7	12.6	0	1213	6.020	10.78	870
14	2300	221.0	97	2.8	44.3	14.2	0	892	1.980	13.48	1825
15	2300	199.0	87	3.8	42.4	14.2	0	879	2.020	13.33	1387
16	2300	182.0	80	4.7	39.1	14.3	0	769	1.800	13.33	1050
17	2300	122.0	53	7.5	31.5	15.1	0	380	.520	14.05	550
18	2300	61.0	27	11.5	21.5	16.3	0	109	.130	13.18	245
19	2300	44.0	19	13.8	18.4	16.3	0	169	.150	13.33	63
20	2300	19.0	8	15.2	15.5	16.2	0	276	.150	13.48	104
21	2300	5.0	2	16.6	13.6	16.1	0	865	.210	13.18	65
22	600	0.0	0	13.9	8.2	16.4	0	10348	.580	11.60	25
23	2300	0.0	0	20.0	8.7	18.9	0	20613	.580	8.60	4

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	344.3	319	2.1	.070	0.0	I	R	R	R
2	0.0	340.7	274	2.1	.060	.1	0.0	372.73	299.3	2.3
3	0.0	131.0	245	4.4	.060	.2	0.0	33.73	63.1	1.1
4	0.0	27.5	188	12.0	.050	.4	0.0	3.08	21.1	1.4
5	0.0	15.4	202	6.5	.030	.4	0.0	1.24	16.4	.5
6	0.0	20.1	199	61.7	.060	1.5	0.0	.82	8.1	2.5
7	0.0	31.1	224	207.4	0.000	0.0	0.0	.84	6.1	5.6
8	0.0	39.4	661	393.8	.040	1.6	0.0	.97	16.4	9.7
9	0.0	53.8	787	443.9	0.000	0.0	0.0	1.18	17.3	9.8
10	0.0	109.3	8763	207.3	0.000	0.0	0.0	2.22	177.6	4.2
11	0.0	301.3	373	2.3	.070	0.0	I	R	R	R
12	0.0	314.2	352	2.2	.120	0.0	I	R	R	R
13	0.0	200.7	20113	477.7	.025	2.7	0.0	1.89	189.0	4.5
14	0.0	115.2	5169	783.0	.055	5.3	0.0	1.19	53.4	8.1
15	0.0	109.5	5083	573.9	.035	3.1	0.0	1.26	58.3	6.6
16	0.0	89.7	4241	406.6	.060	4.8	0.0	1.13	53.2	5.1
17	0.0	37.2	1027	178.6	.060	3.2	0.0	.70	19.2	3.3
18	0.0	8.0	192	59.6	0.000	0.0	0.0	.30	7.2	2.2
19	0.0	10.4	187	12.8	.065	1.3	0.0	.54	9.7	.7
20	0.0	14.2	156	17.7	0.000	0.0	0.0	1.71	18.7	2.1
21	0.0	39.6	194	9.9	0.000	0.0	0.0	18.09	88.7	4.5
22	0.0	291.3	330	2.3	.080	0.0	I	R	R	R
23	0.0	723.6	411	.5	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	8.417	GRAM/BHP HR
	CO	62.101	GRAM/BHP HR
	NO2	5.412	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.753	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

6-29-72 RUN 1 ENG. 2-3, 1972 VERSION, TIMING 4 ATDC W/EGR

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	16.5	4.7	15.3	0	1984	.700	13.77	65
2	1200	3.0	1	13.0	9.8	13.1	0	20565	.470	11.60	28
3	1200	13.0	3	7.4	14.2	15.8	0	735	.130	14.05	67
4	1200	29.0	7	6.4	15.5	15.4	0	307	.150	14.66	98
5	1200	41.0	9	5.9	16.3	15.2	0	626	.250	14.66	117
6	1200	81.0	19	4.6	18.7	15.3	0	1296	.250	14.53	280
7	1200	122.0	28	3.0	21.2	15.1	0	1207	.350	14.66	720
8	1200	133.0	30	2.7	22.1	15.1	0	1161	.390	14.53	450
9	1200	149.0	34	1.8	24.0	14.9	0	2280	.740	14.42	1125
10	1200	162.0	37	.2	30.3	12.8	0	2518	5.450	11.60	500
11	600	0.0	0	16.7	4.1	14.5	0	2491	1.800	13.91	65
12	1200	0.0	0	22.0	4.4	15.5	0	46759	.700	8.75	15
13	2300	206.0	90	.5	64.1	12.5	0	2743	6.070	10.66	500
14	2300	189.0	83	2.8	47.1	14.4	0	1154	1.800	13.63	938
15	2300	169.0	74	3.9	44.4	14.3	0	1029	1.980	13.48	600
16	2300	155.0	68	4.4	43.0	14.3	0	971	1.940	13.48	470
17	2300	103.0	45	6.5	34.7	14.4	0	948	1.550	13.77	300
18	2300	52.0	23	9.9	25.2	16.3	0	25	.070	13.48	165
19	2300	37.0	16	11.8	22.3	16.4	0	28	.070	13.48	126
20	2300	16.0	7	14.4	17.7	16.3	0	74	.100	13.48	90
21	2300	4.0	2	16.0	14.1	16.3	0	619	.130	13.48	68
22	600	0.0	0	16.5	4.0	15.3	0	1515	.550	13.77	65
23	2300	0.0	0	24.2	4.1	18.0	0	28256	.350	9.03	18

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	28.8	206	3.1	.070	0.0	I	R	R	R
2	0.0	647.1	299	3.0	.060	.0	0.0	944.11	435.8	4.3
3	0.0	33.2	119	10.1	.060	.2	0.0	11.19	40.0	3.4
4	0.0	14.5	144	15.3	.050	.3	0.0	2.19	21.7	2.3
5	0.0	30.9	249	19.3	.030	.3	0.0	3.30	26.6	2.1
6	0.0	73.7	287	52.9	.060	1.1	0.0	3.98	15.5	2.9
7	0.0	76.7	449	151.9	0.000	0.0	0.0	2.75	16.1	5.5
8	0.0	77.4	525	99.6	.040	1.2	0.0	2.55	17.3	3.3
9	0.0	161.3	1058	264.2	0.000	0.0	0.0	4.74	31.1	7.8
10	0.0	200.0	8745	131.9	0.000	0.0	0.0	5.40	236.3	3.6
11	0.0	29.0	424	2.5	.070	0.0	I	R	R	R
12	0.0	660.7	200	.7	.120	0.0	I	R	R	R
13	0.0	468.9	20966	283.8	.025	2.3	0.0	5.20	232.4	3.1
14	0.0	158.6	4997	427.8	.055	4.6	0.0	1.92	60.4	5.2
15	0.0	133.1	5176	257.8	.035	2.6	0.0	1.80	69.9	3.5
16	0.0	122.1	4926	196.1	.060	4.1	0.0	1.80	72.6	2.9
17	0.0	96.8	3197	101.7	.060	2.7	0.0	2.15	70.9	2.3
18	0.0	2.1	119	46.2	0.000	0.0	0.0	.09	5.2	2.0
19	0.0	2.1	106	31.3	.065	1.1	0.0	.13	6.5	1.9
20	0.0	4.4	119	17.7	0.000	0.0	0.0	.63	17.0	2.5
21	0.0	29.0	123	10.5	0.000	0.0	0.0	16.54	70.1	6.0
22	0.0	19.0	139	2.7	.080	0.0	I	R	R	R
23	0.0	430.5	108	.9	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	9.763	GRAM/BHP HR
	CO	80.339	GRAM/BHP HR
	NO2	3.413	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.897	LB/BHP HR

ENGINE 2-3

EFFECT OF FACTORY EGR ON EMISSIONS

GRAPHED RESULTS

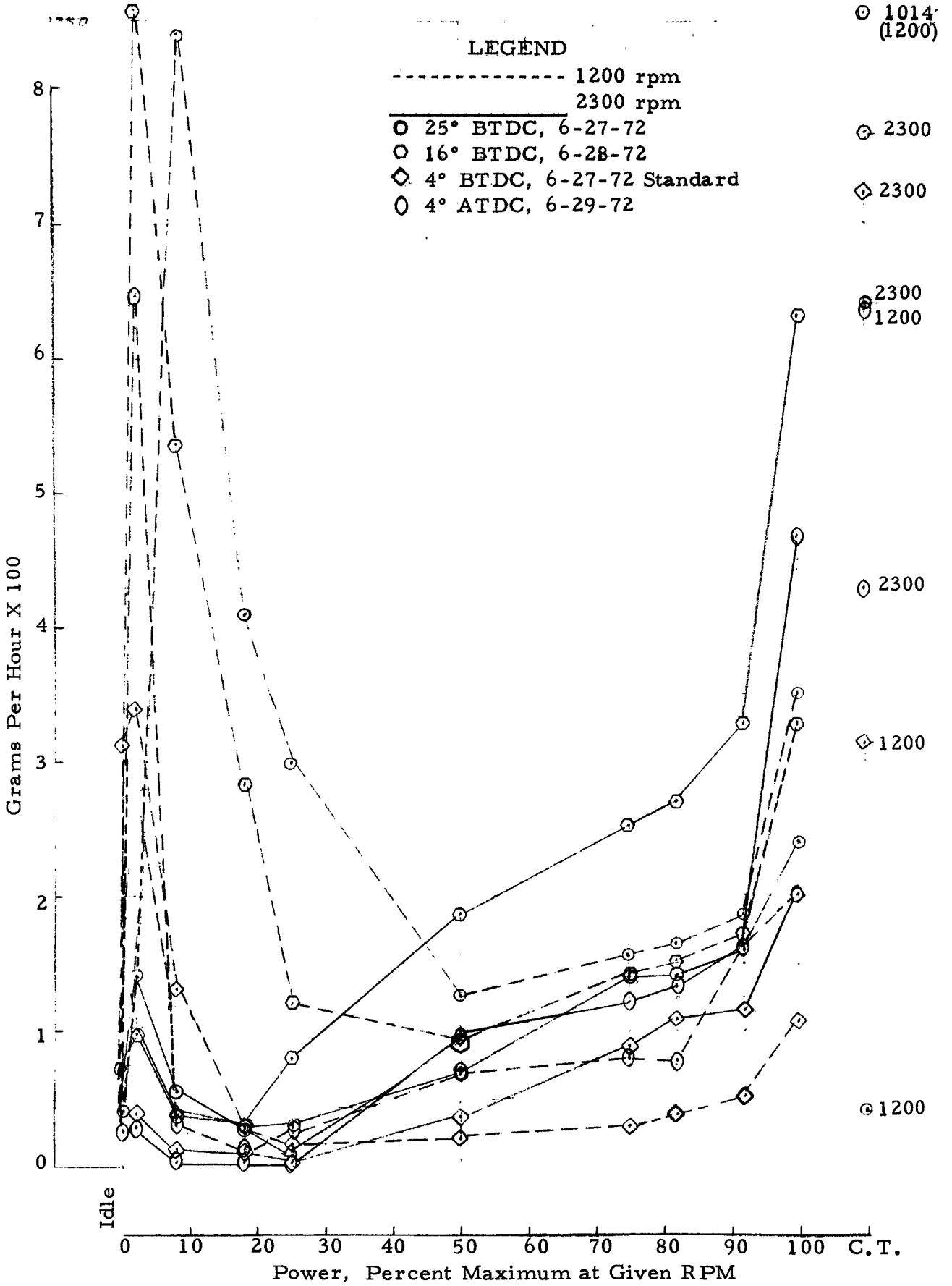


FIGURE K-1. EFFECT OF POWER ON HC EMISSION RATE - FACTORY EGR ENGINE 2-3, 23 MODE TEST

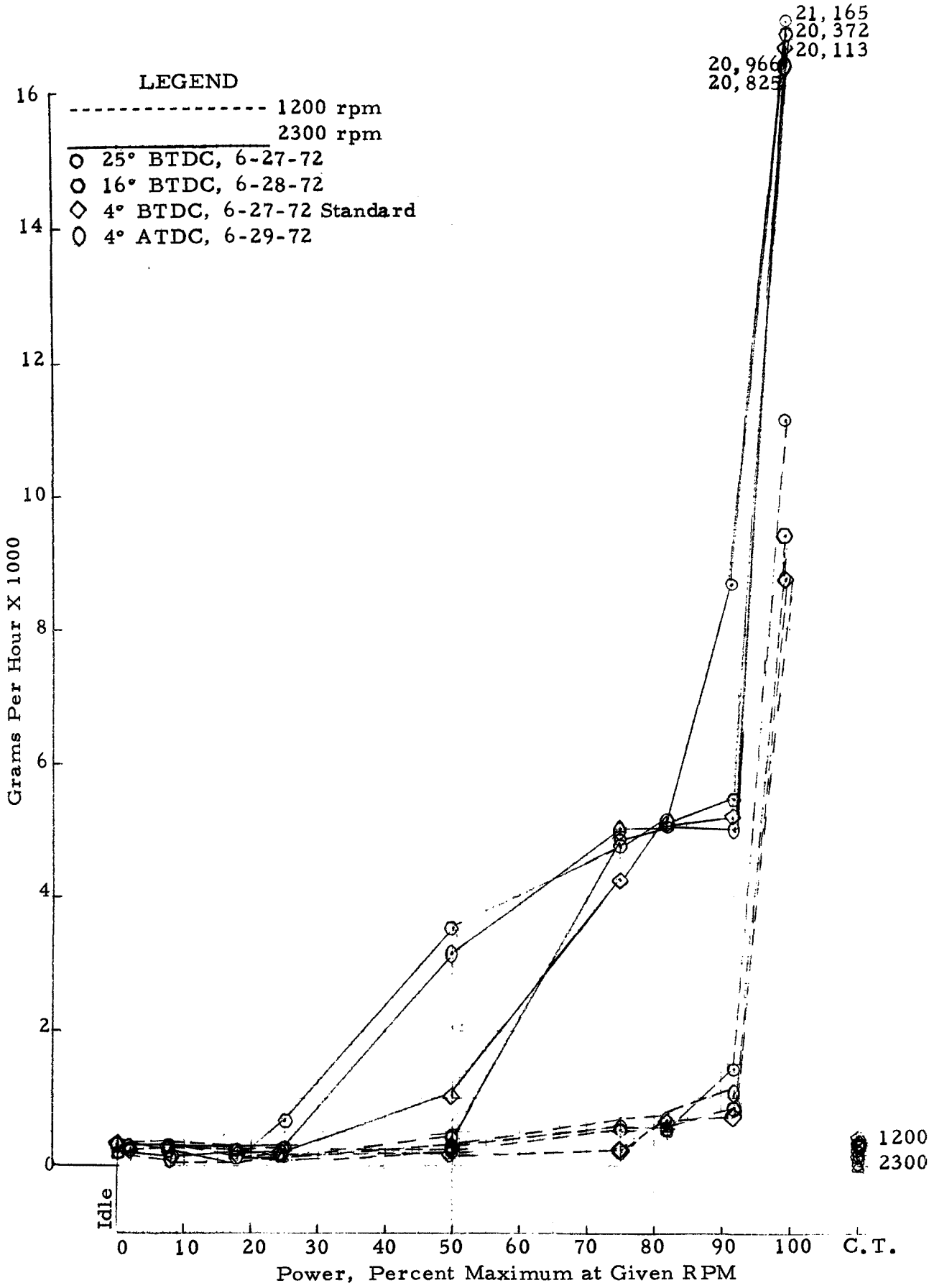


FIGURE K-2. EFFECT OF POWER ON CO EMISSION RATE - FACTORY EGR ENGINE 2-3, 23 MODE TEST

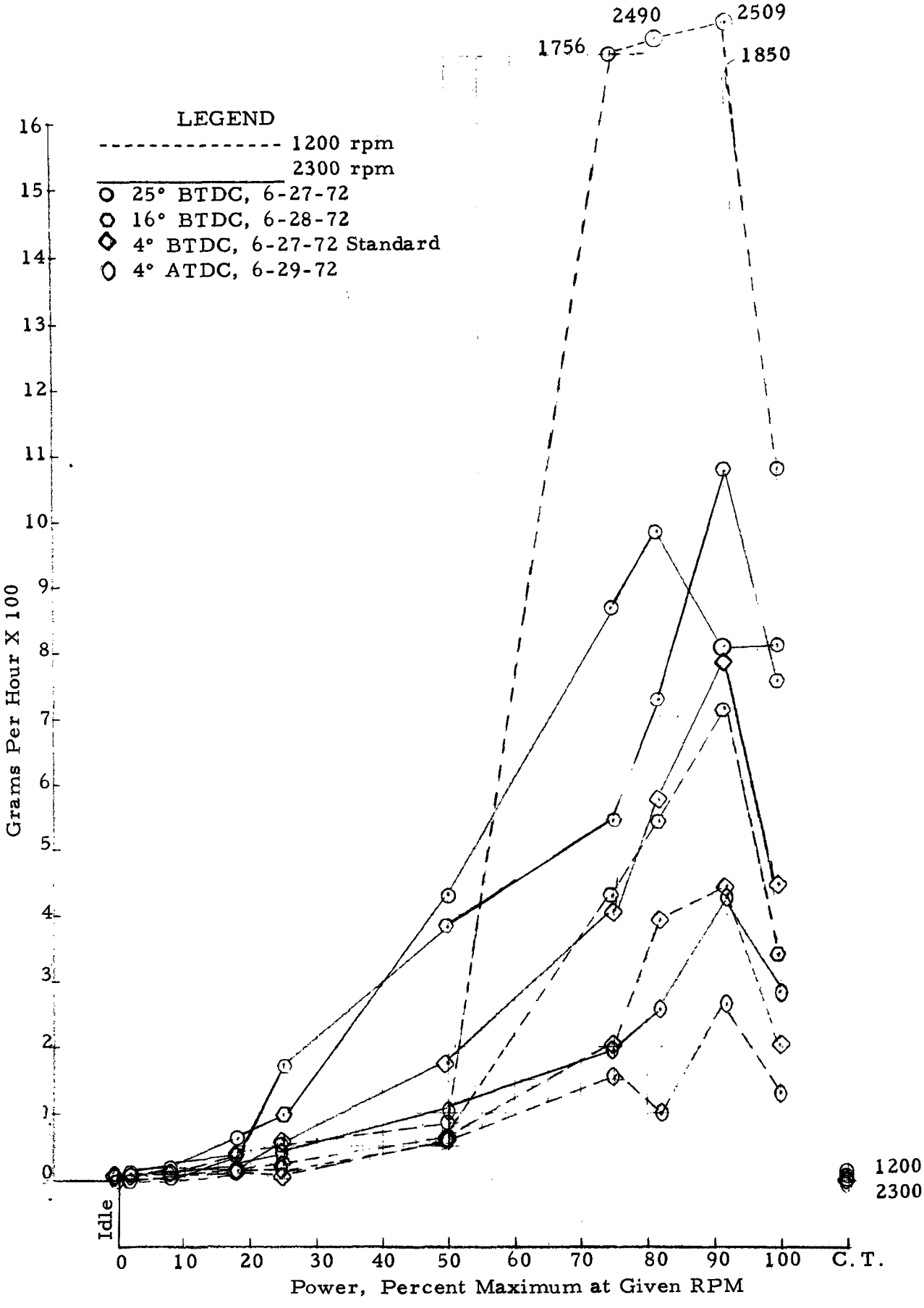


FIGURE K-3. EFFECT OF POWER ON NO_x (AS NO_2) EMISSION RATE - FACTORY EC
ENGINE 2-3, 23 MODE TEST

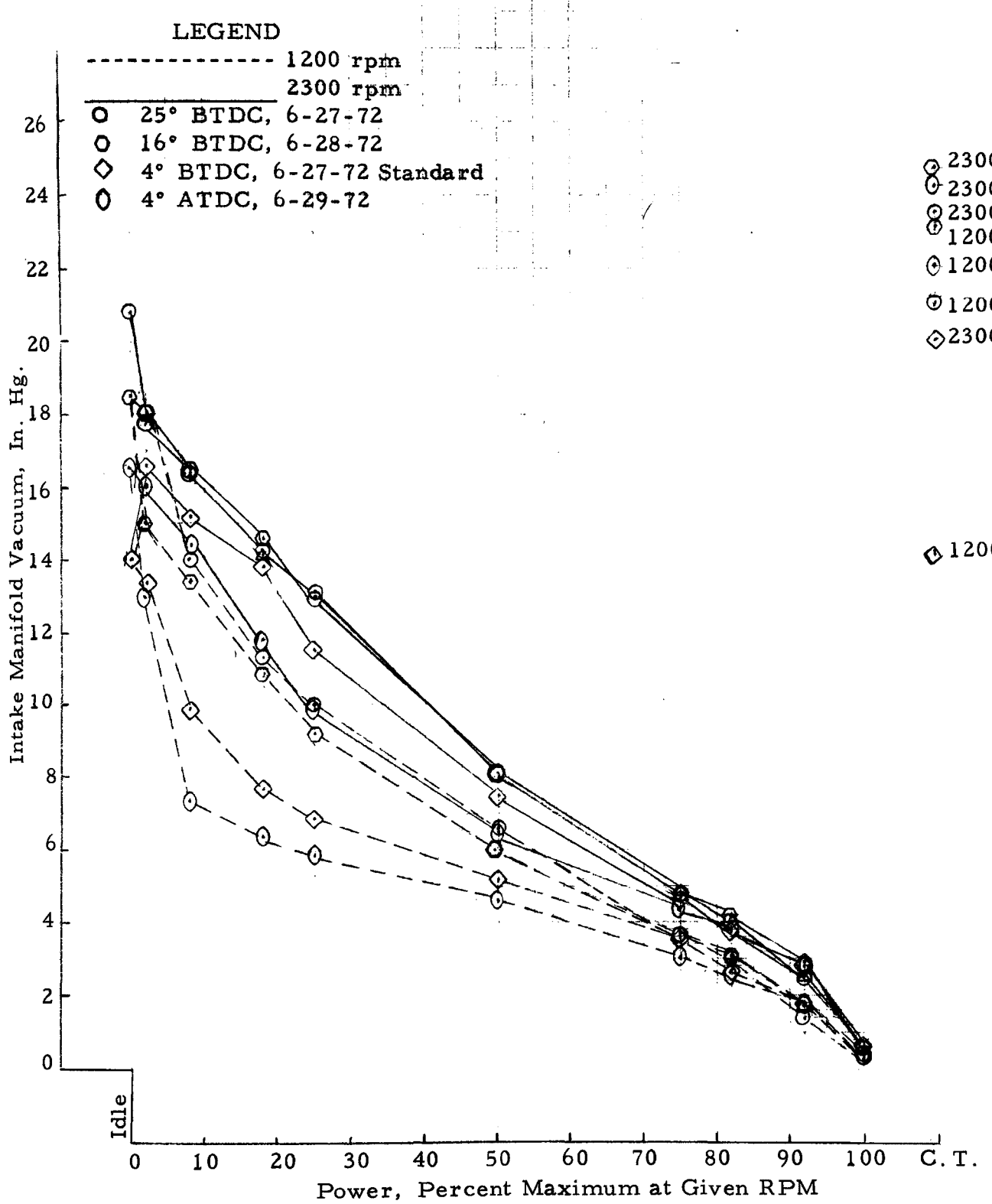


FIGURE K-4. MANIFOLD VACUUM AS A FUNCTION OF POWER - FACTORY EGR
ENGINE 2-3, 23 MODE TEST

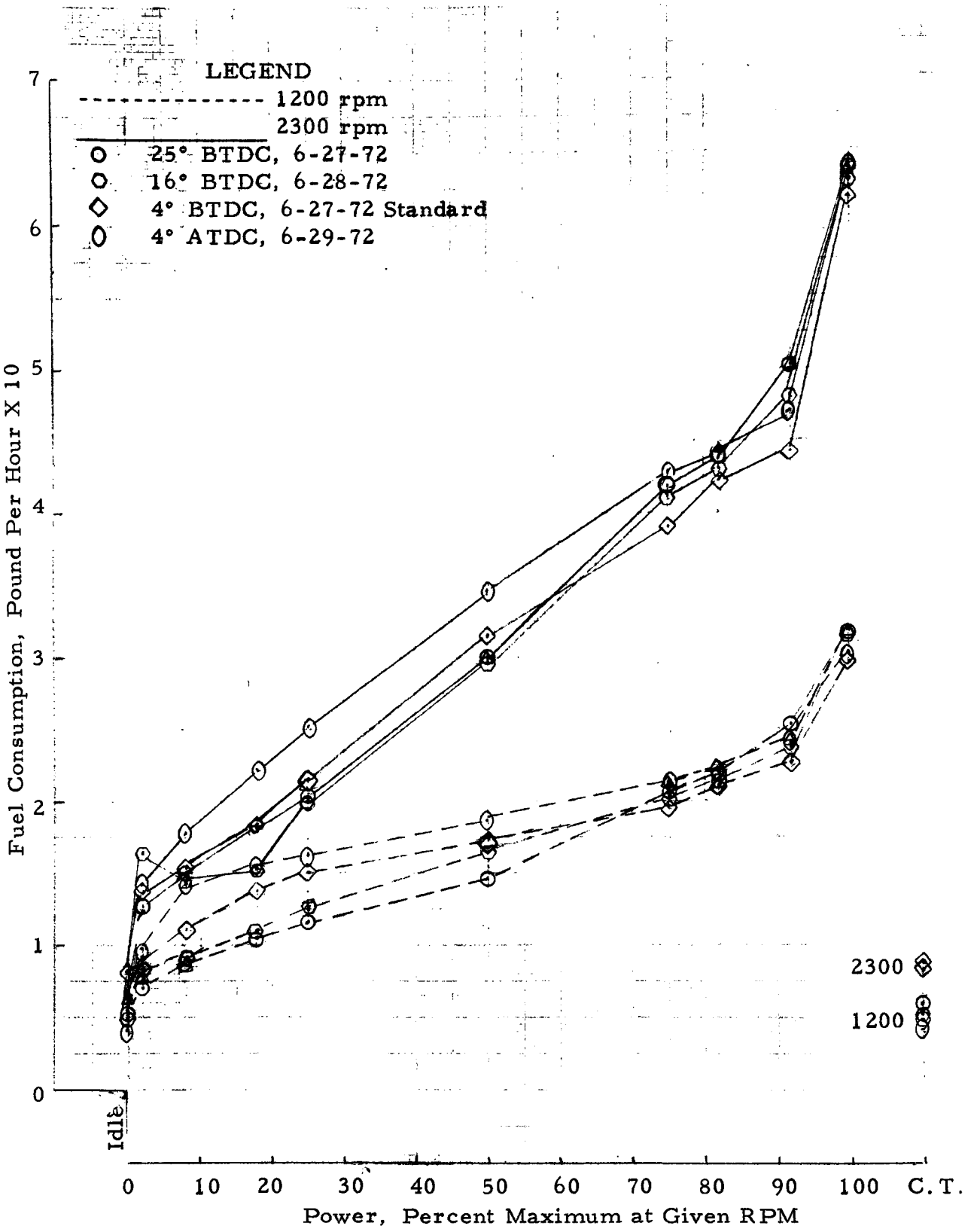


FIGURE K-5. FUEL CONSUMPTION AS A FUNCTION OF POWER - FACTORY EGI
ENGINE 2-3, 23 MODE TEST

APPENDIX L

ENGINE 2-3

EFFECT OF LABORATORY EGR ON EMISSIONS

(23 MODE MASS RESULTS)

ENGINE 2-3

EFFECT OF LABORATORY EGR ON EMISSIONS

TABULAR DATA

PROJECT 11-2877-01 CONTROL TECHNOLOGY

7-18-72 RUN-1 ENG. 2-3 1972 VERSION W/EGR MANIFOLD -NO EGR

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.5	3.6	16.7	0	3420	.420	12.71	39
2	1200	4.0	1	19.4	7.3	16.6	0	721	.150	13.48	68
3	1200	18.0	4	18.4	8.1	16.6	0	800	.150	13.48	119
4	1200	40.0	9	17.2	9.2	16.5	0	1396	.150	13.48	350
5	1200	56.0	13	16.4	10.2	16.5	0	1531	.150	13.48	490
6	1200	112.0	26	10.5	14.1	16.5	0	1385	.130	13.48	1125
7	1200	168.0	38	4.5	21.4	16.2	0	1230	.130	13.77	1550
8	1200	184.0	42	3.5	22.4	16.0	0	1242	.150	13.77	1750
9	1200	206.0	47	2.0	24.5	15.7	0	1368	.350	13.77	1625
10	1200	224.0	51	.6	26.2	15.3	0	1758	.770	13.77	1712
11	600	0.0	0	17.5	3.6	15.7	0	2459	.640	13.48	51
12	1200	0.0	0	22.5	3.8	15.9	0	55569	.420	7.00	12
13	2300	244.0	107	.8	69.0	12.2	0	4146	7.340	9.93	640
14	2300	224.0	98	3.3	48.9	14.6	0	1680	1.800	13.63	1537
15	2300	200.0	88	5.0	42.8	15.2	0	1046	1.010	13.77	1675
16	2300	183.0	80	5.8	41.2	15.7	0	730	.520	13.77	1563
17	2300	122.0	53	11.9	30.1	16.2	0	892	.180	13.77	2100
18	2300	61.0	27	16.6	19.6	16.7	0	598	.150	13.63	1087
19	2300	44.0	19	18.0	16.9	16.8	0	417	.150	13.48	580
20	2300	20.0	9	19.5	14.6	16.9	0	320	.130	13.33	395
21	2300	5.0	2	20.3	12.5	17.2	0	188	.130	13.18	190
22	600	0.0	0	17.7	3.6	17.1	0	287	.440	12.94	44
23	2300	0.0	0	24.7	3.6	18.3	0	40310	.350	7.75	11

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	41.5	103	1.6	.070	0.0	I	R	R	R
2	0.0	17.4	73	5.4	.060	.1	0.0	19.06	80.1	5.9
3	0.0	21.4	81	10.6	.060	.2	0.0	5.21	19.7	2.6
4	0.0	42.3	92	35.2	.050	.5	0.0	4.63	10.0	3.9
5	0.0	51.4	102	54.6	.030	.4	0.0	4.02	7.9	4.3
6	0.0	64.4	122	173.8	.060	1.5	0.0	2.52	4.8	6.8
7	0.0	85.2	182	356.2	0.000	0.0	0.0	2.22	4.7	9.3
8	0.0	89.8	219	420.3	.040	1.7	0.0	2.14	5.2	10.0
9	0.0	106.6	551	420.5	0.000	0.0	0.0	2.27	11.7	8.9
10	0.0	142.0	1256	459.2	0.000	0.0	0.0	2.77	24.5	9.0
11	0.0	28.0	147	1.9	.070	0.0	I	R	R	R
12	0.0	738.1	113	.5	.120	0.0	I	R	R	R
13	0.0	733.8	26241	376.0	.025	2.7	0.0	6.87	245.6	3.5
14	0.0	238.9	5171	725.9	.055	5.4	0.0	2.44	52.7	7.4
15	0.0	136.4	2661	725.3	.035	3.1	0.0	1.56	30.4	8.3
16	0.0	95.0	1367	675.0	.060	4.8	0.0	1.19	17.1	8.4
17	0.0	86.7	354	678.0	.060	3.2	0.0	1.62	6.6	12.7
18	0.0	38.4	195	231.9	0.000	0.0	0.0	1.44	7.3	8.7
19	0.0	23.4	170	108.0	.065	1.3	0.0	1.21	8.8	5.6
20	0.0	15.7	129	64.4	0.000	0.0	0.0	1.80	14.7	7.3
21	0.0	8.0	112	26.8	0.000	0.0	0.0	3.65	51.0	12.3
22	0.0	3.5	108	1.8	.080	0.0	I	R	R	R
23	0.0	542.6	95	.5	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	7.609	GRAM/BHP HR
	CO	49.526	GRAM/BHP HR
	NO2	7.876	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.654	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

7-19-72 RUN-1 ENG. 2-3 1972 VERSION W/EGR MAN NO EGR S+D TIMING

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.3	3.2	17.1	0	7783	.180	11.92	34
2	1200	5.0	1	19.1	7.4	16.4	0	467	.150	13.48	76
3	1200	18.0	4	18.6	8.2	16.4	0	901	.150	13.48	182
4	1200	41.0	9	17.3	11.3	17.3	0	916	.150	12.47	320
5	1200	58.0	13	15.8	13.2	17.4	0	1005	.150	12.47	530
6	1200	115.0	26	9.8	14.1	17.0	0	906	.130	12.71	925
7	1200	173.0	40	3.9	21.6	16.6	0	910	.130	13.18	1450
8	1200	189.0	43	2.8	22.4	16.5	0	865	.130	13.18	1500
9	1200	212.0	48	1.2	24.7	16.2	0	1146	.130	13.18	1850
10	1200	230.0	53	.5	31.9	13.4	0	291	5.240	11.24	738
11	600	0.0	0	17.8	3.4	16.1	0	2414	.210	13.06	48
12	1200	0.0	0	22.8	3.2	16.1	0	54316	.390	6.64	11
13	2300	244.0	107	.2	62.8	13.0	0	2503	5.190	11.13	975
14	2300	224.0	98	3.0	48.8	14.3	0	1677	2.280	12.94	1475
15	2300	200.0	88	4.4	43.3	15.5	0	634	.610	13.63	1675
16	2300	183.0	80	5.4	42.1	15.6	0	712	.520	13.48	1662
17	2300	122.0	53	10.9	30.2	16.2	0	636	.150	13.48	1987
18	2300	61.0	27	16.4	19.4	16.8	0	527	.150	12.94	1175
19	2300	44.0	19	17.5	17.7	16.8	0	448	.130	12.94	2287
20	2300	20.0	9	19.6	12.8	17.0	0	230	.130	13.06	320
21	2300	5.0	2	20.5	12.3	17.1	0	160	.180	12.82	180
22	600	0.0	0	18.3	3.2	17.3	0	3235	.250	12.22	39
23	2300	0.0	0	24.8	3.4	21.5	0	44869	.250	4.45	7

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	87.7	41	1.3	.070	0.0	I	R	R	R
2	0.0	11.5	74	6.2	.060	.1	0.0	10.04	65.1	5.4
3	0.0	24.4	82	16.4	.060	.2	0.0	5.94	20.0	4.0
4	0.0	36.9	122	42.8	.050	.5	0.0	3.94	13.0	4.6
5	0.0	47.3	143	82.8	.030	.4	0.0	3.57	10.8	6.2
6	0.0	44.8	130	151.9	.060	1.6	0.0	1.71	4.9	5.8
7	0.0	66.5	192	352.0	0.000	0.0	0.0	1.68	4.9	8.9
8	0.0	65.6	199	377.7	.040	1.7	0.0	1.52	4.6	8.7
9	0.0	95.6	219	512.6	0.000	0.0	0.0	1.97	4.5	10.6
10	0.0	25.5	9277	214.6	0.000	0.0	0.0	.49	176.5	4.1
11	0.0	27.6	48	1.8	.070	0.0	I	R	R	R
12	0.0	632.7	92	.4	.120	0.0	I	R	R	R
13	0.0	430.3	18023	556.5	.025	2.7	0.0	4.03	168.7	5.2
14	0.0	241.2	6625	704.4	.055	5.4	0.0	2.46	67.5	7.2
15	0.0	87.0	1692	763.6	.035	3.1	0.0	.99	19.3	8.7
16	0.0	96.6	1426	748.8	.060	4.8	0.0	1.21	17.8	9.3
17	0.0	63.6	303	659.9	.060	3.2	0.0	1.19	5.7	12.4
18	0.0	35.3	203	261.2	0.000	0.0	0.0	1.32	7.6	9.8
19	0.0	27.4	161	464.9	.065	1.3	0.0	1.42	8.3	24.1
20	0.0	10.1	115	46.7	0.000	0.0	0.0	1.15	13.2	5.3
21	0.0	6.8	156	25.6	0.000	0.0	0.0	3.13	71.2	11.7
22	0.0	36.7	57	1.5	.080	0.0	I	R	R	R
23	0.0	753.2	85	.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	7.287	GRAM/BHP HR
	CO	42.229	GRAM/BHP HR
	NO2	9.032	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.651	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

7-19-72 RUN-2 ENG.2-3 1972 VERSION -STD W/EGR-MANIFOLD NO-EGR

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.2	3.3	16.5	0	2386	.350	12.94	50
2	1200	5.0	1	19.5	7.1	17.0	0	538	.130	12.94	58
3	1200	18.0	4	18.8	7.5	16.8	0	908	.150	12.94	128
4	1200	41.0	9	17.5	9.0	16.6	0	1460	.130	13.18	450
5	1200	58.0	13	16.6	9.8	16.8	0	1515	.130	13.06	600
6	1200	115.0	26	9.8	15.7	17.2	0	1029	.130	12.71	800
7	1200	173.0	40	4.0	21.6	16.5	0	965	.150	13.06	142
8	1200	189.0	43	2.9	22.5	16.6	0	876	.130	13.18	1575
9	1200	212.0	48	1.3	23.9	16.0	0	1152	.210	13.77	1875
10	1200	230.0	53	.5	31.2	13.3	0	2907	4.880	11.48	870
11	600	0.0	0	18.2	3.2	16.5	0	2021	.440	12.82	46
12	1200	0.0	0	22.9	3.5	19.8	0	50331	.310	4.94	7
13	2300	248.0	109	.9	62.8	13.0	0	2535	5.350	11.13	1075
14	2300	228.0	100	2.9	49.6	14.5	0	1667	1.870	13.48	1625
15	2300	203.0	89	4.4	44.3	15.4	0	680	.700	13.77	1700
16	2300	186.0	81	5.5	42.2	15.4	0	862	.740	13.77	1650
17	2300	124.0	54	11.1	29.7	16.3	0	677	.180	13.63	2037
18	2300	62.0	27	16.4	19.6	16.8	0	539	.150	13.06	1175
19	2300	45.0	20	17.7	17.4	16.9	0	410	.150	13.18	800
20	2300	20.0	9	19.5	13.9	17.0	0	221	.130	12.94	330
21	2300	5.0	2	20.4	12.7	17.1	0	159	.130	13.06	200
22	600	0.0	0	18.3	3.4	17.6	0	2092	.310	12.22	42
23	2300	0.0	0	24.9	3.5	25.4	0	46340	.180	3.04	5

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	26.4	78	1.8	.070	0.0	I	R	R	R
2	0.0	13.2	64	4.7	.060	.1	0.0	11.56	56.4	4.1
3	0.0	23.4	78	11.0	.060	.2	0.0	5.70	19.0	2.7
4	0.0	44.3	80	45.3	.050	.5	0.0	4.73	8.5	4.8
5	0.0	50.5	87	66.4	.030	.4	0.0	3.81	6.6	5.0
6	0.0	56.6	144	146.1	.060	1.6	0.0	2.16	5.5	5.6
7	0.0	71.1	223	34.8	0.000	0.0	0.0	1.80	5.6	.9
8	0.0	66.7	200	398.3	.040	1.7	0.0	1.55	4.6	9.2
9	0.0	88.6	326	478.8	0.000	0.0	0.0	1.83	6.7	9.9
10	0.0	247.1	8378	245.5	0.000	0.0	0.0	4.70	159.4	4.7
11	0.0	21.8	96	1.6	.070	0.0	I	R	R	R
12	0.0	777.1	97	.4	.120	0.0	I	R	R	R
13	0.0	431.6	18397	607.6	.025	2.7	0.0	3.97	169.4	5.6
14	0.0	241.8	5477	782.3	.055	5.5	0.0	2.42	54.9	7.8
15	0.0	94.0	1954	780.1	.035	3.1	0.0	1.06	22.0	8.8
16	0.0	113.0	1960	718.4	.060	4.9	0.0	1.39	24.1	8.8
17	0.0	65.7	353	656.7	.060	3.3	0.0	1.21	6.5	12.1
18	0.0	36.1	203	261.5	0.000	0.0	0.0	1.33	7.5	9.6
19	0.0	24.2	179	156.8	.065	1.3	0.0	1.23	9.1	8.0
20	0.0	10.6	126	52.8	0.000	0.0	0.0	1.21	14.4	6.0
21	0.0	7.0	115	29.0	0.000	0.0	0.0	3.17	52.3	13.2
22	0.0	25.3	76	1.7	.080	0.0	I	R	R	R
23	0.0	936.7	73	.3	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	8.186	GRAM/BHP HR
	CO	41.463	GRAM/BHP HR
	NO2	8.266	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.639	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

7-26-72 RUN 1 ENG-2-3 1972-VERSION-5 EGR STD TIMING

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.4	3.3	16.6	0	5387	.740	12.47	33
2	1200	5.0	1	19.3	7.5	15.9	0	759	.390	14.05	72
3	1200	18.0	4	18.8	7.8	16.3	0	949	.150	13.91	120
4	1200	40.0	9	16.8	9.1	17.4	0	1502	.130	12.94	270
5	1200	55.0	13	15.0	9.9	18.6	0	1623	.130	11.92	195
6	1200	110.0	25	7.9	16.5	17.8	0	660	.100	12.71	480
7	1200	165.0	38	3.4	20.3	17.3	0	600	.100	12.94	900
8	1200	180.0	41	2.4	21.3	17.2	0	628	.100	12.94	1250
9	1200	202.0	46	1.3	22.9	16.6	0	929	.100	13.48	1563
10	1200	220.0	50	.5	28.6	13.5	0	2908	4.300	12.09	645
11	600	0.0	0	18.7	3.5	15.1	0	3967	1.940	12.47	43
12	1200	0.0	0	23.3	3.6	16.3	0	57923	.490	6.30	11
13	2300	225.0	99	.9	58.2	13.1	0	2802	4.880	11.92	480
14	2300	207.0	91	2.8	44.4	15.4	0	865	.520	14.42	1462
15	2300	185.0	81	3.9	41.7	15.6	0	557	.440	14.42	1125
16	2300	169.0	74	4.6	40.5	15.8	0	397	.350	14.31	1050
17	2300	113.0	49	8.2	32.3	17.2	0	103	.130	13.48	770
18	2300	56.0	25	14.7	19.7	18.6	0	368	.210	12.22	310
19	2300	41.0	18	16.1	17.9	18.7	0	318	.210	12.22	260
20	2300	18.0	8	18.9	13.8	18.5	0	262	.180	12.47	122
21	2300	5.0	2	19.4	13.0	18.4	0	341	.180	12.47	110
22	600	0.0	0	18.4	3.4	16.2	0	3396	1.090	13.18	41
23	2300	0.0	0	25.2	3.4	20.0	0	47011	.350	5.75	9

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	58.6	163	1.2	.070	0.0	T	R	R	R
2	0.0	17.8	185	5.6	.060	.1	0.0	15.58	161.6	4.9
3	0.0	23.7	76	10.0	.060	.2	0.0	5.77	18.4	2.4
4	0.0	46.9	82	28.0	.050	.5	0.0	5.13	9.0	3.1
5	0.0	59.7	97	23.8	.030	.4	0.0	4.75	7.7	1.9
6	0.0	38.4	117	92.6	.060	1.5	0.0	1.53	4.7	3.7
7	0.0	42.1	142	210.0	0.000	0.0	0.0	1.12	3.8	5.6
8	0.0	46.3	149	306.0	.040	1.6	0.0	1.13	3.6	7.4
9	0.0	70.5	153	394.1	0.000	0.0	0.0	1.53	3.3	8.5
10	0.0	226.1	6755	166.5	0.000	0.0	0.0	4.50	134.4	3.3
11	0.0	42.5	420	1.5	.070	0.0	I	R	R	R
12	0.0	751.7	128	.5	.120	0.0	I	R	R	R
13	0.0	433.1	15236	246.3	.025	2.5	0.0	4.40	154.6	2.5
14	0.0	115.9	1408	650.8	.055	5.0	0.0	1.28	15.5	7.2
15	0.0	70.7	1127	473.6	.035	2.8	0.0	.87	13.9	5.8
16	0.0	49.7	884	435.7	.060	4.4	0.0	.67	11.9	5.9
17	0.0	11.1	282	275.0	.060	3.0	0.0	.22	5.7	5.6
18	0.0	26.4	304	73.8	0.000	0.0	0.0	1.08	12.4	3.0
19	0.0	20.7	276	56.2	.065	1.2	0.0	1.15	15.4	3.1
20	0.0	13.0	180	20.1	0.000	0.0	0.0	1.64	22.8	2.5
21	0.0	15.8	169	17.0	0.000	0.0	0.0	7.23	77.2	7.8
22	0.0	35.8	232	1.4	.080	0.0	I	R	R	R
23	0.0	671.2	101	.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	7.593	GRAM/BHP HR
	CO	30.315	GRAM/BHP HR
	NO2	5.442	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.681	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

7-24-72 RUN-2 ENG.2-3 1972 VERSION-10 -EGR STD TIMING

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.5	3.4	16.3	0	5941	.740	12.34	34
2	1200	4.0	1	19.7	6.8	16.7	0	592	.070	13.77	102
3	1200	11.0	3	19.2	7.8	16.7	0	546	.070	13.48	109
4	1200	39.0	9	16.8	8.5	18.2	0	1866	.070	11.92	157
5	1200	54.0	12	15.6	9.8	18.6	0	1497	.070	11.72	255
6	1200	107.0	24	6.6	16.4	18.4	0	508	.070	12.59	240
7	1200	161.0	37	3.2	19.7	17.9	0	586	.070	12.59	620
8	1200	175.0	40	2.3	20.6	17.5	0	604	.070	12.71	937
9	1200	197.0	45	.8	22.6	16.8	0	910	.070	13.33	1175
10	1200	214.0	49	.5	27.4	13.8	0	2871	3.560	12.47	535
11	600	0.0	0	18.0	2.1	15.4	0	3913	1.340	13.18	46
12	1200	0.0	0	23.2	3.3	17.0	0	59803	.440	5.88	10
13	2300	202.0	88	.9	54.7	13.2	0	2859	4.540	12.22	245
14	2300	186.0	81	2.5	44.4	15.2	0	762	.520	14.31	520
15	2300	166.0	73	3.2	41.3	15.7	0	420	.180	14.31	430
16	2300	152.0	67	3.7	40.1	16.2	0	255	.150	14.05	410
17	2300	101.0	44	7.3	33.5	16.6	0	282	.150	13.77	225
18	2300	51.0	22	10.5	25.3	18.4	0	713	.180	12.09	107
19	2300	36.0	16	13.4	20.5	18.2	0	3798	.280	11.48	80
20	2300	16.0	7	16.3	16.1	19.1	0	2744	.280	11.48	71
21	2300	4.0	2	18.3	13.3	18.9	0	10815	.310	10.89	38
22	600	0.0	0	18.5	3.5	15.3	0	3895	1.480	13.35	41
23	2300	0.0	0	25.1	3.6	16.2	0	49664	.470	8.14	13

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	67.0	169	1.3	.070	0.0	I	R	R	R
2	0.0	13.1	31	7.6	.060	.1	0.0	14.38	34.3	8.3
3	0.0	14.2	37	9.4	.060	.2	0.0	5.65	14.6	3.7
4	0.0	59.1	45	16.6	.050	.4	0.0	6.63	5.0	1.9
5	0.0	55.7	53	31.5	.030	.4	0.0	4.52	4.3	2.6
6	0.0	29.7	83	46.6	.060	1.5	0.0	1.22	3.4	1.9
7	0.0	41.2	99	144.6	0.000	0.0	0.0	1.12	2.7	3.9
8	0.0	43.9	103	226.4	.040	1.6	0.0	1.10	2.6	5.7
9	0.0	69.2	107	296.4	0.000	0.0	0.0	1.54	2.4	6.6
10	0.0	218.7	5478	135.3	0.000	0.0	0.0	4.47	112.0	2.8
11	0.0	25.0	173	1.0	.070	0.0	I	R	R	R
12	0.0	727.8	108	.4	.120	0.0	I	R	R	R
13	0.0	416.1	13349	118.4	.025	2.2	0.0	4.70	150.9	1.3
14	0.0	102.9	1419	233.3	.055	4.5	0.0	1.26	17.4	2.9
15	0.0	54.1	469	184.0	.035	2.5	0.0	.74	6.4	2.5
16	0.0	32.5	387	174.0	.060	4.0	0.0	.49	5.8	2.6
17	0.0	30.7	330	81.4	.060	2.7	0.0	.70	7.5	1.8
18	0.0	66.3	338	33.2	0.000	0.0	0.0	2.97	15.1	1.5
19	0.0	290.9	433	20.5	.065	1.0	0.0	18.45	27.5	1.3
20	0.0	166.5	343	14.4	0.000	0.0	0.0	23.77	49.0	2.1
21	0.0	531.3	308	6.3	0.000	0.0	0.0	303.28	175.6	3.6
22	0.0	40.6	312	1.4	.080	0.0	I	R	R	R
23	0.0	597.4	114	.5	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	8.732	GRAM/BHP HR
	CO	27.866	GRAM/BHP HR
	NO2	2.566	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.747	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

7-24-72 RUN-1 ENG.2-3 1972 VERSION-10 -EGR STD TIMING

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	DRY CONCENTRATION ALDE.	HC	CO	CO2	NO
1	600	0.0	0	18.5	3.5	15.6	0	4252	1.300	13.18	41
2	1200	4.0	1	19.7	7.6	15.7	0	869	.580	14.05	88
3	1200	15.0	3	19.0	8.1	15.9	0	906	.310	14.05	131
4	1200	35.0	8	18.1	8.7	16.2	0	1537	.150	13.91	380
5	1200	48.0	11	17.2	10.0	16.4	0	1578	.150	13.63	490
6	1200	96.0	22	5.2	18.0	17.3	0	482	.100	12.94	180
7	1200	144.0	33	1.8	21.4	17.1	0	617	.150	13.06	450
8	1200	157.0	36	1.3	22.4	16.7	0	642	.150	13.48	540
9	1200	177.0	40	.9	21.8	16.5	0	705	.150	13.63	620
10	1200	192.0	44	.4	28.7	13.8	0	2467	4.020	11.92	490
11	600	0.0	0	18.7	2.8	14.9	0	3354	1.630	13.18	48
12	1200	0.0	0	23.3	3.4	15.2	0	63006	.700	6.64	12
13	2300	202.0	88	1.0	53.2	13.6	0	2215	3.840	12.47	290
14	2300	186.0	81	2.2	44.8	15.1	0	957	1.010	14.05	500
15	2300	166.0	73	2.6	42.9	15.7	0	545	.350	14.18	490
16	2300	152.0	67	3.3	40.0	16.1	0	311	.180	14.05	410
17	2300	101.0	44	8.1	30.6	17.2	0	131	.100	13.18	360
18	2300	51.0	22	13.9	20.5	18.6	0	534	.180	12.09	270
19	2300	36.0	16	15.9	17.8	18.9	0	568	.180	12.09	200
20	2300	16.0	7	17.3	15.5	18.6	0	834	.180	11.92	103
21	2300	4.0	2	18.8	13.7	18.6	0	623	.150	12.09	76
22	600	0.0	0	18.5	2.8	15.9	0	3958	1.090	13.06	42
23	2300	0.0	0	25.2	2.3	17.6	0	46035	.350	7.28	12

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	45.3	280	1.4	.070	0.0	I	R	R	R
2	0.0	20.3	274	6.8	.060	.1	0.0	22.26	300.3	7.5
3	0.0	23.0	159	11.1	.060	.2	0.0	6.72	46.5	3.2
4	0.0	42.7	84	35.0	.050	.4	0.0	5.34	10.5	4.4
5	0.0	51.4	99	52.9	.030	.3	0.0	4.68	9.0	4.8
6	0.0	30.1	126	37.3	.060	1.3	0.0	1.37	5.7	1.7
7	0.0	45.1	222	109.3	0.000	0.0	0.0	1.37	6.7	3.3
8	0.0	47.6	225	133.0	.040	1.4	0.0	1.33	6.3	3.7
9	0.0	50.3	216	147.0	0.000	0.0	0.0	1.24	5.3	3.6
10	0.0	198.4	6531	130.8	0.000	0.0	0.0	4.52	148.9	3.0
11	0.0	28.1	276	1.3	.070	0.0	I	R	R	R
12	0.0	712.4	160	.5	.120	0.0	I	R	R	R
13	0.0	323.4	11323	140.5	.025	2.2	0.0	3.66	128.0	1.6
14	0.0	128.3	2736	222.6	.055	4.5	0.0	1.58	33.6	2.7
15	0.0	72.7	943	217.1	.035	2.5	0.0	1.00	13.0	3.0
16	0.0	39.6	463	173.2	.060	4.0	0.0	.59	6.9	2.6
17	0.0	13.7	211	124.8	.060	2.7	0.0	.31	4.8	2.8
18	0.0	40.3	274	67.6	0.000	0.0	0.0	1.81	12.3	3.0
19	0.0	37.2	238	43.5	.065	1.0	0.0	2.36	15.1	2.8
20	0.0	48.1	210	19.7	0.000	0.0	0.0	6.87	29.9	2.8
21	0.0	31.5	153	12.7	0.000	0.0	0.0	17.98	87.4	7.3
22	0.0	34.6	192	1.2	.080	0.0	I	R	R	R
23	0.0	392.6	60	.3	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	7.276	GRAM/BHP HR
	CO	31.443	GRAM/BHP HR
	NO2	2.731	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.753	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

7-25-72 RUN2 ENG.2-3 1972 VERSION-15 EGR STD TIMING

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.3	3.0	15.2	0	3172	1.300	13.06	44
2	1200	4.0	1	18.4	7.2	16.8	0	1796	.180	13.06	45
3	1200	15.0	3	17.2	7.8	17.7	0	5659	.250	11.60	44
4	1200	33.0	8	14.0	9.6	18.6	0	4593	.180	11.36	62
5	1200	46.0	11	13.3	9.6	18.7	0	3735	.180	11.36	68
6	1200	91.0	21	6.3	16.5	17.5	0	598	.150	12.59	131
7	1200	137.0	31	1.8	20.8	17.0	0	862	.150	12.82	93
8	1200	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
9	1200	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
10	1200	182.0	42	.5	27.7	13.2	0	3045	4.640	11.48	145
11	600	0.0	0	18.5	2.7	14.6	0	4206	2.180	12.59	43
12	1200	0.0	0	23.3	3.1	15.9	0	63177	.470	6.21	9
13	2300	177.0	78	.9	54.5	13.0	0	3475	5.500	11.60	31
14	2300	163.0	71	1.9	45.5	14.6	0	1498	1.590	13.91	171
15	2300	145.0	63	2.3	43.4	15.0	0	1132	1.160	14.31	167
16	2300	133.0	58	2.4	41.3	15.8	0	443	.180	14.42	186
17	2300	89.0	39	5.2	35.6	16.5	0	3383	.180	13.63	146
18	2300	44.0	19	8.7	27.5	17.8	0	5017	.210	12.22	67
19	2300	32.0	14	9.5	25.9	18.8	0	6103	.250	11.60	53
20	2300	14.0	6	14.3	18.7	18.7	0	9486	.250	10.89	46
21	2300	4.0	2	17.9	14.5	18.3	0	6870	.210	11.48	41
22	600	0.0	0	18.3	3.2	15.6	0	3460	.890	13.63	41
23	2300	0.0	0	25.2	3.6	18.0	0	45919	.250	7.09	10

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	29.4	243	1.4	.070	0.0	I	R	R	R
2	0.0	43.7	88	3.6	.060	.1	0.0	47.82	96.8	4.0
3	0.0	161.3	144	4.2	.060	.2	0.0	47.05	42.0	1.2
4	0.0	166.7	132	7.5	.050	.4	0.0	22.11	17.5	1.0
5	0.0	136.5	133	8.3	.030	.3	0.0	12.99	12.6	.8
6	0.0	35.0	177	25.5	.060	1.2	0.0	1.68	8.5	1.2
7	0.0	62.3	219	22.2	0.000	0.0	0.0	1.99	7.0	.7
8	0.0	0.0	0	0.0	.040	0.0	0.0	0.00	0.0	0.0
9	0.0	0.0	0	0.0	0.000	0.0	0.0	0.00	0.0	0.0
10	0.0	233.0	7170	36.8	0.000	0.0	0.0	5.60	172.4	.9
11	0.0	33.9	355	1.2	.070	0.0	I	R	R	R
12	0.0	683.5	103	.3	.120	0.0	I	R	R	R
13	0.0	492.3	15742	14.6	.025	1.9	0.0	6.35	203.1	.2
14	0.0	197.5	4236	75.0	.055	3.9	0.0	2.77	59.3	1.1
15	0.0	143.0	2960	70.3	.035	2.2	0.0	2.25	46.6	1.1
16	0.0	56.6	465	79.1	.060	3.5	0.0	.97	8.0	1.4
17	0.0	386.1	415	55.4	.060	2.3	0.0	9.91	10.6	1.4
18	0.0	484.0	409	21.5	0.000	0.0	0.0	25.12	21.2	1.1
19	0.0	575.4	476	16.6	.065	.9	0.0	41.06	34.0	1.2
20	0.0	665.6	354	10.7	0.000	0.0	0.0	108.57	57.8	1.7
21	0.0	365.1	225	7.3	0.000	0.0	0.0	208.42	128.7	4.2
22	0.0	33.8	176	1.3	.080	0.0	I	R	R	R
23	0.0	628.4	69	.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	14.434	GRAM/BHP HR
	CO	54.104	GRAM/BHP HR
	NO2	1.119	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.915	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

7-25-72 RUN-1 ENG.2-3 1972 VERSION-20 -EGR STD TIMING

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.5	3.1	15.1	0	4204	1.660	13.06	41
2	1200	3.0	1	19.2	7.2	15.7	0	839	.280	14.18	57
3	1200	12.0	3	18.7	7.6	15.6	0	884	.350	14.05	80
4	1200	28.0	6	15.8	9.1	16.8	0	2803	.150	12.94	88
5	1200	39.0	9	14.8	9.7	16.0	0	3648	.180	13.06	88
6	1200	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
7	1200	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
8	1200	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
9	1200	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
10	1200	154.0	35	.5	25.3	13.4	0	3021	4.070	12.22	76
11	600	0.0	0	19.0	3.4	14.5	0	4323	2.180	12.71	43
12	1200	0.0	0	23.3	3.3	15.0	0	60644	.930	7.00	12
13	2300	152.0	67	1.0	49.7	13.2	0	2965	4.160	12.22	72
14	2300	140.0	61	1.7	43.6	14.3	0	1833	1.800	13.91	104
15	2300	125.0	55	1.8	43.0	14.5	0	1783	1.520	13.91	96
16	2300	114.0	50	2.0	41.8	14.9	0	1436	1.010	14.05	98
17	2300	76.0	33	3.9	36.5	15.8	0	7863	.390	12.94	88
18	2300	38.0	17	8.3	28.1	17.2	0	9995	.350	11.60	53
19	2300	27.0	12	8.9	26.4	17.5	0	13929	.390	11.01	45
20	2300	12.0	5	10.8	23.4	17.9	0	14788	.420	10.78	35
21	2300	3.0	1	16.6	15.4	18.4	0	22313	.420	9.14	23
22	600	0.0	0	18.5	3.3	15.8	0	4802	1.090	12.94	40
23	2300	0.0	0	25.2	3.4	30.6	0	532	.350	6.56	8

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	39.0	311	1.3	.070	0.0	I	R	R	R
2	0.0	18.8	127	4.2	.060	.0	0.0	27.49	185.3	6.2
3	0.0	21.0	168	6.3	.060	.2	0.0	7.67	61.4	2.3
4	0.0	86.5	94	9.0	.050	.3	0.0	13.52	14.6	1.4
5	0.0	118.0	118	9.4	.030	.3	0.0	13.24	13.2	1.1
6	0.0	0.0	0	0.0	.060	0.0	0.0	0.00	0.0	0.0
7	0.0	0.0	0	0.0	0.000	0.0	0.0	0.00	0.0	0.0
8	0.0	0.0	0	0.0	.040	0.0	0.0	0.00	0.0	0.0
9	0.0	0.0	0	0.0	0.000	0.0	0.0	0.00	0.0	0.0
10	0.0	208.9	5686	17.5	0.000	0.0	0.0	5.94	161.6	.5
11	0.0	43.5	443	1.4	.070	0.0	I	R	R	R
12	0.0	648.7	201	.4	.120	0.0	I	R	R	R
13	0.0	400.8	11360	32.3	.025	1.7	0.0	6.02	170.7	.5
14	0.0	228.0	4525	43.0	.055	3.4	0.0	3.72	73.8	.7
15	0.0	222.8	3837	39.8	.035	1.9	0.0	4.07	70.1	.7
16	0.0	179.0	2544	40.6	.060	3.0	0.0	3.59	51.0	.8
17	0.0	922.2	924	34.3	.060	2.0	0.0	27.71	27.8	1.0
18	0.0	983.8	696	17.3	0.000	0.0	0.0	59.12	41.8	1.0
19	0.0	1303.8	737	14.0	.065	.8	0.0	110.27	62.4	1.2
20	0.0	1238.0	710	9.7	0.000	0.0	0.0	235.58	135.2	1.9
21	0.0	1321.9	503	4.5	0.000	0.0	0.0	1006.15	382.6	3.4
22	0.0	49.5	227	1.4	.080	0.0	I	R	R	R
23	0.0	11.8	157	.6	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	20.712	GRAM/BHP HR
	CO	78.010	GRAM/BHP HR
	NO2	.868	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	1.075	LB/BHP HR

ENGINE 2-3

EFFECT OF LABORATORY EGR ON EMISSIONS

GRAPHED RESULTS

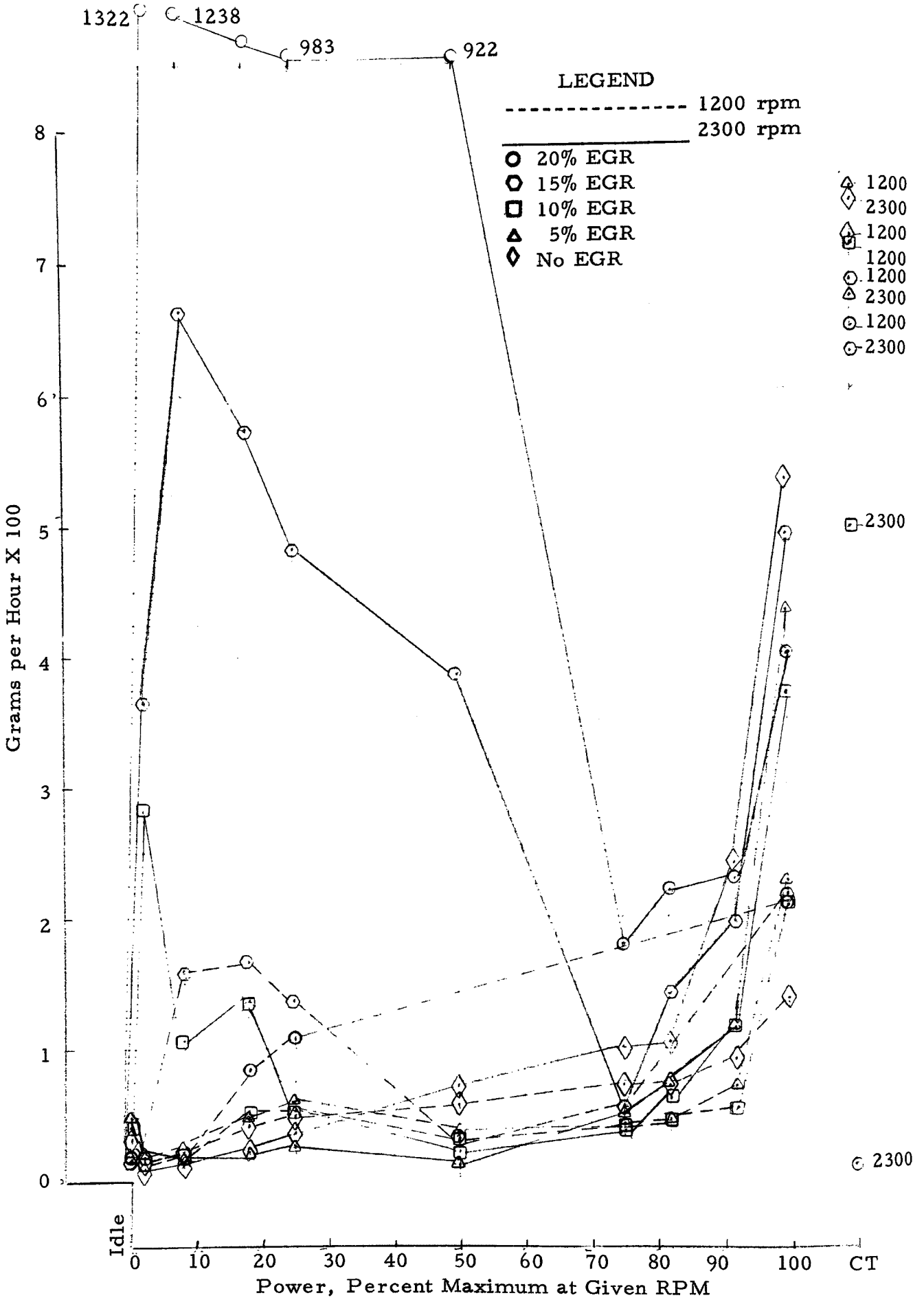


FIGURE L-1. EFFECT OF POWER ON HC EMISSION RATE - LABORATORY EGR, ENGINE 2-3, 23 MODE TEST

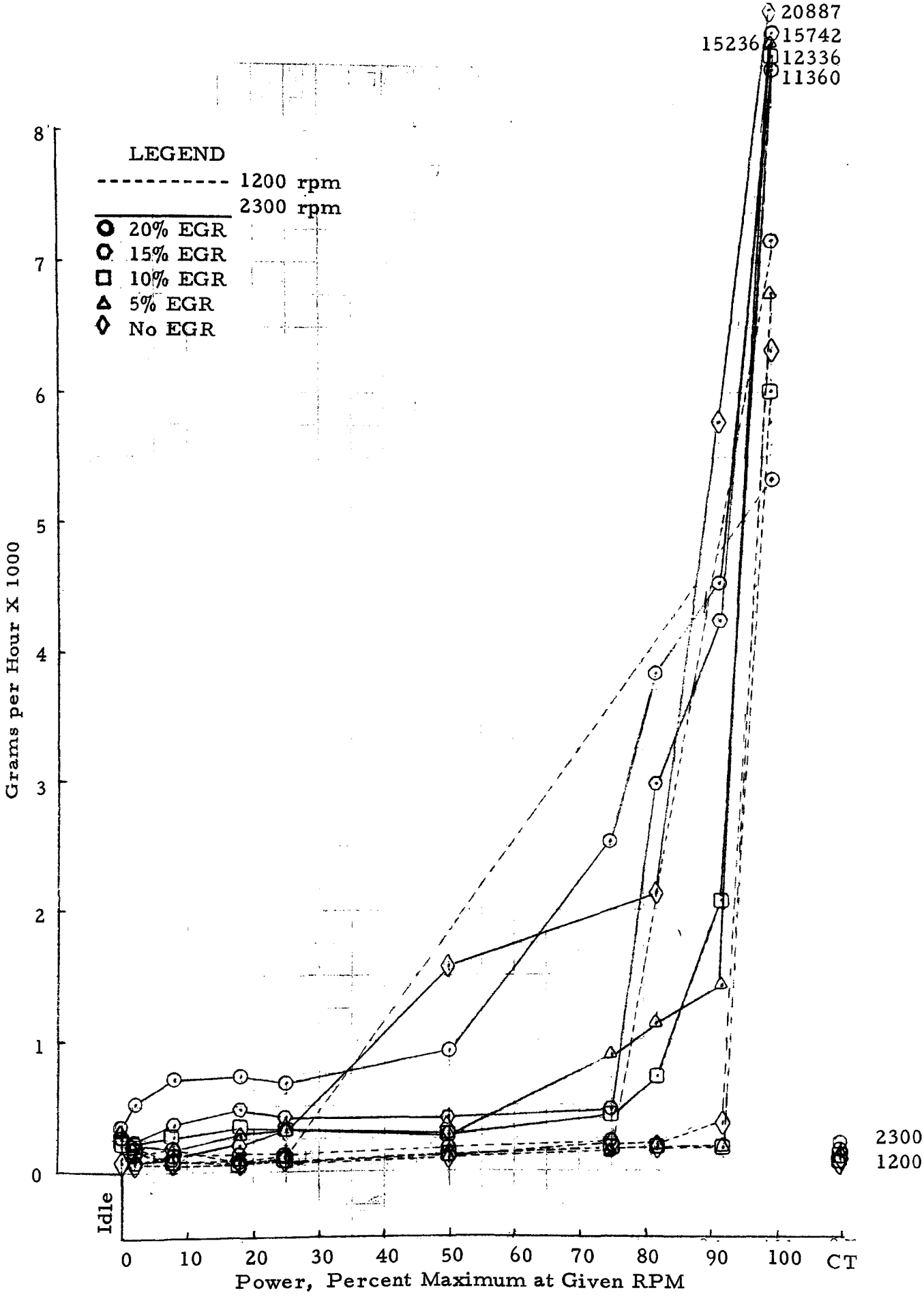


FIGURE L-2. EFFECT OF POWER ON CO EMISSION RATE - LABORATORY EGR, ENGINE 2-3, 23 MODE TEST

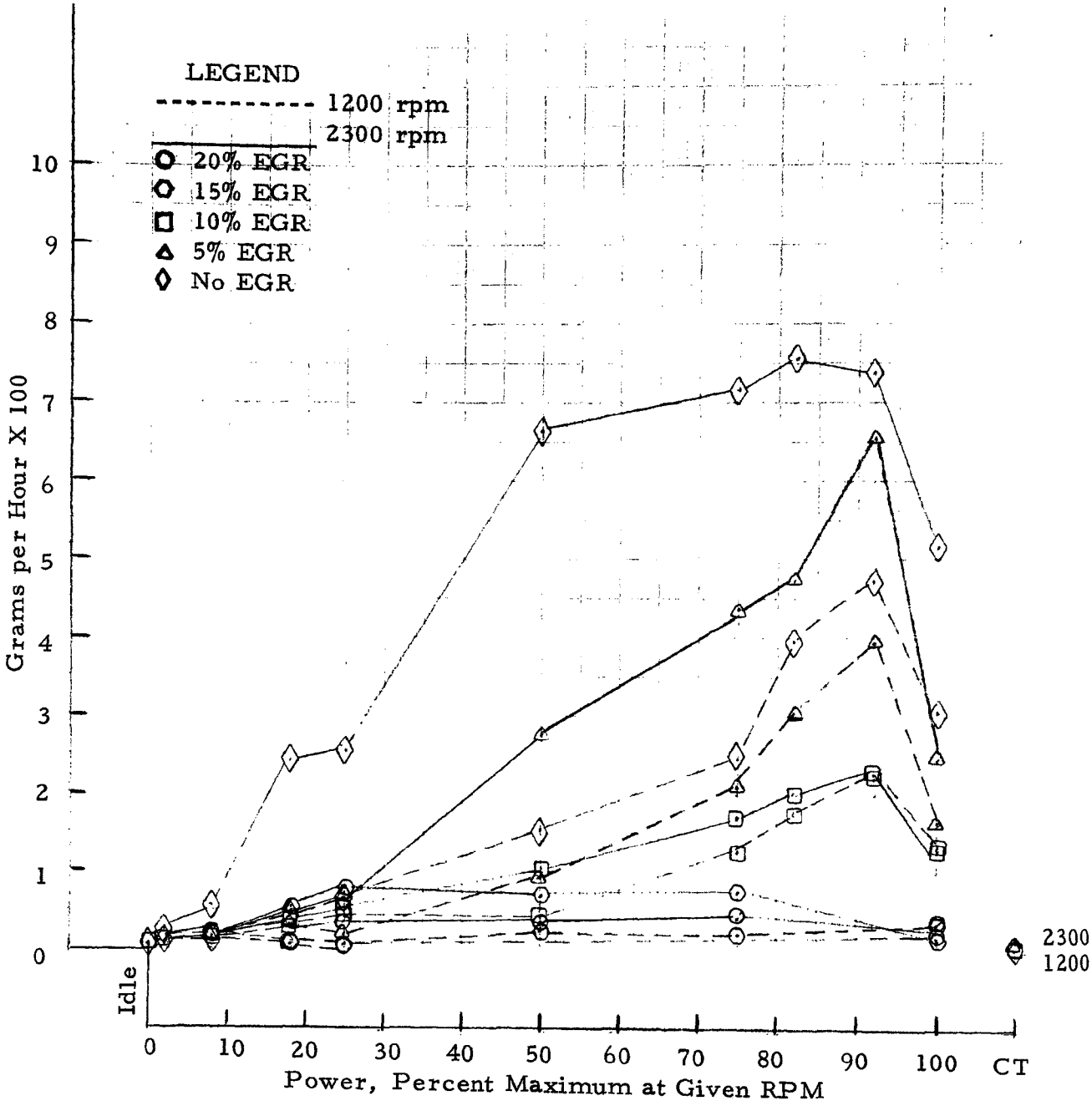


FIGURE L-3. EFFECT OF POWER ON NO_x (AS NO_2) EMISSION RATE - LABORATORY EGR, ENGINE 2-3, 23 MODE TEST

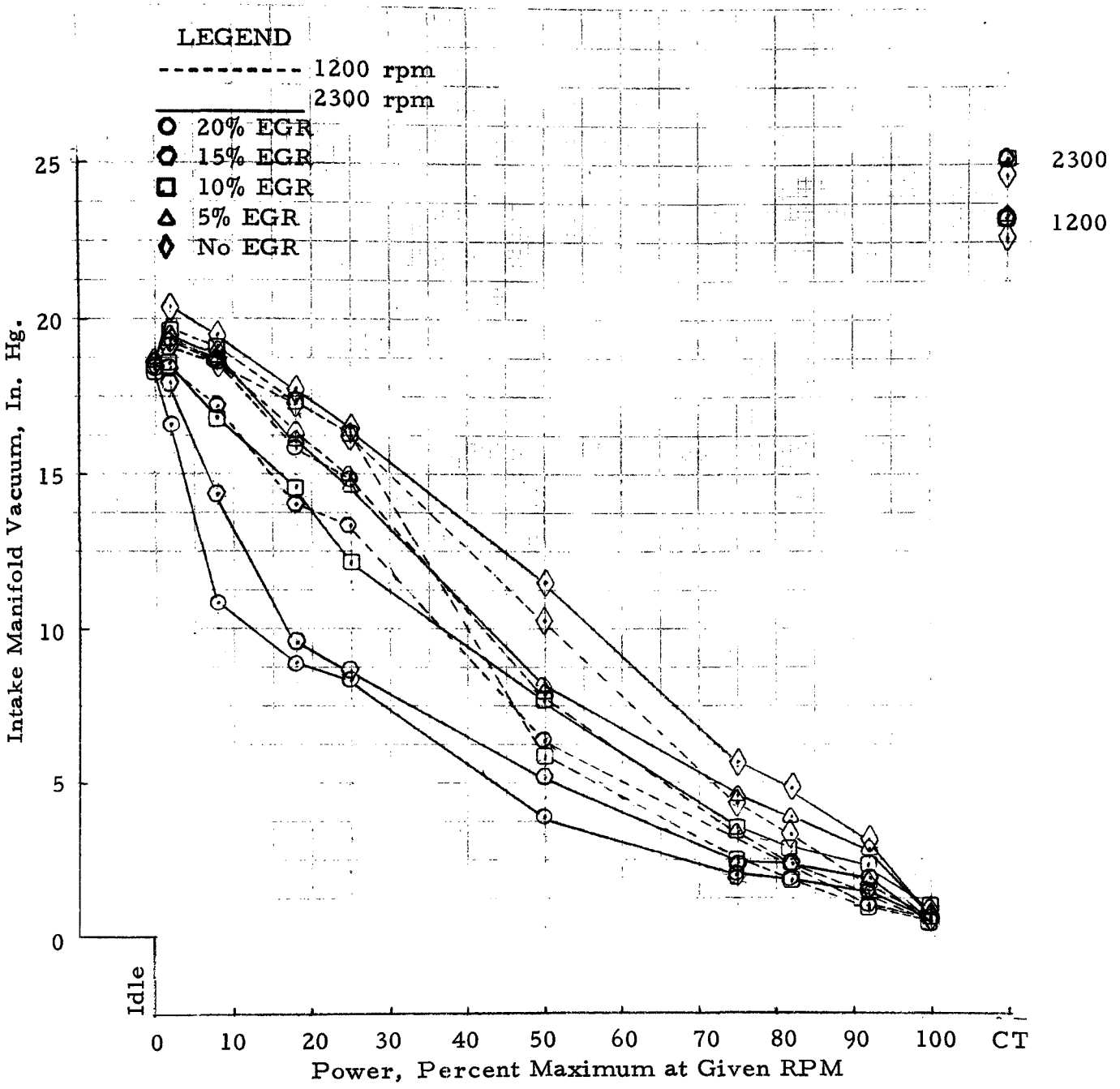


FIGURE L-4. MANIFOLD VACUUM AS A FUNCTION OF POWER - LABORATORY EGR, ENGINE 2-3, 23 MODE TEST

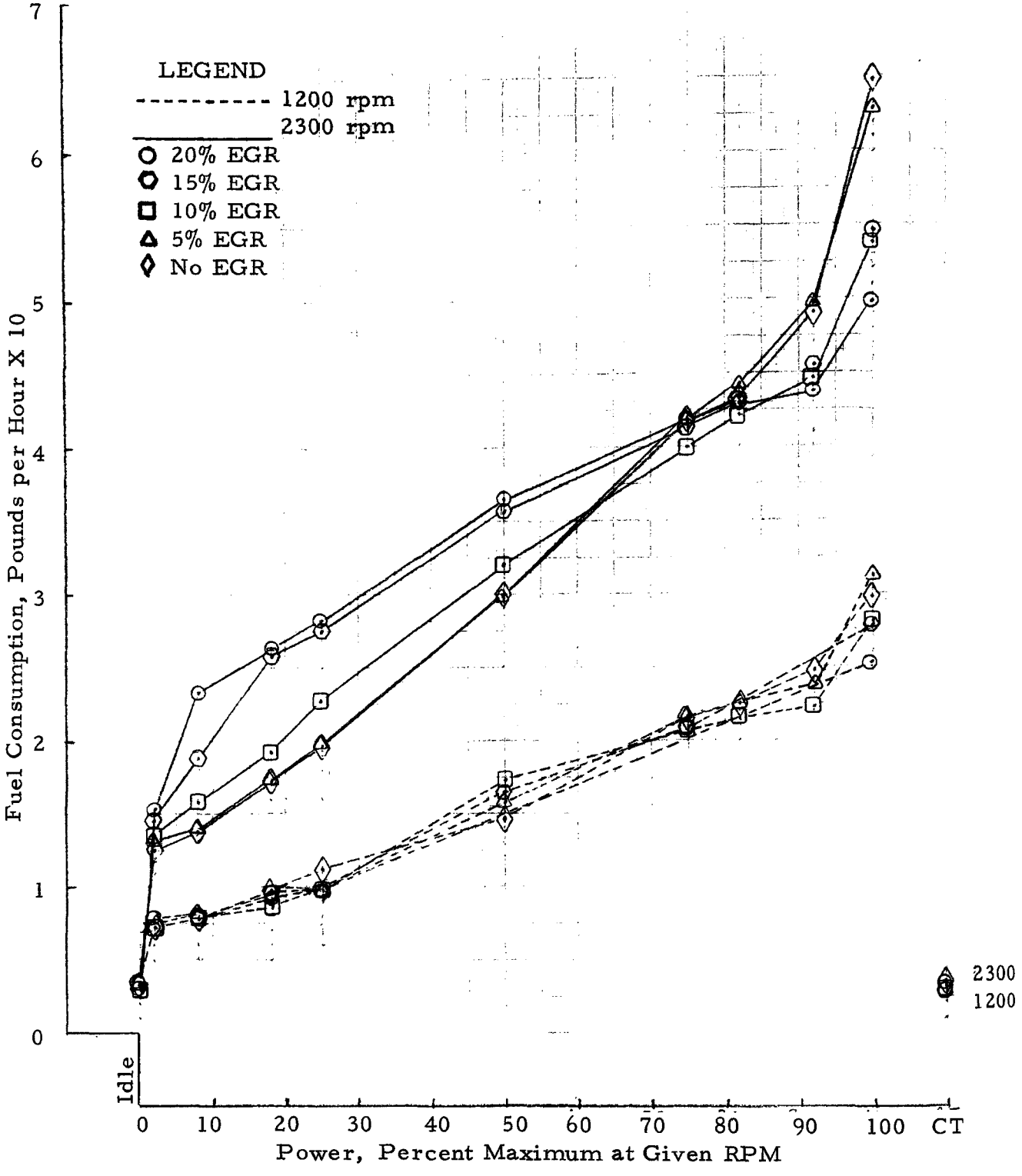


FIGURE L-5. FUEL CONSUMPTION AS A FUNCTION OF POWER - LABORATORY EGR, ENGINE 2-3, 23 MODE TEST

APPENDIX M

ENGINE 2-3

EFFECT OF OXIDATION CATALYST ON EMISSIONS

(23 MODE MASS RESULTS)

ENGINE 2-3

EFFECT OF OXIDATION CATALYST ON EMISSIONS

TABULAR DATA

BEFORE CATALYST

PROJECT 11-2877-01 CONTROL TECHNOLOGY

7-14-72 RUN-2 ENG. 2-3 1972 VERSION B-CATALYTIC W/AIR STD 25 BTBC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	19.5	2.7	26.6	0	1053	.150	7.85	27
2	1200	5.0	1	21.7	5.1	25.5	0	2530	.130	8.14	52
3	1200	20.0	5	19.3	7.2	24.3	0	985	.100	8.84	215
4	1200	46.0	11	17.4	8.5	23.7	0	1409	.100	8.93	900
5	1200	64.0	15	15.5	10.2	22.4	0	1567	.070	9.50	1750
6	1200	128.0	29	9.7	15.1	20.8	0	1613	.070	10.43	2800
7	1200	192.0	44	5.5	20.2	17.9	0	1793	.180	12.09	3600
8	1200	210.0	48	3.8	21.5	17.5	0	1629	.420	12.09	3550
9	1200	234.0	53	1.9	23.8	17.1	0	1663	.180	12.34	3900
10	1200	256.0	58	.3	31.3	14.2	0	3303	4.790	10.25	1700
11	600	0.0	0	20.0	2.7	23.3	0	3893	.210	8.60	44
12	1200	0.0	0	23.7	2.7	35.6	0	37619	.150	1.66	29
13	2300	270.0	118	.5	62.5	14.1	0	3253	4.840	10.43	1875
14	2300	248.0	109	2.2	52.6	14.9	0	1705	3.150	11.60	1325
15	2300	221.0	97	4.2	45.4	16.0	0	1141	1.410	12.59	2800
16	2300	203.0	89	5.6	41.7	16.0	0	989	1.480	12.59	2800
17	2300	135.0	59	10.1	28.7	19.5	0	1051	.130	11.36	3650
18	2300	68.0	30	15.5	19.3	21.8	0	841	.100	9.93	2025
19	2300	49.0	21	17.6	16.4	23.6	0	1063	.100	9.03	1050
20	2300	22.0	10	19.5	13.4	24.9	0	1891	.100	8.60	430
21	2300	5.0	2	20.5	12.2	25.3	0	2587	.100	8.34	260
22	600	0.0	0	19.5	2.7	13.7	0	9212	.130	7.56	32
23	2300	0.0	0	25.1	2.6	133.9	0	14307	.020	.03	2

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	16.0	46	1.4	.070	0.0	I	R	R	R
2	0.0	68.8	71	4.7	.060	.1	0.0	60.22	62.5	4.1
3	0.0	35.4	73	25.6	.060	.3	0.0	7.75	15.9	5.6
4	0.0	58.9	85	125.0	.050	.5	0.0	5.61	8.0	11.9
5	0.0	74.7	67	276.9	.030	.4	0.0	5.11	4.6	18.9
6	0.0	103.3	91	595.2	.060	1.8	0.0	3.53	3.1	20.4
7	0.0	132.1	268	881.0	0.000	0.0	0.0	3.01	6.1	20.1
8	0.0	125.1	652	905.3	.040	1.9	0.0	2.61	13.6	18.9
9	0.0	141.5	309	1101.8	0.000	0.0	0.0	2.65	5.8	20.6
10	0.0	304.7	8923	520.5	0.000	0.0	0.0	5.21	152.6	8.9
11	0.0	51.8	56	2.0	.070	0.0	I	R	R	R
12	0.0	811.6	65	2.1	.120	0.0	I	R	R	R
13	0.0	590.9	17761	1130.9	.025	3.0	0.0	5.00	150.2	9.6
14	0.0	272.7	10181	703.8	.055	6.0	0.0	2.51	93.7	6.5
15	0.0	166.5	4156	1356.4	.035	3.4	0.0	1.72	42.9	14.0
16	0.0	132.0	3990	1240.7	.060	5.3	0.0	1.48	44.9	14.0
17	0.0	118.0	295	1360.1	.060	3.5	0.0	2.00	5.0	23.0
18	0.0	72.8	175	581.9	0.000	0.0	0.0	2.45	5.9	19.5
19	0.0	85.5	162	280.4	.065	1.4	0.0	3.98	7.6	13.1
20	0.0	129.6	138	97.8	0.000	0.0	0.0	13.45	14.4	10.2
21	0.0	165.1	129	55.1	0.000	0.0	0.0	75.42	58.9	25.2
22	0.0	131.0	37	1.5	.080	0.0	I	R	R	R
23	0.0	1122.0	32	.6	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	9.383	GRAM/BHP HR
	CO	53.797	GRAM/BHP HR
	NO2	13.697	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.567	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

7-13-72 RUN-2 ENG. 2-3 1972 VERSION B-CATALYTIC W/AIR 16 BTDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	19.0	3.3	23.9	0	4094	.130	8.24	26
2	1200	5.0	1	20.5	5.6	24.8	0	734	.130	8.48	50
3	1200	21.0	5	19.1	7.0	24.5	0	746	.130	8.60	85
4	1200	46.0	11	17.6	10.2	24.2	0	1168	.100	8.68	380
5	1200	64.0	15	16.4	11.1	23.4	0	1289	.070	8.93	840
6	1200	129.0	29	9.3	15.1	21.1	0	1227	.070	10.25	1625
7	1200	193.0	44	5.5	20.2	17.9	0	1512	.210	11.84	2750
8	1200	212.0	48	3.8	21.9	17.5	0	1538	.440	11.92	2800
9	1200	232.0	53	2.3	23.6	17.2	0	1585	.310	12.22	3100
10	1200	258.0	59	.3	32.0	14.3	0	2902	4.690	10.25	1525
11	600	0.0	0	19.5	3.3	24.3	0	1557	.150	8.60	36
12	1200	0.0	0	23.3	2.8	32.2	0	39880	.280	2.16	12
13	2300	272.0	119	.5	62.1	13.9	0	3138	4.840	10.43	1500
14	2300	250.0	109	3.0	47.5	15.5	0	1177	1.870	12.34	2000
15	2300	223.0	98	5.0	44.1	15.9	0	836	1.380	12.71	2170
16	2300	204.0	89	6.2	41.0	16.1	0	733	1.120	12.71	2250
17	2300	136.0	60	10.1	28.0	19.5	0	840	.180	11.24	2650
18	2300	68.0	30	16.0	18.8	21.9	0	738	.130	9.93	1475
19	2300	49.0	21	17.5	16.9	23.4	0	613	.100	9.14	790
20	2300	22.0	10	19.8	12.9	25.4	0	443	.100	8.48	260
21	2300	5.0	2	21.2	9.4	26.2	0	754	.100	8.24	127
22	600	0.0	0	19.0	3.3	26.1	0	334	.100	8.34	27
23	2300	0.0	0	24.9	2.8	44.2	0	44533	.050	.03	6

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	69.0	44	1.5	.070	0.0	I	R	R	R
2	0.0	21.4	77	4.8	.060	.1	0.0	18.73	67.0	4.2
3	0.0	27.0	95	10.2	.060	.3	0.0	5.62	19.8	2.1
4	0.0	60.7	105	65.5	.050	.5	0.0	5.77	10.0	6.2
5	0.0	71.0	78	153.7	.030	.4	0.0	4.86	5.3	10.5
6	0.0	80.6	93	354.3	.060	1.8	0.0	2.73	3.2	12.0
7	0.0	113.7	319	686.7	0.000	0.0	0.0	2.58	7.2	15.6
8	0.0	122.0	705	737.6	.040	1.9	0.0	2.52	14.6	15.2
9	0.0	134.0	529	870.2	0.000	0.0	0.0	2.53	10.0	16.4
10	0.0	276.2	9015	481.8	0.000	0.0	0.0	4.69	152.9	8.2
11	0.0	26.0	51	2.0	.070	0.0	I	R	R	R
12	0.0	788.0	112	.8	.120	0.0	I	R	R	R
13	0.0	567.3	17672	900.2	.025	3.0	0.0	4.76	148.4	7.6
14	0.0	177.1	5686	999.6	.055	6.0	0.0	1.62	51.9	9.1
15	0.0	117.9	3931	1018.2	.035	3.4	0.0	1.21	40.2	10.4
16	0.0	98.1	3026	999.2	.060	5.4	0.0	1.10	33.9	11.2
17	0.0	92.7	401	970.3	.060	3.6	0.0	1.56	6.7	16.3
18	0.0	62.2	221	412.7	0.000	0.0	0.0	2.09	7.4	13.9
19	0.0	50.5	166	215.9	.065	1.4	0.0	2.35	7.7	10.1
20	0.0	29.9	137	58.3	0.000	0.0	0.0	3.10	14.2	6.1
21	0.0	38.0	102	21.4	0.000	0.0	0.0	17.37	46.5	9.8
22	0.0	5.9	35	1.6	.080	0.0	I	R	R	R
23	0.0	1247.7	28	.6	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	8.537	GRAM/BHP HR
	CO	42.661	GRAM/BHP HR
	NO2	10.995	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.560	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

7-12-72 RUN 1 ENG. 2-3, 1972 VERSION, B-CATALYTIC W/AIR STD

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.5	3.7	23.7	0	896	.180	9.14	30
2	1200	5.0	1	19.5	7.0	25.1	0	308	.100	8.75	43
3	1200	19.0	4	18.4	7.7	24.8	0	611	.100	8.75	102
4	1200	42.0	10	17.5	8.3	24.2	0	802	.100	8.93	220
5	1200	59.0	13	15.7	10.1	23.1	0	979	.100	9.37	460
6	1200	117.0	27	8.8	16.0	20.9	0	737	.100	10.66	770
7	1200	176.0	40	4.9	20.6	18.5	0	691	.180	12.22	1662
8	1200	192.0	44	3.6	22.1	18.2	0	641	.280	12.22	1750
9	1200	215.0	49	2.0	23.8	17.4	0	868	.210	12.71	2212
10	1200	234.0	53	.3	31.5	13.9	0	1813	4.160	11.01	1125
11	600	0.0	0	18.9	3.7	22.4	0	638	.210	9.64	50
12	1200	0.0	0	23.0	3.7	30.0	0	37979	.250	2.61	15
13	2300	263.0	115	.5	63.8	13.8	0	2688	5.140	10.43	1025
14	2300	241.0	106	2.8	51.4	15.2	0	602	2.050	12.71	938
15	2300	216.0	95	4.8	43.6	16.0	0	273	1.090	12.94	1525
16	2300	197.0	86	6.2	42.0	16.3	0	214	.640	13.18	1575
17	2300	132.0	58	9.3	28.8	19.6	0	256	.150	11.60	1462
18	2300	66.0	29	15.8	19.8	22.3	0	443	.150	9.93	863
19	2300	47.0	21	17.2	17.4	23.4	0	384	.100	9.64	520
20	2300	21.0	9	19.4	13.5	25.7	0	292	.100	8.60	200
21	2300	5.0	2	21.0	11.3	26.6	0	223	.100	8.34	94
22	600	0.0	0	18.5	3.7	24.0	0	854	.100	9.14	32
23	2300	0.0	0	25.0	3.5	43.8	0	45046	.050	.06	4

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	15.8	64	1.8	.070	0.0	I	R	R	R
2	0.0	11.0	72	5.0	.060	.1	0.0	9.62	63.0	4.4
3	0.0	24.1	80	13.4	.060	.3	0.0	5.55	18.3	3.1
4	0.0	33.2	84	30.3	.050	.5	0.0	3.46	8.7	3.2
5	0.0	47.1	97	73.5	.030	.4	0.0	3.49	7.2	5.5
6	0.0	49.4	135	171.5	.060	1.6	0.0	1.85	5.1	6.4
7	0.0	51.9	273	414.2	0.000	0.0	0.0	1.29	6.8	10.3
8	0.0	51.2	451	463.6	.040	1.8	0.0	1.17	10.3	10.6
9	0.0	72.0	352	609.7	0.000	0.0	0.0	1.47	7.2	12.4
10	0.0	168.9	7826	347.9	0.000	0.0	0.0	3.16	146.4	6.5
11	0.0	10.7	71	2.8	.070	0.0	I	R	R	R
12	0.0	949.6	126	1.3	.120	0.0	I	R	R	R
13	0.0	491.4	18980	622.1	.025	2.9	0.0	4.27	164.8	5.4
14	0.0	94.8	6516	489.8	.055	5.8	0.0	.90	61.7	4.6
15	0.0	38.5	3098	712.3	.035	3.3	0.0	.41	32.7	7.5
16	0.0	29.5	1780	719.9	.060	5.2	0.0	.34	20.6	8.3
17	0.0	28.5	337	539.4	.060	3.5	0.0	.49	5.8	9.3
18	0.0	39.2	268	253.5	0.000	0.0	0.0	1.36	9.3	8.8
19	0.0	31.0	163	139.5	.065	1.3	0.0	1.51	7.9	6.8
20	0.0	20.5	142	46.6	0.000	0.0	0.0	2.23	15.4	5.1
21	0.0	13.6	123	18.9	0.000	0.0	0.0	6.19	56.1	8.6
22	0.0	15.2	36	1.9	.080	0.0	I	R	R	R
23	0.0	1563.0	35	.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	9.241	GRAM/BHP HR
	CO	43.347	GRAM/BHP HR
	NO2	7.019	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.612	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

7-12-72 RUN-2 ENG. 2-3, 1972 VERSION B-CATALYTIC W/AIR STD

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.5	4.0	23.7	0	1259	.100	9.14	26
2	1200	5.0	1	19.6	7.1	25.2	0	405	.100	8.60	39
3	1200	19.0	4	18.8	7.4	24.8	0	541	.070	8.84	71
4	1200	42.0	10	16.8	8.3	23.7	0	908	.070	9.37	245
5	1200	59.0	13	15.7	10.0	22.7	0	1027	.070	9.93	505
6	1200	117.0	27	9.8	15.1	20.9	0	865	.070	11.01	770
7	1200	176.0	40	4.8	21.4	18.3	0	785	.150	12.94	1813
8	1200	192.0	44	3.8	22.0	17.7	0	727	.280	12.47	1750
9	1200	215.0	49	2.4	23.1	17.5	0	838	.210	12.47	2162
10	1200	234.0	53	.3	31.5	15.0	0	1970	4.350	11.36	1112
11	600	0.0	0	19.0	3.9	22.5	0	668	.180	10.09	38
12	1200	0.0	0	23.0	3.6	31.2	0	38468	.150	2.64	11
13	2300	263.0	115	.5	63.0	17.8	0	2886	5.030	10.43	1050
14	2300	241.0	106	2.7	51.3	15.2	0	600	2.110	12.22	913
15	2300	216.0	95	4.7	45.4	16.1	0	300	1.120	13.06	1625
16	2300	197.0	86	6.0	41.2	16.4	0	210	.670	13.06	1725
17	2300	132.0	58	10.0	28.8	20.0	0	304	.100	11.48	1550
18	2300	66.0	29	15.6	18.6	22.0	0	2672	.100	9.93	975
19	2300	47.0	21	17.5	16.1	23.6	0	397	.100	9.37	530
20	2300	21.0	9	19.2	13.9	25.3	0	303	.100	8.68	240
21	2300	5.0	2	21.0	11.2	26.9	0	217	.070	8.34	98
22	600	0.0	0	18.5	3.9	25.2	0	1016	.100	8.60	31
23	2300	0.0	0	24.8	3.5	46.3	0	41600	.100	.16	7

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	24.1	39	1.7	.070	0.0	I	R	R	R
2	0.0	15.0	75	4.8	.060	.1	0.0	13.12	65.4	4.2
3	0.0	20.2	53	8.8	.060	.3	0.0	4.66	12.2	2.0
4	0.0	35.8	56	32.1	.050	.5	0.0	3.73	5.8	3.3
5	0.0	46.2	64	75.4	.030	.4	0.0	3.42	4.7	5.6
6	0.0	53.0	87	156.6	.060	1.6	0.0	1.98	3.2	5.9
7	0.0	57.7	223	442.5	0.000	0.0	0.0	1.44	5.5	11.0
8	0.0	56.6	440	452.2	.040	1.8	0.0	1.29	10.0	10.3
9	0.0	68.8	348	589.6	0.000	0.0	0.0	1.40	7.1	12.0
10	0.0	176.9	7893	331.8	0.000	0.0	0.0	3.31	147.6	6.2
11	0.0	11.5	63	2.2	.070	0.0	I	R	R	R
12	0.0	946.5	75	.9	.120	0.0	I	R	R	R
13	0.0	523.5	18431	632.4	.025	2.9	0.0	4.55	160.0	5.5
14	0.0	97.1	6892	489.9	.055	5.8	0.0	.92	65.3	4.6
15	0.0	43.5	3281	782.4	.035	3.3	0.0	.46	34.7	8.3
16	0.0	28.5	1840	778.7	.060	5.2	0.0	.33	21.3	9.0
17	0.0	34.3	228	579.8	.060	3.5	0.0	.59	3.9	10.0
18	0.0	218.7	165	264.9	0.000	0.0	0.0	7.57	5.7	9.2
19	0.0	30.4	155	134.8	.065	1.3	0.0	1.48	7.5	6.5
20	0.0	21.7	145	57.1	0.000	0.0	0.0	2.36	15.8	6.2
21	0.0	13.1	85	19.6	0.000	0.0	0.0	5.98	39.0	8.9
22	0.0	20.5	41	2.1	.080	0.0	I	R	R	R
23	0.0	1507.0	73	.8	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	9.211	GRAM/BHP HR
	CO	43.227	GRAM/BHP HR
	NO2	7.276	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.607	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY
7-14-72 RUN-3 ENG.2-3 72-VER. B-CATA. W/AIR STD. J.-0.075 R.-0.038

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.0	3.9	22.7	0	926	.150	9.50	33
2	1200	5.0	1	19.6	7.1	23.4	0	348	.100	9.37	59
3	1200	18.0	4	18.9	7.9	22.7	0	332	.130	9.50	98
4	1200	41.0	9	17.8	9.0	21.8	0	711	.150	9.93	400
5	1200	58.0	13	16.7	9.9	20.7	0	869	.280	10.55	590
6	1200	115.0	26	11.8	14.3	19.2	0	1115	.280	11.01	1400
7	1200	173.0	40	6.0	21.9	16.1	0	859	1.120	12.94	870
8	1200	189.0	43	44.2	34.4	19.6	0	769	1.270	12.82	450
9	1200	212.0	48	2.8	25.6	15.7	0	780	1.520	12.59	975
10	1200	230.0	53	.3	32.3	13.8	0	1855	4.930	10.78	620
11	600	0.0	0	18.5	3.9	21.3	0	482	.280	10.09	39
12	1200	0.0	0	22.5	3.7	28.8	0	30540	.250	3.56	8
13	2300	262.0	115	.5	64.9	13.7	0	2521	5.240	10.55	800
14	2300	239.0	105	2.1	58.0	13.8	0	1079	4.540	11.48	300
15	2300	213.0	93	4.5	47.1	14.4	0	538	3.060	12.59	600
16	2300	195.0	85	5.8	47.0	14.6	0	303	2.360	13.18	640
17	2300	130.0	57	11.2	30.3	17.6	0	274	.310	12.47	1825
18	2300	65.0	28	16.4	20.3	20.1	0	282	.280	11.01	1150
19	2300	47.0	21	17.5	18.3	20.6	0	320	.250	10.89	890
20	2300	21.0	9	19.8	13.9	22.9	0	180	.180	9.78	290
21	2300	5.0	2	21.0	12.7	23.3	0	146	.150	9.37	205
22	600	0.0	0	18.0	3.9	23.1	0	556	.150	9.50	41
23	2300	0.0	0	24.4	3.9	38.1	0	49150	.070	.26	4

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	17.0	56	2.0	.070	0.0	I	R	R	R
2	0.0	11.8	68	6.6	.060	.1	0.0	10.31	59.8	5.8
3	0.0	12.3	97	12.0	.060	.2	0.0	2.99	23.6	2.9
4	0.0	28.5	121	53.2	.050	.5	0.0	3.04	13.0	5.7
5	0.0	35.8	233	80.6	.030	.4	0.0	2.70	17.6	6.1
6	0.0	63.4	322	264.2	.060	1.6	0.0	2.41	12.2	10.1
7	0.0	60.2	1585	202.4	0.000	0.0	0.0	1.52	40.1	5.1
8	0.0	84.7	2827	164.6	.040	1.7	0.0	1.96	65.5	3.8
9	0.0	63.7	2509	264.5	0.000	0.0	0.0	1.32	51.8	5.5
10	0.0	171.0	9176	189.7	0.000	0.0	0.0	3.25	174.6	3.6
11	0.0	8.2	96	2.2	.070	0.0	I	R	R	R
12	0.0	748.7	124	.6	.120	0.0	I	R	R	R
13	0.0	462.8	19427	487.5	.025	2.9	0.0	4.03	169.3	4.2
14	0.0	176.1	14960	162.5	.055	5.8	0.0	1.68	142.9	1.6
15	0.0	73.2	8408	270.9	.035	3.3	0.0	.78	90.1	2.9
16	0.0	41.5	6525	290.8	.060	5.1	0.0	.49	76.4	3.4
17	0.0	29.4	672	650.4	.060	3.4	0.0	.52	11.8	11.4
18	0.0	23.0	461	311.2	0.000	0.0	0.0	.81	16.2	10.9
19	0.0	23.8	376	219.8	.065	1.3	0.0	1.16	18.2	10.7
20	0.0	11.4	230	60.8	0.000	0.0	0.0	1.24	25.0	6.6
21	0.0	8.8	183	41.0	0.000	0.0	0.0	4.01	83.4	18.7
22	0.0	10.2	56	2.5	.080	0.0	I	R	R	R
23	0.0	1666.2	48	.5	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	8.881	GRAM/BHP HR
	CO	85.596	GRAM/BHP HR
	NO2	4.975	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.675	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

7-13-72 RUN 3 ENG. 2-3 1972 VERSION B-CATALYTIC W/AIR 4 ATDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	16.5	4.6	22.4	0	1002	.130	9.50	40
2	1200	4.0	1	18.7	7.6	24.8	0	370	.100	8.60	50
3	1200	16.0	4	18.2	7.8	24.9	0	454	.100	8.60	62
4	1200	37.0	8	16.4	9.8	23.6	0	581	.100	9.14	145
5	1200	51.0	12	15.4	10.0	23.1	0	646	.100	9.25	215
6	1200	102.0	23	7.8	17.6	19.8	0	343	.070	11.36	605
7	1200	153.0	35	4.1	22.3	17.7	0	306	.130	12.22	1137
8	1200	167.0	38	3.0	22.9	17.7	0	323	.150	12.09	1275
9	1200	188.0	43	1.8	24.4	17.1	0	423	.180	12.71	1587
10	1200	204.0	47	.3	31.5	14.4	0	874	3.520	11.84	800
11	600	0.0	0	17.0	4.2	21.8	0	464	.180	9.64	48
12	1200	0.0	0	22.0	4.4	57.0	0	384	.280	3.13	10
13	2300	236.0	103	.5	64.3	13.7	0	2012	4.790	10.66	705
14	2300	217.0	95	2.4	53.6	14.8	0	290	1.730	13.18	560
15	2300	194.0	85	4.2	46.0	16.0	0	158	.490	13.18	1000
16	2300	177.0	78	5.5	42.7	16.1	0	148	.470	13.48	950
17	2300	118.0	52	9.3	30.8	19.4	0	166	.100	11.48	925
18	2300	59.0	26	15.5	18.5	22.4	0	278	.100	9.78	505
19	2300	42.0	18	16.9	18.0	23.2	0	232	.100	9.37	315
20	2300	19.0	8	18.9	14.0	21.5	0	192	.100	8.75	150
21	2300	5.0	2	20.2	12.2	26.2	0	145	.100	8.24	84
22	600	0.0	0	16.5	4.5	22.9	0	1023	.130	9.37	43
23	2300	0.0	0	24.1	4.6	34.9	0	56083	.070	.09	5

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	21.3	56	2.8	.070	0.0	I	R	R	R
2	0.0	14.5	79	6.5	.060	.1	0.0	15.89	86.7	7.1
3	0.0	18.5	82	8.4	.060	.2	0.0	5.06	22.5	2.3
4	0.0	27.7	96	23.0	.050	.4	0.0	3.28	11.4	2.7
5	0.0	31.1	97	34.3	.030	.3	0.0	2.66	8.3	2.9
6	0.0	23.9	98	139.9	.060	1.4	0.0	1.02	4.2	6.0
7	0.0	25.0	214	308.3	0.000	0.0	0.0	.72	6.1	8.8
8	0.0	27.3	256	357.7	.040	1.5	0.0	.71	6.7	9.4
9	0.0	36.2	312	451.8	0.000	0.0	0.0	.84	7.3	10.5
10	0.0	80.8	6573	245.5	0.000	0.0	0.0	1.73	141.0	5.3
11	0.0	8.9	70	3.1	.070	0.0	I	R	R	R
12	0.0	22.1	325	1.8	.120	0.0	I	R	R	R
13	0.0	375.0	18040	436.4	.025	2.6	0.0	3.63	174.5	4.2
14	0.0	47.2	5687	302.6	.055	5.2	0.0	.50	59.8	3.2
15	0.0	24.1	1510	506.6	.035	3.0	0.0	.28	17.8	6.0
16	0.0	20.5	1316	437.0	.060	4.7	0.0	.26	17.0	5.6
17	0.0	20.0	244	370.2	.060	3.1	0.0	.39	4.7	7.2
18	0.0	23.6	171	142.0	0.000	0.0	0.0	.91	6.6	5.5
19	0.0	20.0	174	90.1	.065	1.2	0.0	1.09	9.5	4.9
20	0.0	13.7	144	35.6	0.000	0.0	0.0	1.65	17.3	4.3
21	0.0	9.6	133	18.4	0.000	0.0	0.0	4.39	61.0	8.4
22	0.0	21.9	56	3.0	.080	0.0	I	R	R	R
23	0.0	2006.6	51	.6	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	6.341	GRAM/BHP HR
	CO	42.632	GRAM/BHP HR
	NO2	5.327	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.726	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

7-14-72 RUN-2 ENG. 2-3 1972 VERSION B-CATALYTIC W/O AIR STD

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.0	3.6	15.3	0	3271	.770	13.06	46
2	1200	5.0	1	19.2	7.3	16.3	0	462	.130	13.48	70
3	1200	18.0	4	18.7	7.4	16.4	0	376	.100	13.18	85
4	1200	41.0	9	17.0	9.6	16.7	0	963	.100	12.82	340
5	1200	58.0	13	15.1	10.2	16.7	0	1143	.100	12.94	630
6	1200	115.0	26	8.4	16.6	16.2	0	764	.100	13.33	1125
7	1200	173.0	40	4.7	20.7	15.3	0	1179	.350	14.05	1912
8	1200	189.0	43	3.6	21.3	15.2	0	1086	.470	13.77	2112
9	1200	212.0	48	2.2	23.6	15.0	0	1441	.390	14.18	2450
10	1200	230.0	53	.3	31.7	12.9	0	2656	5.140	11.60	1175
11	600	0.0	0	18.5	3.6	13.6	0	4065	4.070	11.60	56
12	1200	0.0	0	22.5	4.5	14.7	0	35735	2.080	8.68	17
13	2300	260.0	114	.5	62.1	13.2	0	2994	4.790	11.60	1475
14	2300	239.0	105	3.0	47.5	14.4	0	1280	2.110	13.33	1700
15	2300	213.0	93	4.8	44.6	14.4	0	1408	2.180	13.48	1712
16	2300	195.0	85	6.0	41.9	14.6	0	1417	1.840	13.63	1837
17	2300	130.0	57	9.8	29.5	16.7	0	273	.100	13.33	1775
18	2300	65.0	28	15.4	26.6	17.0	0	337	.100	13.06	1200
19	2300	47.0	21	16.8	17.0	17.1	0	269	.100	13.06	770
20	2300	21.0	4	19.1	13.3	17.2	0	163	.070	13.18	315
21	2300	5.0	2	20.5	11.4	17.2	0	93	.070	13.18	176
22	600	0.0	0	18.0	3.6	16.3	0	1807	.350	13.63	53
23	2300	0.0	0	24.5	3.6	18.8	0	38343	.280	7.56	11

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	38.1	181	1.8	.070	0.0	I	R	R	R
2	0.0	11.2	64	5.7	.060	.1	0.0	9.81	55.8	5.0
3	0.0	9.5	51	7.1	.060	.2	0.0	2.30	12.3	1.7
4	0.0	32.2	68	37.8	.050	.5	0.0	3.44	7.2	4.0
5	0.0	40.3	71	73.7	.030	.4	0.0	3.04	5.4	5.6
6	0.0	42.5	112	207.7	.060	1.6	0.0	1.62	4.3	7.9
7	0.0	76.1	456	409.9	0.000	0.0	0.0	1.92	11.5	10.4
8	0.0	73.1	639	471.8	.040	1.7	0.0	1.69	14.8	10.9
9	0.0	104.8	573	591.3	0.000	0.0	0.0	2.16	11.8	12.2
10	0.0	224.7	8785	330.1	0.000	0.0	0.0	4.28	167.2	6.3
11	0.0	41.5	840	1.9	.070	0.0	I	R	R	R
12	0.0	506.6	596	.8	.120	0.0	I	R	R	R
13	0.0	505.2	16326	826.3	.025	2.8	0.0	4.44	143.4	7.3
14	0.0	177.2	5901	781.5	.055	5.8	0.0	1.69	56.4	7.5
15	0.0	180.3	5638	727.9	.035	3.3	0.0	1.93	60.4	7.8
16	0.0	172.7	4529	743.4	.060	5.1	0.0	2.02	53.0	8.7
17	0.0	27.1	201	585.6	.060	3.4	0.0	.48	3.5	10.3
18	0.0	30.7	185	363.9	0.000	0.0	0.0	1.08	6.5	12.8
19	0.0	15.8	118	149.8	.065	1.3	0.0	.77	5.7	7.3
20	0.0	7.4	64	47.5	0.000	0.0	0.0	.80	7.0	5.2
21	0.0	3.6	55	22.9	0.000	0.0	0.0	1.66	25.3	10.5
22	0.0	21.1	82	2.1	.080	0.0	I	R	R	R
23	0.0	536.3	79	.5	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	5.775	GRAM/BHP HR
	CO	54.155	GRAM/BHP HR
	NO2	8.210	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.617	LB/BHP HR

ENGINE 2-3

EFFECT OF OXIDATION CATALYST ON EMISSIONS

TABULAR DATA

AFTER CATALYST

PROJECT 11-2877-01 CONTROL TECHNOLOGY

7-14-72 RUN-2 ENG. 2-3 1972 VERSION A-CATALYTIC W/AIR STD 25 BTDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	19.5	2.7	27.4	0	220	.070	7.85	26
2	1200	5.0	1	21.7	5.1	14.8	0	66	.100	7.94	51
3	1200	20.0	5	19.3	7.2	25.0	0	246	.070	8.60	214
4	1200	46.0	11	17.4	8.5	24.1	0	357	.100	8.84	900
5	1200	64.0	15	15.5	10.2	22.9	0	370	.070	9.37	1737
6	1200	128.0	29	9.7	15.1	21.0	0	398	.070	10.43	2800
7	1200	192.0	44	5.5	20.2	18.2	0	445	.050	12.09	3400
8	1200	210.0	48	3.8	21.5	18.1	0	450	.050	11.92	3500
9	1200	234.0	53	1.9	23.8	17.6	0	613	.050	12.34	3600
10	1200	256.0	58	.3	31.3	14.5	0	2166	2.780	12.34	1600
11	600	0.0	0	20.0	2.7	26.2	0	1344	.050	8.04	68
12	1200	0.0	0	23.7	2.7	54.9	0	62	.050	3.62	25
13	2300	270.0	118	.5	62.5	13.8	0	1553	4.020	12.22	1525
14	2300	248.0	109	2.2	52.6	15.2	0	540	1.120	13.77	1500
15	2300	221.0	97	4.2	45.4	16.5	0	217	.150	13.63	2900
16	2300	203.0	89	5.6	41.7	16.8	0	219	.100	13.18	2900
17	2300	135.0	59	10.1	28.7	20.1	0	435	.050	11.01	3550
18	2300	68.0	30	15.5	19.3	22.5	0	270	.050	9.78	1950
19	2300	49.0	21	17.6	16.4	23.8	0	304	.050	9.14	1075
20	2300	22.0	10	19.5	13.4	25.2	0	284	.050	8.60	450
21	2300	5.0	2	20.5	12.2	25.8	0	728	.050	8.43	250
22	600	0.0	0	19.5	2.7	27.5	0	1501	.020	7.75	31
23	2300	0.0	0	25.1	2.6	85.9	0	63	.020	2.37	2

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	3.4	22	1.3	.070	0.0	I	R	R	R
2	0.0	1.9	58	4.9	.060	.1	0.0	1.66	50.9	4.3
3	0.0	9.2	53	26.5	.060	.3	0.0	2.01	11.6	5.8
4	0.0	15.3	86	127.7	.050	.5	0.0	1.45	8.2	12.2
5	0.0	18.1	69	282.1	.030	.4	0.0	1.24	4.7	19.3
6	0.0	25.8	92	602.1	.060	1.8	0.0	.88	3.1	20.6
7	0.0	33.5	76	850.1	0.000	0.0	0.0	.76	1.7	19.4
8	0.0	36.4	82	941.4	.040	1.9	0.0	.76	1.7	19.6
9	0.0	53.2	88	1036.3	0.000	0.0	0.0	.99	1.6	19.4
10	0.0	200.2	5190	491.0	0.000	0.0	0.0	3.42	88.7	8.4
11	0.0	20.0	15	3.4	.070	0.0	I	R	R	R
12	0.0	2.0	33	2.7	.120	0.0	I	R	R	R
13	0.0	268.3	14032	874.9	.025	3.0	0.0	2.27	118.7	7.4
14	0.0	86.3	3614	795.6	.055	6.0	0.0	.79	33.3	7.3
15	0.0	32.4	452	1436.6	.035	3.4	0.0	.33	4.7	14.8
16	0.0	31.1	287	1368.8	.060	5.3	0.0	.35	3.2	15.4
17	0.0	51.0	118	1381.4	.060	3.5	0.0	.86	2.0	23.4
18	0.0	24.0	90	575.0	0.000	0.0	0.0	.81	3.0	19.3
19	0.0	24.5	81	287.6	.065	1.4	0.0	1.14	3.8	13.4
20	0.0	19.9	71	104.9	0.000	0.0	0.0	2.07	7.4	10.9
21	0.0	47.3	66	53.9	0.000	0.0	0.0	21.58	29.9	24.6
22	0.0	23.2	6	1.6	.080	0.0	I	R	R	R
23	0.0	3.1	20	.3	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	1.016	GRAM/BHP HR
	CO	22.670	GRAM/BHP HR
	NO2	14.178	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.567	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

7-13-72 RUN-2 ENG. 2-3 1972 VERSION A-CATALYTIC W/AIR 16 BTDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	19.0	3.3	25.8	0	1451	.050	8.04	31
2	1200	5.0	1	20.5	5.6	25.7	0	216	.100	8.34	57
3	1200	21.0	5	19.1	7.0	25.1	0	194	.100	8.54	100
4	1200	46.0	11	17.6	10.2	24.5	0	303	.050	8.68	460
5	1200	64.0	15	16.4	11.1	23.9	0	298	.020	8.93	730
6	1200	129.0	29	9.3	15.1	21.3	0	345	.020	10.25	1625
7	1200	193.0	44	5.5	20.2	18.3	0	377	.020	11.84	2750
8	1200	212.0	48	3.8	21.9	18.0	0	423	.050	12.09	2800
9	1200	232.0	53	2.3	23.6	17.8	0	473	.050	12.22	3150
10	1200	258.0	59	.3	32.0	14.4	0	1996	2.970	12.22	1225
11	600	0.0	0	19.5	3.3	23.3	0	8625	.100	8.34	32
12	1200	0.0	0	23.3	2.8	44.1	0	613	.130	4.45	43
13	2300	272.0	119	.5	62.1	14.3	0	1436	4.160	11.92	1125
14	2300	250.0	109	3.0	47.5	16.1	0	192	.180	13.77	2200
15	2300	223.0	98	5.0	44.1	16.6	0	145	.130	13.48	2425
16	2300	204.0	89	6.2	41.0	16.8	0	142	.130	13.18	2250
17	2300	136.0	60	10.1	28.0	20.3	0	287	.100	11.01	2800
18	2300	68.0	30	16.0	18.8	22.7	0	199	.050	9.64	1450
19	2300	49.0	21	17.5	16.9	23.8	0	141	.050	9.14	900
20	2300	22.0	10	19.8	12.9	25.9	0	108	.050	8.48	270
21	2300	5.0	2	21.2	9.4	27.2	0	188	.050	8.04	132
22	600	0.0	0	19.0	3.3	27.2	0	75	.050	8.04	30
23	2300	0.0	0	24.9	2.8	58.3	0	4950	.050	3.02	7

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	26.1	18 23	1.8	.070	0.0	I	R	R	R
2	0.0	6.4	60	5.7	.060	.1	0.0	5.65	52.9	5.0
3	0.0	7.1	74	12.2	.060	.3	0.0	1.49	15.5	2.5
4	0.0	16.0	53	80.6	.050	.5	0.0	1.52	5.1	7.7
5	0.0	16.7	23	135.8	.030	.4	0.0	1.14	1.5	9.3
6	0.0	23.0	27	359.1	.060	1.8	0.0	.78	.9	12.2
7	0.0	29.1	31	704.2	0.000	0.0	0.0	.66	.7	16.0
8	0.0	34.5	82	757.7	.040	1.9	0.0	.71	1.7	15.6
9	0.0	41.2	88	910.8	0.000	0.0	0.0	.78	1.7	17.2
10	0.0	188.0	5650	383.0	0.000	0.0	0.0	3.19	95.8	6.5
11	0.0	137.9	32	1.7	.070	0.0	I	R	R	R
12	0.0	16.8	72	3.9	.120	0.0	I	R	R	R
13	0.0	249.3	14590	648.5	.025	3.0	0.0	2.09	122.5	5.4
14	0.0	29.6	561	1127.8	.055	6.0	0.0	.27	5.1	10.3
15	0.0	21.3	385	1181.0	.035	3.4	0.0	.22	3.9	12.1
16	0.0	19.8	367	1042.6	.060	5.4	0.0	.22	4.1	11.7
17	0.0	32.7	230	1058.8	.060	3.6	0.0	.55	3.9	17.8
18	0.0	17.5	89	423.5	0.000	0.0	0.0	.59	3.0	14.2
19	0.0	11.7	84	248.6	.065	1.4	0.0	.55	3.9	11.6
20	0.0	7.4	69	61.2	0.000	0.0	0.0	.76	7.2	6.3
21	0.0	9.8	53	23.0	0.000	0.0	0.0	4.50	24.2	10.5
22	0.0	1.4	19	1.8	.080	0.0	I	R	R	R
23	0.0	176.3	36	.8	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	1.497	GRAM/BHP HR
	CO	17.373	GRAM/BHP HR
	NO2	11.657	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.560	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

7-12-72 RUN 1 ENG. 2-3 1972 VERSION, A-CATALYTIC W/AIR STD

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.5	3.7	26.0	0	156	.050	8.60	28
2	1200	5.0	1	19.5	7.0	25.8	0	73	.050	8.60	45
3	1200	19.0	4	18.4	7.7	25.6	0	124	.050	8.60	105
4	1200	42.0	10	17.5	8.3	25.0	0	157	.050	8.75	190
5	1200	59.0	13	15.7	10.1	23.5	0	186	.050	9.37	480
6	1200	117.0	27	8.8	16.0	21.1	0	134	.050	10.66	865
7	1200	176.0	40	4.9	20.6	19.1	0	133	.050	11.92	1650
8	1200	192.0	44	3.6	22.1	18.8	0	119	.050	12.22	1700
9	1200	215.0	49	2.0	23.8	18.0	0	144	.050	12.47	2150
10	1200	234.0	53	.3	31.5	14.6	0	869	2.780	12.71	825
11	600	0.0	0	18.9	3.7	24.5	0	108	.050	8.93	50
12	1200	0.0	0	23.0	3.7	35.7	0	1121	.050	5.96	15
13	2300	263.0	115	.5	63.8	13.8	0	863	4.020	12.22	763
14	2300	241.0	106	2.8	51.4	16.4	0	58	.100	13.77	1813
15	2300	216.0	95	4.8	43.6	16.7	0	45	.070	13.48	1700
16	2300	197.0	86	6.2	42.0	17.0	0	42	.070	13.33	1700
17	2300	132.0	58	9.3	28.8	20.4	0	74	.100	11.13	1612
18	2300	66.0	29	15.8	19.8	23.1	0	74	.050	9.78	950
19	2300	47.0	21	17.2	17.4	24.1	0	62	.020	9.25	625
20	2300	21.0	9	19.4	13.5	25.8	0	43	.020	8.60	215
21	2300	5.0	2	21.0	11.3	27.4	0	40	.020	8.14	99
22	600	0.0	0	18.5	3.7	26.2	0	182	.020	8.48	32
23	2300	0.0	0	25.0	3.5	59.8	0	3280	.070	3.08	5

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	3.0	19	1.8	.070	0.0	I	R	R	R
2	0.0	2.7	37	5.5	.060	.1	0.0	2.35	32.3	4.8
3	0.0	5.0	41	14.1	.060	.3	0.0	1.16	9.4	3.3
4	0.0	6.7	43	27.0	.050	.5	0.0	.70	4.5	2.8
5	0.0	4.1	49	77.7	.030	.4	0.0	.67	3.7	5.8
6	0.0	9.1	68	194.6	.060	1.6	0.0	.34	2.6	7.3
7	0.0	10.4	79	427.8	0.000	0.0	0.0	.26	2.0	10.6
8	0.0	9.7	82	460.7	.040	1.8	0.0	.22	1.9	10.5
9	0.0	12.4	87	614.8	0.000	0.0	0.0	.25	1.8	12.5
10	0.0	29.8	5154	251.4	0.000	0.0	0.0	1.49	96.4	4.7
11	0.0	6.0	19	3.1	.070	0.0	I	R	R	R
12	0.0	30.5	27	1.3	.120	0.0	I	R	R	R
13	0.0	153.0	14401	448.9	.025	2.9	0.0	1.33	125.0	3.9
14	0.0	9.7	339	1011.3	.055	5.8	0.0	.09	3.2	9.6
15	0.0	6.6	206	823.5	.035	3.3	0.0	.07	2.2	8.7
16	0.0	5.9	201	802.4	.060	5.2	0.0	.07	2.3	9.3
17	0.0	8.6	235	623.2	.060	3.5	0.0	.15	4.1	10.8
18	0.0	6.8	92	287.4	0.000	0.0	0.0	.23	3.2	9.9
19	0.0	5.3	34	176.8	.065	1.3	0.0	.26	1.7	8.6
20	0.0	3.1	29	50.7	0.000	0.0	0.0	.33	3.1	5.5
21	0.0	2.5	25	20.7	0.000	0.0	0.0	1.15	11.6	9.4
22	0.0	3.5	8	2.1	.080	0.0	I	R	R	R
23	0.0	151.0	65	.8	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	.797	GRAM/BHP HR
	CO	16.593	GRAM/BHP HR
	NO2	8.602	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.612	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

7-12-72 RUN-2 ENG. 2-3 1972 VERSION A-CATALYTIC W/AIR STD

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.5	4.0	26.4	0	345	.020	8.34	26
2	1200	5.0	1	19.6	7.1	24.9	0	127	.070	8.84	47
3	1200	19.0	4	18.8	7.4	25.7	0	108	.020	8.68	84
4	1200	42.0	10	16.8	8.3	24.5	0	175	.020	9.14	265
5	1200	59.0	13	15.7	10.0	23.3	0	198	.020	9.78	575
6	1200	117.0	27	9.8	15.1	21.3	0	163	.020	11.01	820
7	1200	176.0	40	4.8	21.4	18.9	0	173	.020	12.34	1800
8	1200	192.0	44	3.8	22.0	18.4	0	143	.020	12.34	1712
9	1200	215.0	49	2.4	23.1	18.2	0	166	.020	12.34	2150
10	1200	234.0	53	.3	31.5	19.8	0	1007	2.690	12.94	987
11	600	0.0	0	19.0	3.9	25.1	0	121	.020	9.03	35
12	1200	0.0	0	23.0	3.6	38.6	0	2231	.020	5.39	9
13	2300	263.0	115	.5	63.0	14.0	0	789	3.790	12.22	825
14	2300	241.0	106	2.7	51.3	15.4	0	148	.810	13.77	900
15	2300	216.0	95	4.7	45.4	16.6	0	54	.050	13.63	1650
16	2300	197.0	86	6.0	41.2	17.2	0	40	.050	13.18	1825
17	2300	132.0	58	10.0	28.8	21.0	0	72	.050	10.78	1650
18	2300	66.0	29	15.6	18.6	23.4	0	70	.050	9.64	950
19	2300	47.0	21	17.5	16.1	24.6	0	54	.050	9.03	530
20	2300	21.0	9	19.2	13.9	25.7	0	43	.050	8.68	245
21	2300	5.0	2	21.0	11.2	27.5	0	39	.050	8.14	115
22	600	0.0	0	18.5	3.9	28.1	0	212	.050	7.85	30
23	2300	0.0	0	24.8	3.5	61.5	0	2733	.100	3.03	8

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	7.4	9	1.9	.070	0.0	I	R	R	R
2	0.0	4.6	51	5.7	.060	.1	0.0	4.04	44.9	5.0
3	0.0	4.2	16	10.7	.060	.3	0.0	.96	3.6	2.5
4	0.0	7.2	17	36.0	.050	.5	0.0	.75	1.7	3.8
5	0.0	9.1	19	88.3	.030	.4	0.0	.68	1.4	6.5
6	0.0	10.1	25	168.6	.060	1.6	0.0	.38	.9	6.3
7	0.0	13.5	32	467.6	0.000	0.0	0.0	.34	.8	11.6
8	0.0	11.6	33	458.4	.040	1.8	0.0	.26	.7	10.4
9	0.0	14.0	34	604.6	0.000	0.0	0.0	.29	.7	12.3
10	0.0	91.5	4936	297.6	0.000	0.0	0.0	1.71	92.3	5.6
11	0.0	2.4	8	2.3	.070	0.0	I	R	R	R
12	0.0	64.7	12	.9	.120	0.0	I	R	R	R
13	0.0	140.2	13594	486.3	.025	2.9	0.0	1.22	118.0	4.2
14	0.0	23.5	2609	476.4	.055	5.8	0.0	.22	24.7	4.5
15	0.0	8.2	152	824.9	.035	3.3	0.0	.09	1.6	8.7
16	0.0	5.7	143	856.0	.060	5.2	0.0	.07	1.7	9.9
17	0.0	8.7	122	661.3	.060	3.5	0.0	.15	2.1	11.4
18	0.0	6.1	88	274.1	0.000	0.0	0.0	.21	3.0	9.5
19	0.0	4.3	81	141.1	.065	1.3	0.0	.21	3.9	6.9
20	0.0	3.1	73	58.8	0.000	0.0	0.0	.34	7.9	6.4
21	0.0	2.4	63	23.7	0.000	0.0	0.0	1.10	28.7	10.8
22	0.0	4.8	23	2.2	.080	0.0	I	R	R	R
23	0.0	128.6	95	1.2	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	.941	GRAM/BHP HR
	CO	19.890	GRAM/BHP HR
	NO2	7.607	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.607	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

7-13-72 RUN 3 ENG. 2-3 1972 VERSION A-CATALYTIC W/AIR 4 ATDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	16.5	4.6	24.2	0	260	.050	8.93	44
2	1200	4.0	1	18.7	7.6	25.4	0	101	.050	8.60	56
3	1200	16.0	4	18.2	7.8	25.4	0	108	.050	8.60	68
4	1200	37.0	8	16.4	9.8	24.2	0	130	.050	8.93	167
5	1200	51.0	12	15.4	10.0	23.8	0	133	.050	9.03	200
6	1200	102.0	23	7.8	17.6	20.1	0	80	.050	11.24	615
7	1200	153.0	35	4.1	22.3	18.5	0	92	.050	11.84	1125
8	1200	167.0	38	3.0	22.9	18.3	0	74	.050	11.84	1300
9	1200	188.0	43	1.8	24.4	17.8	0	81	.050	12.34	1525
10	1200	204.0	47	.3	31.5	14.7	0	416	2.360	12.82	660
11	600	0.0	0	17.0	4.2	23.9	0	116	.020	8.84	48
12	1200	0.0	0	22.0	4.4	33.0	0	23	.050	6.30	10
13	2300	236.0	103	.5	64.3	13.8	0	641	3.700	11.92	600
14	2300	217.0	95	2.4	53.6	14.9	0	182	1.230	13.48	580
15	2300	194.0	85	4.2	46.0	16.3	0	106	.100	13.48	1100
16	2300	177.0	78	5.5	42.7	16.7	0	110	.070	13.33	1063
17	2300	118.0	52	9.3	30.8	20.3	0	107	.070	11.01	950
18	2300	59.0	26	15.5	18.5	22.9	0	99	.070	9.64	520
19	2300	42.0	18	16.9	18.0	23.8	0	77	.070	9.14	360
20	2300	19.0	8	18.9	14.0	25.0	0	50	.070	8.75	152
21	2300	5.0	2	20.2	12.2	26.1	0	37	.070	8.34	90
22	600	0.0	0	16.5	4.5	24.7	0	188	.050	8.75	43
23	2300	0.0	0	24.1	4.6	51.3	0	4647	.070	3.45	5

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	6.0	23	3.4	.070	0.0	I	R	R	R
2	0.0	4.0	40	7.4	.060	.1	0.0	4.39	43.8	8.1
3	0.0	4.4	42	9.4	.060	.2	0.0	1.21	11.4	2.6
4	0.0	6.4	50	27.5	.050	.4	0.0	.76	5.9	3.2
5	0.0	6.6	50	33.0	.030	.3	0.0	.57	4.3	2.8
6	0.0	5.7	71	144.3	.060	1.4	0.0	.24	3.1	6.2
7	0.0	7.8	86	317.2	0.000	0.0	0.0	.22	2.5	9.1
8	0.0	6.5	88	376.2	.040	1.5	0.0	.17	2.3	9.9
9	0.0	7.2	90	452.7	0.000	0.0	0.0	.17	2.1	10.5
10	0.0	39.0	4472	205.6	0.000	0.0	0.0	.84	95.9	4.4
11	0.0	2.5	9	3.4	.070	0.0	I	R	R	R
12	0.0	.7	32	1.1	.120	0.0	I	R	R	R
13	0.0	119.2	13905	370.6	.025	2.6	0.0	1.15	134.5	3.6
14	0.0	30.0	4102	317.9	.055	5.2	0.0	.32	43.2	3.3
15	0.0	16.3	310	561.2	.035	3.0	0.0	.19	3.7	6.6
16	0.0	15.8	204	509.0	.060	4.7	0.0	.20	2.6	6.6
17	0.0	13.5	178	397.6	.060	3.1	0.0	.26	3.4	7.7
18	0.0	8.6	122	149.0	0.000	0.0	0.0	.33	4.7	5.8
19	0.0	6.9	126	106.1	.065	1.2	0.0	.37	6.8	5.8
20	0.0	3.6	102	36.3	0.000	0.0	0.0	.43	12.2	4.4
21	0.0	2.4	93	19.6	0.000	0.0	0.0	1.11	42.4	9.0
22	0.0	4.4	24	3.3	.080	0.0	I	R	R	R
23	0.0	240.7	73	.9	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	1.034	GRAM/BHP HR
	CO	27.178	GRAM/BHP HR
	NO2	5.724	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.726	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

7-14-72 RUN-3 ENG.2-3 72-VER. A-CATA. W/AIR STD. J.-0.075 R.0.038

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.0	3.9	24.9	0	38	.050	8.75	35
2	1200	5.0	1	19.6	7.1	24.2	0	71	.050	8.93	65
3	1200	18.0	4	18.9	7.9	23.5	0	42	.050	9.37	96
4	1200	41.0	9	17.8	9.0	22.3	0	35	.050	9.93	320
5	1200	58.0	13	16.7	9.9	21.2	0	60	.050	10.55	550
6	1200	115.0	26	11.8	14.3	19.3	0	59	.280	11.24	1337
7	1200	173.0	40	6.0	21.9	16.7	0	85	.100	13.33	755
8	1200	189.0	43	4.4	23.4	16.6	0	41	.100	13.48	900
9	1200	212.0	48	2.8	25.6	16.3	0	43	.150	13.77	963
10	1200	230.0	53	.3	32.3	14.1	0	70	3.700	11.92	615
11	600	0.0	0	18.5	3.9	24.2	0	45	.020	9.03	41
12	1200	0.0	0	22.5	3.7	35.5	0	35	.020	6.05	8
13	2300	262.0	115	.5	64.9	13.7	0	80	4.350	12.22	690
14	2300	239.0	105	2.1	58.0	14.0	0	41	3.420	12.71	360
15	2300	213.0	93	4.5	47.1	14.8	0	77	1.630	13.77	675
16	2300	195.0	85	5.8	47.0	15.1	0	79	.970	14.31	690
17	2300	130.0	57	11.2	30.3	18.2	0	82	.050	12.47	1837
18	2300	65.0	28	16.4	20.3	20.6	0	49	.050	11.13	1100
19	2300	47.0	21	17.5	18.3	21.1	0	87	.050	10.78	790
20	2300	21.0	9	19.8	13.9	23.2	0	31	.050	9.64	280
21	2300	5.0	2	21.0	12.7	23.7	0	76	.100	9.25	175
22	600	0.0	0	18.0	3.9	24.9	0	44	.050	8.84	41
23	2300	0.0	0	24.4	3.9	54.5	0	16	.100	3.68	4

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	.8	21	2.4	.070	0.0	I	R	R	R
2	0.0	2.5	36	7.8	.060	.1	0.0	2.22	31.6	6.8
3	0.0	1.6	38	12.1	.060	.2	0.0	.39	9.3	2.9
4	0.0	1.4	41	43.3	.050	.5	0.0	.15	4.4	4.6
5	0.0	2.6	43	77.3	.030	.4	0.0	.19	3.2	5.8
6	0.0	3.3	318	249.7	.060	1.6	0.0	.13	12.1	9.5
7	0.0	6.3	149	184.9	0.000	0.0	0.0	.16	3.8	4.7
8	0.0	3.2	158	233.9	.040	1.7	0.0	.07	3.7	5.4
9	0.0	3.6	252	266.1	0.000	0.0	0.0	.07	5.2	5.5
10	0.0	6.6	7005	191.4	0.000	0.0	0.0	.13	133.3	3.6
11	0.0	.9	8	2.7	.070	0.0	I	R	R	R
12	0.0	1.0	11	.8	.120	0.0	I	R	R	R
13	0.0	14.1	15606	406.9	.025	2.9	0.0	.12	136.0	3.5
14	0.0	6.7	11265	194.9	.055	5.8	0.0	.06	107.6	1.9
15	0.0	10.7	4565	310.7	.035	3.3	0.0	.11	48.9	3.3
16	0.0	11.0	2731	319.3	.060	5.1	0.0	.13	32.0	3.7
17	0.0	9.0	111	669.5	.060	3.4	0.0	.16	1.9	11.8
18	0.0	4.0	83	301.2	0.000	0.0	0.0	.14	2.9	10.6
19	0.0	6.7	77	201.1	.065	1.3	0.0	.32	3.8	9.8
20	0.0	2.0	66	60.5	0.000	0.0	0.0	.22	7.1	6.6
21	0.0	4.7	124	35.7	0.000	0.0	0.0	2.13	56.7	16.3
22	0.0	.9	20	2.7	.080	0.0	I	R	R	R
23	0.0	.8	95	.6	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	.145	GRAM/BHP HR
	CO	52.906	GRAM/BHP HR
	NO2	5.138	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.658	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

7-14-72 RUN-2 ENG. 2-3 1972 VERSION A-CATALYTIC W/O AIR STD

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.0	3.6	17.4	0	683	.050	12.47	40
2	1200	5.0	1	19.2	7.3	17.2	0	123	.050	12.82	71
3	1200	18.0	4	18.7	7.4	17.2	0	90	.050	12.82	85
4	1200	41.0	9	17.0	9.6	17.6	0	192	.050	12.34	430
5	1200	58.0	13	15.1	10.2	17.5	0	192	.050	12.22	570
6	1200	115.0	26	8.4	16.6	16.6	0	191	.050	13.06	1188
7	1200	173.0	40	4.7	20.7	15.3	0	4573	.050	13.91	1875
8	1200	189.0	43	3.6	21.3	15.8	0	467	.070	13.48	1975
9	1200	212.0	48	2.2	23.6	15.5	0	712	.100	13.91	2200
10	1200	230.0	53	.3	31.7	13.0	0	2882	5.290	11.24	1000
11	600	0.0	0	18.5	3.6	15.3	0	2626	1.770	12.22	48
12	1200	0.0	0	22.5	4.5	18.8	0	35	.100	11.84	22
13	2300	260.0	114	.5	62.1	12.9	0	2278	5.450	11.13	1112
14	2300	239.0	105	3.0	47.5	14.7	0	107	1.590	13.48	2063
15	2300	213.0	93	4.8	44.6	14.8	0	899	1.300	13.63	1987
16	2300	195.0	85	6.0	41.9	14.7	0	1085	1.480	13.91	1987
17	2300	130.0	57	9.8	29.5	17.0	0	94	.020	13.33	1800
18	2300	65.0	28	15.4	17.7	17.4	0	75	.020	12.94	1162
19	2300	47.0	21	16.8	17.0	17.4	0	55	.020	13.06	720
20	2300	21.0	9	19.1	13.3	17.6	0	26	.050	13.06	285
21	2300	5.0	2	20.5	11.4	17.7	0	16	.050	12.94	188
22	600	0.0	0	18.0	3.6	18.2	0	262	.020	12.47	45
23	2300	0.0	0	24.5	3.6	26.6	0	61	.020	8.34	11

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	9.0	13	1.7	.070	0.0	I	R	R	R
2	0.0	3.2	26	6.1	.060	.1	0.0	2.77	22.8	5.3
3	0.0	2.3	26	7.3	.060	.2	0.0	.57	6.4	1.8
4	0.0	6.8	35	50.1	.050	.5	0.0	.72	3.8	5.4
5	0.0	7.2	38	71.4	.030	.4	0.0	.55	2.9	5.4
6	0.0	10.9	58	225.6	.060	1.6	0.0	.42	2.2	8.6
7	0.0	247.2	66	404.6	0.000	0.0	0.0	7.52	1.7	10.2
8	0.0	33.2	100	465.5	.040	1.7	0.0	.77	2.3	10.8
9	0.0	54.1	153	554.8	0.000	0.0	0.0	1.12	3.2	11.5
10	0.0	246.6	9142	284.0	0.000	0.0	0.0	4.69	174.0	5.4
11	0.0	30.3	412	1.8	.070	0.0	I	R	R	R
12	0.0	.6	34	1.2	.120	0.0	I	R	R	R
13	0.0	381.6	18444	618.8	.025	2.8	0.0	3.35	162.0	5.4
14	0.0	15.3	4591	978.7	.055	5.8	0.0	.15	43.9	9.4
15	0.0	121.1	3537	888.8	.035	3.3	0.0	1.30	37.9	9.5
16	0.0	133.2	3670	809.9	.060	5.1	0.0	1.56	43.0	9.5
17	0.0	9.4	40	598.2	.060	3.4	0.0	.17	.7	10.5
18	0.0	4.6	25	239.1	0.000	0.0	0.0	.16	.9	8.4
19	0.0	3.2	24	141.1	.065	1.3	0.0	.16	1.2	6.9
20	0.0	1.2	46	43.5	0.000	0.0	0.0	.13	5.0	4.7
21	0.0	.6	40	24.9	0.000	0.0	0.0	.29	18.4	11.4
22	0.0	3.5	5	2.0	.080	0.0	I	R	R	R
23	0.0	1.2	8	.7	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	1.121	GRAM/BHP HR
	CO	42.312	GRAM/BHP HR
	NO2	8.855	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.517	LB/BHP HR

ENGINE 2-3

EFFECT OF OXIDATION CATALYST ON EMISSIONS

GRAPHED RESULTS

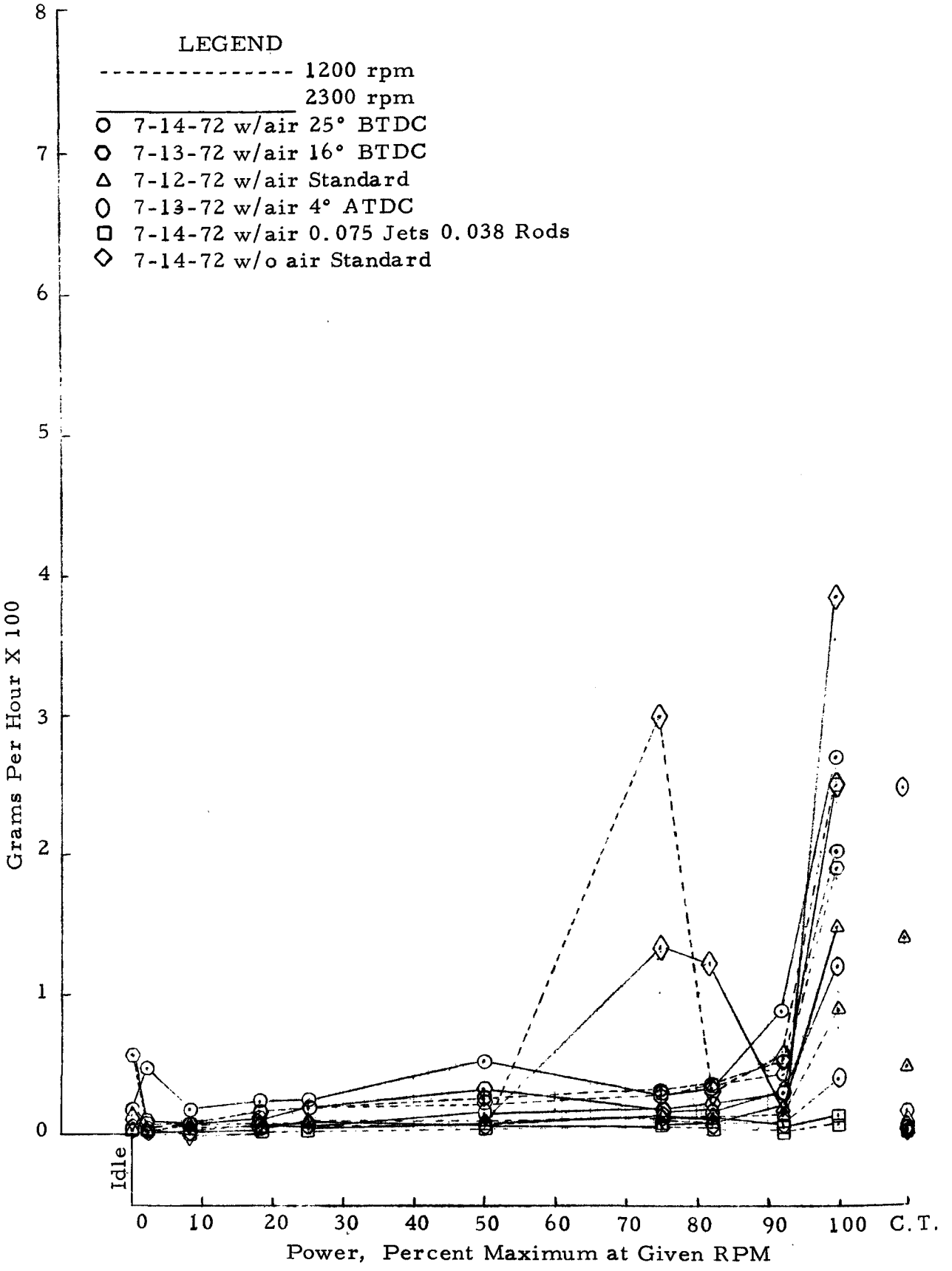


FIGURE M-1. EFFECT OF POWER ON HC EMISSION RATE - AFTER OXIDATION CATALYST ENGINE 2-3, 23 MODE TEST

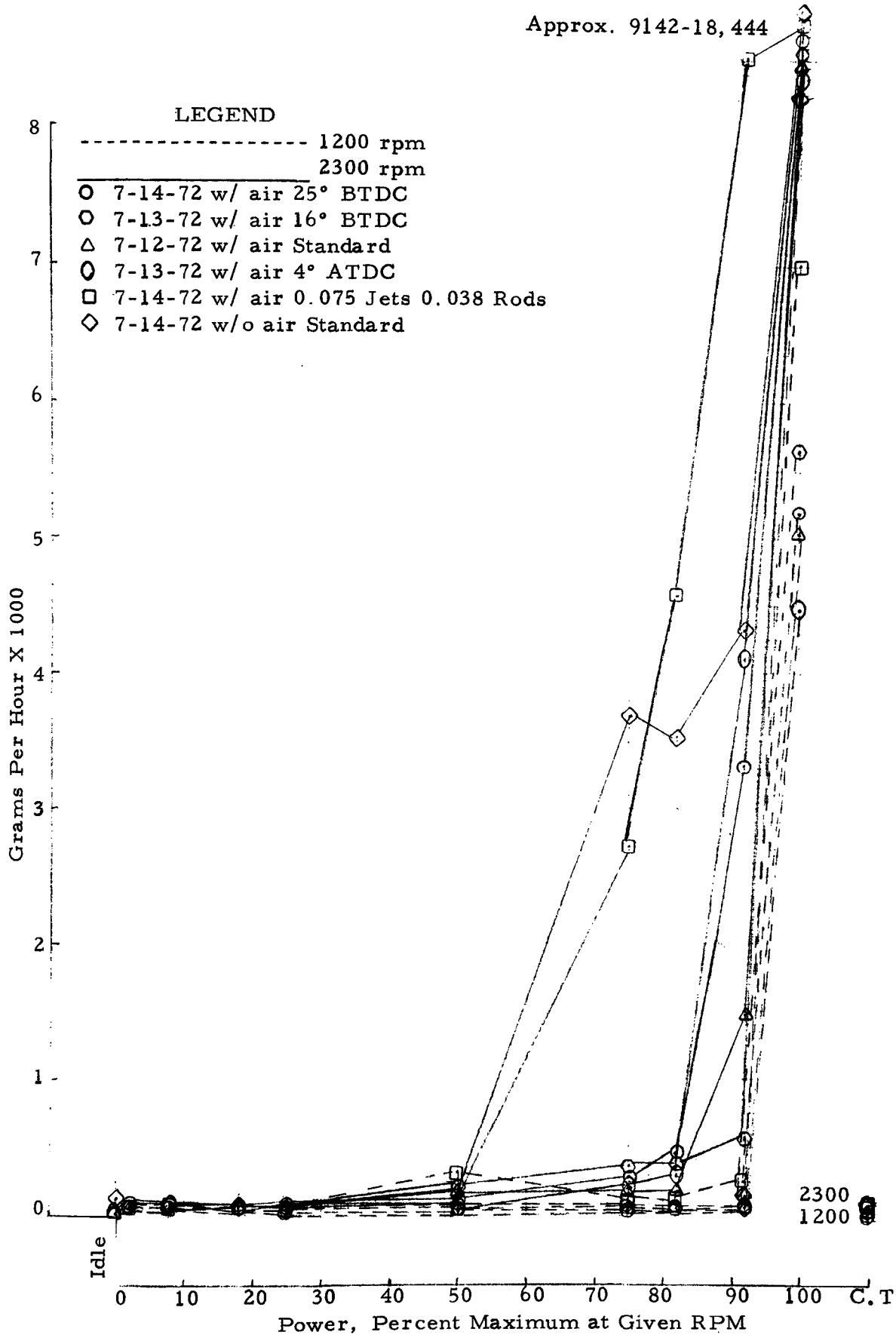


FIGURE M-2. EFFECT OF POWER ON CO EMISSION RATE - AFTER OXIDATION CATALYST ENGINE 2-3, 23 MODE TEST

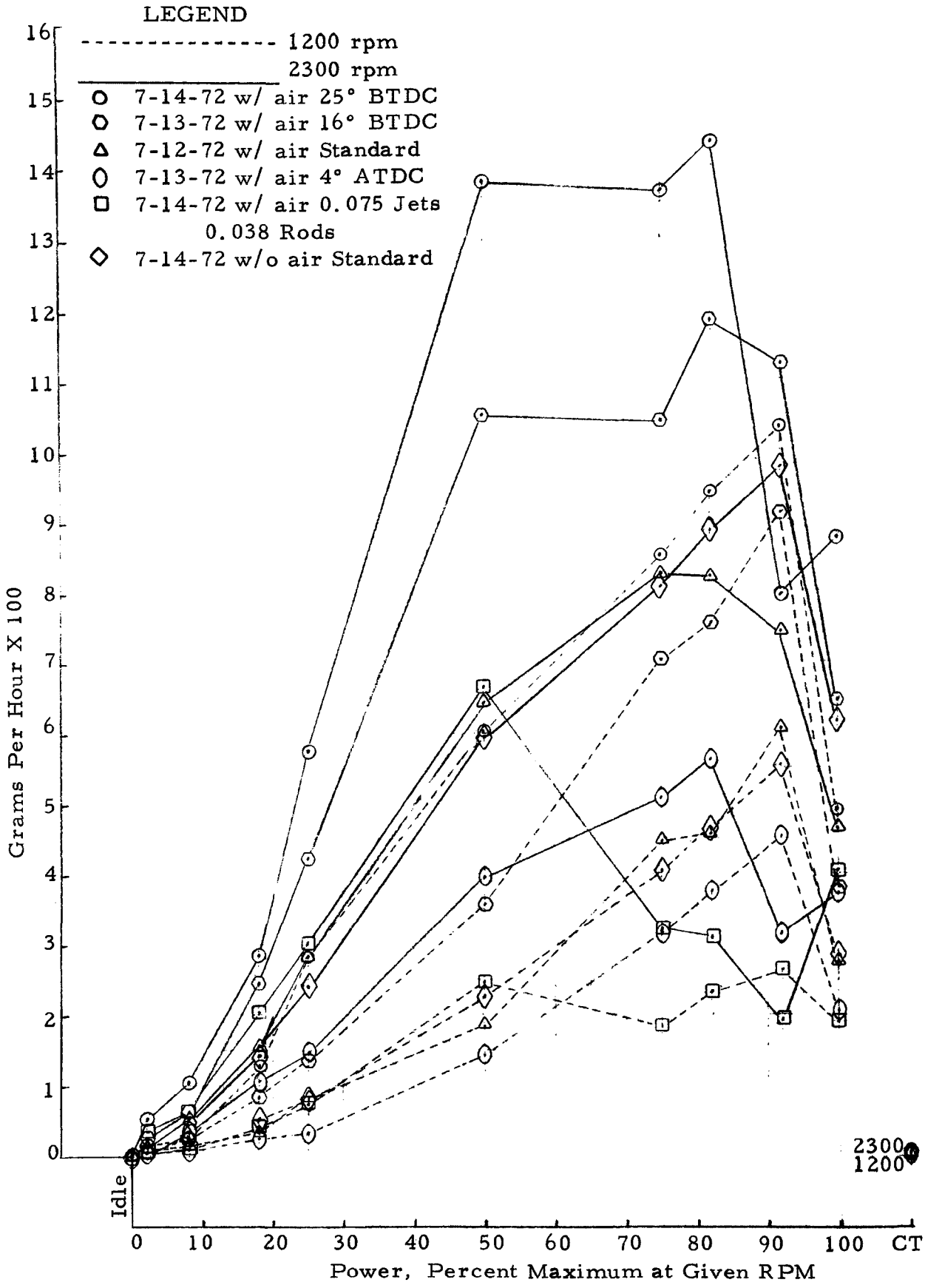


FIGURE M-3. EFFECT OF POWER ON NO_x (AS NO_2) EMISSION RATE - AFTER OXIDATION CATALYST ENGINE 2-3, 23 MODE TEST

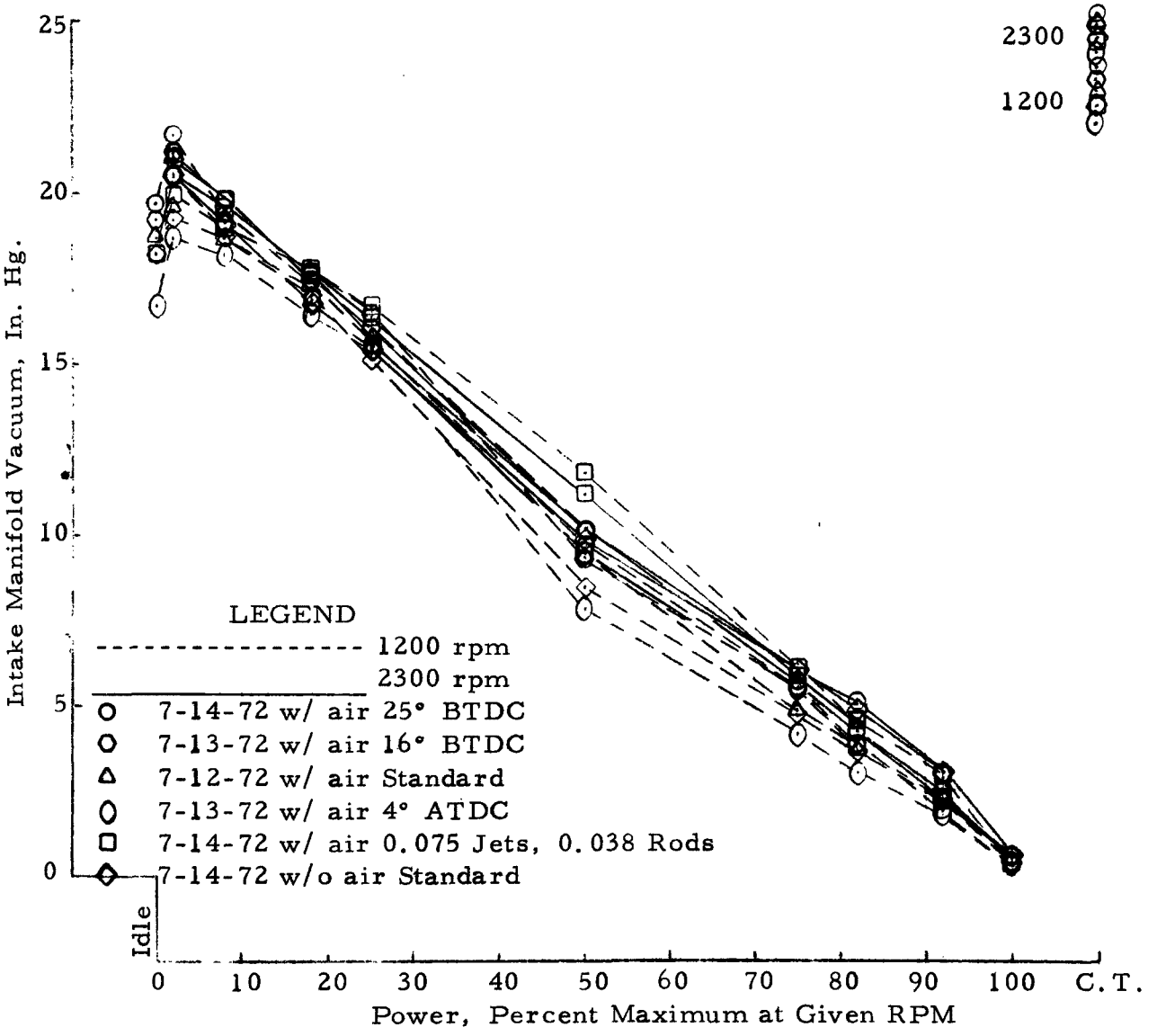


FIGURE M-4. MANIFOLD VACUUM AS A FUNCTION OF POWER - OXIDATION CATALYST
ENGINE 2-3, 23 MODE TEST

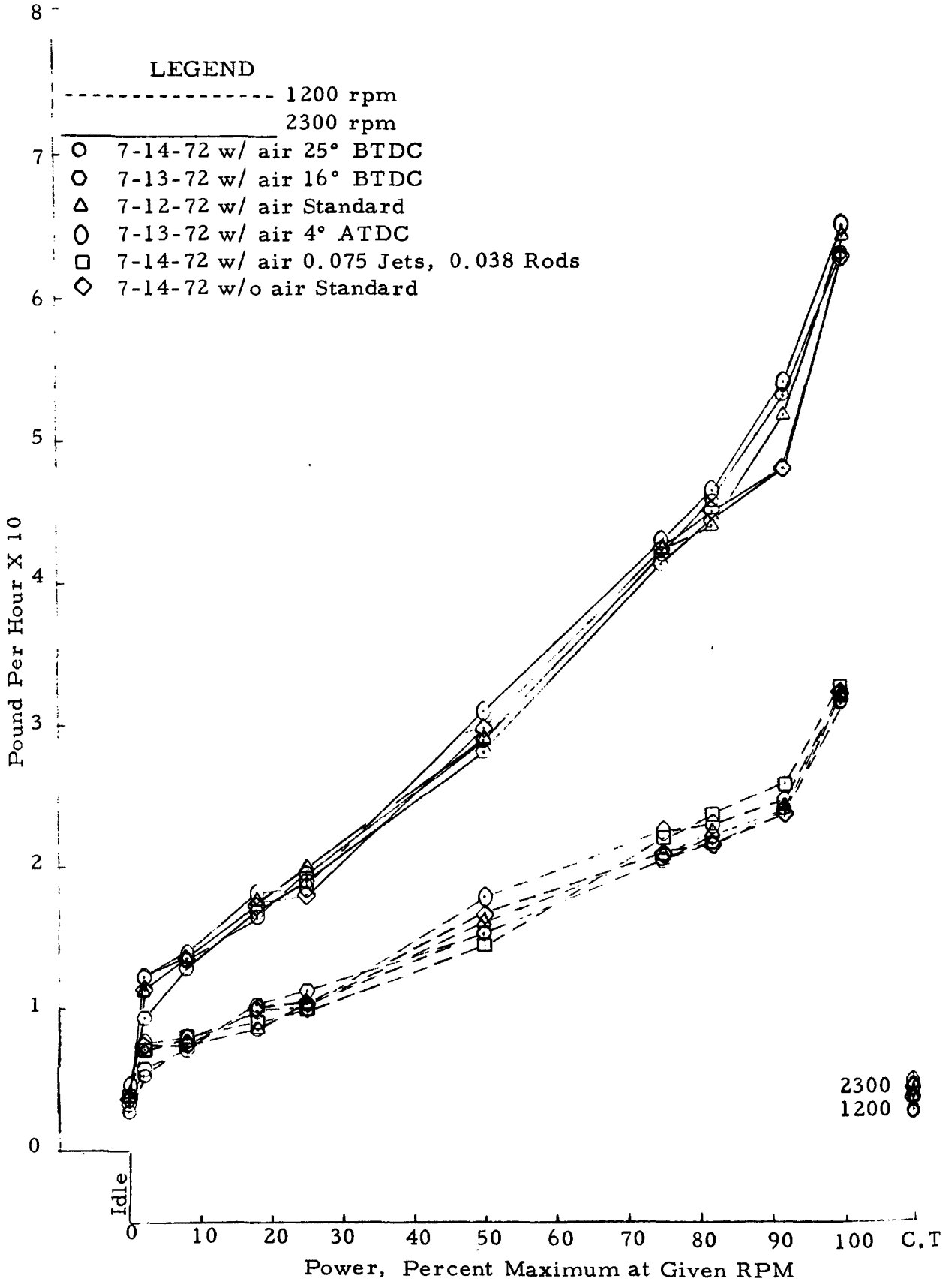


FIGURE M-5. FUEL CONSUMPTION AS A FUNCTION OF POWER - OXIDATION CATALYST
ENGINE 2-3, 23 MODE TEST

APPENDIX N

ENGINE 2-3

EFFECT OF ENGINE DERATING ON EMISSIONS

(23 MODE MASS RESULTS)

PROJECT 11-2877-01 CONTROL TECHNOLOGY

7-26-72 RUN1 ENG.2-3 1972-VERSION- STD-TIM-STD-4BBL-W/REAR PLUG

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.3	3.1	18.8	0	4145	1.160	11.84	35
2	1200	5.0	1	20.3	6.7	16.3	0	671	.390	13.48	70
3	1200	19.0	4	19.1	7.3	16.6	0	968	.150	13.48	169
4	1200	42.0	10	18.2	7.9	16.6	0	1560	.130	13.06	395
5	1200	59.0	13	17.2	9.2	16.5	0	1730	.130	13.18	645
6	1200	117.0	27	11.2	14.0	16.8	0	1502	.130	12.94	1438
7	1200	176.0	40	5.7	20.9	15.7	0	1630	.180	14.05	2050
8	1200	192.0	44	3.9	21.7	16.0	0	1298	.180	13.77	2150
9	1200	215.0	49	2.0	23.7	15.8	0	1354	.250	13.63	2250
10	1200	234.0	53	.5	26.1	15.4	0	1667	.850	13.63	2075
11	600	0.0	0	18.7	3.4	15.6	0	4515	1.590	12.34	46
12	1200	0.0	0	23.3	3.6	18.2	0	48753	.420	6.05	12
13	2300	240.0	105	2.3	51.7	14.6	0	2080	1.630	13.48	2125
14	2300	221.0	97	3.6	47.6	14.7	0	1478	1.660	13.18	1787
15	2300	197.0	86	5.8	42.3	14.9	0	1138	1.270	13.63	1612
16	2300	180.0	79	6.9	38.0	15.1	0	1261	.930	13.77	2000
17	2300	120.0	53	11.4	28.2	16.4	0	377	.180	13.33	2000
18	2300	60.0	26	16.9	18.3	16.6	0	374	.180	13.18	1125
19	2300	43.0	19	18.2	16.5	16.7	0	343	.180	13.18	765
20	2300	19.0	8	20.1	12.5	16.8	0	205	.150	13.18	300
21	2300	5.0	2	21.3	10.6	16.8	0	115	.150	13.18	154
22	600	0.0	0	18.3	3.3	16.4	0	3595	1.520	11.84	42
23	2300	0.0	0	25.2	3.5	22.9	0	46623	.280	3.62	7

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	43.4	246	1.2	.070	0.0	I	R	R	R
2	0.0	14.6	172	5.1	.060	.1	0.0	12.81	150.4	4.5
3	0.0	23.4	73	13.5	.060	.3	0.0	5.38	16.8	3.1
4	0.0	41.9	71	35.2	.050	.5	0.0	4.36	7.3	3.7
5	0.0	53.5	81	66.3	.030	.4	0.0	3.97	6.0	4.9
6	0.0	72.1	126	229.2	.060	1.6	0.0	2.70	4.7	8.6
7	0.0	107.3	239	448.3	0.000	0.0	0.0	2.67	6.0	11.1
8	0.0	90.8	254	499.0	.040	1.8	0.0	2.07	5.8	11.4
9	0.0	103.9	387	573.0	0.000	0.0	0.0	2.11	7.9	11.7
10	0.0	134.7	1388	556.8	0.000	0.0	0.0	2.52	26.0	10.4
11	0.0	48.4	344	1.7	.070	0.0	I	R	R	R
12	0.0	701.7	122	.6	.120	0.0	I	R	R	R
13	0.0	318.4	5041	1080.1	.025	2.6	0.0	3.03	48.0	10.3
14	0.0	213.0	4831	854.9	.055	5.3	0.0	2.20	49.9	8.8
15	0.0	145.4	3279	684.2	.035	3.0	0.0	1.69	38.0	7.9
16	0.0	146.6	2184	772.0	.060	4.7	0.0	1.86	27.7	9.8
17	0.0	35.6	343	626.9	.060	3.2	0.0	.68	6.5	11.9
18	0.0	23.1	225	231.4	0.000	0.0	0.0	.88	8.6	8.8
19	0.0	19.1	203	141.9	.065	1.2	0.0	1.02	10.8	7.5
20	0.0	8.7	129	42.3	0.000	0.0	0.0	1.05	15.5	5.1
21	0.0	4.1	109	18.4	0.000	0.0	0.0	1.90	49.9	8.4
22	0.0	39.2	335	1.5	.080	0.0	I	R	R	R
23	0.0	864.5	105	.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	7.973	GRAM/BHP HR
	CO	32.405	GRAM/BHP HR
	NO2	9.336	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.609	LB/BHP HR

APPENDIX O

ENGINE 2-3

EFFECT OF "BEST COMBINATION" ON EMISSIONS

Factory Exhaust Manifold Air Injection (Light Duty)
Factory Exhaust Gas Recirculation (Light Duty)
Standard 1972 Carburetor-Distributor
Oxidation Catalyst (Platinum Type)
Basic Spark Timing as noted

ENGINE 2-3

EFFECT OF "BEST COMBINATION" ON EMISSIONS

TABULAR 23 MODE DATA
BEFORE AND AFTER CATALYST

PROJECT 11-2877-01 CONTROL TECHNOLOGY

7-28-72 RUN-1 ENG.2-3 1972 VERSION- 8-CATA W/AIR W/EGR 4 ATDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	16.5	4.0	21.5	0	1096	.280	10.09	31
2	1200	4.0	1	10.0	11.2	21.7	0	10600	.390	8.43	17
3	1200	15.0	3	8.7	12.6	20.6	0	2575	.280	10.09	27
4	1200	33.0	8	6.9	14.8	19.4	0	482	.100	11.48	68
5	1200	46.0	11	6.1	15.1	19.4	0	200	.100	11.72	100
6	1200	92.0	21	4.4	18.7	19.0	0	200	.070	12.09	310
7	1200	138.0	32	2.9	21.2	18.2	0	189	.100	12.22	325
8	1200	151.0	35	2.3	22.3	18.4	0	269	.050	11.92	1000
9	1200	169.0	39	1.4	23.4	17.9	0	293	.150	12.47	1212
10	1200	184.0	42	.3	29.2	14.7	0	645	2.780	12.59	765
11	600	0.0	0	17.0	5.0	21.3	0	214	.470	10.09	57
12	1200	0.0	0	21.1	5.8	23.5	0	7967	.440	7.85	24
13	2300	222.0	97	.6	63.0	13.4	0	1719	4.300	11.48	500
14	2300	204.0	89	2.6	50.8	16.0	0	210	.350	13.48	925
15	2300	182.0	80	3.6	41.8	16.8	0	123	.180	12.94	713
16	2300	166.0	73	4.2	42.8	17.3	0	106	.150	12.59	605
17	2300	111.0	49	6.6	34.6	18.5	0	58	.070	12.34	375
18	2300	55.0	24	10.0	25.2	20.6	0	121	.050	10.78	142
19	2300	40.0	18	12.4	20.9	22.9	0	350	.100	9.93	117
20	2300	18.0	8	15.3	16.6	24.3	0	835	.150	9.03	51
21	2300	4.0	2	17.0	15.5	22.4	0	366	.100	9.93	74
22	600	0.0	0	16.5	4.0	23.3	0	1130	.210	9.14	39
23	2300	0.0	0	24.4	3.6	31.3	0	51567	.050	.09	4

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	18.8	97	1.8	.070	0.0	I	R	R	R
2	0.0	543.1	404	2.8	.060	.1	0.0	594.23	441.7	3.1
3	0.0	138.5	304	4.8	.060	.2	0.0	40.41	88.8	1.4
4	0.0	27.7	116	13.0	.050	.4	0.0	3.68	15.4	1.7
5	0.0	11.6	117	19.2	.030	.3	0.0	1.10	11.1	1.8
6	0.0	14.0	99	71.8	.060	1.3	0.0	.66	4.7	3.4
7	0.0	14.8	158	84.3	0.000	0.0	0.0	.47	5.0	2.7
8	0.0	22.7	85	280.2	.040	1.4	0.0	.66	2.5	8.1
9	0.0	24.6	254	337.8	0.000	0.0	0.0	.64	6.6	8.7
10	0.0	55.3	4812	217.7	0.000	0.0	0.0	1.32	114.5	5.2
11	0.0	4.6	205	4.1	.070	0.0	I	R	R	R
12	0.0	229.1	256	2.3	.120	0.0	I	R	R	R
13	0.0	307.9	15560	297.4	.025	2.4	0.0	3.17	160.1	3.1
14	0.0	34.9	1175	510.5	.055	4.9	0.0	.39	13.2	5.7
15	0.0	17.8	524	341.2	.035	2.8	0.0	.22	6.6	4.3
16	0.0	16.2	462	306.1	.060	4.4	0.0	.22	6.4	4.2
17	0.0	7.3	179	157.2	.060	2.9	0.0	.15	3.7	3.2
18	0.0	12.8	106	49.9	0.000	0.0	0.0	.53	4.4	2.1
19	0.0	32.9	190	36.7	.065	1.1	0.0	1.88	10.9	2.1
20	0.0	67.7	246	13.7	0.000	0.0	0.0	8.59	31.2	1.7
21	0.0	25.5	141	17.1	0.000	0.0	0.0	14.58	80.4	9.8
22	0.0	21.4	81	2.5	.080	0.0	I	R	R	R
23	0.0	1589.8	31	.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	8.327	GRAM/BHP HR
	CO	29.082	GRAM/BHP HR
	NO2	4.323	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.827	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

7-28-72 RUN-2 ENG.2-3 1972 VERSION B-CATA W/AIR W/EGR 4 BTDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.5	2.9	23.8	0	2162	.100	8.68	22
2	1200	5.0	1	10.9	10.1	22.8	0	15447	.210	7.65	15
3	1200	18.0	4	8.9	12.6	21.5	0	3163	.150	9.64	34
4	1200	41.0	9	7.5	13.7	20.2	0	645	.130	10.89	73
5	1200	57.0	13	6.9	14.8	20.0	0	474	.100	11.01	100
6	1200	115.0	26	5.0	18.0	19.2	0	460	.100	11.60	630
7	1200	172.0	39	3.3	20.5	18.8	0	527	.100	11.72	1188
8	1200	189.0	43	2.7	22.7	18.5	0	578	.100	11.92	1800
9	1200	212.0	48	1.8	24.5	18.0	0	708	.150	12.22	2188
10	1200	230.0	53	.3	29.2	15.7	0	1265	2.180	11.84	1338
11	600	0.0	0	18.0	3.2	23.4	0	1354	.280	8.75	35
12	1200	0.0	0	23.0	3.6	29.1	0	46514	.150	2.26	5
13	2300	250.0	109	.6	63.7	14.3	0	2794	4.640	10.55	938
14	2300	230.0	101	2.6	46.1	16.8	0	572	.440	12.71	1825
15	2300	205.0	90	3.8	42.1	17.1	0	333	.390	12.47	1300
16	2300	187.0	82	4.5	41.8	17.4	0	221	.350	12.47	1063
17	2300	125.0	55	7.5	31.3	18.7	0	91	.070	11.84	505
18	2300	62.0	27	11.8	21.6	21.4	0	389	.100	10.25	255
19	2300	45.0	20	14.4	19.1	21.2	0	505	.100	10.55	320
20	2300	20.0	9	15.2	16.2	23.7	0	933	.130	9.03	82
21	2300	5.0	2	16.5	14.0	24.4	0	1277	.150	8.75	54
22	600	0.0	0	17.5	3.2	24.7	0	1622	.100	8.68	25
23	2300	0.0	0	24.7	3.2	42.3	0	47566	.020	.13	3

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	31.6	30	1.1	.070	0.0	I	R	R	R
2	0.0	752.5	207	2.4	.060	.1	0.0	658.67	180.9	2.1
3	0.0	178.9	171	6.4	.060	.2	0.0	43.49	41.7	1.6
4	0.0	36.1	147	13.5	.050	.5	0.0	3.86	15.7	1.4
5	0.0	28.5	122	20.0	.030	.4	0.0	2.19	9.3	1.5
6	0.0	32.0	140	145.4	.060	1.6	0.0	1.22	5.3	5.5
7	0.0	41.3	158	308.9	0.000	0.0	0.0	1.05	4.0	7.9
8	0.0	49.3	172	509.5	.040	1.7	0.0	1.14	4.0	11.8
9	0.0	63.2	271	648.9	0.000	0.0	0.0	1.31	5.6	13.4
10	0.0	118.5	4123	415.9	0.000	0.0	0.0	2.25	78.5	7.9
11	0.0	21.4	90	1.8	.070	0.0	I	R	R	R
12	0.0	1075.6	70	.4	.120	0.0	I	R	R	R
13	0.0	521.9	17507	581.7	.025	2.7	0.0	4.77	159.9	5.3
14	0.0	90.6	1407	959.3	.055	5.5	0.0	.90	14.0	9.5
15	0.0	49.4	1167	639.3	.035	3.1	0.0	.55	13.0	7.1
16	0.0	32.7	1044	521.1	.060	4.9	0.0	.40	12.7	6.4
17	0.0	10.8	168	199.7	.060	3.3	0.0	.20	3.1	3.6
18	0.0	36.7	191	79.8	0.000	0.0	0.0	1.35	7.0	2.9
19	0.0	40.9	164	86.0	.065	1.3	0.0	2.08	8.3	4.4
20	0.0	74.1	209	21.6	0.000	0.0	0.0	8.46	23.8	2.5
21	0.0	89.8	213	12.7	0.000	0.0	0.0	41.03	97.3	5.8
22	0.0	26.3	33	1.3	.080	0.0	I	R	R	R
23	0.0	1407.1	12	.3	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	12.090	GRAM/BHP HR
	CO	27.914	GRAM/BHP HR
	NO2	6.691	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.671	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-1-72 RUN-1 ENG.2-3 72-VER. B-CATA. W/AIR-W/EGR 4 BTDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.2	3.6	23.1	0	2437	.250	8.75	26
2	1200	5.0	1	13.5	8.6	19.9	0	25419	.180	6.21	12
3	1200	18.0	4	10.1	11.5	21.0	0	8441	.210	8.68	22
4	1200	41.0	9	8.3	13.3	20.3	0	1457	.150	10.66	55
5	1200	57.0	13	7.3	14.4	19.9	0	625	.100	11.36	85
6	1200	115.0	26	5.2	16.9	19.4	0	421	.070	11.72	330
7	1200	172.0	39	3.1	20.5	18.7	0	528	.100	11.92	1225
8	1200	189.0	43	2.7	21.9	18.5	0	540	.130	12.22	1588
9	1200	212.0	48	1.8	23.4	18.2	0	630	.130	12.34	2163
10	1200	230.0	53	.3	29.5	15.3	0	1096	2.210	11.84	1300
11	600	0.0	0	18.7	3.2	23.2	0	1153	.310	9.14	39
12	1200	0.0	0	23.0	3.6	25.4	0	39931	.100	2.48	10
13	2300	252.0	110	.6	63.3	13.3	0	3147	4.540	8.84	838
14	2300	232.0	102	2.6	48.9	15.9	0	729	.640	12.47	1475
15	2300	207.0	91	3.9	42.8	17.1	0	302	.390	12.34	1200
16	2300	189.0	83	4.5	42.1	17.4	0	213	.350	12.59	938
17	2300	126.0	55	7.7	31.7	18.8	0	81	.070	12.47	535
18	2300	63.0	28	12.4	20.9	21.5	0	445	.100	10.55	220
19	2300	45.0	20	13.8	19.4	22.2	0	754	.130	9.93	160
20	2300	20.0	9	15.6	15.8	23.0	0	1055	.150	9.37	79
21	2300	5.0	2	17.0	13.7	24.1	0	2136	.150	8.68	44
22	600	0.0	0	18.2	3.6	24.0	0	1518	.150	8.93	29
23	2300	0.0	0	24.7	3.2	32.5	0	47535	.020	.06	3

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	43.1	89	1.5	.070	0.0	I	R	R	R
2	0.0	1110.1	159	1.7	.060	.1	0.0	971.75	139.0	1.5
3	0.0	452.4	227	3.9	.060	.2	0.0	109.99	55.3	1.0
4	0.0	80.3	167	10.1	.050	.5	0.0	8.57	17.8	1.1
5	0.0	35.4	115	16.0	.030	.4	0.0	2.72	8.8	1.2
6	0.0	27.3	92	71.0	.060	1.6	0.0	1.04	3.5	2.7
7	0.0	40.7	156	313.3	0.000	0.0	0.0	1.03	4.0	8.0
8	0.0	43.3	210	422.2	.040	1.7	0.0	1.00	4.9	9.8
9	0.0	53.4	222	608.2	0.000	0.0	0.0	1.10	4.6	12.6
10	0.0	103.6	4219	407.9	0.000	0.0	0.0	1.97	80.3	7.8
11	0.0	17.7	96	2.0	.070	0.0	I	R	R	R
12	0.0	992.0	50	.8	.120	0.0	I	R	R	R
13	0.0	659.7	19228	583.3	.025	2.8	0.0	5.98	174.2	5.3
14	0.0	122.6	2175	824.0	.055	5.6	0.0	1.21	21.4	8.1
15	0.0	45.9	1199	606.1	.035	3.2	0.0	.51	13.2	6.7
16	0.0	31.4	1042	459.0	.060	5.0	0.0	.38	12.6	5.5
17	0.0	9.3	162	203.4	.060	3.3	0.0	.17	2.9	3.7
18	0.0	39.4	179	64.7	0.000	0.0	0.0	1.43	6.5	2.3
19	0.0	65.6	228	46.2	.065	1.3	0.0	3.33	11.6	2.3
20	0.0	78.8	226	19.6	0.000	0.0	0.0	8.99	25.8	2.2
21	0.0	146.6	208	10.0	0.000	0.0	0.0	66.94	94.9	4.6
22	0.0	26.8	54	1.7	.080	0.0	I	R	R	R
23	0.0	1445.3	12	.3	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	13.535	GRAM/BHP HR
	CO	31.393	GRAM/BHP HR
	NO2	5.746	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.667	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-1-72 RUN-2 ENG.2-3 72-VER. B-CATA. W/AIR-W/EGR 4 BTDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.2	3.3	23.7	0	3570	.150	8.68	25
2	1200	5.0	1	13.5	8.6	23.8	0	24644	.180	6.30	11
3	1200	18.0	4	10.0	11.3	22.4	0	8115	.180	8.68	22
4	1200	41.0	9	8.4	13.5	20.6	0	1364	.150	10.66	55
5	1200	57.0	13	7.3	14.6	20.1	0	685	.130	11.13	80
6	1200	115.0	26	5.3	16.9	19.3	0	494	.100	11.84	340
7	1200	172.0	39	3.3	20.7	18.5	0	579	.130	12.22	1287
8	1200	189.0	43	2.8	22.5	18.2	0	574	.150	12.22	1550
9	1200	212.0	48	1.8	23.8	17.6	0	761	.180	12.71	1950
10	1200	230.0	53	.3	29.9	15.6	0	1211	2.360	11.92	1275
11	600	0.0	0	18.7	3.5	22.5	0	1142	.350	9.14	35
12	1200	0.0	0	23.4	3.7	29.6	0	42960	.150	2.32	6
13	2300	252.0	110	.6	64.3	14.1	0	2629	4.930	10.55	900
14	2300	232.0	102	2.6	48.8	17.0	0	493	.490	12.47	1862
15	2300	207.0	91	3.9	42.8	17.2	0	280	.470	12.59	1237
16	2300	189.0	83	4.5	41.8	17.4	0	186	.420	12.71	988
17	2300	126.0	55	7.8	31.2	18.6	0	84	.130	12.34	570
18	2300	63.0	28	12.4	20.9	21.6	0	422	.150	10.35	245
19	2300	45.0	20	13.8	19.2	22.9	0	622	.150	9.64	177
20	2300	20.0	9	15.6	15.9	23.7	0	853	.180	9.25	85
21	2300	5.0	2	17.0	13.7	23.6	0	1528	.250	9.64	49
22	600	0.0	0	18.2	3.8	23.9	0	975	.180	8.84	34
23	2300	0.0	0	24.6	3.4	38.9	0	50134	.100	.19	4

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	57.3	49	1.3	.070	0.0	I	R	R	R
2	0.0	1071.0	158	1.6	.060	.1	0.0	937.52	138.3	1.4
3	0.0	428.2	192	3.9	.060	.2	0.0	104.11	46.6	.9
4	0.0	76.1	169	10.2	.050	.5	0.0	8.12	18.0	1.1
5	0.0	34.9	153	15.5	.030	.4	0.0	3.06	11.7	1.2
6	0.0	31.6	129	72.1	.060	1.6	0.0	1.20	4.9	2.7
7	0.0	43.8	199	323.5	0.000	0.0	0.0	1.12	5.1	8.2
8	0.0	47.0	248	421.7	.040	1.7	0.0	1.09	5.7	9.8
9	0.0	63.4	303	539.7	0.000	0.0	0.0	1.31	6.3	11.1
10	0.0	114.1	4490	398.7	0.000	0.0	0.0	2.17	85.4	7.6
11	0.0	18.7	116	1.9	.070	0.0	I	R	R	R
12	0.0	1062.7	75	.5	.120	0.0	I	R	R	R
13	0.0	487.0	18444	553.4	.025	2.8	0.0	4.41	167.1	5.0
14	0.0	83.8	1682	1051.1	.055	5.6	0.0	.82	16.6	10.3
15	0.0	41.5	1408	609.1	.035	3.2	0.0	.46	15.5	6.7
16	0.0	26.8	1222	472.3	.060	5.0	0.0	.32	14.8	5.7
17	0.0	9.5	298	214.8	.060	3.3	0.0	.17	5.4	3.9
18	0.0	38.0	273	73.2	0.000	0.0	0.0	1.38	9.9	2.7
19	0.0	55.1	269	52.2	.065	1.3	0.0	2.80	13.6	2.7
20	0.0	64.7	276	21.4	0.000	0.0	0.0	7.39	31.5	2.4
21	0.0	94.5	312	10.2	0.000	0.0	0.0	43.15	142.6	4.6
22	0.0	18.6	69	2.2	.080	0.0	I	R	R	R
23	0.0	1440.8	58	.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	13.441	GRAM/BHP HR
	CO	31.023	GRAM/BHP HR
	NO2	6.283	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.667	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-2-72 RUN 1 ENG.2-3 72-VER. B-CATA. W/AIR-W/EGR 4 BTDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.0	3.6	23.7	0	4052	.180	8.54	23
2	1200	5.0	1	13.5	8.0	20.8	0	27998	.150	5.96	10
3	1200	18.0	4	10.1	11.6	21.1	0	11435	.180	8.34	15
4	1200	41.0	9	8.3	13.5	20.6	0	1619	.130	10.43	44
5	1200	57.0	13	7.4	14.1	20.2	0	639	.100	10.89	66
6	1200	115.0	26	5.2	17.3	19.4	0	437	.070	11.48	290
7	1200	172.0	39	3.2	20.7	18.6	0	556	.100	11.92	1175
8	1200	189.0	43	2.7	22.1	18.4	0	568	.130	12.09	1525
9	1200	212.0	48	1.8	23.8	17.9	0	687	.150	12.47	2100
10	1200	230.0	53	.3	30.3	15.0	0	1174	2.440	11.48	1075
11	600	0.0	0	18.5	3.6	23.2	0	1087	.390	9.03	37
12	1200	0.0	0	22.9	3.7	26.3	0	34243	.150	3.08	7
13	2300	252.0	110	.6	62.4	13.7	0	2272	3.910	10.78	813
14	2300	232.0	102	2.7	49.1	16.8	0	469	.420	12.22	1675
15	2300	207.0	91	3.9	43.0	17.0	0	315	.350	12.47	1225
16	2300	189.0	83	4.5	41.5	17.3	0	224	.350	12.47	1025
17	2300	126.0	55	7.7	31.2	18.8	0	92	.100	11.92	540
18	2300	63.0	28	12.4	21.1	21.7	0	391	.100	9.93	230
19	2300	45.0	20	13.7	19.3	22.6	0	663	.100	9.37	155
20	2300	20.0	9	15.6	15.9	23.4	0	1085	.130	9.03	76
21	2300	5.0	2	17.0	13.6	24.4	0	2346	.150	8.34	39
22	600	0.0	0	18.0	3.6	24.5	0	1319	.130	8.60	28
23	2300	0.0	0	24.6	3.3	34.0	0	45062	.020	.13	5

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	72.9	65	1.4	.070	0.0	I	R	R	R
2	0.0	1146.0	124	1.4	.060	.1	0.0	1003.13	108.6	1.2
3	0.0	620.0	197	2.7	.060	.2	0.0	150.74	47.9	.7
4	0.0	92.2	150	8.3	.050	.5	0.0	9.84	16.0	.9
5	0.0	37.0	117	12.7	.030	.4	0.0	2.84	9.0	1.0
6	0.0	29.7	96	65.3	.060	1.6	0.0	1.13	3.7	2.5
7	0.0	43.1	157	302.9	0.000	0.0	0.0	1.10	4.0	7.7
8	0.0	46.3	214	413.0	.040	1.7	0.0	1.07	5.0	9.6
9	0.0	58.4	258	592.7	0.000	0.0	0.0	1.21	5.3	12.2
10	0.0	114.9	4826	349.4	0.000	0.0	0.0	2.19	91.8	6.6
11	0.0	18.7	135	2.1	.070	0.0	I	R	R	R
12	0.0	859.0	76	.6	.120	0.0	I	R	R	R
13	0.0	430.8	14977	511.8	.025	2.8	0.0	3.90	135.7	4.6
14	0.0	82.4	1490	976.6	.055	5.6	0.0	.81	14.7	9.6
15	0.0	47.9	1074	617.5	.035	3.2	0.0	.53	11.8	6.8
16	0.0	32.8	1037	499.1	.060	5.0	0.0	.40	12.5	6.0
17	0.0	10.9	238	211.2	.060	3.3	0.0	.20	4.3	3.8
18	0.0	37.2	192	72.5	0.000	0.0	0.0	1.35	7.0	2.6
19	0.0	60.9	186	47.3	.065	1.3	0.0	3.09	9.4	2.4
20	0.0	84.2	204	19.6	0.000	0.0	0.0	9.62	23.3	2.2
21	0.0	165.9	214	9.2	0.000	0.0	0.0	75.75	97.8	4.2
22	0.0	24.2	48	1.7	.080	0.0	I	R	R	R
23	0.0	1470.6	13	.5	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	13.247	GRAM/BHP HR
	CO	25.626	GRAM/BHP HR
	NO2	6.095	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.666	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

7-28-72 RUN-1 ENG.2-3 1972 VERSION- A-CATA W/AIR W/EGR 4 ATDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	16.5	4.0	22.4	0	191	.020	9.64	37
2	1200	4.0	1	10.0	11.2	23.5	0	1132	.050	9.50	18
3	1200	15.0	3	8.7	12.6	21.2	0	350	.020	10.25	27
4	1200	33.0	8	6.9	14.8	19.5	0	80	.070	11.48	69
5	1200	46.0	11	6.1	15.1	19.5	0	53	.050	11.48	96
6	1200	92.0	21	4.4	18.7	19.2	0	83	.050	11.72	340
7	1200	138.0	32	2.9	21.2	18.3	0	60	.050	12.09	470
8	1200	151.0	35	2.3	22.3	18.4	0	86	.020	12.09	1125
9	1200	169.0	39	1.4	23.4	17.9	0	84	.070	12.71	1150
10	1200	184.0	42	.3	29.2	15.1	0	191	2.020	13.18	600
11	600	0.0	0	17.0	5.0	21.8	0	57	.150	9.93	60
12	1200	0.0	0	21.1	5.8	25.4	0	1240	.150	8.34	26
13	2300	222.0	97	.6	63.0	13.8	0	609	3.790	12.34	545
14	2300	204.0	89	2.6	50.8	16.1	0	45	.100	13.91	850
15	2300	182.0	80	3.6	41.8	16.8	0	36	.050	13.63	675
16	2300	166.0	73	4.2	42.8	17.3	0	39	.050	13.33	610
17	2300	111.0	49	6.6	34.6	18.5	0	34	.050	12.34	370
18	2300	55.0	24	10.0	25.2	20.7	0	53	.050	10.55	140
19	2300	40.0	18	12.4	20.9	22.9	0	63	.050	10.09	113
20	2300	18.0	8	15.3	16.6	24.6	0	149	.020	9.14	55
21	2300	4.0	2	17.0	15.5	22.6	0	52	.020	9.93	83
22	600	0.0	0	16.5	4.0	23.9	0	293	.020	9.14	41
23	2300	0.0	0	24.4	3.6	50.6	0	9271	.050	3.20	3

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	3.5	7	2.3	.070	0.0	I	R	R	R
2	0.0	59.3	53	3.0	.060	.1	0.0	64.88	57.9	3.3
3	0.0	19.4	22	5.0	.060	.2	0.0	5.67	6.5	1.5
4	0.0	4.6	82	13.4	.050	.4	0.0	.62	10.9	1.8
5	0.0	3.1	60	19.0	.030	.3	0.0	.30	5.7	1.8
6	0.0	6.0	73	81.4	.060	1.3	0.0	.29	3.5	3.9
7	0.0	4.7	80	123.8	0.000	0.0	0.0	.15	2.5	3.9
8	0.0	7.2	34	312.0	.040	1.4	0.0	.21	1.0	9.0
9	0.0	7.0	117	316.9	0.000	0.0	0.0	.18	3.0	8.2
10	0.0	16.6	3546	173.1	0.000	0.0	0.0	.39	84.4	4.1
11	0.0	1.3	69	4.5	.070	0.0	I	R	R	R
12	0.0	37.6	92	2.6	.120	0.0	I	R	R	R
13	0.0	107.5	13512	319.4	.025	2.4	0.0	1.11	139.0	3.3
14	0.0	7.3	332	463.6	.055	4.9	0.0	.08	3.7	5.2
15	0.0	5.0	140	310.2	.035	2.8	0.0	.06	1.8	3.9
16	0.0	5.7	147	294.0	.060	4.4	0.0	.08	2.0	4.0
17	0.0	4.4	128	155.4	.060	2.9	0.0	.09	2.6	3.2
18	0.0	5.8	109	50.1	0.000	0.0	0.0	.24	4.5	2.1
19	0.0	5.9	94	34.9	.065	1.1	0.0	.34	5.4	2.0
20	0.0	12.2	33	14.9	0.000	0.0	0.0	1.55	4.2	1.9
21	0.0	3.7	28	19.6	0.000	0.0	0.0	2.09	16.3	11.2
22	0.0	5.7	8	2.7	.080	0.0	I	R	R	R
23	0.0	362.4	39	.3	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	1.671	GRAM/BHP HR
	CO	18.923	GRAM/BHP HR
	NO2	4.230	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.827	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

7-28-72 RUN-2 ENG.2-3 1972 VERSION A-CATA W/AIR W/EGR 4 BTDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.5	2.9	24.6	0	675	.050	8.68	25
2	1200	5.0	1	10.9	10.1	23.7	0	2545	.020	8.93	19
3	1200	18.0	4	8.9	12.6	21.6	0	574	.050	10.09	42
4	1200	41.0	9	7.5	13.7	20.6	0	171	.050	10.78	74
5	1200	57.0	13	6.9	14.8	20.2	0	125	.070	11.01	103
6	1200	115.0	26	5.0	18.0	19.5	0	151	.070	11.48	704
7	1200	172.0	39	3.3	20.5	19.2	0	188	.100	11.60	1225
8	1200	189.0	43	2.7	22.7	18.6	0	211	.100	11.92	1875
9	1200	212.0	48	1.8	24.5	18.2	0	243	.100	12.22	2013
10	1200	230.0	53	.3	29.2	15.5	0	713	1.520	12.71	1000
11	600	0.0	0	18.0	3.2	24.6	0	406	.050	8.75	31
12	1200	0.0	0	23.0	3.6	35.6	0	3104	.150	5.50	6
13	2300	250.0	109	.6	63.7	13.8	0	1152	4.070	10.78	950
14	2300	230.0	101	2.6	46.1	17.1	0	95	.050	12.94	1738
15	2300	205.0	90	3.8	42.1	17.0	0	66	.050	12.94	1275
16	2300	187.0	82	4.5	41.8	17.4	0	56	.050	12.71	1113
17	2300	125.0	55	7.5	31.3	19.1	0	52	.020	11.92	590
18	2300	62.0	27	11.8	21.6	21.8	0	82	.020	10.25	245
19	2300	45.0	20	14.4	19.1	21.4	0	80	.020	10.55	300
20	2300	20.0	9	15.2	16.2	24.1	0	179	.020	9.14	83
21	2300	5.0	2	16.5	14.0	24.7	0	297	.020	8.75	59
22	600	0.0	0	17.5	3.2	25.5	0	318	.050	8.60	27
23	2300	0.0	0	24.7	3.2	56.9	0	6239	.050	3.08	2

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	10.1	15	1.2	.070	0.0	I	R	R	R
2	0.0	126.7	20	3.1	.060	.1	0.0	110.86	17.6	2.7
3	0.0	32.2	57	7.8	.060	.2	0.0	7.83	13.8	1.9
4	0.0	9.8	58	14.1	.050	.5	0.0	1.04	6.2	1.5
5	0.0	7.5	86	20.7	.030	.4	0.0	.58	6.6	1.6
6	0.0	10.6	100	165.0	.060	1.6	0.0	.40	3.8	6.3
7	0.0	14.9	160	322.7	0.000	0.0	0.0	.38	4.1	8.2
8	0.0	18.1	173	532.3	.040	1.7	0.0	.42	4.0	12.3
9	0.0	21.9	182	601.7	0.000	0.0	0.0	.45	3.8	12.4
10	0.0	66.0	2844	307.5	0.000	0.0	0.0	1.26	54.1	5.9
11	0.0	6.7	17	1.7	.070	0.0	I	R	R	R
12	0.0	85.0	83	.5	.120	0.0	I	R	R	R
13	0.0	222.5	15874	609.0	.025	2.7	0.0	2.03	145.0	5.6
14	0.0	15.3	162	928.2	.055	5.5	0.0	.15	1.6	9.2
15	0.0	9.7	148	622.0	.035	3.1	0.0	.11	1.7	6.9
16	0.0	8.3	150	548.8	.060	4.9	0.0	.10	1.8	6.7
17	0.0	6.2	48	232.8	.060	3.3	0.0	.11	.9	4.3
18	0.0	7.8	39	77.5	0.000	0.0	0.0	.29	1.4	2.9
19	0.0	6.6	33	81.6	.065	1.3	0.0	.33	1.7	4.1
20	0.0	14.3	32	22.1	0.000	0.0	0.0	1.64	3.7	2.5
21	0.0	21.5	29	14.1	0.000	0.0	0.0	9.80	13.3	6.5
22	0.0	5.3	17	1.5	.080	0.0	I	R	R	R
23	0.0	241.2	39	.3	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	1.810	GRAM/BHP HR
	CO	18.278	GRAM/BHP HR
	NO2	6.850	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.671	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY
8-1-72 RUN-1 ENG.2-3 72-VER. A-CATA. W/AIR-W/EGR 4 BTDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.2	3.6	23.9	22	636	.020	8.84	50
2	1200	5.0	1	13.5	8.6	23.6	37	3375	.050	8.60	18
3	1200	18.0	4	10.1	11.5	22.3	48	1305	.050	9.37	50
4	1200	41.0	9	8.3	13.3	20.5	37	268	.050	10.78	65
5	1200	57.0	13	7.3	14.4	20.1	23	143	.020	11.13	32
6	1200	115.0	26	5.2	16.9	19.6	28	116	.020	11.48	325
7	1200	172.0	39	3.1	20.5	18.9	12	181	.020	11.92	1375
8	1200	189.0	43	2.7	21.9	18.6	16	189	.020	12.09	1700
9	1200	212.0	48	1.8	23.4	18.3	13	209	.020	12.34	2037
10	1200	230.0	53	.3	29.5	15.7	21	510	1.520	12.94	1000
11	600	0.0	0	18.7	3.2	24.0	6	244	.020	9.03	37
12	1200	0.0	0	23.0	3.6	35.4	27	3943	.050	5.50	12
13	2300	252.0	110	.6	63.3	14.0	24	1242	3.790	11.60	875
14	2300	232.0	102	2.6	48.9	16.2	18	163	.150	13.48	1325
15	2300	207.0	91	3.9	42.8	17.2	6	57	.050	12.94	1175
16	2300	189.0	83	4.5	42.1	17.6	6	43	.050	12.82	1000
17	2300	126.0	55	7.7	31.7	18.9	7	43	.050	12.22	580
18	2300	63.0	28	12.4	20.9	21.6	3	93	.050	10.55	190
19	2300	45.0	20	13.8	19.4	22.4	7	137	.050	9.93	143
20	2300	20.0	9	15.6	15.8	23.6	6	206	.020	9.25	79
21	2300	5.0	2	17.0	13.7	24.6	12	541	.020	8.84	68
22	600	0.0	0	18.2	3.6	24.6	11	379	.020	8.84	30
23	2300	0.0	0	24.7	3.2	52.1	43	6567	.050	3.20	2

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	.9	11.6	7	3.0	.070	0.0	R	R	R	R
2	3.4	146.5	44	2.6	.060	.1	3.0	128.23	38.4	2.3
3	5.6	71.3	55	9.1	.060	.2	1.4	17.33	13.4	2.2
4	4.5	14.9	56	12.0	.050	.5	.5	1.59	6.0	1.3
5	2.9	8.4	24	6.2	.030	.4	.2	.64	1.8	.5
6	4.1	7.7	27	71.9	.060	1.6	.2	.29	1.0	2.7
7	2.0	14.1	31	355.0	0.000	0.0	.1	.36	.8	9.0
8	2.8	15.5	33	462.3	.040	1.7	.1	.36	.8	10.7
9	2.4	18.0	35	579.8	0.000	0.0	.0	.37	.7	12.0
10	4.3	47.0	2831	306.2	0.000	0.0	.1	.90	53.9	5.8
11	.2	3.9	7	2.0	.070	0.0	R	R	R	R
12	1.6	108.3	28	1.1	.120	0.0	R	R	R	R
13	9.8	229.8	14169	537.6	.025	2.8	.1	2.08	128.4	4.9
14	6.5	26.5	493	715.0	.055	5.6	.1	.26	4.8	7.0
15	1.8	8.5	151	582.8	.035	3.2	.0	.09	1.7	6.4
16	2.1	6.3	150	492.7	.060	5.0	.0	.08	1.8	6.0
17	1.9	5.1	118	225.4	.060	3.3	.0	.09	2.1	4.1
18	.5	8.3	90	56.3	0.000	0.0	.0	.30	3.3	2.0
19	1.4	12.0	89	41.9	.065	1.3	.1	.61	4.5	2.1
20	1.0	16.0	31	20.3	0.000	0.0	.1	1.82	3.6	2.3
21	1.7	37.7	28	15.7	0.000	0.0	.8	17.20	12.8	7.2
22	.4	6.9	7	1.8	.080	0.0	R	R	R	R
23	3.5	247.0	38	.2	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	2.097	GRAM/BHP HR
	CO	16.749	GRAM/BHP HR
	NO2	5.631	GRAM/BHP HR
	ALDE	.106	GRAM/BHP HR
	BSFC	.667	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-1-72 RUN-2 ENG.2-3 72-VER. A-CATA. W/AIR-W/EGR 4 BTDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.2	3.3	24.8	28	1351	.020	8.68	28
2	1200	5.0	1	13.5	8.6	24.9	37	4043	.020	8.43	15
3	1200	18.0	4	10.0	11.3	23.3	67	1741	.020	9.50	28
4	1200	41.0	9	8.4	13.5	21.0	36	324	.050	10.66	63
5	1200	57.0	13	7.3	14.6	20.3	23	154	.050	11.13	83
6	1200	115.0	26	5.3	16.9	19.7	24	133	.050	11.60	325
7	1200	172.0	39	3.3	20.7	18.9	26	217	.050	12.09	1312
8	1200	189.0	43	2.8	22.5	18.5	17	220	.050	12.09	1675
9	1200	212.0	48	1.8	23.8	18.1	16	257	.050	12.47	1800
10	1200	230.0	53	.3	29.9	15.4	15	670	1.660	12.94	1000
11	600	0.0	0	18.7	3.5	24.0	7	271	.050	8.93	34
12	1200	0.0	0	23.4	3.7	36.0	27	4789	.100	5.27	5
13	2300	252.0	110	.6	64.3	13.8	31	1146	4.070	11.72	888
14	2300	232.0	102	2.6	48.8	16.6	15	112	.100	13.33	1750
15	2300	207.0	91	3.9	42.8	17.0	11	58	.100	13.18	1225
16	2300	189.0	83	4.5	41.8	17.3	6	42	.100	13.06	1025
17	2300	126.0	55	7.8	31.2	19.0	8	45	.070	12.09	650
18	2300	63.0	28	12.4	20.9	21.7	5	77	.130	10.43	215
19	2300	45.0	20	13.8	19.2	22.8	7	97	.070	9.93	170
20	2300	20.0	9	15.6	15.9	24.1	7	133	.070	9.25	90
21	2300	5.0	2	17.0	13.7	24.9	12	332	.070	8.68	54
22	600	0.0	0	18.2	3.8	24.9	10	195	.070	8.75	35
23	2300	0.0	0	24.6	3.4	52.3	49	5160	.150	3.31	3

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	1.0	22.5	7	1.5	.070	0.0	R	R	R	R
2	3.5	177.5	18	2.2	.060	.1	3.1	155.38	15.5	1.9
3	7.6	91.6	21	5.0	.060	.2	1.9	22.28	5.2	1.2
4	4.4	18.4	57	12.0	.050	.5	.5	1.97	6.1	1.3
5	2.9	9.1	60	16.1	.030	.4	.2	.70	4.6	1.2
6	3.4	8.7	66	70.9	.060	1.6	.1	.33	2.5	2.7
7	4.3	16.7	78	336.3	0.000	0.0	.1	.43	2.0	8.6
8	3.1	18.4	85	465.6	.040	1.7	.1	.43	2.0	10.8
9	2.9	22.1	87	514.9	0.000	0.0	.1	.46	1.8	10.6
10	3.0	61.9	3101	307.0	0.000	0.0	.1	1.18	59.0	5.8
11	.3	4.7	18	2.0	.070	0.0	R	R	R	R
12	1.7	137.0	58	.5	.120	0.0	R	R	R	R
13	12.2	210.1	15072	540.2	.025	2.8	.1	1.90	136.6	4.9
14	5.3	18.5	332	955.8	.055	5.6	.1	.18	3.3	9.4
15	3.5	8.4	295	594.0	.035	3.2	.0	.09	3.3	6.6
16	1.7	6.1	291	489.7	.060	5.0	.0	.07	3.5	5.9
17	2.1	5.3	165	251.2	.060	3.3	.0	.10	3.0	4.6
18	1.1	6.9	236	64.1	0.000	0.0	.0	.25	8.5	2.3
19	1.4	8.5	123	49.2	.065	1.3	.1	.43	6.3	2.5
20	1.2	10.3	109	23.1	0.000	0.0	.1	1.17	12.5	2.6
21	1.8	23.5	100	12.7	0.000	0.0	.8	10.73	45.7	5.8
22	.4	3.8	28	2.3	.080	0.0	R	R	R	R
23	4.1	197.8	116	.4	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	2.227	GRAM/BHP HR
	CO	18.506	GRAM/BHP HR
	NO2	6.238	GRAM/BHP HR
	ALDE	.114	GRAM/BHP HR
	BSFC	.667	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-2-72 RUN 1 ENG.2-3 72-VER. A-CATA. W/AIR-W/EGR 4 BTDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.0	3.6	24.7	19	1214	.020	8.54	25
2	1200	5.0	1	13.5	8.0	25.1	40	4306	.020	8.24	14
3	1200	18.0	4	10.1	11.6	22.9	45	1737	.020	9.25	22
4	1200	41.0	9	8.3	13.5	20.9	40	302	.020	10.55	55
5	1200	57.0	13	7.4	14.1	20.3	22	198	.020	10.89	70
6	1200	115.0	26	5.2	17.3	19.8	31	132	.020	11.01	270
7	1200	172.0	39	3.2	20.7	18.8	18	200	.020	11.72	1150
8	1200	189.0	43	2.7	22.1	18.6	18	211	.050	11.72	1600
9	1200	212.0	48	1.8	23.8	18.1	19	225	.050	12.34	1925
10	1200	230.0	53	.3	30.3	15.4	26	600	1.870	12.47	875
11	600	0.0	0	18.5	3.6	24.0	13	260	.050	8.93	35
12	1200	0.0	0	22.9	3.7	34.0	27	5394	.050	5.63	6
13	2300	252.0	110	.6	62.4	14.2	22	841	3.060	12.22	925
14	2300	232.0	102	2.7	49.1	17.0	17	112	.050	12.94	1675
15	2300	207.0	91	3.9	43.0	17.2	9	63	.050	12.94	1275
16	2300	189.0	83	4.5	41.5	17.4	8	48	.050	12.94	1025
17	2300	126.0	55	7.7	31.2	19.0	5	51	.020	11.72	600
18	2300	63.0	28	12.4	21.1	21.8	6	84	.020	10.09	190
19	2300	45.0	20	13.7	19.3	22.7	9	114	.020	9.50	153
20	2300	20.0	9	15.6	15.9	23.8	9	195	.020	9.03	79
21	2300	5.0	2	17.0	13.6	24.8	9	513	.020	8.60	44
22	600	0.0	0	18.0	3.6	25.1	9	302	.020	8.54	30
23	2300	0.0	0	24.6	3.3	53.3	38	6432	.020	3.13	3

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	.8	23.0	8	1.6	.070	0.0	R	R	R	R
2	3.6	180.7	17	2.0	.060	.1	3.2	158.16	14.8	1.7
3	5.4	96.4	22	4.1	.060	.2	1.3	23.43	5.4	1.0
4	5.0	17.4	23	10.5	.050	.5	.5	1.86	2.5	1.1
5	2.8	11.6	24	13.6	.030	.4	.2	.89	1.8	1.0
6	4.7	9.4	29	63.8	.060	1.6	.2	.36	1.1	2.4
7	3.2	15.9	32	304.4	0.000	0.0	.1	.40	.8	7.7
8	3.4	17.9	86	451.2	.040	1.7	.1	.41	2.0	10.4
9	3.6	19.6	88	555.4	0.000	0.0	.1	.40	1.8	11.5
10	5.4	57.3	3605	277.3	0.000	0.0	.1	1.09	68.6	5.3
11	.5	4.7	18	2.1	.070	0.0	R	R	R	R
12	1.6	144.8	27	.5	.120	0.0	R	R	R	R
13	8.6	154.9	11380	565.4	.025	2.8	.1	1.40	103.1	5.1
14	6.2	19.2	173	953.0	.055	5.6	.1	.19	1.7	9.4
15	3.0	9.4	152	635.6	.035	3.2	.0	.10	1.7	7.0
16	2.4	7.0	146	493.2	.060	5.0	.0	.08	1.8	6.0
17	1.2	6.2	49	240.3	.060	3.3	.0	.11	.9	4.4
18	1.3	8.0	38	59.6	0.000	0.0	.0	.29	1.4	2.2
19	1.8	10.5	37	46.7	.065	1.3	.1	.53	1.9	2.4
20	1.5	15.5	32	20.8	0.000	0.0	.2	1.77	3.7	2.4
21	1.4	36.5	29	10.4	0.000	0.0	.6	16.66	13.1	4.7
22	.4	5.7	8	1.9	.080	0.0	R	R	R	R
23	3.3	257.7	16	.4	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	2.390	GRAM/BHP HR
	CO	12.893	GRAM/BHP HR
	NO2	6.242	GRAM/BHP HR
	ALDE	.109	GRAM/BHP HR
	BSFC	.666	LB/BHP HR

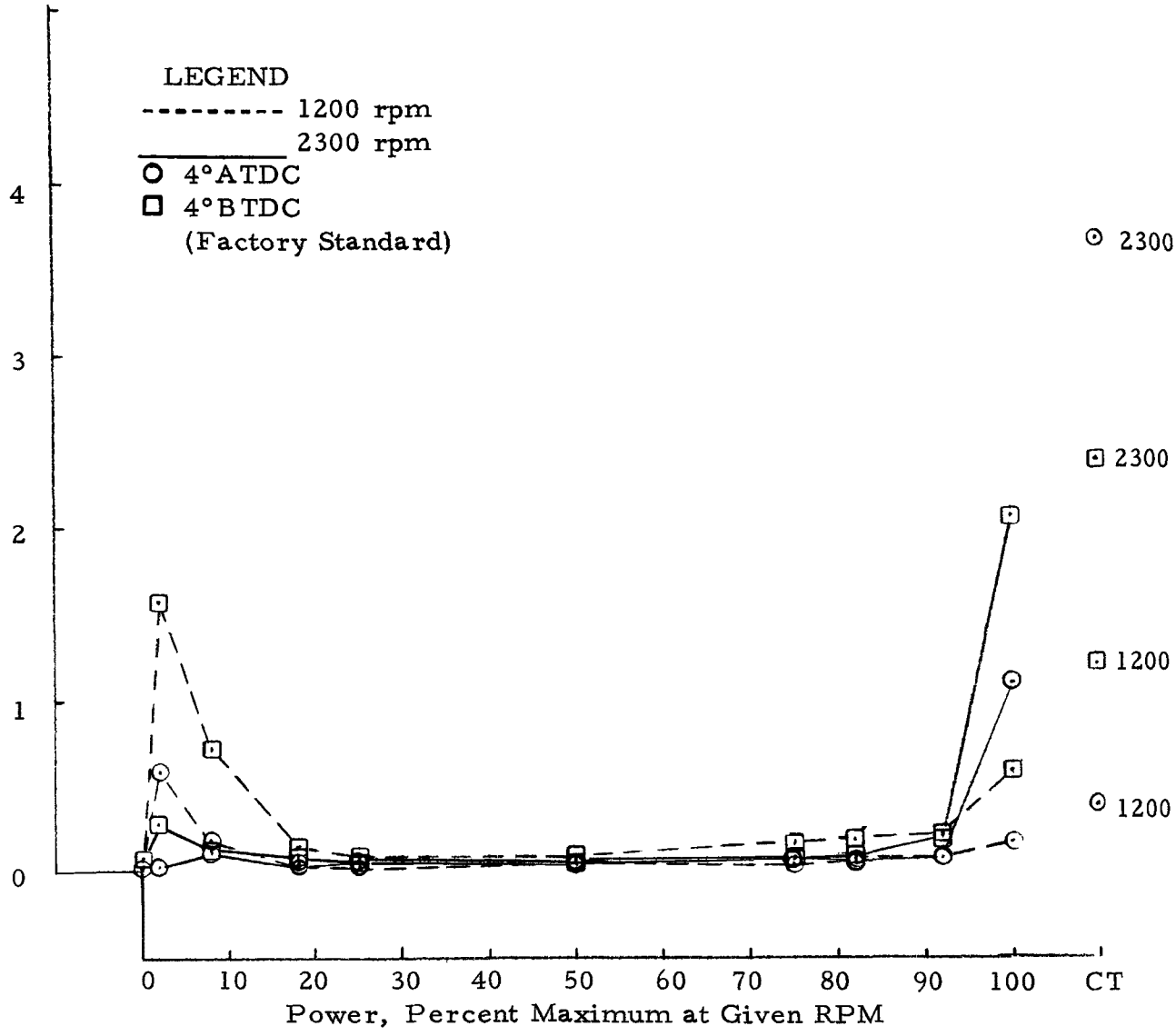


FIGURE O-1. EFFECT OF POWER ON HC EMISSION RATE - "BEST COMBINATION", ENGINE 2-3, 23 MODE TEST

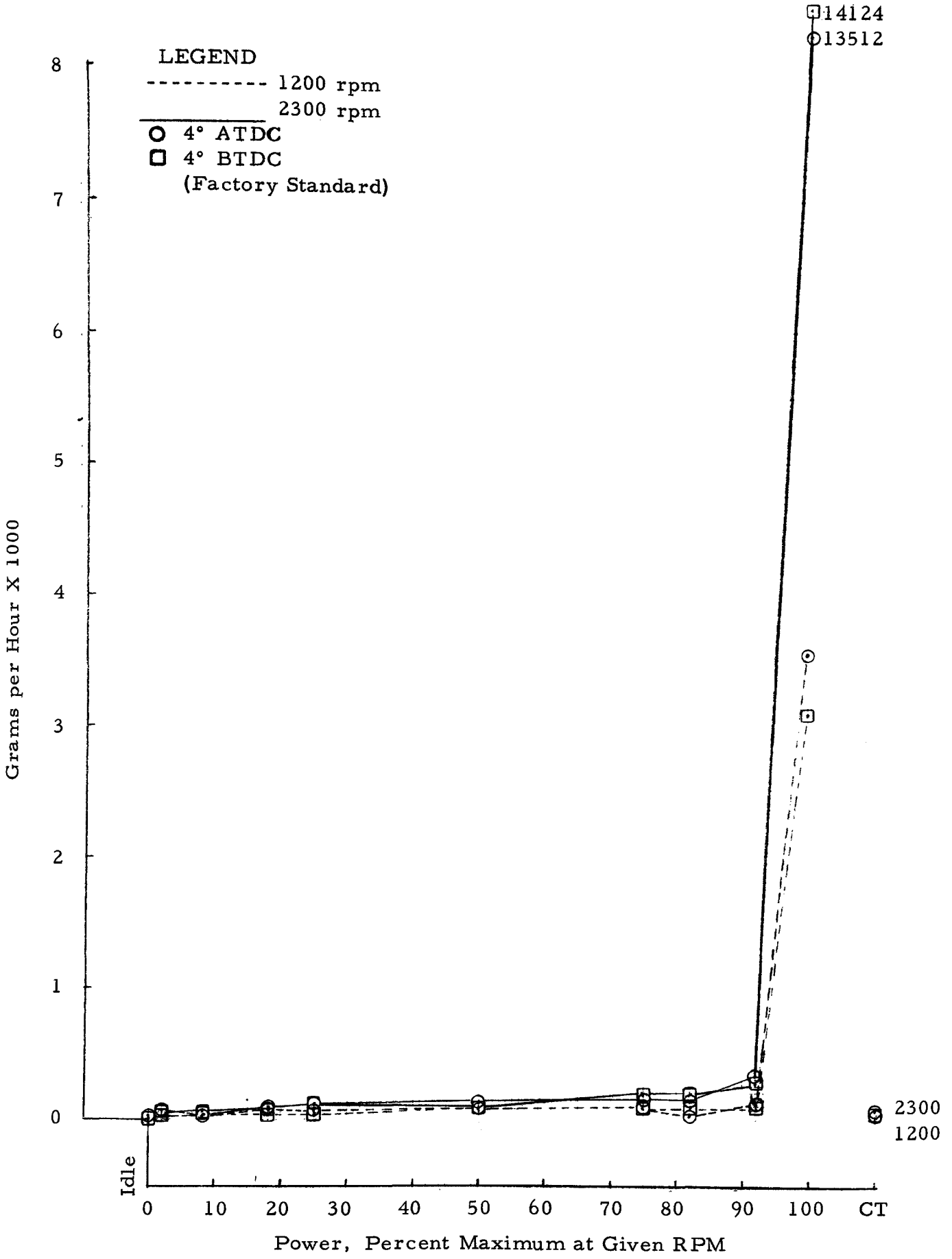


FIGURE 0-2. EFFECT OF POWER ON CO EMISSION RATE - "BEST COMBINATION", ENGINE 2-3, 23 MODE TEST

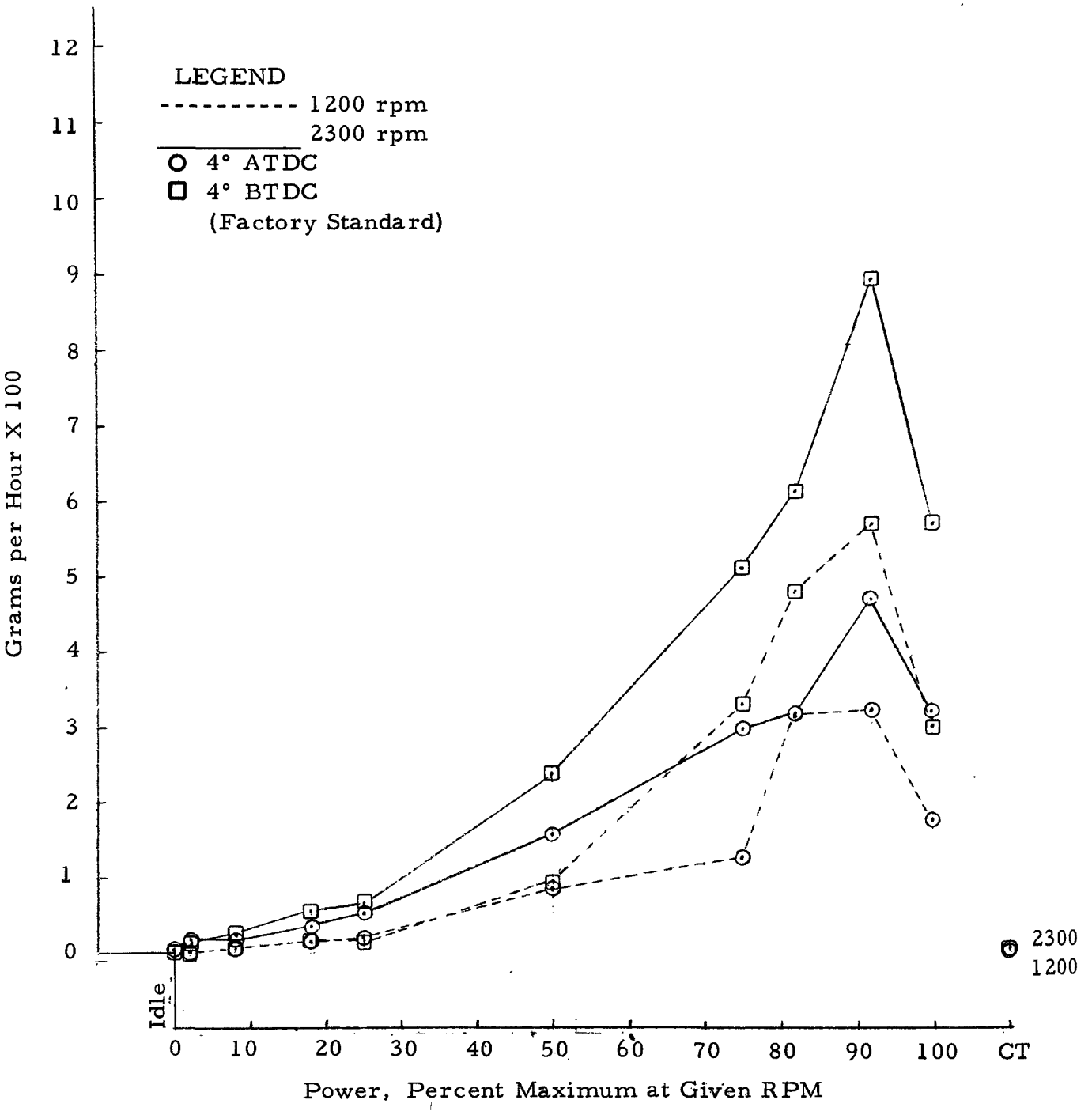


FIGURE 0-3. EFFECT OF POWER ON NO_x (AS NO_2) EMISSION RATE - "BEST COMBINATION", ENGINE 2-3, 23 MODE TEST

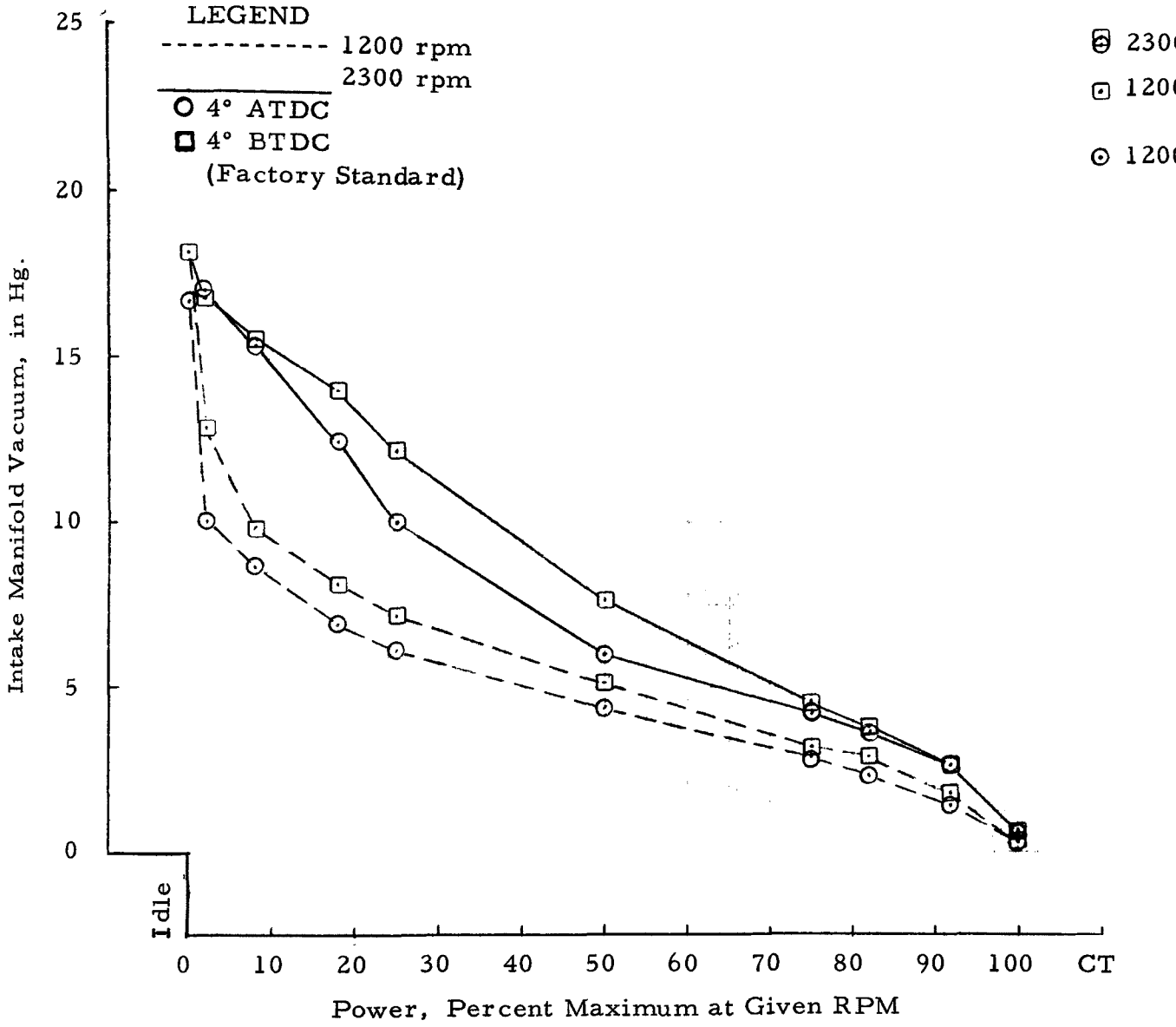


FIGURE 0-4. MANIFOLD VACUUM AS A FUNCTION OF POWER - "BEST COMBINATION", ENGINE 2-3, 23 MODE TEST

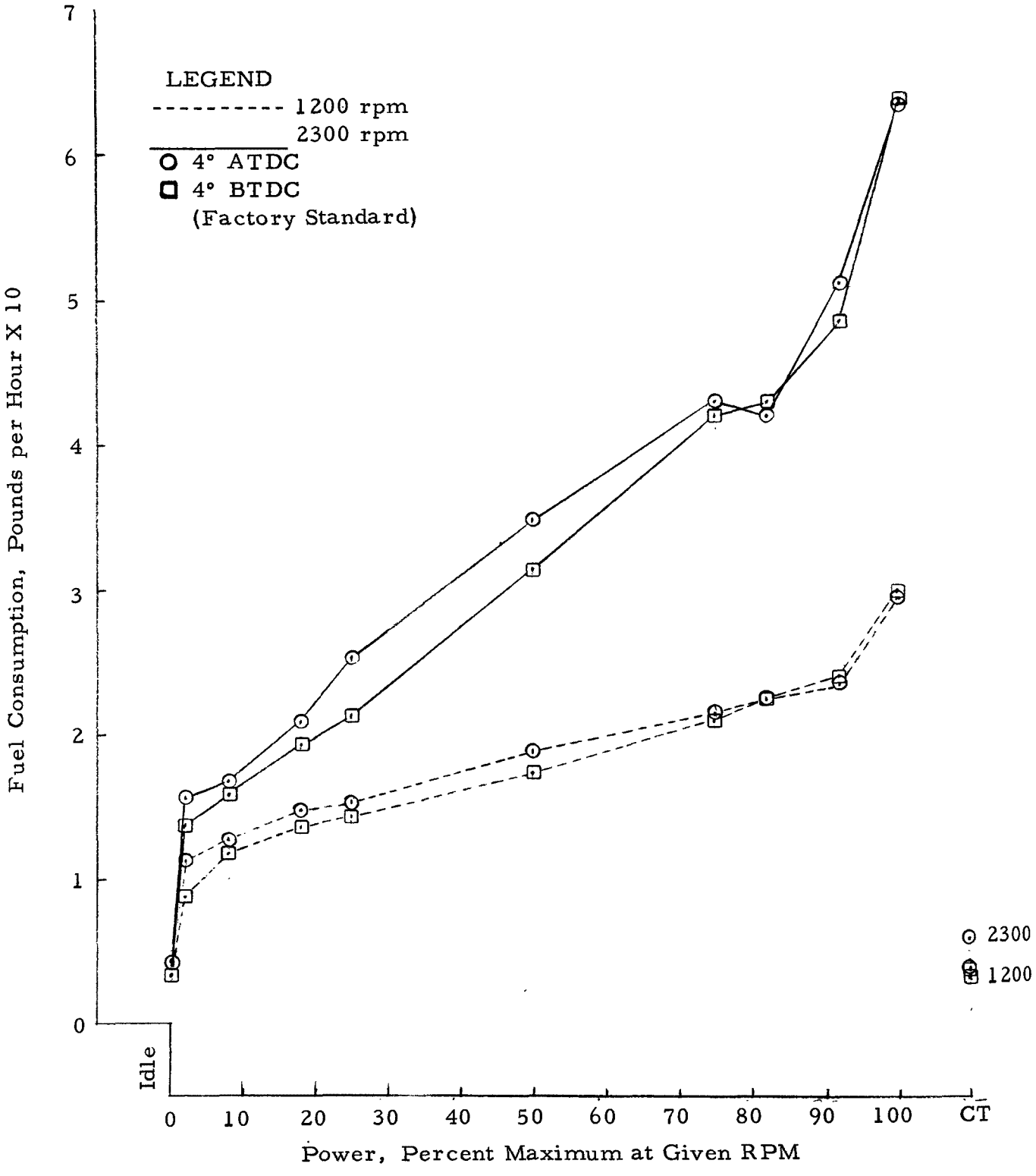


FIGURE 0-5. FUEL CONSUMPTION AS A FUNCTION OF POWER - "BEST COMBINATION", ENGINE 2-3, 23 MODE TEST

ENGINE 2-3

EFFECT OF "BEST COMBINATION" ON EMISSIONS

TABULAR NINE-MODE FTP DATA

CONCENTRATION AND CALIFORNIA ARB MASS

ENGINE 2-3

EFFECT OF "BEST COMBINATION" ON EMISSIONS

GRAPHED RESULTS OF 23 MODE TESTS
(AFTER CATALYST)

8-2-72 RUN-2 2-3 48TDC 600 RPM W/AIR EGR OXIDATION CATALYST K =1.051 HUM = 90 GR/LB

	FEDERAL MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
	1 IDLE	21	.050	8.750	64	1.648	35	.082	105	.036	1.246	.003	3.797
	2 16'HG	239	.050	8.600	64	1.632	390	.082	104	.089	34.721	.007	9.298
	3 10'HG	13	.050	10.430	157	1.385	18	.069	217	.257	4.627	.018	55.885
	4 16'HG	49	.050	8.840	90	1.626	80	.081	146	.089	7.091	.007	13.024
	5 19'HG	573	.050	7.000	57	1.897	1087	.095	108	.047	51.087	.004	5.082
	6 16'HG	63	.050	8.840	64	1.623	102	.081	104	.089	9.101	.007	9.246
	7 3'HG	4	.070	13.060	1463	1.107	4	.077	1619	.283	1.253	.022	458.300
	8 16'HG	4	.050	9.140	112	1.581	6	.079	177	.089	.563	.007	15.763
	9 C.T.	293	.060	4.930	63	2.748	805	.165	173	.021	16.909	.003	3.636
	SUM----------(CYCLE COMPOSITE)----------										126.598	.079	574.030
CYCLE 2													
	1 IDLE	21	.050	8.750	64	1.648	35	.082	105	.036	1.246	.003	3.797
	2 16'HG	113	.050	8.840	90	1.613	182	.081	145	.089	16.226	.007	12.924
	3 10'HG	4	.050	10.660	210	1.356	5	.068	285	.257	1.394	.017	73.210
	4 16'HG	48	.050	8.930	96	1.610	77	.080	155	.089	6.877	.007	13.755
	5 19'HG	625	.050	6.820	64	1.928	1205	.096	123	.047	56.641	.005	5.800
	6 16'HG	62	.050	8.930	64	1.607	100	.080	103	.089	8.868	.007	9.155
	7 3'HG	4	.070	12.940	1559	1.117	4	.078	1742	.283	1.265	.022	492.888
	8 16'HG	9	.050	9.140	108	1.580	14	.079	171	.089	1.266	.007	15.191
	9 C.T.	295	.050	4.590	65	2.939	867	.147	191	.021	18.207	.003	4.012
	SUM----------(CYCLE COMPOSITE)----------										111.991	.079	630.732
CYCLE 3													
	1 IDLE	4	.020	8.840	70	1.638	7	.033	115	.036	.236	.001	4.127
	2 16'HG	111	.020	8.840	90	1.617	179	.032	145	.089	15.970	.003	12.948
	3 10'HG	4	.050	10.510	190	1.376	6	.069	261	.257	1.414	.018	67.180
	4 16'HG	37	.050	8.930	97	1.612	60	.081	156	.089	5.308	.007	13.917
	5 19'HG	590	.050	7.090	71	1.870	1104	.094	133	.047	51.867	.004	6.242
	6 16'HG	50	.050	9.030	77	1.592	80	.080	123	.089	7.084	.007	10.909
	7 3'HG	4	.070	13.060	1579	1.107	4	.077	1748	.283	1.253	.022	494.638
	8 16'HG	6	.020	9.180	108	1.577	9	.032	170	.089	.842	.003	15.155
	9 C.T.	296	.060	4.580	66	2.941	871	.176	194	.021	18.284	.004	4.077
	SUM----------(CYCLE COMPOSITE)----------										102.258	.069	629.193
CYCLE 4													
	1 IDLE	4	.050	8.840	70	1.635	7	.082	114	.036	.235	.003	4.120
	2 16'HG	88	.050	8.840	90	1.618	142	.081	146	.089	12.674	.007	12.963
	3 10'HG	4	.050	10.550	197	1.371	5	.069	270	.257	1.409	.018	69.392
	4 16'HG	40	.050	8.840	103	1.628	65	.081	168	.089	5.795	.007	14.921
	5 19'HG	588	.050	6.910	71	1.915	1126	.096	136	.047	52.935	.005	6.392
	6 16'HG	51	.020	8.930	77	1.612	82	.032	124	.089	7.317	.003	11.047
	7 3'HG	4	.070	12.940	1579	1.117	4	.078	1764	.283	1.265	.022	499.212
	8 16'HG	9	.050	9.140	117	1.580	14	.079	185	.089	1.266	.007	16.457
	9 C.T.	301	.060	4.560	68	2.950	888	.177	201	.021	18.648	.004	4.213
	SUM----------(CYCLE COMPOSITE)----------										101.544	.075	638.716

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 119.295 .079 602.381

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 101.901 .072 633.954

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(119.295) + 0.65*(101.901) =	107.989	PPM
CO	0.35*(.079) + 0.65*(.072) =	.074	PERCENT
NO	0.35*(602.381) + 0.65*(633.954) =	622.904	PPM
	CORRECTED NO =	654.510	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

8-2-72 RUN3 2-3 4BTDC 600RPM W/AIR EGR OXIDATION CATALYST K =1.051 HUM = 90 GR/LB

	FEDERAL MODE	CONCENTRATION HC	CO	AS CO2	MEASURED NO	DILUTION FACTOR	A D J U S T E D HC	CO	NO	WEIGHTING FACTOR	W E I G H T E D HC	CO	NO
CYCLE 1													
	1 IDLE	32	.020	8.930	51	1.616	52	.032	82	.036	1.861	.001	2.966
	2 16'HG	253	.020	8.750	83	1.605	406	.032	133	.089	36.144	.003	11.857
	3 10'HG	22	.020	10.550	169	1.370	30	.027	232	.257	7.746	.007	59.504
	4 16'HG	88	.020	8.930	77	1.605	141	.032	124	.089	12.569	.003	10.998
	5 19'HG	693	.020	7.000	64	1.869	1295	.037	120	.047	60.873	.002	5.622
	6 16'HG	106	.020	8.930	58	1.601	170	.032	93	.089	15.108	.003	8.267
	7 3'HG	17	.070	13.060	1546	1.106	19	.077	1709	.283	5.320	.022	483.782
	8 16'HG	21	.020	9.250	112	1.562	33	.031	175	.089	2.919	.003	15.571
	9 C.T.	364	.040	4.600	64	2.892	1053	.116	185	.021	22.110	.002	3.887
	SUM----------(CYCLE COMPOSITE)----------										164.650	.046	602.455
CYCLE 2													
	1 IDLE	32	.020	8.930	51	1.616	52	.032	82	.036	1.861	.001	2.966
	2 16'HG	216	.020	8.750	64	1.612	348	.032	103	.089	30.995	.003	9.184
	3 10'HG	17	.020	10.780	183	1.342	23	.027	246	.257	5.861	.007	63.095
	4 16'HG	44	.020	9.250	96	1.558	69	.031	150	.089	6.101	.003	13.311
	5 19'HG	694	.020	7.090	64	1.847	1282	.037	118	.047	60.253	.002	5.557
	6 16'HG	102	.020	8.930	70	1.602	163	.032	112	.089	14.545	.003	9.982
	7 3'HG	17	.070	13.330	1518	1.083	18	.076	1645	.283	5.212	.021	465.437
	8 16'HG	17	.020	9.370	122	1.543	26	.031	188	.089	2.334	.003	16.752
	9 C.T.	333	.040	4.750	68	2.827	941	.113	192	.021	19.767	.002	4.037
	SUM----------(CYCLE COMPOSITE)----------										146.930	.045	590.319
CYCLE 3													
	1 IDLE	8	.020	9.370	77	1.544	12	.031	119	.036	.445	.001	4.281
	2 16'HG	131	.020	8.930	97	1.597	209	.032	155	.089	18.615	.003	13.784
	3 10'HG	13	.050	10.550	189	1.369	18	.068	259	.257	4.575	.018	66.513
	4 16'HG	61	.020	8.930	97	1.610	98	.032	156	.089	8.741	.003	13.900
	5 19'HG	688	.050	6.820	77	1.911	1315	.096	147	.047	61.791	.004	6.916
	6 16'HG	87	.050	8.930	77	1.602	139	.080	123	.089	12.407	.007	10.981
	7 3'HG	17	.070	13.330	1552	1.083	18	.076	1681	.283	5.212	.021	475.862
	8 16'HG	17	.050	9.370	117	1.540	26	.077	180	.089	2.331	.007	16.040
	9 C.T.	341	.040	4.750	79	2.822	962	.113	223	.021	20.208	.002	4.682
	SUM----------(CYCLE COMPOSITE)----------										134.325	.067	612.958
CYCLE 4													
	1 IDLE	8	.020	9.370	77	1.544	12	.031	119	.036	.445	.001	4.281
	2 16'HG	188	.020	8.840	97	1.602	301	.032	155	.089	26.799	.003	13.827
	3 10'HG	13	.020	10.780	199	1.342	17	.027	267	.257	4.484	.007	68.639
	4 16'HG	66	.020	9.030	103	1.591	105	.032	164	.089	9.348	.003	14.589
	5 19'HG	666	.020	7.000	77	1.876	1249	.038	144	.047	58.722	.002	6.789
	6 16'HG	71	.020	9.140	77	1.572	112	.031	121	.089	9.930	.003	10.770
	7 3'HG	13	.070	13.180	1540	1.096	14	.077	1688	.283	4.032	.022	477.691
	8 16'HG	13	.020	9.370	130	1.544	20	.031	201	.089	1.786	.003	17.859
	9 C.T.	337	.040	4.720	80	2.841	957	.114	227	.021	20.105	.002	4.773
	SUM----------(CYCLE COMPOSITE)----------										135.652	.045	619.217
	AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------										155.790	.045	596.387
	AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------										134.989	.056	616.087

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(155.790) + 0.65*(134.989) =	142.269	PPM
CO	0.35*(.045) + 0.65*(.056) =	.052	PERCENT
NO	0.35*(596.387) + 0.65*(616.087) =	609.192	PPM
	CORRECTED NO =	640.103	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

8-2-72 RUN1 2-3 4BTDC 600RPM W/AIR EGR OXIDATION CATALYST K = 1.04 HUM = 90 GR/LB

MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1														
1 IDLE	65	.220	9.41	52	9.700	1634	12	75	3	.232	2.7	17	.7	0
2 16 HG	521	.340	8.21	77	9.113	5539	342	417	16	.077	26.3	32	1.2	7
3 10 HG	35	.180	10.95	146	11.168	9897	33	322	43	.147	4.9	47	6.3	30
4 16 HG	76	.080	9.06	103	9.222	5539	49	97	21	.077	3.8	7	1.6	7
5 19 HG	612	.070	7.18	64	7.911	3178	266	57	9	.057	15.1	3	.5	9
6 16 HG	60	.100	9.21	77	9.375	5539	38	119	15	.077	2.9	9	1.2	7
7 3 HG	21	.140	13.20	1482	13.363	18560	32	393	683	.113	3.6	44	77.2	81
8 16 HG	21	.100	9.37	103	9.493	5539	13	118	20	.077	1.0	9	1.5	7
9 C.T.	320	.110	4.73	69	5.186	994	66	43	4	.143	9.5	6	.6	0
SUM----------(CYCLE COMPOSITE)----------											4.3	11	5.6	
CYCLE 2														
1 IDLE	65	.220	9.41	52	9.700	1634	12	75	3	.232	2.7	17	.7	0
2 16 HG	176	.080	8.78	90	9.050	5539	116	99	18	.077	9.0	8	1.4	7
3 10 HG	13	.100	10.78	210	10.894	9897	13	184	63	.147	1.9	27	9.3	30
4 16 HG	48	.100	9.14	100	9.292	5539	31	120	20	.077	2.4	9	1.5	7
5 19 HG	642	.070	7.23	64	7.993	3178	276	56	8	.057	15.7	3	.5	9
6 16 HG	66	.090	9.25	77	9.411	5539	42	107	15	.077	3.2	8	1.2	7
7 3 HG	13	.130	13.33	1463	13.474	18560	19	362	669	.113	2.2	41	75.6	81
8 16 HG	17	.070	9.37	103	9.458	5539	11	83	20	.077	.8	6	1.5	7
9 C.T.	318	.110	4.69	73	5.143	994	66	43	5	.143	9.5	6	.7	0
SUM----------(CYCLE COMPOSITE)----------											2.9	8	5.7	
CYCLE 3														
1 IDLE	8	.070	9.25	77	9.329	1634	2	25	4	.232	.4	6	1.0	0
2 16 HG	138	.070	8.93	74	9.149	5539	90	86	15	.077	6.9	7	1.1	7
3 10 HG	8	.100	10.78	224	10.889	9897	8	184	68	.147	1.2	27	9.9	30
4 16 HG	57	.070	9.03	103	9.162	5539	37	85	21	.077	2.9	7	1.6	7
5 19 HG	715	.090	7.00	64	7.862	3178	312	73	9	.057	17.8	4	.5	9
6 16 HG	70	.090	9.18	77	9.346	5539	45	108	15	.077	3.5	8	1.2	7
7 3 HG	17	.130	13.18	1510	13.328	18560	26	366	698	.113	2.9	41	78.9	81
8 16 HG	16	.070	9.19	109	9.277	5539	10	84	22	.077	.8	7	1.7	7
9 C.T.	317	.100	4.39	72	4.832	994	70	42	5	.143	10.1	6	.7	0
SUM----------(CYCLE COMPOSITE)----------											2.9	7	6.0	
CYCLE 4														
1 IDLE	8	.070	9.25	77	9.329	1634	2	25	4	.232	.4	6	1.0	0
2 16 HG	103	.070	9.14	103	9.321	5539	66	84	20	.077	5.1	6	1.6	7
3 10 HG	8	.070	10.78	237	10.859	9897	8	129	72	.147	1.2	19	10.5	30
4 16 HG	50	.070	9.14	103	9.264	5539	32	85	20	.077	2.5	7	1.6	7
5 19 HG	671	.070	7.09	77	7.885	3178	292	57	10	.057	16.6	3	.6	9
6 16 HG	73	.070	9.14	77	9.289	5539	47	84	15	.077	3.6	6	1.2	7
7 3 HG	13	.110	13.18	1463	13.304	18560	20	310	678	.113	2.2	35	76.6	81
8 16 HG	13	.070	9.19	117	9.274	5539	8	84	23	.077	.6	7	1.8	7
9 C.T.	325	.090	4.61	73	5.051	994	69	36	5	.143	9.9	5	.7	0
SUM----------(CYCLE COMPOSITE)----------											2.6	6	5.9	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------											3.6	9	5.7	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------											2.7	6	5.9	

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(3.6) + 0.65(2.7) = 3.048 (MASS)
CO 0.35(9) + 0.65(6) = 7.4 (MASS)
NO2 0.35(5.7) + 0.65(5.9) = 5.848 (MASS)
CORRECTED NO2 = 6.098 (MASS)

8-2-72 RUN-2 2-3 48TDC 600 RPM W/AIR EGR OXIDATION CATALYST K = 1.04 HUM = 90 GR/LB

MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1														
1 IDLE	21	.050	8.75	64	8.823	1634	4	19	4	.232	1.0	4	.9	0
2 16 HG	239	.050	8.60	64	8.908	5539	160	63	13	.077	12.4	5	1.0	7
3 10 HG	13	.050	10.43	157	10.494	9897	13	95	49	.147	1.9	14	7.2	30
4 16 HG	49	.050	8.84	90	8.943	5539	33	63	19	.077	2.5	5	1.4	7
5 19 HG	573	.050	7.00	57	7.669	3178	256	42	8	.057	14.6	2	.4	9
6 16 HG	63	.050	8.84	64	8.958	5539	42	62	13	.077	3.2	5	1.0	7
7 3 HG	4	.070	13.06	1463	13.134	18560	6	200	686	.113	.7	23	77.6	81
8 16 HG	4	.050	9.14	112	9.194	5539	3	61	22	.077	.2	5	1.7	7
9 C.T.	293	.060	4.93	63	5.306	994	59	23	4	.143	8.5	3	.6	0
SUM----------(CYCLE COMPOSITE)----------											2.8	4	5.7	
CYCLE 2														
1 IDLE	21	.050	8.75	64	8.823	1634	4	19	4	.232	1.0	4	.9	0
2 16 HG	113	.050	8.84	90	9.012	5539	75	62	18	.077	5.8	5	1.4	7
3 10 HG	4	.050	10.66	210	10.714	9897	4	93	64	.147	.6	14	9.5	30
4 16 HG	48	.050	8.93	96	9.032	5539	32	62	20	.077	2.4	5	1.5	7
5 19 HG	625	.050	6.82	64	7.545	3178	284	43	9	.057	16.2	2	.5	9
6 16 HG	62	.050	8.93	64	9.047	5539	41	62	13	.077	3.2	5	1.0	7
7 3 HG	4	.070	12.94	1559	13.014	18560	6	202	738	.113	.7	23	83.4	81
8 16 HG	9	.050	9.14	108	9.200	5539	6	61	22	.077	.5	5	1.7	7
9 C.T.	295	.050	4.59	65	4.959	994	64	20	4	.143	9.1	3	.6	0
SUM----------(CYCLE COMPOSITE)----------											2.4	4	6.2	
CYCLE 3														
1 IDLE	4	.020	8.84	70	8.864	1634	1	7	4	.232	.2	2	1.0	0
2 16 HG	111	.020	8.84	90	8.980	5539	74	25	18	.077	5.7	2	1.4	7
3 10 HG	4	.050	10.51	190	10.564	9897	4	95	59	.147	.6	14	8.7	30
4 16 HG	37	.050	8.93	97	9.020	5539	25	62	20	.077	1.9	5	1.5	7
5 19 HG	590	.050	7.09	71	7.777	3178	260	41	10	.057	14.8	2	.5	9
6 16 HG	50	.050	9.03	77	9.134	5539	33	61	16	.077	2.5	5	1.2	7
7 3 HG	4	.070	13.06	1579	13.134	18560	6	200	741	.113	.7	23	83.7	81
8 16 HG	6	.020	9.18	108	9.206	5539	4	24	22	.077	.3	2	1.7	7
9 C.T.	296	.060	4.58	66	4.960	994	64	24	4	.143	9.2	3	.6	0
SUM----------(CYCLE COMPOSITE)----------											2.2	4	6.2	
CYCLE 4														
1 IDLE	4	.050	8.84	70	8.894	1634	1	19	4	.232	.2	4	1.0	0
2 16 HG	88	.050	8.84	90	8.985	5539	59	62	18	.077	4.5	5	1.4	7
3 10 HG	4	.050	10.55	197	10.604	9897	4	94	61	.147	.6	14	9.0	30
4 16 HG	40	.050	8.84	103	8.933	5539	27	63	21	.077	2.1	5	1.6	7
5 19 HG	588	.050	6.91	71	7.595	3178	266	42	10	.057	15.1	2	.6	9
6 16 HG	51	.020	8.93	77	9.005	5539	34	25	16	.077	2.6	2	1.2	7
7 3 HG	4	.070	12.94	1579	13.014	18560	6	202	748	.113	.7	23	84.5	81
8 16 HG	9	.050	9.14	117	9.200	5539	6	61	23	.077	.5	5	1.8	7
9 C.T.	301	.060	4.56	68	4.945	994	65	24	5	.143	9.3	3	.6	0
SUM----------(CYCLE COMPOSITE)----------											2.2	4	6.3	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------											2.6	4	6.0	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------											2.2	4	6.3	

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(2.6) + 0.65(2.2) = 2.352 (MASS)
CO 0.35(4) + 0.65(4) = 3.8 (MASS)
NO2 0.35(6.0) + 0.65(6.3) = 6.147 (MASS)
CORRECTED NO2 = 6.410 (MASS)

8-2-72 RUN3 2-3 48TDC 600RPM W/AIR EGR OXIDATION CATALYST K = 1.04 HUM = 90 GR/LB

MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1														
1 IDLE	32	.020	8.93	51	8.985	1634	6	7	3	.232	1.5	2	.7	0
2 16 HG	253	.020	8.75	83	9.043	5539	167	25	17	.077	12.9	2	1.3	7
3 10 HG	22	.020	10.55	169	10.594	9897	22	38	52	.147	3.3	6	7.7	30
4 16 HG	88	.020	8.93	77	9.045	5539	58	25	16	.077	4.5	2	1.2	7
5 19 HG	693	.020	7.00	64	7.768	3178	306	17	9	.057	17.5	1	.5	9
6 16 HG	106	.020	8.93	58	9.064	5539	70	25	12	.077	5.4	2	.9	7
7 3 HG	17	.070	13.06	1546	13.148	18560	26	200	725	.113	2.9	23	81.9	81
8 16 HG	21	.020	9.25	112	9.293	5539	14	24	22	.077	1.0	2	1.7	7
9 C.T.	364	.040	4.60	64	5.033	994	78	16	4	.143	11.1	2	.6	0
SUM----------(CYCLE COMPOSITE)----------											3.7	3	6.0	
CYCLE 2														
1 IDLE	32	.020	8.93	51	8.985	1634	6	7	3	.232	1.5	2	.7	0
2 16 HG	216	.020	8.75	64	9.003	5539	144	25	13	.077	11.1	2	1.0	7
3 10 HG	17	.020	10.78	183	10.818	9897	17	37	56	.147	2.5	5	8.2	30
4 16 HG	44	.020	9.25	96	9.318	5539	28	24	19	.077	2.2	2	1.5	7
5 19 HG	694	.020	7.09	64	7.860	3178	303	16	9	.057	17.3	1	.5	9
6 16 HG	102	.020	8.93	70	9.060	5539	67	25	14	.077	5.2	2	1.1	7
7 3 HG	17	.070	13.33	1518	13.418	18560	25	196	697	.113	2.9	22	78.8	81
8 16 HG	17	.020	9.37	122	9.408	5539	11	24	24	.077	.8	2	1.8	7
9 C.T.	333	.040	4.75	68	5.150	994	69	16	4	.143	9.9	2	.6	0
SUM----------(CYCLE COMPOSITE)----------											3.3	2	5.8	
CYCLE 3														
1 IDLE	8	.020	9.37	77	9.399	1634	2	7	4	.232	.3	2	1.0	0
2 16 HG	131	.020	8.93	97	9.091	5539	86	25	20	.077	6.6	2	1.5	7
3 10 HG	13	.050	10.55	189	10.614	9897	13	94	59	.147	1.9	14	8.6	30
4 16 HG	61	.020	8.93	97	9.016	5539	40	25	20	.077	3.1	2	1.5	7
5 19 HG	688	.050	6.82	77	7.613	3178	310	42	11	.057	17.7	2	.6	9
6 16 HG	87	.050	8.93	77	9.074	5539	57	62	16	.077	4.4	5	1.2	7
7 3 HG	17	.070	13.33	1552	13.418	18560	25	196	713	.113	2.9	22	80.5	81
8 16 HG	17	.050	9.37	117	9.438	5539	11	59	23	.077	.8	5	1.8	7
9 C.T.	341	.040	4.75	79	5.158	994	71	16	5	.143	10.1	2	.7	0
SUM----------(CYCLE COMPOSITE)----------											3.0	3	6.0	
CYCLE 4														
1 IDLE	8	.020	9.37	77	9.399	1634	2	7	4	.232	.3	2	1.0	0
2 16 HG	188	.020	8.84	97	9.063	5539	124	25	20	.077	9.6	2	1.5	7
3 10 HG	13	.020	10.78	199	10.814	9897	13	37	60	.147	1.9	5	8.9	30
4 16 HG	66	.020	9.03	103	9.121	5539	43	25	21	.077	3.3	2	1.6	7
5 19 HG	666	.020	7.00	77	7.739	3178	295	17	10	.057	16.8	1	.6	9
6 16 HG	71	.020	9.14	77	9.237	5539	46	24	15	.077	3.5	2	1.2	7
7 3 HG	13	.070	13.18	1540	13.264	18560	20	198	715	.113	2.2	22	80.8	81
8 16 HG	13	.020	9.37	130	9.404	5539	8	24	25	.077	.6	2	2.0	7
9 C.T.	337	.040	4.72	80	5.124	994	71	16	5	.143	10.1	2	.7	0
SUM----------(CYCLE COMPOSITE)----------											3.0	2	6.1	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------											3.5	2	5.9	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------											3.0	3	6.1	

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(3.5) + 0.65(3.0) = 3.165 (MASS)
CO 0.35(2) + 0.65(3) = 2.8 (MASS)
NO2 0.35(5.9) + 0.65(6.1) = 6.003 (MASS)
CORRECTED NO2 = 6.260 (MASS)

APPENDIX P

ENGINE 2-3

STANDARD 1972 ENGINE EMISSION RATES

TABULAR DATA

EXPERIMENTAL 23 MODE MASS

NINE-MODE FTP CONCENTRATION

NINE-MODE CALIFORNIA ARB MASS

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-3-72 RUN-1 ENG.2-3 1972 VERSION 4 BTDC STAT.ERL

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	DRY CONCENTRATION ALDE.	HC	CO	CO2	NO
1	600	0.0	0	18.2	3.5	14.9	0	6523	2.780	12.82	40
2	1200	5.0	1	19.4	7.5	15.5	0	834	.470	14.05	104
3	1200	19.0	4	19.0	7.5	15.6	0	758	.280	13.91	131
4	1200	42.0	10	17.9	8.1	16.2	0	1407	.130	13.48	370
5	1200	58.0	13	16.4	8.3	16.3	0	1507	.150	13.33	720
6	1200	116.0	27	10.7	14.5	16.7	0	1300	.100	12.94	1212
7	1200	175.0	40	5.7	20.2	15.3	0	1518	.280	14.05	1975
8	1200	191.0	44	3.8	21.8	15.5	0	1368	.250	13.91	2100
9	1200	214.0	49	2.3	23.0	15.5	0	1324	.150	14.05	2350
10	1200	233.0	53	.3	30.6	13.1	0	2566	4.840	11.72	1087
11	600	0.0	0	18.3	3.3	14.5	0	3864	1.800	12.94	51
12	1200	0.0	0	22.0	3.6	16.3	0	54958	.470	6.54	7
13	2300	250.0	109	.6	64.5	12.4	0	2690	6.310	10.66	913
14	2300	230.0	101	2.7	48.5	14.6	0	1299	1.450	13.63	1950
15	2300	205.0	90	4.8	44.8	14.4	0	1290	1.630	13.63	1837
16	2300	186.0	81	6.3	41.7	14.3	0	1586	1.730	13.48	1762
17	2300	125.0	55	11.1	28.4	15.9	0	587	.150	13.77	2050
18	2300	63.0	28	16.3	18.4	16.1	0	541	.150	13.48	1375
19	2300	45.0	20	18.0	16.3	16.2	0	400	.150	13.48	738
20	2300	20.0	9	19.8	13.5	16.4	0	236	.130	13.48	310
21	2300	5.0	2	20.6	11.7	16.4	0	190	.130	13.33	190
22	600	0.0	0	18.3	3.5	14.9	0	3809	1.630	13.18	49
23	2300	0.0	0	24.9	3.8	19.8	0	38328	.360	8.05	8

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	63.7	549	1.3	.070	0.0	I	R	R	R
2	0.0	19.4	221	8.0	.060	.1	0.0	17.00	193.6	7.0
3	0.0	18.1	135	10.4	.060	.3	0.0	4.16	31.1	2.4
4	0.0	37.6	70	32.8	.050	.5	0.0	3.92	7.3	3.4
5	0.0	41.6	84	66.0	.030	.4	0.0	3.14	6.3	5.0
6	0.0	64.9	101	201.0	.060	1.6	0.0	2.45	3.8	7.6
7	0.0	96.0	358	414.9	0.000	0.0	0.0	2.40	8.9	10.4
8	0.0	94.7	349	482.2	.040	1.7	0.0	2.17	8.0	11.0
9	0.0	96.4	221	567.9	0.000	0.0	0.0	1.97	4.5	11.6
10	0.0	211.8	8070	297.9	0.000	0.0	0.0	3.98	151.6	5.6
11	0.0	38.2	360	1.7	.070	0.0	I	R	R	R
12	0.0	717.6	124	.3	.120	0.0	I	R	R	R
13	0.0	456.5	21632	514.2	.025	2.7	0.0	4.17	197.6	4.7
14	0.0	187.9	4237	936.4	.055	5.5	0.0	1.87	42.1	9.3
15	0.0	170.3	4348	805.4	.035	3.1	0.0	1.90	48.4	9.0
16	0.0	195.1	4301	720.2	.060	4.9	0.0	2.40	52.8	8.8
17	0.0	54.1	279	627.2	.060	3.3	0.0	.99	5.1	11.5
18	0.0	33.0	185	278.4	0.000	0.0	0.0	1.19	6.7	10.1
19	0.0	21.6	164	132.4	.065	1.3	0.0	1.10	8.3	6.7
20	0.0	10.6	118	46.2	0.000	0.0	0.0	1.21	13.5	5.3
21	0.0	7.5	103	24.8	0.000	0.0	0.0	3.41	47.2	11.3
22	0.0	39.8	344	1.7	.080	0.0	I	R	R	R
23	0.0	539.6	102	.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	7.316	GRAM/BHP HR
	CO	53.947	GRAM/BHP HR
	NO2	8.597	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.623	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-3-72 RUN-2 ENG.2-3 1972 VERSION 4 BTDC STAT.ERL

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.2	3.5	15.1	0	5200	1.380	12.71	41
2	1200	5.0	1	19.5	7.6	15.5	0	702	.390	13.91	104
3	1200	19.0	4	19.0	7.7	15.5	0	928	.280	13.91	151
4	1200	42.0	10	17.9	8.0	16.1	0	1396	.100	13.48	370
5	1200	58.0	13	16.5	8.4	16.3	0	1572	.100	13.18	680
6	1200	116.0	27	10.8	14.3	16.7	0	1378	.100	12.94	1313
7	1200	175.0	40	5.7	20.1	15.2	0	1587	.280	14.18	2050
8	1200	191.0	44	3.8	21.7	15.6	0	1413	.210	13.91	2200
9	1200	214.0	49	2.3	23.0	15.5	0	1469	.150	13.91	2350
10	1200	233.0	53	.3	30.7	13.1	0	2708	4.880	11.60	1037
11	600	0.0	0	18.5	3.7	14.1	0	3998	2.440	12.94	53
12	1200	0.0	0	22.0	3.6	16.2	0	55004	.470	6.55	6
13	2300	250.0	109	.6	64.5	12.4	0	2892	6.310	10.66	900
14	2300	230.0	101	2.7	48.2	14.7	0	1267	1.230	13.77	2100
15	2300	205.0	90	4.8	44.5	14.6	0	1265	1.480	13.63	1987
16	2300	186.0	81	6.3	41.4	14.5	0	1471	1.380	13.77	2200
17	2300	125.0	55	11.0	28.5	16.1	0	555	.150	13.48	2150
18	2300	63.0	28	16.4	18.5	16.3	0	475	.150	13.33	1313
19	2300	45.0	20	18.0	16.3	16.4	0	343	.130	13.33	795
20	2300	20.0	9	19.8	13.4	16.5	0	222	.100	13.33	330
21	2300	5.0	2	20.6	11.9	16.5	0	188	.100	13.18	200
22	600	0.0	0	18.3	3.5	15.5	0	3959	.850	13.33	47
23	2300	0.0	0	24.9	3.8	19.9	0	38129	.360	8.10	8

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	56.5	303	1.5	.070	0.0	I	R	R	R
2	0.0	16.8	189	8.3	.060	.1	0.0	14.74	165.4	7.2
3	0.0	22.7	138	12.3	.060	.3	0.0	5.23	31.9	2.8
4	0.0	36.9	53	32.5	.050	.5	0.0	3.85	5.6	3.4
5	0.0	44.6	57	64.0	.030	.4	0.0	3.36	4.3	4.8
6	0.0	67.8	99	214.5	.060	1.6	0.0	2.56	3.8	8.1
7	0.0	99.0	353	424.5	0.000	0.0	0.0	2.48	8.8	10.6
8	0.0	97.5	293	504.1	.040	1.7	0.0	2.24	6.7	11.6
9	0.0	107.9	223	572.9	0.000	0.0	0.0	2.21	4.6	11.7
10	0.0	225.1	8195	286.4	0.000	0.0	0.0	4.23	153.9	5.4
11	0.0	42.5	524	1.9	.070	0.0	I	R	R	R
12	0.0	717.4	124	.3	.120	0.0	I	R	R	R
13	0.0	440.3	21607	506.5	.025	2.7	0.0	4.48	197.4	4.6
14	0.0	183.1	3591	1007.7	.055	5.5	0.0	1.82	35.7	10.0
15	0.0	167.6	3961	874.2	.035	3.1	0.0	1.87	44.1	9.7
16	0.0	180.6	3422	896.7	.060	4.9	0.0	2.22	42.0	11.0
17	0.0	52.4	286	674.3	.060	3.3	0.0	.96	5.2	12.3
18	0.0	29.5	188	270.3	0.000	0.0	0.0	1.07	6.8	9.8
19	0.0	18.8	144	144.6	.065	1.3	0.0	.95	7.3	7.3
20	0.0	10.0	91	49.5	0.000	0.0	0.0	1.15	10.4	5.7
21	0.0	7.6	82	27.0	0.000	0.0	0.0	3.49	37.4	12.3
22	0.0	43.1	187	1.7	.080	0.0	I	R	R	R
23	0.0	535.5	102	.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	7.300	GRAM/BHP HR
	CO	48.938	GRAM/BHP HR
	NO2	9.466	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.622	LB/BHP HR

8-4-72 RUN 1 2-3 48TDC 600RPM E.R.L STD.ENG. STA. K =1.031 HUM = 84 GR/LB

	FEDERAL MODE	CONCENTRATION HC	CO	AS CO2	MEASURED NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
	1 IDLE	148	.800	13.480	105	1.033	153	.826	108	.036	5.503	.030	3.904
	2 16'HG	93	.180	13.770	1135	1.039	97	.187	1179	.089	8.597	.017	104.919
	3 10'HG	49	.180	13.770	1377	1.042	51	.188	1435	.257	13.124	.048	368.822
	4 16'HG	40	.180	13.770	956	1.043	42	.188	997	.089	3.713	.017	88.736
	5 19'HG	26	.180	13.770	393	1.044	27	.188	410	.047	1.276	.009	19.285
	6 16'HG	40	.180	13.630	1085	1.054	42	.190	1143	.089	3.751	.017	101.735
	7 3'HG	75	1.110	14.310	1939	.970	73	1.077	1881	.283	20.592	.305	532.362
	8 16'HG	35	.180	14.420	1371	.997	35	.179	1366	.089	3.105	.016	121.618
	9 C.T.	1712	.950	8.130	129	1.387	2375	1.318	179	.021	49.867	.028	3.757
	SUM----------(CYCLE COMPOSITE)----------										109.526	.485	1345.138
CYCLE 2													
	1 IDLE	148	.800	13.480	105	1.033	153	.826	108	.036	5.503	.030	3.904
	2 16'HG	76	.180	13.770	1036	1.040	79	.187	1077	.089	7.035	.017	95.894
	3 10'HG	49	.180	13.910	1599	1.032	51	.186	1650	.257	12.994	.048	424.017
	4 16'HG	44	.180	13.910	1185	1.032	45	.186	1223	.089	4.042	.017	108.862
	5 19'HG	26	.180	13.910	501	1.034	27	.186	518	.047	1.263	.009	24.339
	6 16'HG	40	.180	13.770	1236	1.043	42	.188	1289	.089	3.713	.017	114.726
	7 3'HG	76	1.160	14.310	1939	.968	74	1.123	1878	.283	20.830	.318	531.435
	8 16'HG	35	.180	14.050	1431	1.023	36	.184	1464	.089	3.186	.016	130.253
	9 C.T.	1661	.980	8.940	147	1.292	2146	1.266	190	.021	45.062	.027	3.988
	SUM----------(CYCLE COMPOSITE)----------										103.627	.497	1437.418
CYCLE 3													
	1 IDLE	89	1.170	14.180	165	.976	87	1.142	161	.036	3.126	.041	5.796
	2 16'HG	80	.180	13.910	1185	1.029	82	.185	1220	.089	7.329	.016	108.562
	3 10'HG	48	.180	14.050	1676	1.022	49	.184	1712	.257	12.604	.047	440.085
	4 16'HG	44	.180	14.050	1224	1.022	45	.184	1251	.089	4.002	.016	111.335
	5 19'HG	31	.180	14.050	542	1.023	32	.184	554	.047	1.491	.009	26.061
	6 16'HG	44	.180	14.050	1306	1.022	45	.184	1335	.089	4.002	.016	118.794
	7 3'HG	80	1.200	14.310	1939	.967	77	1.160	1875	.283	21.891	.328	530.573
	8 16'HG	35	.210	14.050	1389	1.022	36	.215	1419	.089	3.182	.019	126.297
	9 C.T.	1624	.900	9.100	168	1.283	2083	1.154	216	.021	43.747	.024	4.526
	SUM----------(CYCLE COMPOSITE)----------										101.374	.518	1472.028
CYCLE 4													
	1 IDLE	89	1.170	14.180	165	.976	87	1.142	161	.036	3.126	.041	5.796
	2 16'HG	71	.180	13.910	1195	1.030	73	.185	1231	.089	6.509	.017	109.553
	3 10'HG	48	.180	14.050	1702	1.022	49	.184	1739	.257	12.604	.047	446.912
	4 16'HG	44	.180	13.960	1202	1.029	45	.185	1236	.089	4.028	.016	110.032
	5 19'HG	31	.180	14.050	501	1.023	32	.184	513	.047	1.491	.009	24.089
	6 16'HG	44	.180	14.050	1306	1.022	45	.184	1335	.089	4.002	.016	118.794
	7 3'HG	77	1.200	14.420	1982	.960	74	1.152	1903	.283	20.921	.326	538.506
	8 16'HG	25	.190	14.050	1468	1.023	26	.194	1502	.089	2.276	.017	133.676
	9 C.T.	1603	.850	9.070	127	1.292	2070	1.098	164	.021	43.480	.023	3.445
	SUM----------(CYCLE COMPOSITE)----------										98.437	.513	1490.803

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 106.577 .491 1391.278

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 99.905 .515 1481.415

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(106.577) + 0.65*(99.905) =	102.240	PPM
CO	0.35*(.491) + 0.65*(.515) =	.507	PERCENT
NO	0.35*(1391.278) + 0.65*(1481.415) =	1449.867	PPM
	CORRECTED NO =	1495.356	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

8-4-72 RUN 2 2-3 48TDC 600RPM E.R.L STD.ENG. STA. K =1.031 HUM = 84 GR/LB

	FEDERAL MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
	1 IDLE	427	.810	12.220	90	1.108	473	.898	100	.036	17.033	.032	3.590
	2 16'HG	120	.180	12.090	1444	1.178	141	.212	1701	.089	12.580	.019	151.384
	3 10'HG	62	.180	13.060	1463	1.097	68	.197	1605	.257	17.481	.051	412.490
	4 16'HG	49	.180	12.940	1031	1.108	54	.199	1143	.089	4.833	.018	101.698
	5 19'HG	36	.180	12.340	450	1.163	42	.209	523	.047	1.968	.010	24.595
	6 16'HG	44	.180	12.920	1117	1.110	49	.200	1240	.089	4.349	.018	110.395
	7 3'HG	80	1.090	13.630	2040	1.017	81	1.108	2074	.283	23.019	.314	586.979
	8 16'HG	42	.210	13.180	1520	1.088	46	.228	1653	.089	4.066	.020	147.150
	9 C.T.	2444	1.100	6.560	133	1.487	3635	1.636	198	.021	76.332	.034	4.154
	SUM----------(CYCLE COMPOSITE)----------										161.660	.516	1542.436
CYCLE 2													
	1 IDLE	427	.810	12.220	90	1.108	473	.898	100	.036	17.033	.032	3.590
	2 16'HG	79	.180	13.060	1170	1.096	87	.197	1282	.089	7.703	.018	114.080
	3 10'HG	49	.180	13.180	1625	1.088	53	.196	1769	.257	13.706	.050	454.522
	4 16'HG	45	.180	13.180	1313	1.089	49	.196	1429	.089	4.360	.017	127.223
	5 19'HG	31	.180	13.330	582	1.078	33	.194	627	.047	1.570	.009	29.482
	6 16'HG	45	.180	13.180	1292	1.089	49	.196	1407	.089	4.360	.017	125.188
	7 3'HG	76	1.300	13.630	2130	1.010	77	1.312	2150	.283	21.715	.371	608.579
	8 16'HG	40	.180	13.330	1625	1.077	43	.194	1750	.089	3.834	.017	155.763
	9 C.T.	2372	1.090	6.750	152	1.471	3489	1.603	224	.021	73.277	.034	4.696
	SUM----------(CYCLE COMPOSITE)----------										147.558	.567	1623.121
CYCLE 3													
	1 IDLE	156	1.010	13.480	130	1.024	160	1.035	133	.036	5.753	.037	4.795
	2 16'HG	70	.180	13.850	1295	1.035	72	.186	1340	.089	6.445	.017	119.238
	3 10'HG	45	.180	13.940	1759	1.030	46	.185	1812	.257	11.911	.048	465.594
	4 16'HG	45	.180	13.940	1392	1.030	46	.185	1434	.089	4.125	.016	127.596
	5 19'HG	31	.180	14.030	620	1.024	32	.184	635	.047	1.493	.009	29.853
	6 16'HG	37	.180	13.980	1539	1.028	38	.185	1582	.089	3.384	.016	140.757
	7 3'HG	76	1.200	13.630	2143	1.013	77	1.216	2171	.283	21.790	.344	614.432
	8 16'HG	36	.180	13.940	1598	1.031	37	.186	1647	.089	3.302	.017	146.580
	9 C.T.	2318	1.150	6.760	168	1.474	3416	1.695	248	.021	71.742	.036	5.200
	SUM----------(CYCLE COMPOSITE)----------										129.946	.539	1654.046
CYCLE 4													
	1 IDLE	156	1.010	13.480	130	1.024	160	1.035	133	.036	5.753	.037	4.795
	2 16'HG	76	.180	13.180	1350	1.086	83	.195	1466	.089	7.346	.017	130.480
	3 10'HG	45	.180	13.180	1784	1.089	49	.196	1942	.257	12.591	.050	499.157
	4 16'HG	40	.180	13.180	1313	1.089	44	.196	1430	.089	3.877	.017	127.274
	5 19'HG	31	.180	13.400	600	1.072	33	.193	643	.047	1.562	.009	30.236
	6 16'HG	40	.180	13.180	1444	1.089	44	.196	1573	.089	3.877	.017	139.973
	7 3'HG	78	1.320	13.630	2099	1.009	79	1.332	2117	.283	22.267	.377	599.214
	8 16'HG	36	.180	13.330	1545	1.077	39	.194	1665	.089	3.452	.017	148.142
	9 C.T.	2288	1.040	6.790	131	1.482	3392	1.542	194	.021	71.229	.032	4.078
	SUM----------(CYCLE COMPOSITE)----------										131.955	.575	1683.349

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 154.609 .541 1582.779

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 130.951 .557 1668.697

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(154.609) + 0.65*(130.951) =	139.291	PPM
CO	0.35*(.541) + 0.65*(.557) =	.552	PERCENT
NO	0.35*(1582.779) + 0.65*(1668.697) =	1638.626	PPM
	CORRECTED NO =	1690.037	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

8-4-72 RUN 3 2-3 48TDC 600RPM E.R.L STD.ENG. STA. K =1.031 HUM = 84 GR/LB

	FEDERAL MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
	1 IDLE	272	1.380	13.060	105	1.032	281	1.425	108	.036	10.110	.051	3.903
	2 16'HG	80	.210	13.210	1340	1.082	87	.227	1450	.089	7.704	.020	129.037
	3 10'HG	48	.220	13.220	1698	1.084	52	.238	1840	.257	13.367	.061	472.850
	4 16'HG	46	.240	13.180	1406	1.086	50	.261	1527	.089	4.447	.023	135.917
	5 19'HG	28	.240	13.330	560	1.076	30	.258	602	.047	1.416	.012	28.311
	6 16'HG	42	.240	13.180	1387	1.087	46	.261	1507	.089	4.061	.023	134.123
	7 3'HG	80	1.380	13.630	2121	1.006	81	1.389	2135	.283	22.787	.393	604.143
	8 16'HG	35	.250	13.250	1530	1.081	38	.270	1654	.089	3.367	.024	147.208
	9 C.T.	1868	1.200	8.220	115	1.338	2499	1.606	154	.021	52.485	.034	3.231
	SUM----------(CYCLE COMPOSITE)----------										119.744	.642	1658.721
CYCLE 2													
	1 IDLE	272	1.380	13.060	105	1.032	281	1.425	108	.036	10.110	.051	3.903
	2 16'HG	77	.230	13.110	1332	1.090	84	.251	1451	.089	7.467	.022	129.165
	3 10'HG	48	.210	13.330	1925	1.075	52	.226	2070	.257	13.263	.058	531.890
	4 16'HG	44	.220	13.330	1425	1.075	47	.237	1532	.089	4.210	.021	136.345
	5 19'HG	31	.220	13.330	628	1.076	33	.237	676	.047	1.568	.011	31.765
	6 16'HG	40	.220	13.180	1501	1.088	44	.239	1632	.089	3.872	.021	145.279
	7 3'HG	77	1.450	13.480	2099	1.015	78	1.471	2130	.283	22.114	.416	602.824
	8 16'HG	31	.250	13.180	1559	1.087	34	.272	1695	.089	2.999	.024	150.833
	9 C.T.	1813	1.250	9.040	131	1.248	2262	1.559	163	.021	47.497	.033	3.432
	SUM----------(CYCLE COMPOSITE)----------										113.099	.658	1735.437
CYCLE 3													
	1 IDLE	159	1.140	13.480	150	1.020	162	1.162	153	.036	5.836	.042	5.506
	2 16'HG	77	.220	13.180	1369	1.084	83	.239	1484	.089	7.430	.021	132.107
	3 10'HG	48	.210	13.330	1947	1.075	52	.226	2093	.257	13.263	.058	537.969
	4 16'HG	44	.210	13.180	1406	1.088	48	.228	1529	.089	4.259	.020	136.092
	5 19'HG	31	.210	13.390	674	1.072	33	.225	722	.047	1.562	.011	33.953
	6 16'HG	41	.210	13.180	1539	1.088	45	.228	1674	.089	3.969	.020	149.001
	7 3'HG	80	1.450	13.390	2077	1.021	82	1.480	2121	.283	23.116	.419	600.150
	8 16'HG	32	.250	13.060	1490	1.097	35	.274	1634	.089	3.124	.024	145.455
	9 C.T.	1772	1.150	9.200	142	1.241	2198	1.427	176	.021	46.162	.030	3.699
	SUM----------(CYCLE COMPOSITE)----------										108.721	.646	1743.931
CYCLE 4													
	1 IDLE	159	1.140	13.480	150	1.020	162	1.162	153	.036	5.836	.042	5.506
	2 16'HG	77	.220	13.180	1388	1.084	83	.239	1505	.089	7.430	.021	133.941
	3 10'HG	48	.210	13.060	1968	1.097	53	.230	2159	.257	13.534	.059	554.879
	4 16'HG	44	.220	13.180	1490	1.087	48	.239	1620	.089	4.257	.021	144.168
	5 19'HG	31	.220	13.330	628	1.076	33	.237	676	.047	1.568	.011	31.765
	6 16'HG	41	.250	13.180	1444	1.086	45	.272	1568	.089	3.964	.024	139.594
	7 3'HG	77	1.430	13.480	2121	1.016	78	1.452	2154	.283	22.130	.411	609.569
	8 16'HG	35	.250	13.180	1618	1.087	38	.272	1758	.089	3.385	.024	156.491
	9 C.T.	1750	1.070	9.170	115	1.251	2188	1.338	144	.021	45.957	.028	3.020
	SUM----------(CYCLE COMPOSITE)----------										108.061	.642	1778.933

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 116.422 .650 1697.079

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 108.391 .644 1761.432

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(116.422) + 0.65*(108.391) =	111.202	PPM
CO	0.35*(.650) + 0.65*(.644) =	.646	PERCENT
NO	0.35*(1697.079) + 0.65*(1761.432) =	1738.909	PPM
	CORRECTED NO =	1793.466	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

8-4-72 RUN 1 2-3 4BTDC 600RPM F.R.L STD.ENG. STA. K = 1.03 HUM = 84 GR/LB

MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1														
1 IDLE	148	.800	13.48	105	14.440	1543	17	173	4	.232	4.0	40	.9	0
2 16 HG	93	.180	13.77	1135	14.050	7173	51	186	192	.077	3.9	14	14.8	26
3 10 HG	49	.180	13.77	1377	14.003	11895	45	309	388	.147	6.6	45	57.1	51
4 16 HG	40	.180	13.77	956	13.993	7173	22	186	163	.077	1.7	14	12.5	26
5 19 HG	26	.180	13.77	393	13.978	6084	12	158	57	.057	.7	9	3.2	15
6 16 HG	40	.180	13.63	1085	13.853	7173	22	188	187	.077	1.7	14	14.4	26
7 3 HG	75	1.110	14.31	1439	15.501	18796	98	2719	781	.113	11.1	307	88.2	88
8 16 HG	35	.180	14.42	1371	14.638	7173	19	178	223	.077	1.4	14	17.2	26
9 C.T.	1712	.950	8.13	129	10.929	1589	269	279	6	.143	38.4	40	.9	0
SUM----------(CYCLE COMPOSITE)----------											2.7	19	8.0	
CYCLE 2														
1 IDLE	148	.800	13.48	105	14.440	1543	17	173	4	.232	4.0	40	.9	0
2 16 HG	76	.180	13.77	1036	14.032	7173	42	186	176	.077	3.2	14	13.5	26
3 10 HG	49	.180	13.91	1599	14.143	11895	45	306	446	.147	6.5	45	65.6	51
4 16 HG	44	.180	13.91	1185	14.138	7173	24	184	200	.077	1.9	14	15.4	26
5 19 HG	26	.180	13.91	501	14.118	6084	12	157	72	.057	.7	9	4.1	15
6 16 HG	40	.180	13.77	1236	13.993	7173	22	186	210	.077	1.7	14	16.2	26
7 3 HG	76	1.160	14.31	1939	15.552	18796	99	2832	778	.113	11.2	320	87.9	88
8 16 HG	35	.180	14.05	1431	14.268	7173	19	183	239	.077	1.5	14	18.4	26
9 C.T.	1661	.980	8.94	147	11.714	1589	243	269	7	.143	34.8	38	.9	0
SUM----------(CYCLE COMPOSITE)----------											2.5	19	8.5	
CYCLE 3														
1 IDLE	89	1.170	14.18	165	15.446	1543	10	236	5	.232	2.2	55	1.3	0
2 16 HG	80	.180	13.91	1185	14.176	7173	44	184	199	.077	3.4	14	15.3	26
3 10 HG	48	.180	14.05	1676	14.282	11895	43	303	463	.147	6.3	45	68.1	51
4 16 HG	44	.180	14.05	1224	14.278	7173	24	183	204	.077	1.8	14	15.7	26
5 19 HG	31	.180	14.05	542	14.263	6084	14	155	77	.057	.8	9	4.4	15
6 16 HG	44	.180	14.05	1306	14.278	7173	24	183	218	.077	1.8	14	16.8	26
7 3 HG	80	1.200	14.31	1939	15.596	18796	104	2921	776	.113	11.8	330	87.7	88
8 16 HG	35	.210	14.05	1389	14.298	7173	19	213	231	.077	1.5	16	17.8	26
9 C.T.	1624	.900	9.10	168	11.754	1589	237	246	8	.143	33.9	35	1.1	0
SUM----------(CYCLE COMPOSITE)----------											2.4	20	8.7	
CYCLE 4														
1 IDLE	89	1.170	14.18	165	15.446	1543	10	236	5	.232	2.2	55	1.3	0
2 16 HG	71	.180	13.91	1195	14.167	7173	39	184	201	.077	3.0	14	15.5	26
3 10 HG	48	.180	14.05	1702	14.282	11895	43	303	471	.147	6.3	45	69.2	51
4 16 HG	44	.180	13.96	1202	14.188	7173	24	184	202	.077	1.8	14	15.5	26
5 19 HG	31	.180	14.05	501	14.263	6084	14	155	71	.057	.8	9	4.0	15
6 16 HG	44	.180	14.05	1306	14.278	7173	24	183	218	.077	1.8	14	16.8	26
7 3 HG	77	1.200	14.42	1982	15.703	18796	100	2901	788	.113	11.2	328	89.0	88
8 16 HG	25	.190	14.05	1468	14.267	7173	14	193	245	.077	1.0	15	18.9	26
9 C.T.	1603	.850	9.07	127	11.651	1589	236	234	6	.143	33.8	33	.8	0
SUM----------(CYCLE COMPOSITE)----------											2.4	20	8.8	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------											2.6	19	8.2	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------											2.4	20	8.8	

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(2.6) + 0.65(2.4) = 2.461 (MASS)
CO 0.35(19) + 0.65(20) = 19.9 (MASS)
NO2 0.35(8.2) + 0.65(8.8) = 8.579 (MASS)
CORRECTED NO2 = 8.808 (MASS)

8-4-72 RUN 2 2-3 48TDC 600RPM E.R.I. STD.ENG. STA. K = 1.03 HUM = 84 GR/LB

MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1														
1 IDLE	427	.810	12.22	90	13.491	1543	53	187	3	.232	12.2	43	.8	0
2 16 HG	120	.180	12.09	1444	12.400	7173	75	210	277	.077	5.8	16	21.4	26
3 10 HG	62	.180	13.06	1463	13.307	11895	60	325	434	.147	8.8	48	63.8	51
4 16 HG	49	.180	12.94	1031	13.173	7173	29	198	186	.077	2.2	15	14.4	26
5 19 HG	36	.180	12.34	450	12.559	6084	19	176	72	.057	1.1	10	4.1	15
6 16 HG	44	.180	12.92	1117	13.148	7173	26	198	202	.077	2.0	15	15.6	26
7 3 HG	80	1.090	13.63	2040	14.806	18796	110	2795	860	.113	12.4	316	97.2	88
8 16 HG	42	.210	13.18	1520	13.435	7173	24	226	269	.077	1.9	17	20.7	26
9 C.T.	2444	1.100	6.56	133	10.300	1589	407	343	7	.143	58.2	49	1.0	0
SUM----------(CYCLE COMPOSITE)----------											4.0	20	9.1	
CYCLE 2														
1 IDLE	427	.810	12.22	90	13.491	1543	53	187	3	.232	12.2	43	.8	0
2 16 HG	79	.180	13.06	1170	13.325	7173	46	196	209	.077	3.5	15	16.1	26
3 10 HG	49	.180	13.18	1625	13.413	11895	47	322	478	.147	6.9	47	70.3	51
4 16 HG	45	.180	13.18	1313	13.409	7173	26	195	233	.077	2.0	15	18.0	26
5 19 HG	31	.180	13.33	582	13.543	6084	15	163	87	.057	.9	9	4.9	15
6 16 HG	45	.180	13.18	1292	13.409	7173	26	195	229	.077	2.0	15	17.7	26
7 3 HG	76	1.300	13.63	2130	15.012	18796	103	3288	885	.113	11.6	372	100.1	88
8 16 HG	40	.180	13.33	1625	13.553	7173	23	192	286	.077	1.8	15	22.0	26
9 C.T.	2372	1.090	6.75	152	10.402	1589	391	336	8	.143	56.0	48	1.1	0
SUM----------(CYCLE COMPOSITE)----------											3.7	22	9.6	
CYCLE 3														
1 IDLE	156	1.010	13.48	130	14.658	1543	18	215	5	.232	4.1	50	1.1	0
2 16 HG	70	.180	13.85	1295	14.106	7173	38	185	219	.077	3.0	14	16.8	26
3 10 HG	45	.180	13.94	1759	14.169	11895	41	305	490	.147	6.0	45	72.1	51
4 16 HG	45	.180	13.94	1392	14.169	7173	25	184	234	.077	1.9	14	18.0	26
5 19 HG	31	.180	14.03	620	14.243	6084	14	155	88	.057	.8	9	5.0	15
6 16 HG	37	.180	13.98	1539	14.200	7173	20	184	258	.077	1.6	14	19.9	26
7 3 HG	76	1.200	13.63	2143	14.912	18796	103	3055	897	.113	11.7	345	101.3	88
8 16 HG	36	.180	13.94	1598	14.159	7173	20	184	269	.077	1.5	14	20.7	26
9 C.T.	2318	1.150	6.76	168	10.413	1589	382	354	9	.143	54.6	51	1.2	0
SUM----------(CYCLE COMPOSITE)----------											3.2	21	9.8	
CYCLE 4														
1 IDLE	156	1.010	13.48	130	14.658	1543	18	215	5	.232	4.1	50	1.1	0
2 16 HG	76	.180	13.18	1350	13.442	7173	44	194	239	.077	3.4	15	18.4	26
3 10 HG	45	.180	13.18	1784	13.409	11895	43	323	525	.147	6.3	47	77.2	51
4 16 HG	40	.180	13.18	1313	13.403	7173	23	195	233	.077	1.8	15	18.0	26
5 19 HG	31	.180	13.40	600	13.613	6084	15	162	89	.057	.9	9	5.1	15
6 16 HG	40	.180	13.18	1444	13.403	7173	23	195	257	.077	1.8	15	19.8	26
7 3 HG	78	1.320	13.63	2099	15.034	18796	105	3334	871	.113	11.9	377	98.4	88
8 16 HG	36	.180	13.33	1545	13.549	7173	21	192	272	.077	1.6	15	20.9	26
9 C.T.	2288	1.040	6.79	131	10.301	1589	381	324	7	.143	54.5	46	1.0	0
SUM----------(CYCLE COMPOSITE)----------											3.3	22	9.9	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------											3.8	21	9.3	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------											3.3	22	9.8	

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(3.8) + 0.65(3.3) = 3.471 (MASS)
CO 0.35(21) + 0.65(22) = 21.6 (MASS)
NO2 0.35(9.3) + 0.65(9.8) = 9.669 (MASS)
CORRECTED NO2 = 9.928 (MASS)

8-4-72 RUN 3 2-3 48TOC 600RPM E.R.L STD.ENG. STA. K = 1.03 HUM = 84 GR/LB

MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1														
1 IDLE	272	1.380	13.06	105	14.734	1543	31	292	4	.232	7.1	68	.8	0
2 16 HG	80	.210	13.21	1340	13.506	7173	46	225	236	.077	3.5	17	18.2	26
3 10 HG	48	.220	13.22	1698	13.492	11895	46	392	497	.147	6.7	58	73.1	51
4 16 HG	46	.240	13.18	1406	13.470	7173	26	258	249	.077	2.0	20	19.1	26
5 19 HG	28	.240	13.33	560	13.600	6084	14	217	83	.057	.8	12	4.7	15
6 16 HG	42	.240	13.18	1387	13.465	7173	24	258	245	.077	1.9	20	18.9	26
7 3 HG	80	1.380	13.63	2121	15.096	18796	108	3471	877	.113	12.2	392	99.1	88
8 16 HG	35	.250	13.25	1530	13.538	7173	20	268	269	.077	1.5	21	20.7	26
9 C.T.	1868	1.200	8.22	115	11.437	1589	280	337	5	.143	40.1	48	.8	0
SUM----------(CYCLE COMPOSITE)----------											2.9	25	9.7	
CYCLE 2														
1 IDLE	272	1.380	13.06	105	14.734	1543	31	292	4	.232	7.1	68	.8	0
2 16 HG	77	.230	13.11	1332	13.423	7173	44	248	236	.077	3.4	19	18.2	26
3 10 HG	48	.210	13.33	1925	13.542	11895	45	371	559	.147	6.7	55	82.2	51
4 16 HG	44	.220	13.33	1425	13.598	7173	25	234	250	.077	1.9	18	19.2	26
5 19 HG	31	.220	13.33	628	13.583	6084	15	199	93	.057	.9	11	5.3	15
6 16 HG	40	.220	13.18	1501	13.443	7173	23	237	266	.077	1.8	18	20.5	26
7 3 HG	77	1.450	13.48	2099	15.013	18796	104	3667	872	.113	11.8	414	98.6	88
8 16 HG	31	.250	13.18	1559	13.463	7173	18	269	276	.077	1.4	21	21.2	26
9 C.T.	1813	1.250	9.04	131	12.248	1589	254	328	6	.143	36.3	47	.8	0
SUM----------(CYCLE COMPOSITE)----------											2.7	26	10.2	
CYCLE 3														
1 IDLE	159	1.140	13.48	150	14.792	1543	18	240	5	.232	4.2	56	1.2	0
2 16 HG	77	.220	13.18	1369	13.483	7173	44	236	242	.077	3.4	18	18.6	26
3 10 HG	48	.210	13.33	1947	13.592	11895	45	371	566	.147	6.7	55	83.2	51
4 16 HG	44	.210	13.18	1406	13.438	7173	25	226	249	.077	2.0	17	19.2	26
5 19 HG	31	.210	13.39	674	13.633	6084	15	189	100	.057	.9	11	5.7	15
6 16 HG	41	.210	13.18	1539	13.434	7173	24	226	273	.077	1.8	17	21.0	26
7 3 HG	80	1.450	13.39	2077	14.926	18796	109	3688	868	.113	12.3	417	98.1	88
8 16 HG	32	.250	13.06	1490	13.345	7173	19	271	266	.077	1.4	21	20.5	26
9 C.T.	1772	1.150	9.20	142	12.264	1589	248	301	6	.143	35.5	43	.9	0
SUM----------(CYCLE COMPOSITE)----------											2.6	25	10.2	
CYCLE 4														
1 IDLE	159	1.140	13.48	150	14.792	1543	18	240	5	.232	4.2	56	1.2	0
2 16 HG	77	.220	13.18	1388	13.483	7173	44	236	245	.077	3.4	18	18.9	26
3 10 HG	48	.210	13.06	1968	13.322	11895	46	379	583	.147	6.8	56	85.8	51
4 16 HG	44	.220	13.18	1490	13.448	7173	25	237	264	.077	2.0	18	20.3	26
5 19 HG	31	.220	13.33	628	13.583	6084	15	199	93	.057	.9	11	5.3	15
6 16 HG	41	.250	13.18	1444	13.474	7173	24	269	255	.077	1.8	21	19.7	26
7 3 HG	77	1.430	13.48	2121	14.993	18796	104	3621	883	.113	11.8	409	99.8	88
8 16 HG	35	.250	13.18	1618	13.468	7173	20	269	286	.077	1.6	21	22.0	26
9 C.T.	1750	1.070	9.17	115	12.130	1589	248	283	5	.143	35.4	40	.7	0
SUM----------(CYCLE COMPOSITE)----------											2.6	25	10.4	

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 2.8 25 10.0

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 2.6 25 10.3

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(2.8) + 0.65(2.6) = 2.666 (MASS)
CO 0.35(25) + 0.65(25) = 25.0 (MASS)
NO2 0.35(10.0) + 0.65(10.3) = 10.209 (MASS)
CORRECTED NO2 = 10.482 (MASS)

6-2-72 RUN1 2-4 48TDC 600RPM W/AIR EGR OXIDATION CATALYST K =1.051 HUM = 90 GR/LB

	FEDERAL MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
	1 IDLE	65	.220	9.410	52	1.512	98	.333	79	.036	3.538	.012	2.830
	2 16'HG	521	.340	8.210	77	1.621	845	.551	125	.089	75.184	.049	11.112
	3 10'HG	35	.180	10.950	146	1.309	46	.236	191	.257	11.774	.061	49.113
	4 16'HG	76	.080	9.060	103	1.579	120	.126	163	.089	10.681	.011	14.476
	5 19'HG	612	.070	7.180	64	1.841	1127	.129	118	.047	52.956	.006	5.538
	6 16'HG	60	.100	9.210	77	1.555	93	.155	120	.089	8.304	.014	10.656
	7 3'HG	21	.140	13.200	1482	1.091	23	.153	1617	.283	6.483	.043	457.499
	8 16'HG	21	.100	9.370	103	1.536	32	.154	158	.089	2.870	.014	14.077
	9 C.T.	320	.110	4.730	69	2.826	904	.311	195	.021	18.992	.007	4.095
	SUM----------(CYCLE COMPOSITE)----------										190.782	.216	569.397
CYCLE 2													
	1 IDLE	65	.220	9.410	52	1.512	98	.333	79	.036	3.538	.012	2.830
	2 16'HG	176	.080	8.780	90	1.609	283	.129	145	.089	25.208	.011	12.891
	3 10'HG	13	.100	10.780	210	1.337	17	.134	281	.257	4.467	.034	72.165
	4 16'HG	48	.100	9.140	100	1.569	75	.157	157	.089	6.703	.014	13.964
	5 19'HG	642	.070	7.230	64	1.822	1170	.128	117	.047	54.977	.006	5.481
	6 16'HG	66	.090	9.250	77	1.548	102	.139	119	.089	9.094	.012	10.609
	7 3'HG	13	.130	13.330	1453	1.081	14	.141	1582	.283	3.978	.040	447.714
	8 16'HG	17	.070	9.370	103	1.539	26	.108	158	.089	2.328	.010	14.106
	9 C.T.	318	.110	4.690	73	2.850	906	.313	208	.021	19.030	.007	4.368
	SUM----------(CYCLE COMPOSITE)----------										129.322	.146	584.128
CYCLE 3													
	1 IDLE	8	.070	9.250	77	1.560	12	.109	120	.036	.449	.004	4.325
	2 16'HG	138	.070	8.930	74	1.591	220	.111	118	.089	19.540	.010	10.478
	3 10'HG	8	.100	10.780	224	1.338	11	.134	300	.257	2.751	.034	77.015
	4 16'HG	57	.070	9.030	103	1.589	91	.111	164	.089	8.060	.010	14.564
	5 19'HG	715	.090	7.000	64	1.855	1326	.167	119	.047	62.333	.008	5.579
	6 16'HG	70	.090	9.180	77	1.559	109	.140	120	.089	9.713	.012	10.684
	7 3'HG	17	.130	13.180	1510	1.093	19	.142	1651	.283	5.260	.040	467.173
	8 16'HG	16	.070	9.190	109	1.569	25	.110	171	.089	2.234	.010	15.220
	9 C.T.	317	.100	4.390	72	3.032	961	.303	218	.021	20.184	.006	4.584
	SUM----------(CYCLE COMPOSITE)----------										130.523	.135	609.623
CYCLE 4													
	1 IDLE	8	.070	9.250	77	1.560	12	.109	120	.036	.449	.004	4.325
	2 16'HG	103	.070	9.140	103	1.561	161	.109	161	.089	14.314	.010	14.314
	3 10'HG	8	.070	10.780	237	1.340	11	.094	317	.257	2.754	.024	81.597
	4 16'HG	50	.070	9.140	103	1.571	79	.110	162	.089	6.992	.010	14.403
	5 19'HG	671	.070	7.090	77	1.847	1239	.129	142	.047	58.255	.006	6.685
	6 16'HG	73	.070	9.140	77	1.567	114	.110	121	.089	10.180	.010	10.738
	7 3'HG	13	.110	13.180	1463	1.094	14	.120	1601	.283	4.026	.034	453.121
	8 16'HG	13	.070	9.190	117	1.569	20	.110	184	.089	1.816	.010	16.342
	9 C.T.	325	.090	4.610	73	2.897	941	.261	211	.021	19.769	.005	4.440
	SUM----------(CYCLE COMPOSITE)----------										118.556	.113	605.966
	AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------										160.052	.181	576.762
	AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------										124.540	.124	607.794

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(160.052) + 0.65*(124.540) =	136.969	PPM
CO	0.35*(.181) + 0.65*(.124) =	.144	PERCENT
NO	0.35*(576.762) + 0.65*(607.794) =	596.933	PPM
	CORRECTED NO =	627.221	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

APPENDIX Q

ENGINE 1-3

EFFECT OF BASIC SPARK TIMING ON EMISSIONS

(23 MODE MASS RESULTS)

ENGINE 1-3

EFFECT OF BASIC SPARK TIMING ON EMISSIONS

TABULAR DATA

PROJECT 11-2877-01 CONTROL TECHNOLOGY
8-17-72 RUN-2 ENG.1-3 72-VERSION 30 BTDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.8	3.5	16.5	0	15522	2.600	10.89	49
2	1200	5.0	1	20.5	6.9	18.2	0	15570	.520	11.60	163
3	1200	20.0	5	18.0	9.2	19.1	0	29138	.150	9.50	1125
4	1200	44.0	10	16.2	10.4	19.4	0	17064	.130	10.78	1700
5	1200	62.0	14	15.0	11.8	19.5	0	14078	.130	11.13	2213
6	1200	123.0	28	10.1	16.3	19.6	0	2649	.130	12.34	4100
7	1200	185.0	42	5.0	21.4	19.2	0	2098	.130	12.71	4600
8	1200	202.0	46	3.9	22.2	19.1	0	1994	.130	12.82	4650
9	1200	226.0	52	1.9	24.5	18.7	0	2172	.180	12.94	4250
10	1200	246.0	56	.3	34.4	14.4	0	3833	5.720	11.24	800
11	600	0.0	0	18.8	3.5	16.2	0	12687	2.870	11.48	55
12	1200	0.0	0	22.5	3.7	20.8	0	52581	.310	5.27	29
13	2300	258.0	113	1.3	65.4	14.4	0	2806	5.400	11.60	1000
14	2300	237.0	104	2.3	54.5	16.0	0	1778	2.870	12.22	2750
15	2300	212.0	93	2.7	48.7	17.7	0	1195	1.450	12.34	2125
16	2300	194.0	85	4.2	45.5	17.9	0	1330	1.160	12.59	2550
17	2300	129.0	56	10.3	33.8	17.9	0	1620	.420	13.06	4550
18	2300	65.0	28	15.3	22.7	18.5	0	4082	.210	12.59	2850
19	2300	46.0	20	16.2	21.4	18.6	0	6695	.180	12.34	2250
20	2300	21.0	9	17.8	18.4	19.4	0	12817	.210	11.13	1250
21	2300	5.0	2	18.7	15.4	19.9	0	23381	.210	9.25	740
22	600	0.0	0	18.7	3.4	17.0	0	20053	2.080	10.25	60
23	2300	0.0	0	24.3	4.2	23.9	0	36871	.280	5.50	12

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	163.8	554	1.7	.070	0.0	I	R	R	R
2	0.0	356.3	240	12.4	.060	.1	0.0	311.88	210.4	10.8
3	0.0	967.8	101	124.1	.060	.3	0.0	211.79	22.0	27.1
4	0.0	638.1	98	211.0	.050	.5	0.0	63.47	9.8	21.0
5	0.0	594.8	111	310.4	.030	.4	0.0	41.99	7.8	21.9
6	0.0	153.8	152	790.3	.060	1.7	0.0	5.47	5.4	28.1
7	0.0	156.0	195	1136.0	0.000	0.0	0.0	3.69	4.6	26.9
8	0.0	152.7	201	1182.3	.040	1.8	0.0	3.31	4.4	25.6
9	0.0	181.0	303	1175.7	0.000	0.0	0.0	3.50	5.9	22.8
10	0.0	344.8	10396	239.0	0.000	0.0	0.0	6.14	185.0	4.3
11	0.0	129.0	589	1.9	.070	0.0	I	R	R	R
12	0.0	814.2	97	1.5	.120	0.0	I	R	R	R
13	0.0	481.8	18726	569.9	.025	2.8	0.0	4.26	165.7	5.0
14	0.0	287.8	9387	1478.3	.055	5.7	0.0	2.77	90.4	14.2
15	0.0	189.8	4652	1120.4	.035	3.2	0.0	2.04	50.1	12.1
16	0.0	197.7	3483	1258.6	.060	5.1	0.0	2.33	41.0	14.8
17	0.0	182.0	953	1697.7	.060	3.4	0.0	3.22	16.9	30.1
18	0.0	318.2	331	737.6	0.000	0.0	0.0	11.18	11.6	25.9
19	0.0	492.7	268	549.8	.065	1.3	0.0	24.46	13.3	27.3
20	0.0	847.5	281	274.4	0.000	0.0	0.0	92.16	30.5	29.8
21	0.0	1384.4	251	145.5	0.000	0.0	0.0	632.23	114.7	66.4
22	0.0	215.7	452	2.1	.080	0.0	I	R	R	R
23	0.0	742.0	114	.8	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	15.687	GRAM/BHP HR
	CO	61.081	GRAM/BHP HR
	NO2	17.864	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.669	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-17-72 RUN-1 ENG.1-3 72-VERSION 15 BTDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	19.1	3.5	16.2	0	6038	3.330	11.72	55
2	1200	5.0	1	20.2	7.4	17.9	0	1829	.490	13.48	80
3	1200	20.0	5	19.5	8.0	17.9	0	2539	.420	13.48	205
4	1200	45.0	10	17.7	9.5	18.5	0	2695	.210	13.06	575
5	1200	62.0	14	15.7	11.0	19.0	0	2280	.150	12.71	880
6	1200	124.0	28	10.3	16.3	19.4	0	2136	.150	12.47	1912
7	1200	186.0	42	4.0	22.2	19.0	0	1761	.150	12.59	2150
8	1200	203.0	46	2.4	23.5	18.7	0	2015	.180	12.71	2300
9	1200	228.0	52	1.8	26.8	17.1	0	2771	1.120	13.06	2125
10	1200	248.0	57	.3	34.4	13.9	0	4396	6.640	11.13	570
11	600	0.0	0	18.9	3.3	15.0	0	6031	4.840	11.24	42
12	1200	0.0	0	22.8	3.5	19.5	0	53466	.470	5.88	10
13	2300	262.0	115	1.3	66.2	14.5	0	3256	5.240	11.24	750
14	2300	241.0	106	2.3	60.1	15.2	0	2577	3.790	11.92	1438
15	2300	215.0	94	2.5	53.0	16.6	0	1134	2.020	12.47	1150
16	2300	197.0	86	2.7	49.1	17.5	0	708	1.120	12.34	1063
17	2300	131.0	57	10.2	33.6	17.7	0	1550	.350	12.94	7950
18	2300	66.0	29	15.1	23.3	18.2	0	1153	.180	12.71	1662
19	2300	47.0	21	16.4	20.7	18.6	0	850	.150	12.59	1125
20	2300	21.0	9	18.2	17.2	18.9	0	893	.150	12.47	570
21	2300	5.0	2	19.8	13.5	19.3	0	6313	.150	11.48	210
22	600	0.0	0	18.9	3.4	16.1	0	3852	2.520	11.84	49
23	2300	0.0	0	24.3	3.8	22.3	0	38526	.250	5.75	10

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	61.2	682	1.9	.070	0.0	I	R	R	R
2	0.0	43.4	235	6.3	.060	.1	0.0	37.98	205.5	5.5
3	0.0	65.1	218	17.4	.060	.3	0.0	14.25	47.6	3.8
4	0.0	85.8	135	60.8	.050	.5	0.0	8.34	13.1	5.9
5	0.0	86.9	116	111.4	.030	.4	0.0	6.14	8.2	7.9
6	0.0	123.1	175	365.8	.060	1.7	0.0	4.34	6.2	12.9
7	0.0	137.3	236	556.5	0.000	0.0	0.0	3.23	5.6	13.1
8	0.0	164.0	296	621.8	.040	1.9	0.0	3.54	6.4	13.4
9	0.0	233.0	1902	593.2	0.000	0.0	0.0	4.47	36.5	11.4
10	0.0	376.7	11493	162.2	0.000	0.0	0.0	6.65	202.8	2.9
11	0.0	54.1	877	1.3	.070	0.0	I	R	R	R
12	0.0	725.7	129	.5	.120	0.0	I	R	R	R
13	0.0	581.7	18913	444.9	.025	2.9	0.0	5.07	164.8	3.9
14	0.0	440.0	13071	814.8	.055	5.8	0.0	4.17	123.8	7.7
15	0.0	186.7	6717	628.5	.035	3.3	0.0	1.98	71.3	6.7
16	0.0	116.6	3724	580.6	.060	5.2	0.0	1.35	43.2	6.7
17	0.0	175.7	801	2992.0	.060	3.4	0.0	3.06	14.0	52.2
18	0.0	93.7	295	448.5	0.000	0.0	0.0	3.24	10.2	15.5
19	0.0	62.2	222	273.5	.065	1.3	0.0	3.02	10.8	13.3
20	0.0	54.8	186	116.2	0.000	0.0	0.0	5.96	20.2	12.6
21	0.0	315.3	151	34.8	0.000	0.0	0.0	143.99	69.1	15.9
22	0.0	40.3	532	1.7	.080	0.0	I	R	R	R
23	0.0	674.0	88	.6	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	8.707	GRAM/BHP HR
	CO	72.676	GRAM/BHP HR
	NO2	13.644	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.679	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-16-72 RUN-2 ENG.1-3 72-VERSION 6 BTDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.4	4.3	14.9	0	3793	1.590	12.71	49
2	1200	5.0	1	19.8	7.8	15.8	0	1240	.250	13.48	86
3	1200	19.0	4	19.0	8.4	15.9	0	2024	.250	13.18	245
4	1200	42.0	10	16.8	10.3	16.4	0	1842	.130	13.18	520
5	1200	58.0	13	16.2	10.5	16.6	0	1917	.150	12.94	580
6	1200	116.0	27	10.7	15.6	16.9	0	2049	.100	12.82	1512
7	1200	174.0	40	3.6	22.8	16.5	0	1603	.130	12.94	1700
8	1200	190.0	43	2.1	24.5	16.3	0	1706	.150	13.06	2012
9	1200	213.0	49	1.8	26.9	14.9	0	2414	1.050	13.63	1900
10	1200	232.0	53	.4	34.2	12.4	0	4019	5.780	11.13	565
11	600	0.0	0	17.3	3.5	14.1	0	4219	2.440	12.71	53
12	1200	0.0	0	22.0	4.1	17.5	0	51519	.350	6.38	10
13	2300	252.0	110	1.3	66.3	12.6	0	3352	5.140	11.72	765
14	2300	232.0	102	2.3	60.2	13.2	0	2406	3.980	12.47	1412
15	2300	207.0	91	2.5	53.4	14.5	0	994	2.050	12.71	1075
16	2300	189.0	83	2.8	49.4	15.5	0	474	.970	12.94	1012
17	2300	126.0	55	10.5	32.5	15.6	0	1326	.350	13.06	2600
18	2300	63.0	28	15.2	23.0	16.1	0	819	.250	12.94	1313
19	2300	45.0	20	16.4	20.6	16.3	0	571	.150	12.82	875
20	2300	20.0	9	17.7	17.5	16.4	0	442	.150	12.71	540
21	2300	5.0	2	18.9	16.3	16.6	0	615	.150	12.71	330
22	600	0.0	0	17.4	4.0	14.4	0	3632	1.870	12.71	74
23	2300	0.0	0	24.1	4.6	9.4	0	41623	.310	5.50	9

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	50.4	427	2.2	.070	0.0	I	R	R	R
2	0.0	31.7	129	7.3	.060	.1	0.0	27.71	112.9	6.4
3	0.0	56.6	141	22.7	.060	.3	0.0	13.03	32.5	5.2
4	0.0	63.8	91	59.8	.050	.5	0.0	6.65	9.5	6.2
5	0.0	68.7	109	69.1	.030	.4	0.0	5.19	8.2	5.2
6	0.0	110.5	109	270.7	.060	1.6	0.0	4.17	4.1	10.2
7	0.0	125.3	205	441.2	0.000	0.0	0.0	3.15	5.2	11.1
8	0.0	141.7	252	554.9	.040	1.7	0.0	3.26	5.8	12.8
9	0.0	197.4	1734	515.8	0.000	0.0	0.0	4.06	35.6	10.6
10	0.0	360.1	10462	168.1	0.000	0.0	0.0	6.79	197.4	3.2
11	0.0	43.0	503	1.8	.070	0.0	I	R	R	R
12	0.0	806.4	111	.5	.120	0.0	I	R	R	R
13	0.0	586.3	18159	444.2	.025	2.8	0.0	5.31	164.5	4.0
14	0.0	393.6	13153	767.2	.055	5.6	0.0	3.87	129.5	7.6
15	0.0	162.1	6750	581.8	.035	3.2	0.0	1.79	74.5	6.4
16	0.0	76.1	3146	539.7	.060	5.0	0.0	.92	38.0	6.5
17	0.0	144.4	770	939.6	.060	3.3	0.0	2.62	13.9	17.0
18	0.0	64.4	397	342.5	0.000	0.0	0.0	2.33	14.4	12.4
19	0.0	41.0	217	208.4	.065	1.3	0.0	2.08	11.0	10.6
20	0.0	27.2	186	110.3	0.000	0.0	0.0	3.10	21.3	12.6
21	0.0	35.2	173	62.7	0.000	0.0	0.0	16.08	79.2	28.6
22	0.0	44.1	459	3.0	.080	0.0	I	R	R	R
23	0.0	870.9	131	.6	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	9.363	GRAM/BHP HR
	CO	71.306	GRAM/BHP HR
	NO2	8.664	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.720	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-16-72 RUN-3 ENG.1-3 72- VERSION 6 BTDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.4	3.8	15.1	0	4236	1.300	12.71	51
2	1200	5.0	1	19.9	7.7	15.9	0	1101	.150	13.18	85
3	1200	19.0	4	19.5	8.0	15.7	0	1690	.180	13.48	155
4	1200	42.0	10	17.1	9.6	16.5	0	2014	.050	12.82	500
5	1200	58.0	13	15.5	11.4	16.8	0	2081	.050	12.82	720
6	1200	116.0	27	10.7	15.8	17.0	0	2166	.050	12.71	1700
7	1200	174.0	40	3.7	23.1	16.5	0	1681	.070	12.94	1850
8	1200	190.0	43	2.2	24.0	16.4	0	1793	.100	12.94	2025
9	1200	213.0	49	1.8	26.7	14.9	0	2578	1.090	13.33	1900
10	1200	232.0	53	.4	34.2	12.5	0	4100	5.500	11.24	590
11	600	0.0	0	17.5	3.8	14.7	0	3770	1.520	12.94	64
12	1200	0.0	0	22.0	4.1	17.4	0	47993	.280	6.91	12
13	2300	252.0	110	1.3	66.2	13.9	0	3314	5.140	11.36	720
14	2300	232.0	102	2.2	60.2	13.1	0	2292	3.930	11.84	1325
15	2300	207.0	91	2.5	52.9	14.5	0	861	1.910	12.47	1000
16	2300	189.0	83	2.7	50.2	15.2	0	473	1.200	12.47	900
17	2300	126.0	55	10.5	32.5	15.5	0	1459	.390	12.82	2700
18	2300	63.0	28	15.3	23.0	16.1	0	883	.180	12.59	1350
19	2300	45.0	20	16.4	20.7	16.2	0	671	.180	12.59	950
20	2300	20.0	9	18.2	17.5	16.6	0	457	.150	12.22	470
21	2300	5.0	2	19.2	14.5	16.9	0	500	.130	11.92	265
22	600	0.0	0	17.6	3.8	14.5	0	3561	1.770	12.34	57
23	2300	0.0	0	24.0	4.0	18.4	0	43707	.250	5.50	16

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	50.6	314	2.0	.070	0.0	I	R	R	R
2	0.0	28.6	79	7.3	.060	.1	0.0	25.04	68.9	6.4
3	0.0	44.3	95	13.5	.060	.3	0.0	10.21	22.0	3.1
4	0.0	67.1	34	55.3	.050	.5	0.0	6.99	3.5	5.8
5	0.0	82.3	40	94.5	.030	.4	0.0	6.21	3.0	7.1
6	0.0	119.6	56	311.7	.060	1.6	0.0	4.51	2.1	11.8
7	0.0	133.6	112	488.4	0.000	0.0	0.0	3.36	2.8	12.3
8	0.0	147.7	166	553.7	.040	1.7	0.0	3.40	3.8	12.8
9	0.0	212.8	1817	520.5	0.000	0.0	0.0	4.37	37.3	10.7
10	0.0	370.8	10050	177.2	0.000	0.0	0.0	7.00	189.6	3.3
11	0.0	43.8	357	2.5	.070	0.0	I	R	R	R
12	0.0	744.5	88	.6	.120	0.0	I	R	R	R
13	0.0	591.2	18524	426.5	.025	2.8	0.0	5.36	167.9	3.9
14	0.0	391.1	13549	750.8	.055	5.6	0.0	3.85	133.4	7.4
15	0.0	142.8	6400	550.7	.035	3.2	0.0	1.58	70.6	6.1
16	0.0	78.5	4024	496.0	.060	5.0	0.0	.95	48.6	6.0
17	0.0	161.0	870	989.4	.060	3.3	0.0	2.92	15.8	17.9
18	0.0	71.7	295	363.7	0.000	0.0	0.0	2.60	10.7	13.2
19	0.0	49.1	266	230.7	.065	1.3	0.0	2.49	13.5	11.7
20	0.0	29.2	194	99.8	0.000	0.0	0.0	3.34	22.1	11.4
21	0.0	27.2	143	47.8	0.000	0.0	0.0	12.42	65.2	21.8
22	0.0	42.4	426	2.3	.080	0.0	I	R	R	R
23	0.0	783.6	91	1.0	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	8.922	GRAM/BHP HR
	CO	72.762	GRAM/BHP HR
	NO2	8.734	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.717	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-18-72 RUN-1 ENG.1-3 72-VERSION TDC 600 RPM

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	16.5	4.7	17.0	0	3054	1.450	12.71	62
2	1200	4.0	1	19.5	7.7	17.7	0	1072	.350	13.48	106
3	1200	16.0	4	18.8	8.6	18.1	0	1493	.390	13.33	175
4	1200	36.0	8	16.9	10.2	18.8	0	1192	.150	13.06	295
5	1200	50.0	11	15.6	11.0	19.2	0	1198	.150	12.82	365
6	1200	100.0	23	10.7	14.3	19.6	0	1316	.130	12.34	825
7	1200	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
8	1200	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
9	1200	184.0	42	1.9	27.6	16.4	0	1741	1.450	13.48	1188
10	1200	200.0	46	.4	34.2	14.2	0	3235	5.780	11.01	415
11	600	0.0	0	16.6	4.0	16.3	0	3270	2.140	12.71	61
12	1200	0.0	0	21.6	4.5	19.1	0	33572	.490	8.48	19
13	2300	226.0	99	1.4	66.3	14.4	0	2825	5.080	11.48	560
14	2300	208.0	91	2.2	64.2	14.4	0	2336	5.140	11.48	675
15	2300	185.0	81	2.4	56.1	15.6	0	864	2.520	13.06	680
16	2300	170.0	74	2.5	53.1	16.1	0	535	1.940	12.94	595
17	2300	113.0	49	10.4	33.4	17.7	0	613	.390	13.06	1500
18	2300	57.0	25	14.9	23.7	18.5	0	294	.180	12.71	705
19	2300	41.0	18	15.7	22.3	18.7	0	269	.150	12.71	545
20	2300	18.0	8	17.2	19.4	19.0	0	151	.150	12.71	340
21	2300	5.0	2	18.3	17.2	19.3	0	115	.150	12.59	230
22	600	0.0	0	16.4	4.1	17.3	0	2881	1.450	12.59	71
23	2300	0.0	0	23.7	4.6	23.3	0	36530	.310	6.05	12

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	45.0	432	3.0	.070	0.0	I	R	R	R
2	0.0	26.9	177	8.8	.060	.1	0.0	29.38	193.9	9.6
3	0.0	42.0	222	16.3	.060	.2	0.0	11.49	60.6	4.5
4	0.0	41.4	105	34.0	.050	.4	0.0	5.03	12.8	4.1
5	0.0	45.7	115	46.2	.030	.3	0.0	4.00	10.1	4.0
6	0.0	67.7	135	141.0	.060	1.4	0.0	2.96	5.9	6.2
7	0.0	0.0	0	0.0	0.000	0.0	0.0	0.00	0.0	0.0
8	0.0	0.0	0	0.0	.040	0.0	0.0	0.00	0.0	0.0
9	0.0	144.3	2428	326.9	0.000	0.0	0.0	3.43	57.7	7.8
10	0.0	293.2	10584	124.9	0.000	0.0	0.0	6.42	231.6	2.7
11	0.0	39.1	517	2.4	.070	0.0	I	R	R	R
12	0.0	555.9	164	1.0	.120	0.0	I	R	R	R
13	0.0	504.5	18323	332.0	.025	2.5	0.0	5.10	185.1	3.4
14	0.0	403.7	17940	387.2	.055	5.0	0.0	4.43	197.0	4.3
15	0.0	140.3	8268	366.7	.035	2.8	0.0	1.73	102.1	4.5
16	0.0	86.2	6321	318.6	.060	4.5	0.0	1.16	84.9	4.3
17	0.0	68.7	883	558.4	.060	3.0	0.0	1.39	17.9	11.3
18	0.0	24.5	303	194.8	0.000	0.0	0.0	.98	12.1	7.8
19	0.0	21.1	238	142.0	.065	1.2	0.0	1.17	13.2	7.9
20	0.0	10.3	207	77.2	0.000	0.0	0.0	1.31	26.3	9.8
21	0.0	7.0	185	46.7	0.000	0.0	0.0	3.22	84.7	21.3
22	0.0	37.4	380	3.1	.080	0.0	I	R	R	R
23	0.0	761.2	130	.8	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	8.596	GRAM/BHP HR
	CO	110.072	GRAM/BHP HR
	NO2	5.541	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.855	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-17-72 RUN-4 ENG.1-3 72-VERSION 5 ATDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	14.5	4.0	18.5	0	1770	.470	13.33	118
2	1200	4.0	1	19.4	6.3	18.8	0	699	.210	13.48	85
3	1200	15.0	3	18.2	8.8	19.1	0	782	.130	13.48	160
4	1200	33.0	8	16.8	10.4	19.5	0	821	.100	13.33	210
5	1200	46.0	11	15.1	11.5	19.9	0	852	.100	12.94	275
6	1200	91.0	21	10.8	15.1	20.1	0	1096	.100	12.71	555
7	1200	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
8	1200	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
9	1200	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
10	1200	182.0	42	.3	34.2	14.8	0	2888	5.560	11.24	410
11	600	1.0	0	15.0	4.2	17.7	0	2184	.930	13.63	110
12	1200	1.0	0	20.9	4.4	18.7	0	20168	.470	10.89	29
13	2300	198.0	87	1.3	70.1	13.2	0	2429	5.450	11.48	380
14	2300	182.0	80	2.0	69.8	12.6	0	2698	7.430	9.93	245
15	2300	162.0	71	2.5	57.8	14.9	0	870	2.870	12.71	585
16	2300	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
17	2300	99.0	43	10.9	32.5	17.3	0	422	.280	13.18	1125
18	2300	50.0	22	14.5	24.6	17.8	0	198	.180	13.06	590
19	2300	36.0	16	15.6	22.7	16.1	0	151	.150	12.71	450
20	2300	16.0	7	16.9	20.1	20.0	0	91	.100	12.71	280
21	2300	4.0	2	17.8	18.4	19.1	0	75	.100	12.47	200
22	600	0.0	0	14.9	7.3	17.5	0	1858	1.010	12.59	113
23	2300	0.0	0	23.0	6.7	23.2	0	25870	.310	6.91	14

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	23.0	123	5.1	.070	0.0	I	R	R	R
2	0.0	14.5	88	5.9	.060	.1	0.0	15.87	96.4	6.4
3	0.0	22.8	77	15.5	.060	.2	0.0	6.66	22.3	4.5
4	0.0	28.7	71	24.3	.050	.4	0.0	3.80	9.4	3.2
5	0.0	33.8	80	36.3	.030	.3	0.0	3.22	7.6	3.5
6	0.0	58.1	107	97.7	.060	1.2	0.0	2.79	5.2	4.7
7	0.0	0.0	0	0.0	0.000	0.0	0.0	0.00	0.0	0.0
8	0.0	0.0	0	0.0	.040	0.0	0.0	0.00	0.0	0.0
9	0.0	0.0	0	0.0	0.000	0.0	0.0	0.00	0.0	0.0
10	0.0	262.2	10196	123.6	0.000	0.0	0.0	6.31	245.2	3.0
11	0.0	28.2	242	4.7	.070	.0	0.0	246.47	2119.8	41.2
12	0.0	300.9	142	1.4	.120	.0	0.0	1316.97	620.0	6.3
13	0.0	449.7	20384	233.6	.025	2.2	0.0	5.19	235.1	2.7
14	0.0	484.6	26954	146.1	.055	4.4	0.0	6.08	338.2	1.8
15	0.0	145.5	9702	325.0	.035	2.5	0.0	2.05	136.8	4.6
16	0.0	0.0	0	0.0	.060	0.0	0.0	0.00	0.0	0.0
17	0.0	46.0	618	407.8	.060	2.6	0.0	1.06	14.2	9.4
18	0.0	16.6	306	164.8	0.000	0.0	0.0	.76	14.0	7.5
19	0.0	12.1	242	119.5	.065	1.0	0.0	.77	15.4	7.6
20	0.0	6.4	144	66.1	0.000	0.0	0.0	.92	20.5	9.4
21	0.0	5.0	134	44.1	0.000	0.0	0.0	2.83	76.5	25.2
22	0.0	44.6	490	9.0	.080	0.0	I	R	R	R
23	0.0	801.7	194	1.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	9.806	GRAM/BHP HR
	CO	167.834	GRAM/BHP HR
	NO2	4.605	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	1.061	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY
8-17-72 RUN-3 ENG.1-3 72-VERSION 10 ATDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	12.5	3.5	18.6	0	1231	.420	12.47	135
2	1200	3.0	1	18.8	6.5	18.6	0	1008	.210	12.82	79
3	1200	12.0	3	17.4	10.0	19.1	0	414	.130	12.59	128
4	1200	28.0	6	15.2	11.1	19.9	0	455	.130	12.22	185
5	1200	39.0	9	14.9	11.8	19.9	0	440	.130	12.22	191
6	1200	77.0	18	10.6	14.7	19.9	0	623	.130	12.09	410
7	1200	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
8	1200	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
9	1200	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
10	1200	154.0	35	.3	34.2	14.6	0	2394	5.610	11.01	350
11	600	0.0	0	13.0	3.8	17.9	0	1304	.470	12.94	145
12	1200	0.0	0	20.4	4.0	19.0	0	23752	.580	9.37	28
13	2300	180.0	79	1.3	66.2	14.4	0	2131	5.290	11.13	380
14	2300	166.0	73	1.8	68.7	13.5	0	2490	7.340	9.78	235
15	2300	148.0	65	2.3	58.3	15.2	0	1030	3.520	12.09	540
16	2300	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
17	2300	90.0	39	11.0	33.1	18.0	0	409	.310	12.71	938
18	2300	45.0	20	14.6	24.0	18.6	0	154	.150	12.59	490
19	2300	32.0	14	15.3	22.9	18.8	0	134	.130	12.59	410
20	2300	14.0	6	16.6	20.0	19.0	0	83	.100	12.47	265
21	2300	4.0	2	17.7	18.4	19.3	0	72	.100	12.22	183
22	600	0.0	0	13.0	3.8	18.2	0	1523	.580	12.34	135
23	2300	0.0	0	23.3	4.2	20.8	0	29504	.420	7.46	21

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	15.0	104	5.5	.070	0.0	I	R	R	R
2	0.0	22.6	95	5.9	.060	.0	0.0	33.04	139.0	8.6
3	0.0	14.7	93	15.1	.060	.2	0.0	5.36	34.0	5.5
4	0.0	18.5	107	24.9	.050	.3	0.0	2.89	16.7	3.9
5	0.0	19.0	113	27.4	.030	.3	0.0	2.13	12.7	3.1
6	0.0	33.8	143	73.9	.060	1.1	0.0	1.92	8.1	4.2
7	0.0	0.0	0	0.0	0.000	0.0	0.0	0.00	0.0	0.0
8	0.0	0.0	0	0.0	.040	0.0	0.0	0.00	0.0	0.0
9	0.0	0.0	0	0.0	0.000	0.0	0.0	0.00	0.0	0.0
10	0.0	220.3	10427	106.9	0.000	0.0	0.0	6.26	296.3	3.0
11	0.0	16.6	121	6.1	.070	0.0	I	R	R	R
12	0.0	349.7	172	1.4	.120	0.0	I	R	R	R
13	0.0	384.7	19291	227.8	.025	2.0	0.0	4.88	244.7	2.9
14	0.0	446.8	26601	140.0	.055	4.0	0.0	6.15	365.9	1.9
15	0.0	173.3	11967	301.7	.035	2.3	0.0	2.67	184.6	4.7
16	0.0	0.0	0	0.0	.060	0.0	0.0	0.00	0.0	0.0
17	0.0	47.0	720	358.0	.060	2.4	0.0	1.19	18.3	9.1
18	0.0	13.2	259	138.8	0.000	0.0	0.0	.67	13.1	7.0
19	0.0	10.9	214	111.0	.065	.9	0.0	.78	15.3	7.9
20	0.0	6.0	146	63.5	0.000	0.0	0.0	.97	23.8	10.3
21	0.0	4.9	137	41.1	0.000	0.0	0.0	2.80	78.1	23.5
22	0.0	20.1	154	5.9	.080	0.0	I	R	R	R
23	0.0	519.0	149	1.2	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	9.465	GRAM/BHP HR
	CO	187.674	GRAM/BHP HR
	NO2	4.635	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	1.143	LB/BHP HR

ENGINE 1-3

EFFECT OF BASIC SPARK TIMING ON EMISSIONS

GRAPHED RESULTS

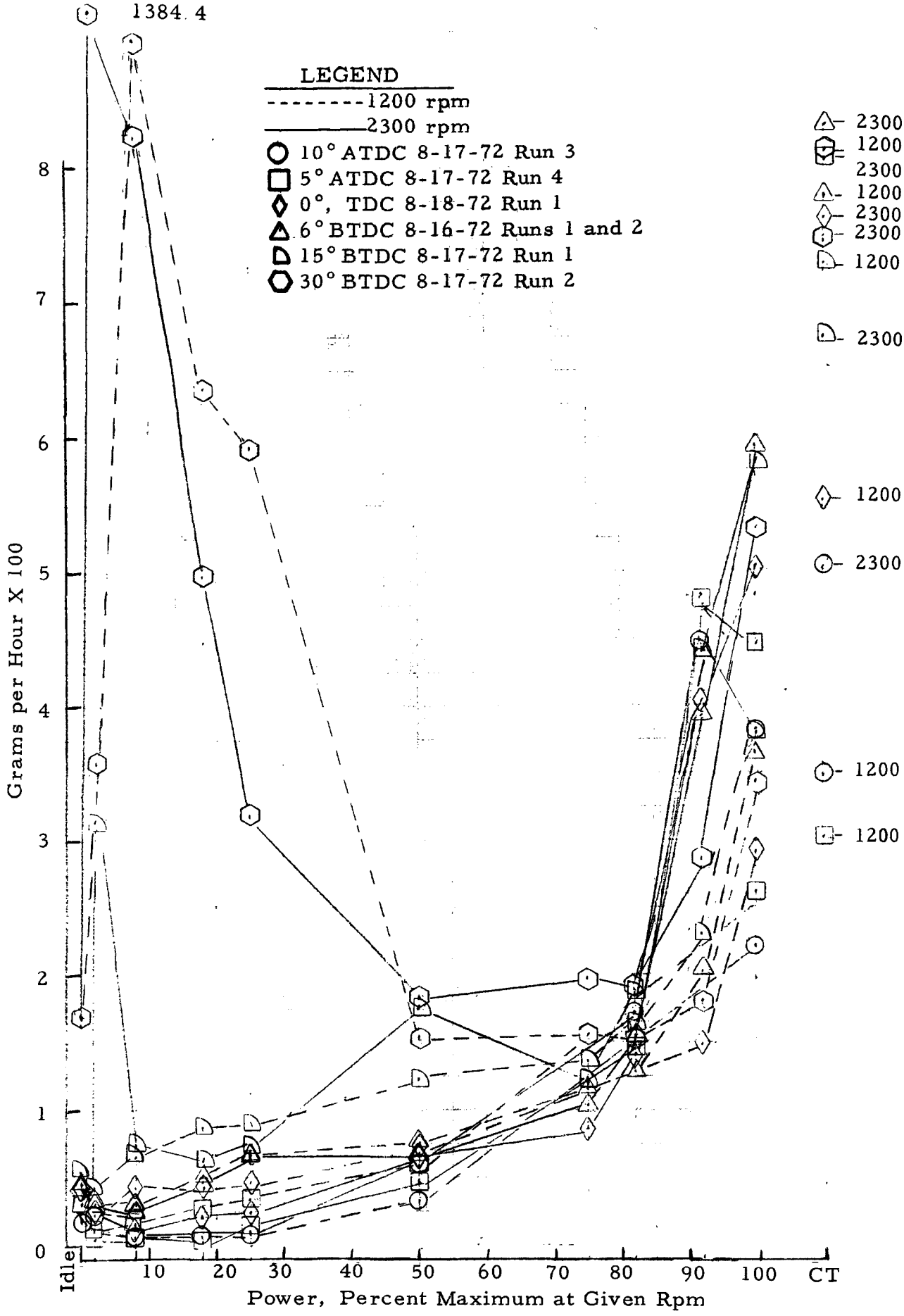


FIGURE Q-1. EFFECT OF POWER ON HC EMISSIONS RATE
ENGINE 1-3, 23 MODE TEST

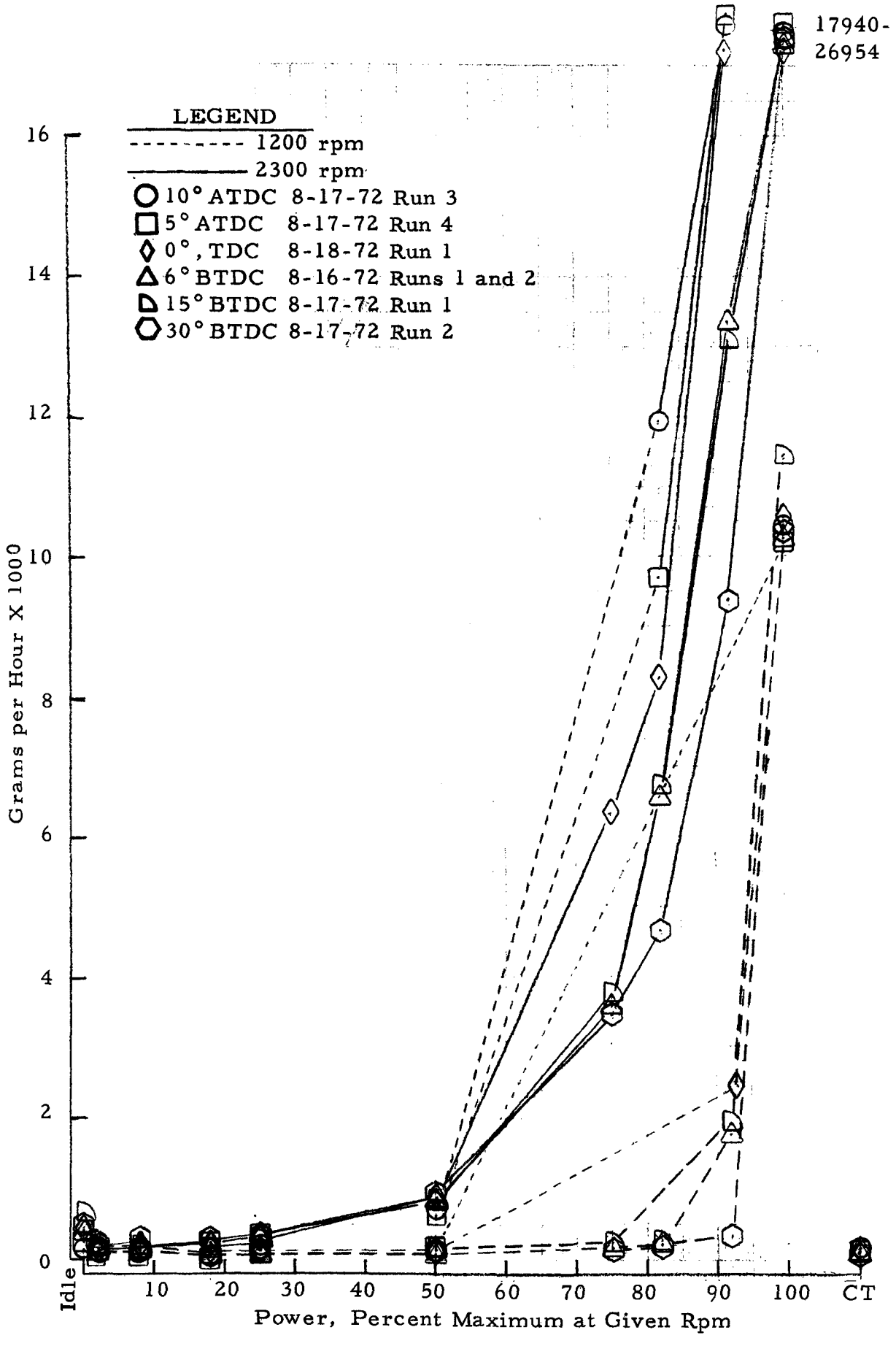


FIGURE Q-2. EFFECT OF POWER ON CO EMISSION RATE
ENGINE 1-3, 23 MODE TEST

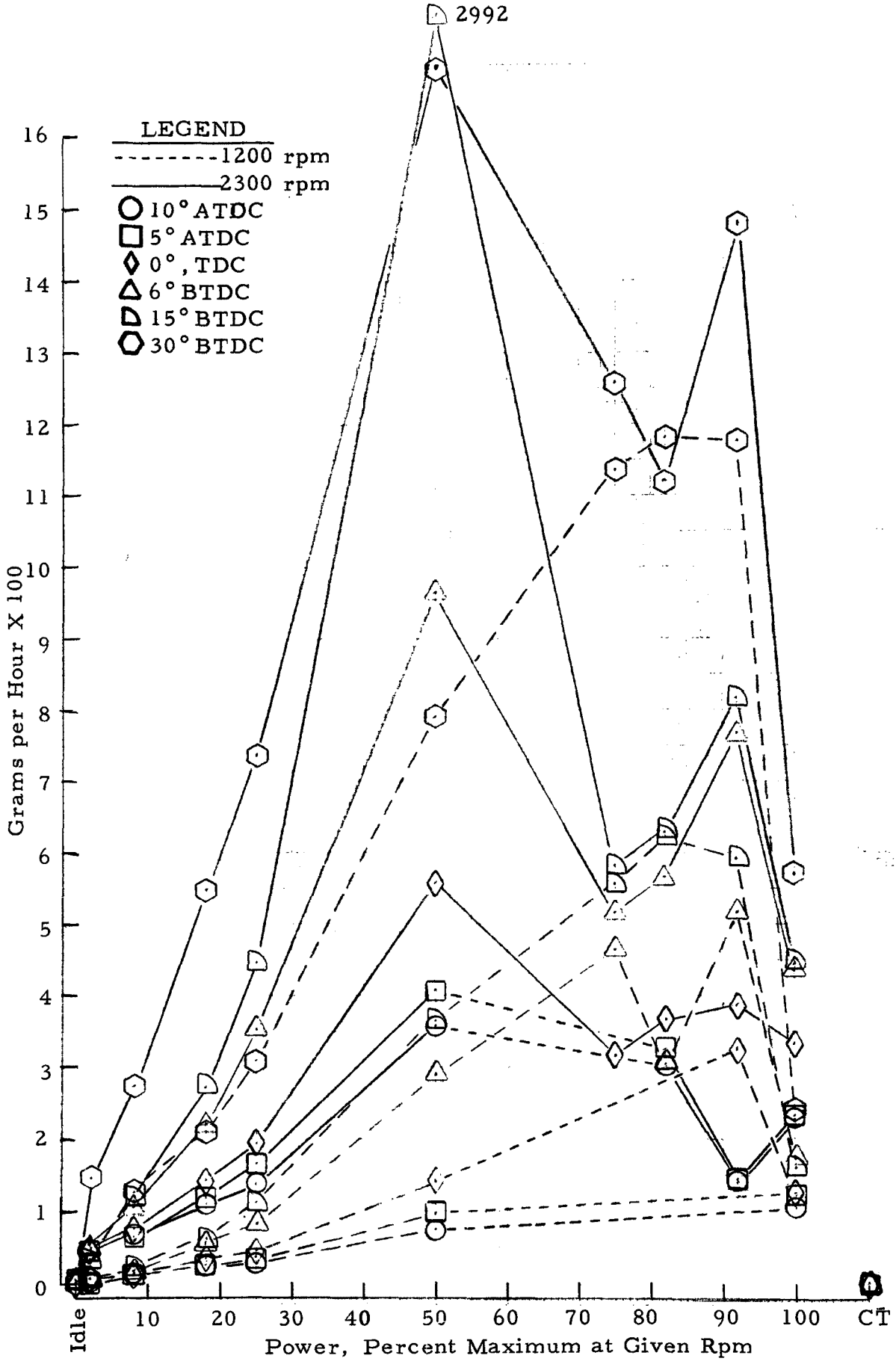


FIGURE Q-3. EFFECT OF POWER ON NO_x (AS NO_2) EMISSION RATE
ENGINE 1-3, 23 MODE TEST

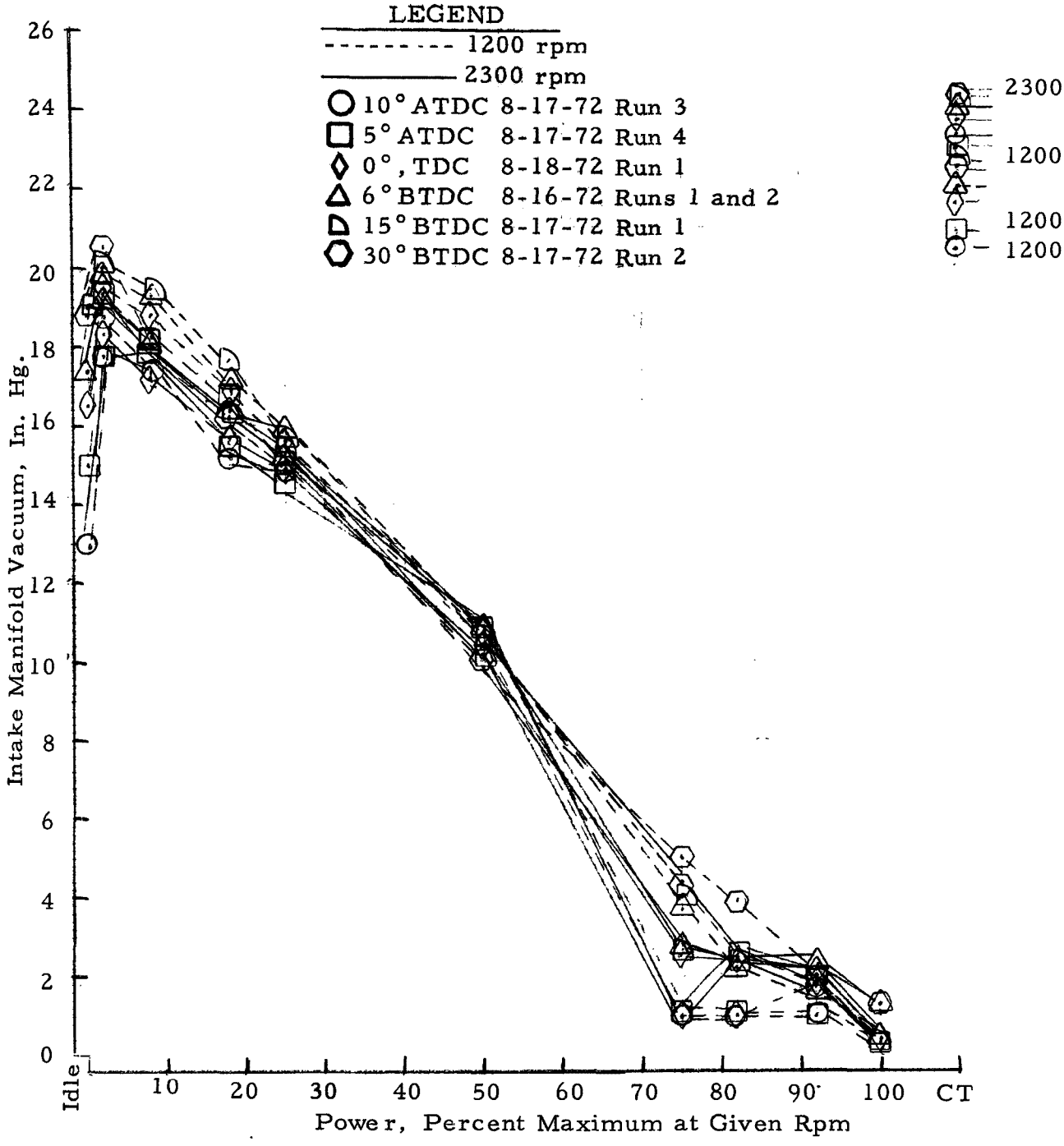


FIGURE Q-4. MANIFOLD VACUUM AS A FUNCTION OF POWER
ENGINE 1-3, 23 MODE TEST

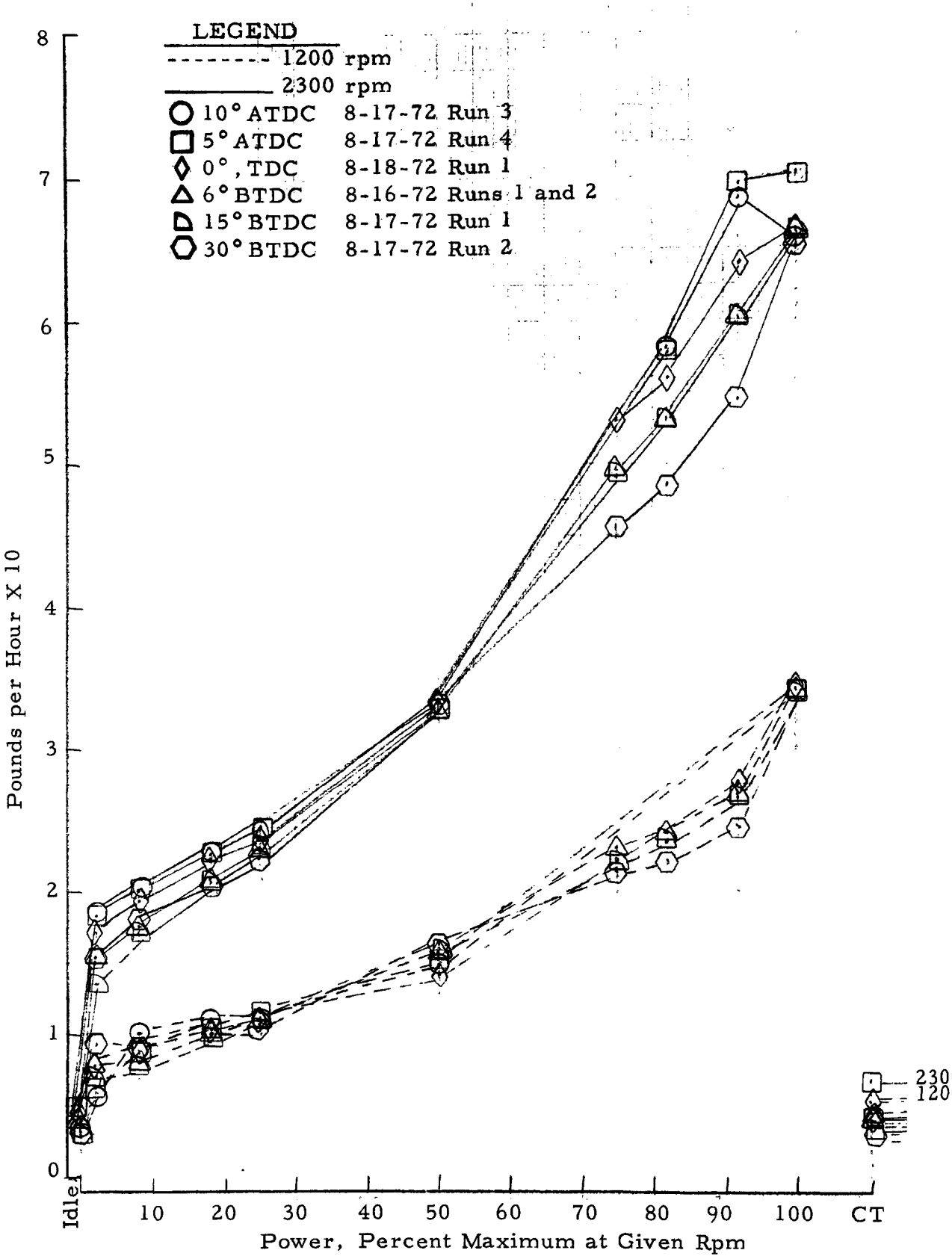


FIGURE O-5. FUEL CONSUMPTION AS A FUNCTION OF POWER
ENGINE 1-3, 23 MODE TEST

APPENDIX R

ENGINE 1-3

EFFECT OF AIR-FUEL RATIO ON EMISSIONS

(23 MODE MASS RESULTS)

ENGINE 1- 3

EFFECT OF AIR-FUEL RATIO ON EMISSIONS

TABULAR DATA

PROJECT 11-2877-01 CONTROL TECHNOLOGY
8-18-72 RUN-3 ENG.1-3 72 VERSION STD TIMING 0.060 JETS

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.8	4.7	16.0	0	3257	1.550	12.82	66
2	1200	4.0	1	19.9	7.4	16.0	0	1060	.310	13.48	110
3	1200	18.0	4	18.9	7.9	15.8	0	1692	.350	13.48	280
4	1200	40.0	9	17.6	10.6	16.0	0	1692	.180	13.63	530
5	1200	55.0	13	16.2	11.3	16.2	0	1780	.180	13.48	850
6	1200	110.0	25	12.5	15.1	15.9	0	2286	.310	13.63	2075
7	1200	165.0	38	8.1	20.7	15.3	0	2380	.640	13.77	2500
8	1200	180.0	41	6.5	22.5	15.0	0	2385	.770	13.91	2225
9	1200	202.0	46	3.2	26.7	14.7	0	2396	1.480	13.77	1688
10	1200	220.0	50	.4	37.1	11.6	0	3957	8.220	9.50	250
11	600	0.0	0	17.7	4.3	14.7	0	3391	2.280	12.82	64
12	1200	0.0	0	21.9	4.3	17.5	0	42745	.420	7.00	12
13	2300	244.0	107	1.3	72.4	11.5	0	3095	7.620	9.37	290
14	2300	224.0	98	23.0	68.5	11.6	0	3177	7.430	9.37	440
15	2300	200.0	88	3.3	55.2	13.6	0	1259	3.150	12.47	1100
16	2300	183.0	80	5.0	50.8	13.6	0	1350	3.100	12.47	1075
17	2300	122.0	53	11.4	35.9	13.5	0	2455	3.010	12.34	1450
18	2300	61.0	27	15.9	24.6	14.2	0	2016	1.940	12.71	1050
19	2300	44.0	19	17.1	21.3	14.4	0	1680	1.660	12.94	830
20	2300	20.0	9	18.7	17.7	14.9	0	1177	1.200	13.06	450
21	2300	5.0	2	20.3	13.1	15.5	0	1794	.390	12.71	160
22	600	0.0	0	17.7	4.3	14.7	0	2969	2.080	12.09	66
23	2300	0.0	0	23.8	5.0	19.0	0	33847	.280	5.96	11

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	47.3	454	3.2	.070	0.0	I	R	R	R
2	0.0	25.6	151	8.8	.060	.1	0.0	28.01	165.5	9.7
3	0.0	43.3	181	23.8	.060	.2	0.0	10.53	44.0	5.8
4	0.0	58.2	125	60.5	.050	.5	0.0	6.37	13.7	6.6
5	0.0	65.9	135	104.5	.030	.4	0.0	5.25	10.7	8.3
6	0.0	110.5	303	333.0	.060	1.5	0.0	4.40	12.0	13.3
7	0.0	152.6	829	532.0	0.000	0.0	0.0	4.05	22.0	14.1
8	0.0	163.2	1064	505.4	.040	1.6	0.0	3.97	25.9	12.3
9	0.0	187.4	2338	438.2	0.000	0.0	0.0	4.06	50.6	9.5
10	0.0	367.6	15425	77.1	0.000	0.0	0.0	7.31	306.9	1.5
11	0.0	42.8	582	2.7	.070	0.0	I	R	R	R
12	0.0	712.9	142	.7	.120	0.0	I	R	R	R
13	0.0	587.6	29220	182.8	.025	2.7	0.0	5.50	273.5	1.7
14	0.0	576.7	27243	265.2	.055	5.4	0.0	5.88	277.7	2.7
15	0.0	200.2	10118	580.7	.035	3.1	0.0	2.29	115.5	6.6
16	0.0	198.1	9188	523.7	.060	4.8	0.0	2.47	114.6	6.5
17	0.0	256.4	6349	502.7	.060	3.2	0.0	4.80	118.8	9.4
18	0.0	151.4	2944	261.9	0.000	0.0	0.0	5.67	110.2	9.8
19	0.0	109.9	2194	180.3	.065	1.3	0.0	5.70	113.9	9.4
20	0.0	65.7	1354	83.4	0.000	0.0	0.0	7.51	154.5	9.5
21	0.0	80.3	353	23.8	0.000	0.0	0.0	36.66	161.0	10.9
22	0.0	40.0	566	3.0	.080	0.0	I	R	R	R
23	0.0	797.6	133	.9	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	10.245	GRAM/BHP HR
	CO	157.634	GRAM/BHP HR
	NO2	6.557	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.789	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY
8-21-72 RUN-1 ENG.1-3 72 VERSION 6 BTDC 0.065 JETS

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.9	4.5	14.6	0	4983	3.190	11.13	44
2	1200	4.0	1	20.2	6.6	15.2	0	2147	1.120	12.94	87
3	1200	16.0	4	19.5	8.3	15.5	0	2195	.520	13.06	178
4	1200	36.0	8	18.3	9.4	15.8	0	2274	.350	12.94	430
5	1200	49.0	11	17.6	10.1	15.5	0	2477	.440	13.18	625
6	1200	99.0	23	14.0	16.4	13.4	0	3572	3.750	11.72	595
7	1200	148.0	34	10.3	22.3	12.8	0	3901	4.930	11.01	470
8	1200	162.0	37	8.8	24.0	12.7	0	4048	5.140	10.89	410
9	1200	182.0	42	7.1	26.6	12.5	0	4132	5.560	10.43	330
10	1200	198.0	45	.3	43.2	10.4	0	7181	10.560	7.56	95
11	600	0.0	0	18.6	4.2	13.7	0	5303	4.300	10.89	46
12	1200	0.0	0	22.5	4.3	18.2	0	54019	.440	5.96	9
13	2300	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
14	2300	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
15	2300	189.0	83	6.1	59.5	11.4	0	4134	8.010	9.78	380
16	2300	172.0	75	7.9	53.6	11.3	0	4154	8.740	9.64	360
17	2300	115.0	50	12.3	41.5	11.3	0	4259	8.530	9.50	265
18	2300	57.0	25	16.4	29.0	11.9	0	3803	7.180	10.25	195
19	2300	41.0	18	17.8	25.2	12.3	0	3529	6.190	10.78	180
20	2300	18.0	8	19.4	19.4	12.9	0	3051	4.880	11.48	171
21	2300	5.0	2	20.6	15.9	13.6	0	3153	3.520	12.34	131
22	600	0.0	0	18.4	4.1	14.1	0	4290	3.660	11.92	50
23	2300	0.0	0	24.1	4.3	19.5	0	33856	.310	5.96	11

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	68.6	888	2.0	.070	0.0	I	R	R	R
2	0.0	45.0	474	6.1	.060	.1	0.0	49.27	519.2	6.6
3	0.0	59.9	287	16.1	.060	.2	0.0	16.38	78.4	4.4
4	0.0	71.7	223	45.0	.050	.4	0.0	8.72	27.1	5.5
5	0.0	81.8	294	68.6	.030	.3	0.0	7.31	26.2	6.1
6	0.0	167.9	3560	92.8	.060	1.4	0.0	7.42	157.4	4.1
7	0.0	241.7	6169	96.7	0.000	0.0	0.0	7.15	182.4	2.9
8	0.0	268.1	6878	90.2	.040	1.5	0.0	7.24	185.8	2.4
9	0.0	304.0	8261	80.6	0.000	0.0	0.0	7.31	198.7	1.9
10	0.0	747.0	22189	32.8	0.000	0.0	0.0	16.51	490.5	.7
11	0.0	64.3	1053	1.9	.070	0.0	I	R	R	R
12	0.0	892.8	147	.5	.120	0.0	I	R	R	R
13	0.0	0.0	0	0.0	.025	0.0	0.0	0.00	0.0	0.0
14	0.0	0.0	0	0.0	.055	0.0	0.0	0.00	0.0	0.0
15	0.0	613.0	23989	187.1	.035	2.9	0.0	7.41	289.8	2.3
16	0.0	537.3	22838	154.6	.060	4.5	0.0	7.13	303.2	2.1
17	0.0	434.4	17575	89.7	.060	3.0	0.0	8.63	349.0	1.8
18	0.0	280.9	10712	47.8	0.000	0.0	0.0	11.25	429.1	1.9
19	0.0	232.9	8251	39.4	.065	1.2	0.0	12.97	459.5	2.2
20	0.0	161.1	5205	30.0	0.000	0.0	0.0	20.44	660.3	3.8
21	0.0	140.6	3170	19.4	0.000	0.0	0.0	64.21	1447.9	8.9
22	0.0	49.8	859	1.9	.080	0.0	I	R	R	R
23	0.0	683.9	126	.7	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	18.719	GRAM/BHP HR
	CO	296.476	GRAM/BHP HR
	NO2	2.529	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.954	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-18-72 RUN-2 ENG.1-3 72-VERSION CARB.JETS 0.051

ODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.5	4.0	16.5	0	3247	1.270	12.71	86
2	1200	5.0	1	19.3	6.3	18.7	0	1564	.210	12.47	69
3	1200	18.0	4	18.6	8.1	19.1	0	1380	.150	12.09	260
4	1200	41.0	9	16.5	10.0	19.8	0	1332	.130	11.72	345
5	1200	57.0	13	14.6	11.6	20.4	0	1459	.130	11.24	380
6	1200	0.0	0	0.0	0.0	0.0	0	0	0.000	0.00	0
7	1200	170.0	39	2.0	24.7	18.8	0	7747	.180	11.36	1737
8	1200	185.0	42	1.9	25.4	18.0	0	5125	.250	12.09	2075
9	1200	208.0	48	1.6	27.3	16.7	0	4549	.850	12.47	2050
10	1200	226.0	52	.4	30.3	15.4	0	2812	2.780	11.92	1250
11	600	0.0	0	17.6	3.9	16.4	0	3076	1.590	12.34	66
12	1200	0.0	0	22.2	3.9	20.1	0	41187	.420	6.38	1412
13	2300	240.0	105	1.3	60.1	16.1	0	2112	2.250	13.06	1687
14	2300	221.0	97	2.2	55.2	16.3	0	1288	2.020	13.06	1512
15	2300	197.0	86	2.3	52.4	18.1	0	770	1.300	12.94	1375
16	2300	180.0	79	2.5	48.1	19.0	0	294	.470	12.82	1275
17	2300	120.0	53	2.6	43.3	20.7	0	954	.210	11.60	1212
18	2300	60.0	26	11.6	25.5	22.1	0	220	.150	10.78	300
19	2300	43.0	19	12.9	23.0	22.3	0	303	.150	10.78	250
20	2300	19.0	8	14.8	20.4	22.7	0	742	.150	10.55	145
21	2300	5.0	2	15.9	18.5	23.0	0	3281	.180	9.93	97
22	600	0.0	0	17.4	4.1	17.6	0	2907	1.230	12.71	71
23	2300	0.0	0	23.8	4.1	24.9	0	34985	.250	5.39	11

ODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	41.2	325	3.6	.070	0.0	I	R	R	R
2	0.0	34.8	94	5.1	.060	.1	0.0	30.48	82.7	4.5
3	0.0	41.0	90	25.6	.060	.2	0.0	9.96	21.9	6.2
4	0.0	50.4	99	43.4	.050	.5	0.0	5.38	10.6	4.6
5	0.0	66.7	120	57.6	.030	.4	0.0	5.12	9.2	4.4
6	0.0	0.0	0	0.0	.060	0.0	0.0	0.00	0.0	0.0
7	0.0	704.8	331	524.7	0.000	0.0	0.0	18.15	8.5	13.5
8	0.0	459.4	453	617.6	.040	1.7	0.0	10.87	10.7	14.6
9	0.0	408.9	1544	611.8	0.000	0.0	0.0	8.60	32.5	12.9
10	0.0	257.9	5152	380.7	0.000	0.0	0.0	5.00	99.8	7.4
11	0.0	38.2	399	2.7	.070	0.0	I	R	R	R
12	0.0	667.3	137	76.0	.120	0.0	I	R	R	R
13	0.0	370.4	7983	983.7	.025	2.6	0.0	3.53	76.0	9.4
14	0.0	212.0	6718	826.4	.055	5.3	0.0	2.19	69.4	8.5
15	0.0	127.8	4360	757.9	.035	3.0	0.0	1.48	50.5	8.8
16	0.0	48.2	1555	693.4	.060	4.7	0.0	.61	19.7	8.8
17	0.0	157.4	700	663.8	.060	3.2	0.0	2.99	13.3	12.6
18	0.0	23.3	320	105.2	0.000	0.0	0.0	.89	12.2	4.0
19	0.0	28.8	288	79.0	.065	1.2	0.0	1.53	15.3	4.2
20	0.0	63.7	260	41.3	0.000	0.0	0.0	7.66	31.3	5.0
21	0.0	263.7	292	25.9	0.000	0.0	0.0	120.45	133.5	11.8
22	0.0	38.0	325	3.1	.080	0.0	I	R	R	R
23	0.0	712.0	103	.8	.060	0.0	I	R	R	R

CLE COMPOSITE			
	HC	8.650	GRAM/BHP HR
	CO	44.145	GRAM/BHP HR
	NO2	9.739	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.770	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-18-72 RUN-1 ENG.1-3 72 VERSION STD TIMING 0.056 STD JETS

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.4	4.1	16.2	0	4015	1.450	12.71	51
2	1200	5.0	1	19.9	7.8	16.5	0	1170	.200	13.33	86
3	1200	19.0	4	19.3	8.2	16.4	0	1857	.220	13.33	200
4	1200	42.0	10	17.0	10.0	17.1	0	1928	.090	13.00	510
5	1200	58.0	13	15.9	11.0	17.5	0	1999	.100	12.88	650
6	1200	116.0	27	10.7	15.7	18.0	0	2108	.080	12.77	1607
7	1200	174.0	40	3.7	23.0	17.4	0	1642	.100	12.94	1775
8	1200	190.0	43	2.2	24.3	16.7	0	1749	.130	13.00	2019
9	1200	213.0	49	1.8	26.8	15.4	0	2496	1.070	13.48	1900
10	1200	232.0	53	.4	34.2	13.0	0	4060	5.640	11.19	578
11	600	0.0	0	17.4	3.7	15.3	0	3994	1.980	12.83	59
12	1200	0.0	0	22.0	4.1	18.6	0	49764	.320	6.65	11
13	2300	252.0	110	1.3	66.3	13.0	0	3334	5.140	11.54	743
14	2300	232.0	102	2.3	60.2	13.7	0	2349	3.960	12.16	1369
15	2300	207.0	91	2.5	53.2	15.0	0	928	1.980	12.59	1038
16	2300	189.0	83	2.8	49.8	15.8	0	474	1.090	12.71	957
17	2300	126.0	55	10.5	32.5	16.5	0	1393	.370	12.94	2650
18	2300	63.0	28	15.3	23.0	17.2	0	851	.220	12.77	1332
19	2300	45.0	20	16.4	20.7	17.6	0	621	.170	12.71	913
20	2300	20.0	9	18.0	17.5	18.0	0	450	.150	12.47	505
21	2300	5.0	2	19.1	15.4	18.5	0	558	.140	12.32	298
22	600	0.0	0	17.5	3.9	16.0	0	3596	1.820	12.53	66
23	2300	0.0	0	24.1	4.3	21.6	0	42665	.280	5.50	13

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	51.3	374	2.2	.070	0.0	I	R	R	R
2	0.0	30.3	105	7.4	.060	.1	0.0	26.56	91.7	6.5
3	0.0	50.3	120	18.0	.060	.3	0.0	11.58	27.7	4.1
4	0.0	65.8	62	57.8	.050	.5	0.0	6.86	6.5	6.0
5	0.0	75.7	76	81.7	.030	.4	0.0	5.71	5.8	6.2
6	0.0	114.9	88	290.9	.060	1.6	0.0	4.34	3.3	11.0
7	0.0	129.7	160	465.6	0.000	0.0	0.0	3.26	4.0	11.7
8	0.0	144.9	218	555.3	.040	1.7	0.0	3.34	5.0	12.8
9	0.0	205.0	1775	518.1	0.000	0.0	0.0	4.21	36.5	10.6
10	0.0	365.4	10254	172.7	0.000	0.0	0.0	6.89	193.4	3.3
11	0.0	44.1	441	2.2	.070	0.0	I	R	R	R
12	0.0	774.7	101	.6	.120	0.0	I	R	R	R
13	0.0	589.3	18353	436.0	.025	2.8	0.0	5.34	166.3	4.0
14	0.0	392.2	13356	758.9	.055	5.6	0.0	3.86	131.5	7.5
15	0.0	152.8	6582	567.2	.035	3.2	0.0	1.69	72.6	6.3
16	0.0	77.3	3592	518.3	.060	5.0	0.0	.93	43.4	6.3
17	0.0	152.7	819	964.4	.060	3.3	0.0	2.77	14.8	17.5
18	0.0	67.9	355	352.9	0.000	0.0	0.0	2.46	12.9	12.8
19	0.0	45.1	249	219.9	.065	1.3	0.0	2.29	12.6	11.2
20	0.0	28.2	190	105.1	0.000	0.0	0.0	3.22	21.7	12.0
21	0.0	31.1	158	55.2	0.000	0.0	0.0	14.21	72.1	25.2
22	0.0	43.3	442	2.6	.080	0.0	I	R	R	R
23	0.0	828.3	110	.8	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	9.147	GRAM/BHP HR
	CO	72.183	GRAM/BHP HR
	NO2	8.704	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.719	LB/BHP HR

ENGINE 1-3

EFFECT OF AIR-FUEL RATIO ON EMISSIONS

GRAPHED RESULTS

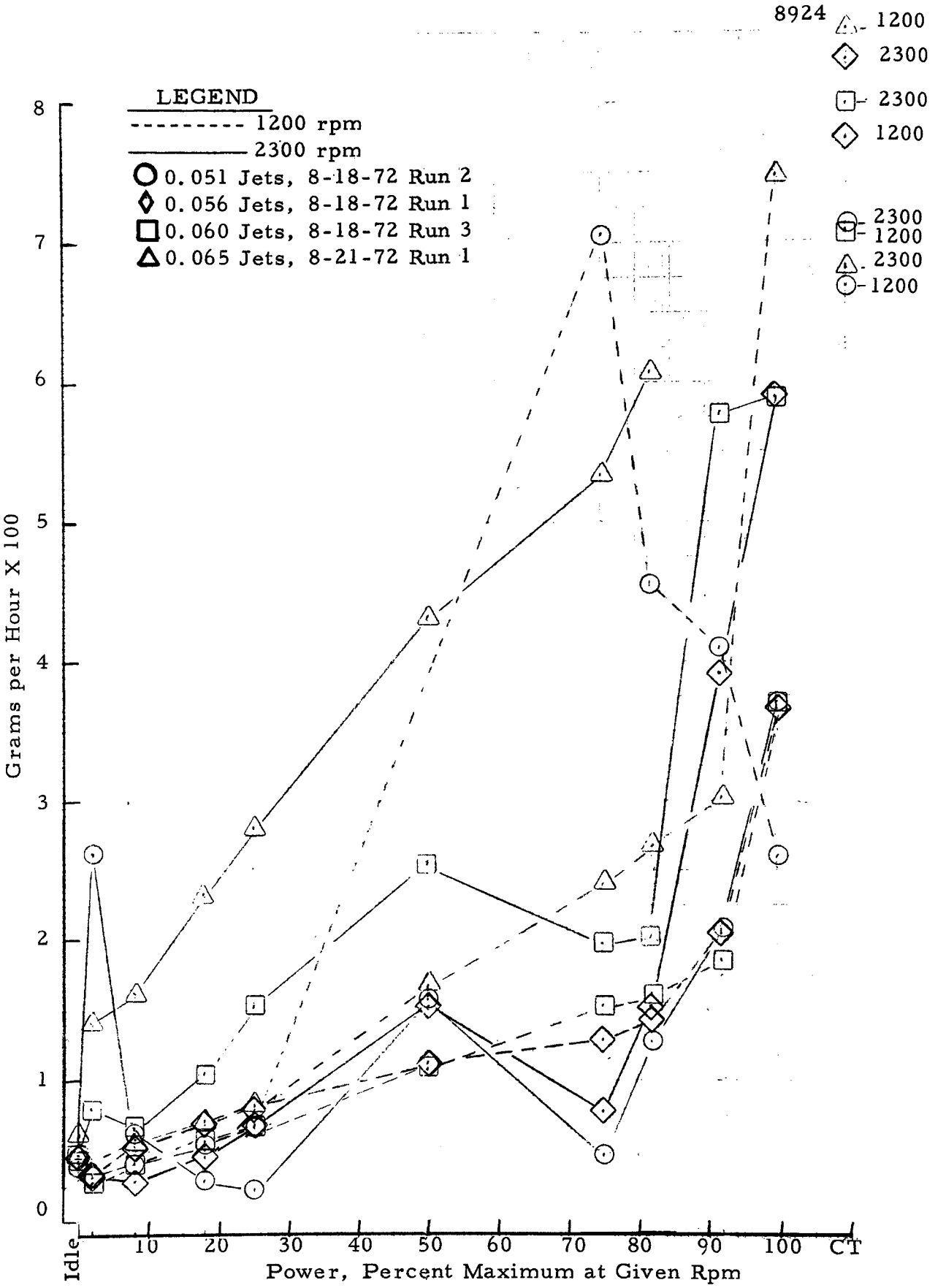


FIGURE R-1. EFFECT OF POWER ON HC EMISSION RATE
ENGINE 1-3, 23 MODE TEST

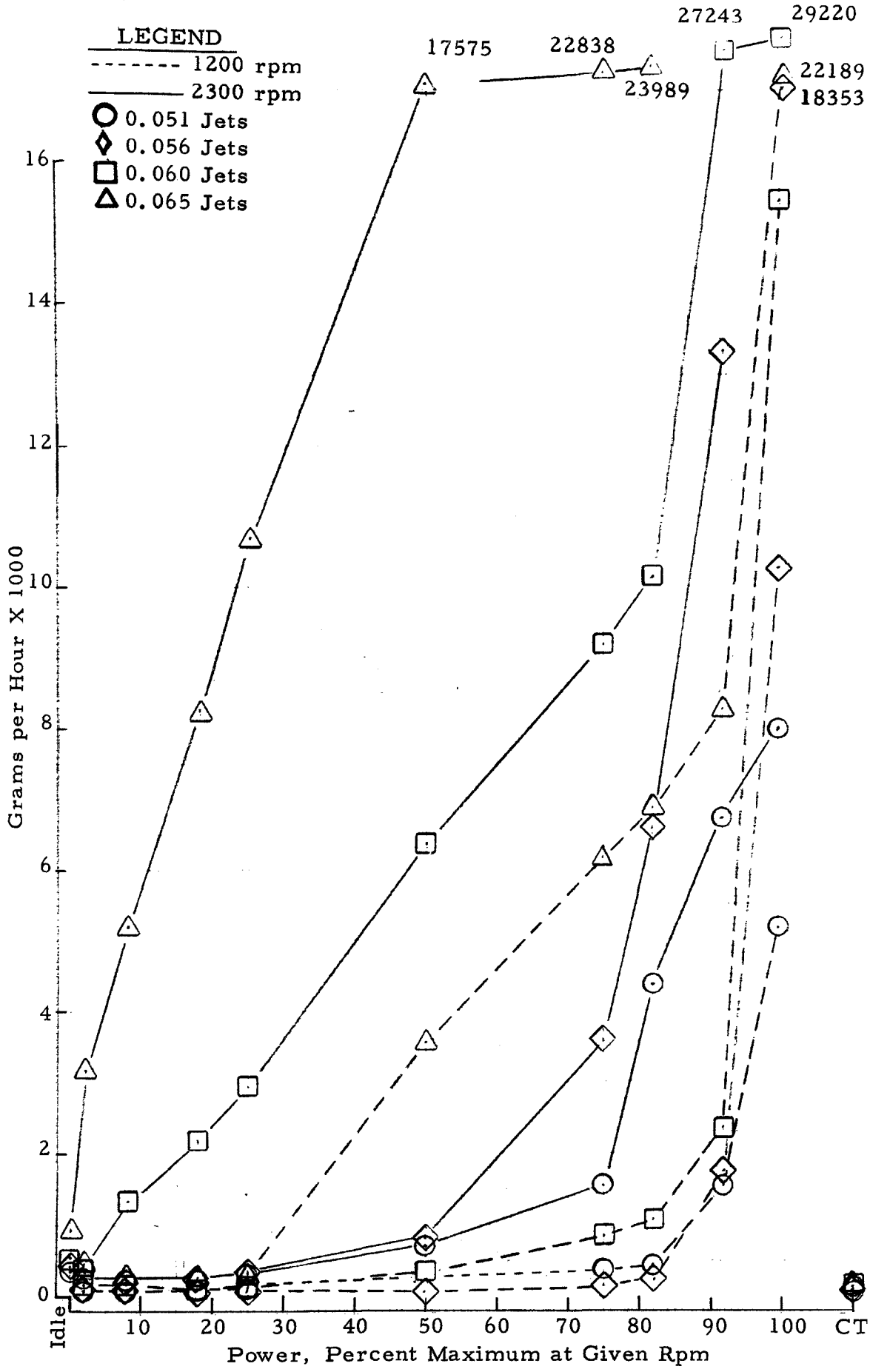


FIGURE R-2. EFFECT OF POWER ON CO EMISSION RATE
ENGINE 1-3, 23 MODE TEST

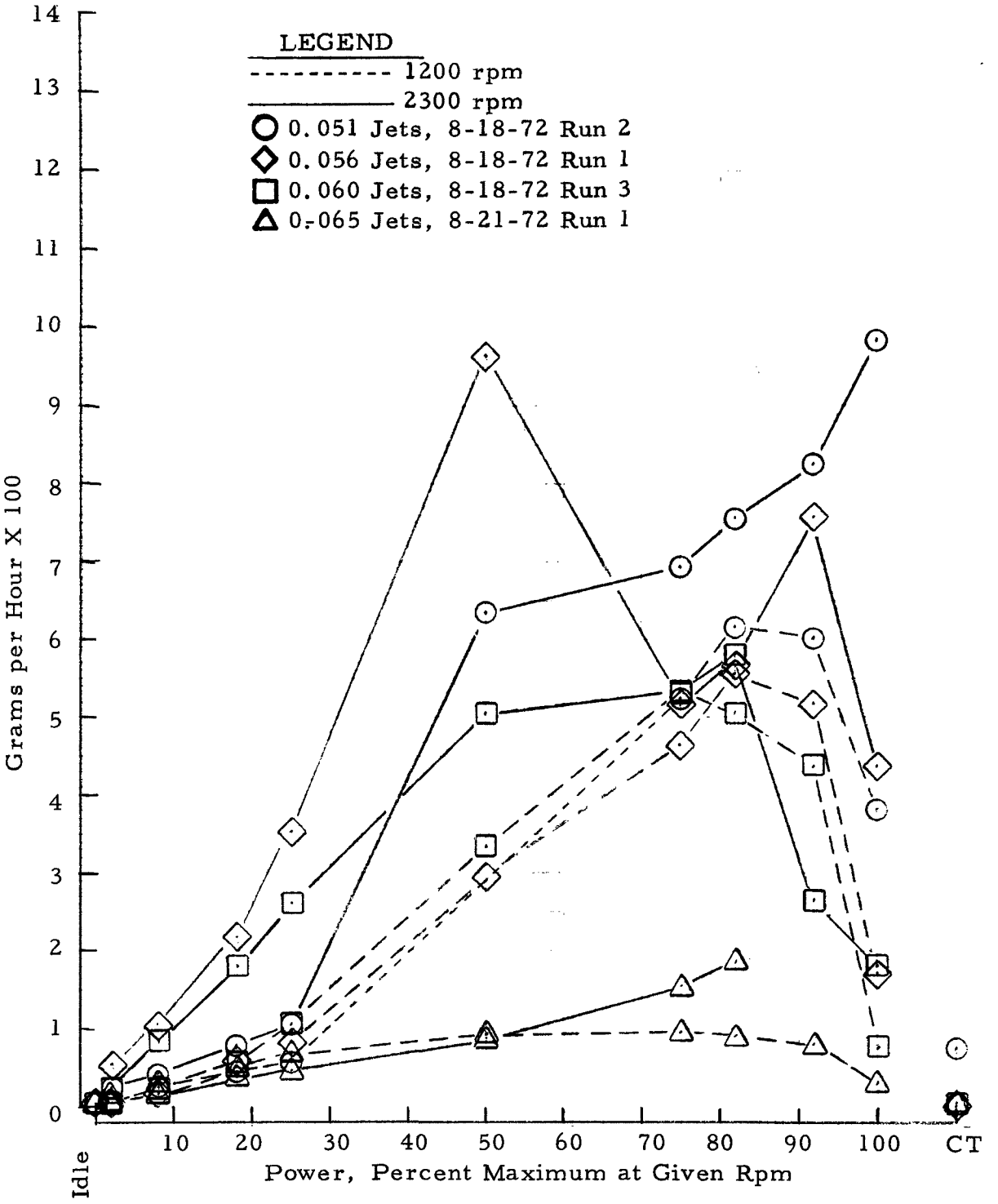


FIGURE R-3. EFFECT OF POWER ON NO_x (AS NO_2) EMISSION RATE
ENGINE 1-3, 23 MODE TEST

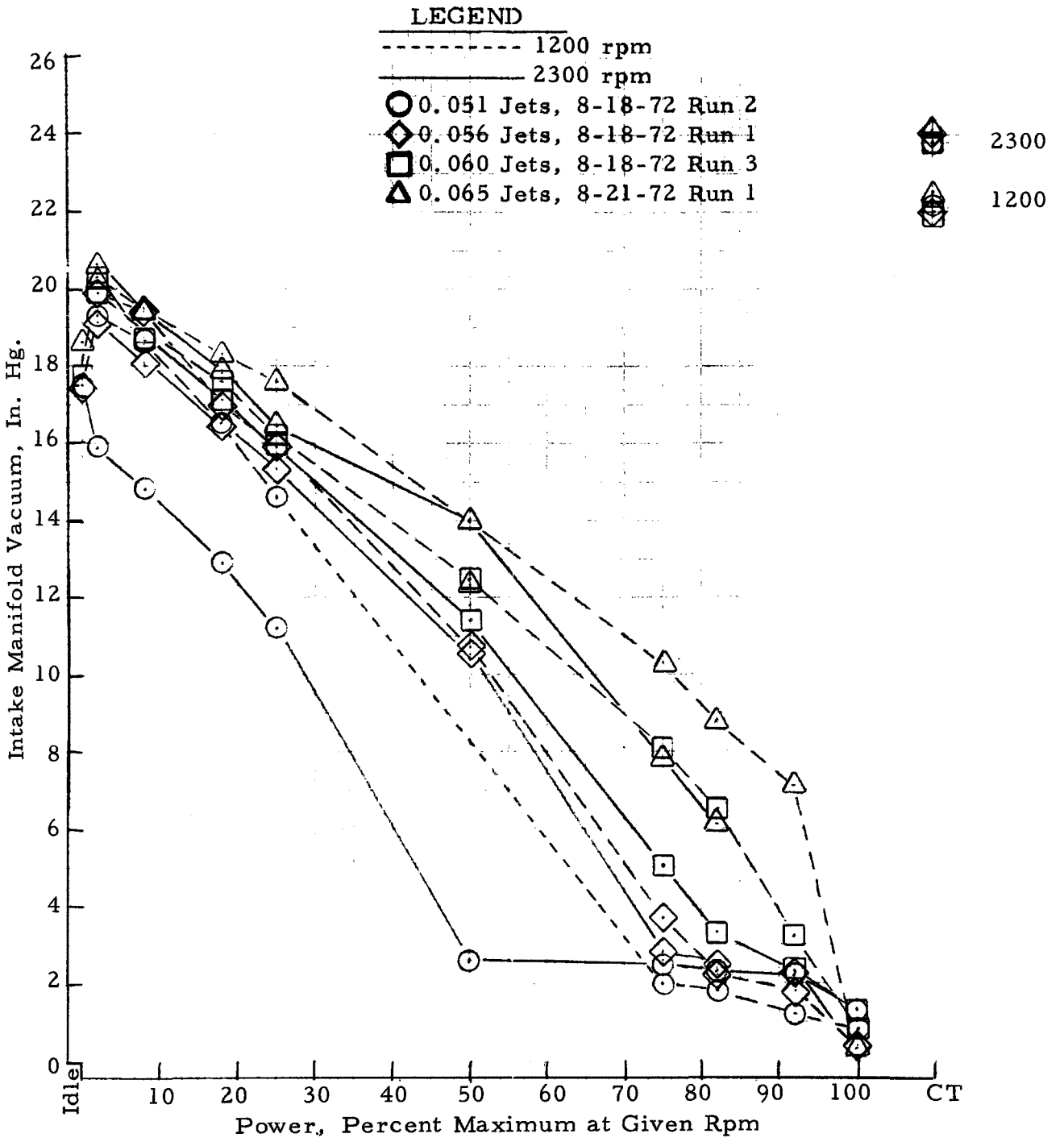


FIGURE R-4. MANIFOLD VACUUM AS A FUNCTION OF POWER
ENGINE 1-3, 23 MODE TEST

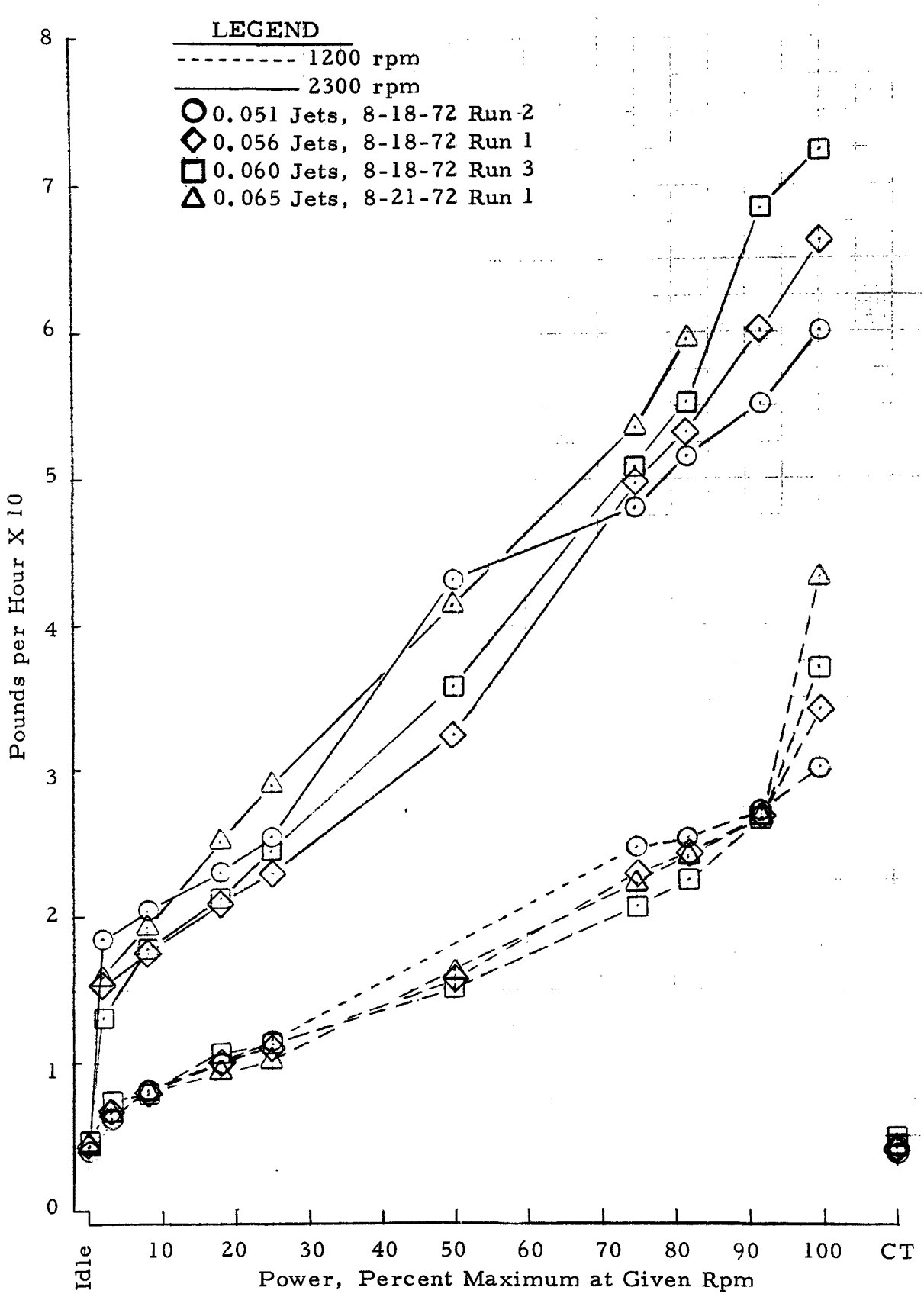


FIGURE R-5. FUEL CONSUMPTION AS A FUNCTION OF POWER
ENGINE 1-3, 23 MODE TEST

APPENDIX S

ENGINE 1-3

EFFECT OF LABORATORY EGR ON EMISSIONS

(23 MODE MASS RESULTS)

ENGINE 1-3

EFFECT OF LABORATORY EGR ON EMISSIONS

TABULAR DATA

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-22-72 RUN-1 ENG.1-3 72-VERSION STD TIMING STD JETS 5 %EGR

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	16.9	3.9	17.8	0	3690	.930	11.84	56
2	1200	4.0	1	19.6	7.5	18.0	0	2231	.250	12.22	63
3	1200	17.0	4	18.1	8.8	18.3	0	1671	.130	12.22	155
4	1200	37.0	8	16.8	9.9	19.0	0	1499	.050	11.92	250
5	1200	52.0	12	15.4	11.0	19.5	0	1486	.050	11.72	350
6	1200	104.0	24	10.6	15.2	20.3	0	1636	.050	11.36	930
7	1200	155.0	35	3.8	22.0	19.7	0	1110	.100	11.84	1063
8	1200	170.0	39	2.5	23.2	19.6	0	1256	.100	11.92	1475
9	1200	190.0	43	2.2	24.5	18.2	0	1787	.440	12.22	1663
10	1200	207.0	47	.5	33.2	13.7	0	4170	6.860	10.25	210
11	600	0.0	0	16.9	4.0	16.5	0	3235	1.630	11.92	60
12	1200	0.0	0	21.9	4.4	24.7	0	22823	.440	6.21	12
13	2300	223.0	98	1.7	64.0	13.1	0	3678	6.250	10.89	390
14	2300	205.0	90	2.6	54.1	14.1	0	2546	4.020	11.60	913
15	2300	183.0	80	2.8	50.1	16.1	0	689	1.660	12.34	620
16	2300	167.0	73	2.8	47.4	17.1	0	381	.930	12.22	625
17	2300	112.0	49	10.6	31.6	17.7	0	1230	.280	12.47	1988
18	2300	56.0	25	15.1	22.7	18.3	0	580	.180	12.22	1050
19	2300	40.0	18	16.4	20.3	18.8	0	451	.150	12.22	720
20	2300	18.0	8	17.9	15.9	19.2	0	317	.150	11.84	395
21	2300	4.0	2	19.0	14.2	19.6	0	1524	.150	11.60	235
22	600	0.0	0	17.3	4.2	16.9	0	3149	1.550	11.92	59
23	2300	0.0	0	23.9	4.7	23.3	0	39800	.280	4.84	7

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	49.7	253	2.5	.070	0.0	I	R	R	R
2	0.0	59.8	135	5.6	.060	.1	0.0	65.42	148.1	6.1
3	0.0	53.3	84	16.4	.060	.2	0.0	13.72	21.6	4.2
4	0.0	55.6	37	30.8	.050	.4	0.0	6.57	4.4	3.6
5	0.0	62.2	42	48.6	.030	.4	0.0	5.24	3.6	4.1
6	0.0	97.5	60	183.9	.060	1.4	0.0	4.10	2.5	7.7
7	0.0	92.0	167	292.2	0.000	0.0	0.0	2.60	4.7	8.3
8	0.0	108.8	175	424.3	.040	1.6	0.0	2.80	4.5	10.9
9	0.0	154.7	769	477.9	0.000	0.0	0.0	3.56	17.7	11.0
10	0.0	358.3	11906	59.9	0.000	0.0	0.0	7.58	251.7	1.3
11	0.0	42.3	431	2.6	.070	0.0	I	R	R	R
12	0.0	510.0	199	.9	.120	0.0	I	R	R	R
13	0.0	609.9	20934	214.7	.025	2.4	0.0	6.25	214.4	2.2
14	0.0	393.6	12553	468.6	.055	4.9	0.0	4.38	139.8	5.2
15	0.0	111.3	5416	332.5	.035	2.8	0.0	1.39	67.6	4.1
16	0.0	62.2	3063	338.3	.060	4.4	0.0	.85	41.9	4.6
17	0.0	136.9	630	734.9	.060	2.9	0.0	2.79	12.8	15.0
18	0.0	47.9	301	288.1	0.000	0.0	0.0	1.95	12.3	11.7
19	0.0	33.5	225	177.3	.065	1.1	0.0	1.91	12.8	10.1
20	0.0	19.0	182	78.7	0.000	0.0	0.0	2.41	23.1	10.0
21	0.0	82.5	164	42.2	0.000	0.0	0.0	47.09	93.6	24.1
22	0.0	43.5	433	2.7	.080	0.0	I	R	R	R
23	0.0	932.4	133	.5	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	8.969	GRAM/BHP HR
	CO	78.442	GRAM/BHP HR
	NO2	6.684	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.781	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY
8-22-72 RUN-2 ENG.1-3 72 VERSION 6 BTDC 10% EGR

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.0	4.2	18.1	0	3318	1.050	13.48	54
2	1200	4.0	1	19.8	6.5	18.5	0	1133	.280	14.05	62
3	1200	15.0	3	19.2	8.0	18.4	0	1426	.210	14.05	145
4	1200	35.0	8	18.1	9.4	18.5	0	1625	.150	13.77	185
5	1200	48.0	11	16.1	10.2	18.9	0	1655	.150	13.48	245
6	1200	96.0	22	8.6	15.8	19.4	0	1802	.150	12.71	245
7	1200	144.0	33	2.3	22.1	18.1	0	1397	.210	13.48	500
8	1200	157.0	36	2.1	23.0	17.3	0	1630	.350	13.91	720
9	1200	177.0	40	1.9	25.5	15.8	0	2636	1.730	14.05	515
10	1200	192.0	44	.5	31.6	13.0	0	4416	8.320	10.89	135
11	600	0.0	0	17.4	4.4	16.5	0	3107	1.120	14.05	59
12	1200	0.0	0	22.0	4.3	18.4	0	44602	.520	7.56	8
13	2300	205.0	90	1.6	63.9	13.9	0	3341	6.500	11.01	167
14	2300	189.0	83	2.2	62.5	13.4	0	419	8.010	9.64	117
15	2300	168.0	74	2.7	51.2	15.0	0	1794	3.240	12.71	280
16	2300	154.0	67	2.8	48.7	15.0	0	1794	3.240	12.71	280
17	2300	103.0	45	7.8	34.1	17.7	0	958	.250	13.48	465
18	2300	51.0	22	13.7	23.7	18.8	0	499	.100	13.06	360
19	2300	37.0	16	15.2	21.1	18.4	0	357	.070	12.59	275
20	2300	16.0	7	16.3	19.3	19.4	0	502	.100	12.47	213
21	2300	4.0	2	18.4	15.0	20.1	0	3657	.100	11.60	135
22	600	0.0	0	17.4	4.3	17.7	0	2730	1.120	12.47	60
23	2300	0.0	0	23.9	4.6	23.8	0	38613	.210	5.27	9

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	42.5	272	2.3	.070	0.0	I	R	R	R
2	0.0	23.1	115	4.2	.060	.1	0.0	25.30	126.3	4.6
3	0.0	35.9	107	12.1	.060	.2	0.0	10.48	31.2	3.5
4	0.0	49.2	92	18.6	.050	.4	0.0	6.15	11.5	2.3
5	0.0	55.5	102	27.3	.030	.3	0.0	5.06	9.3	2.5
6	0.0	99.0	167	44.7	.060	1.3	0.0	4.51	7.6	2.0
7	0.0	101.3	307	120.3	0.000	0.0	0.0	3.08	9.3	3.7
8	0.0	117.9	511	172.9	.040	1.4	0.0	3.29	14.3	4.8
9	0.0	190.0	2519	123.3	0.000	0.0	0.0	4.70	62.3	3.0
10	0.0	322.1	12258	32.7	0.000	0.0	0.0	7.34	279.4	.7
11	0.0	40.1	292	2.5	.070	0.0	I	R	R	R
12	0.0	693.7	163	.4	.120	0.0	I	R	R	R
13	0.0	542.6	21328	90.3	.025	2.2	0.0	6.04	237.6	1.0
14	0.0	67.1	25928	62.5	.055	4.6	0.0	.81	313.3	.8
15	0.0	258.3	9424	133.9	.035	2.6	0.0	3.51	128.1	1.8
16	0.0	245.6	8964	127.3	.060	4.0	0.0	3.64	132.9	1.9
17	0.0	107.2	565	172.7	.060	2.7	0.0	2.38	12.5	3.8
18	0.0	40.6	164	97.3	0.000	0.0	0.0	1.82	7.4	4.4
19	0.0	26.9	107	68.8	.065	1.1	0.0	1.66	6.6	4.2
20	0.0	34.8	140	48.9	0.000	0.0	0.0	4.97	20.0	7.0
21	0.0	206.2	114	25.3	0.000	0.0	0.0	117.73	65.0	14.4
22	0.0	38.4	318	2.8	.080	0.0	I	R	R	R
23	0.0	862.5	95	.6	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	10.106	GRAM/BHP HR
	CO	143.862	GRAM/BHP HR
	NO2	2.191	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.881	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-23-72 RUN-1 ENG.1-3 72-VERSION 6 BTDC 15% EGR STD.TIMING +JETS

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.5	4.4	15.4	0	4424	2.600	11.92	45
2	1200	3.0	1	19.3	8.3	16.9	0	1560	.310	13.77	80
3	1200	11.0	3	18.2	8.8	17.0	0	2533	.280	13.33	81
4	1200	25.0	6	16.5	9.7	17.5	0	2076	.130	13.06	94
5	1200	35.0	8	15.2	10.9	17.8	0	1596	.130	12.82	101
6	1200	70.0	16	7.8	16.1	18.6	0	3113	.150	11.92	104
7	1200	105.0	24	2.0	22.9	16.0	0	2297	.770	13.77	145
8	1200	115.0	26	2.0	23.5	15.7	0	2159	1.120	13.63	140
9	1200	129.0	29	1.9	24.0	15.4	0	2568	1.800	13.48	139
10	1200	140.0	32	.4	31.5	12.0	0	7057	9.060	8.93	49
11	600	0.0	0	17.5	4.2	15.2	0	3994	2.440	12.82	53
12	1200	0.0	0	22.3	4.5	16.7	0	43508	1.050	8.43	9
13	2300	148.0	65	1.5	59.8	12.0	0	6103	9.280	9.50	56
14	2300	136.0	60	1.7	61.0	11.4	0	9914	10.350	9.14	48
15	2300	121.0	53	2.7	48.6	14.0	0	3119	4.540	12.22	80
16	2300	111.0	49	2.8	47.8	14.3	0	2762	4.070	12.22	85
17	2300	74.0	32	2.8	42.4	16.1	0	8258	1.590	12.59	84
18	2300	37.0	16	11.5	26.0	18.0	0	1228	.150	12.47	125
19	2300	27.0	12	13.0	23.8	18.3	0	919	.150	12.47	120
20	2300	12.0	5	15.4	19.8	18.6	0	1404	.150	12.22	109
21	2300	3.0	1	17.0	17.4	18.8	0	4114	.180	11.92	90
22	600	0.0	0	17.4	4.2	16.2	0	3281	1.730	12.47	60
23	2300	0.0	0	23.8	4.7	22.4	0	41222	.280	5.88	9

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	59.0	701	2.0	.070	0.0	I	R	R	R
2	0.0	41.2	166	7.0	.060	.0	0.0	60.18	241.6	10.2
3	0.0	72.9	163	7.7	.060	.2	0.0	29.02	64.8	3.1
4	0.0	68.2	86	10.2	.050	.3	0.0	11.93	15.1	1.8
5	0.0	60.2	99	12.6	.030	.2	0.0	7.53	12.4	1.6
6	0.0	183.6	179	20.4	.060	1.0	0.0	11.48	11.2	1.3
7	0.0	161.6	1094	33.9	0.000	0.0	0.0	6.73	45.6	1.4
8	0.0	153.8	1611	33.1	.040	1.1	0.0	5.85	61.3	1.3
9	0.0	179.9	2548	32.3	0.000	0.0	0.0	6.10	86.4	1.1
10	0.0	539.3	13987	12.4	0.000	0.0	0.0	16.86	437.3	.4
11	0.0	48.6	600	2.1	.070	0.0	I	R	R	R
12	0.0	642.1	313	.4	.120	0.0	I	R	R	R
13	0.0	853.8	26223	26.0	.025	1.6	0.0	13.17	404.6	.4
14	0.0	1339.4	28245	21.5	.055	3.3	0.0	22.49	474.2	.4
15	0.0	402.7	11842	34.3	.035	1.9	0.0	7.60	223.5	.6
16	0.0	361.4	10760	36.9	.060	2.9	0.0	7.44	221.4	.8
17	0.0	1058.4	4117	35.7	.060	1.9	0.0	32.66	127.0	1.1
18	0.0	113.7	280	38.4	0.000	0.0	0.0	7.02	17.3	2.4
19	0.0	78.1	257	33.8	.065	.8	0.0	6.60	21.8	2.9
20	0.0	100.8	218	26.0	0.000	0.0	0.0	19.18	41.4	4.9
21	0.0	259.5	229	18.8	0.000	0.0	0.0	197.55	174.6	14.3
22	0.0	43.0	458	2.6	.080	0.0	I	R	R	R
23	0.0	854.7	117	.6	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	24.351	GRAM/BHP HR
	CO	251.999	GRAM/BHP HR
	NO2	.960	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	1.259	LB/BHP HR

ENGINE 1-3

EFFECT OF LABORATORY EGR ON EMISSIONS

GRAPHED RESULTS

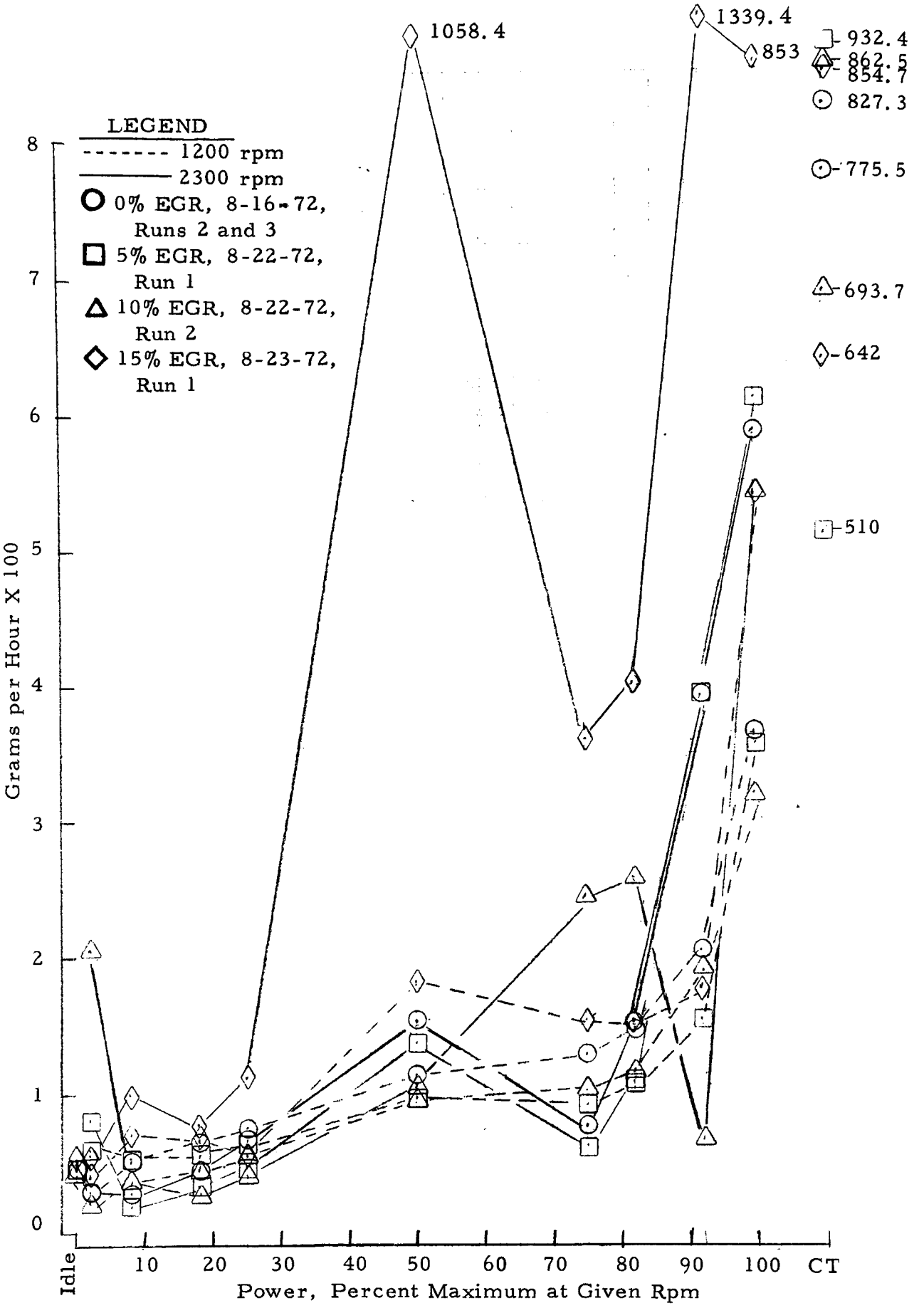


FIGURE S-1. EFFECT OF LABORATORY EGR ON HC EMISSION RATE
ENGINE 1-3, 23 MODE TEST

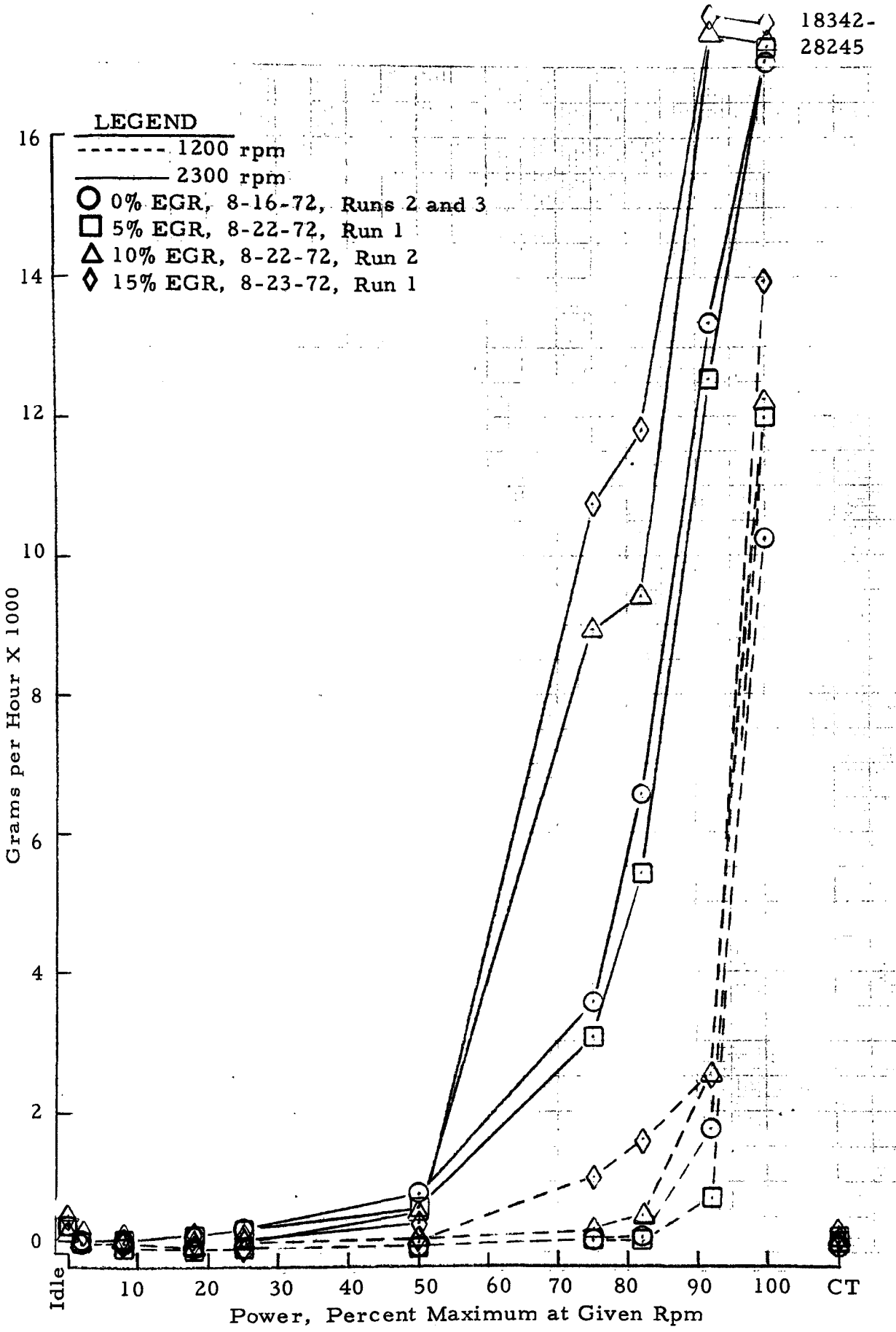


FIGURE S-2. EFFECT OF LABORATORY EGR ON CO EMISSION RATE
ENGINE 1-3, 23 MODE TEST

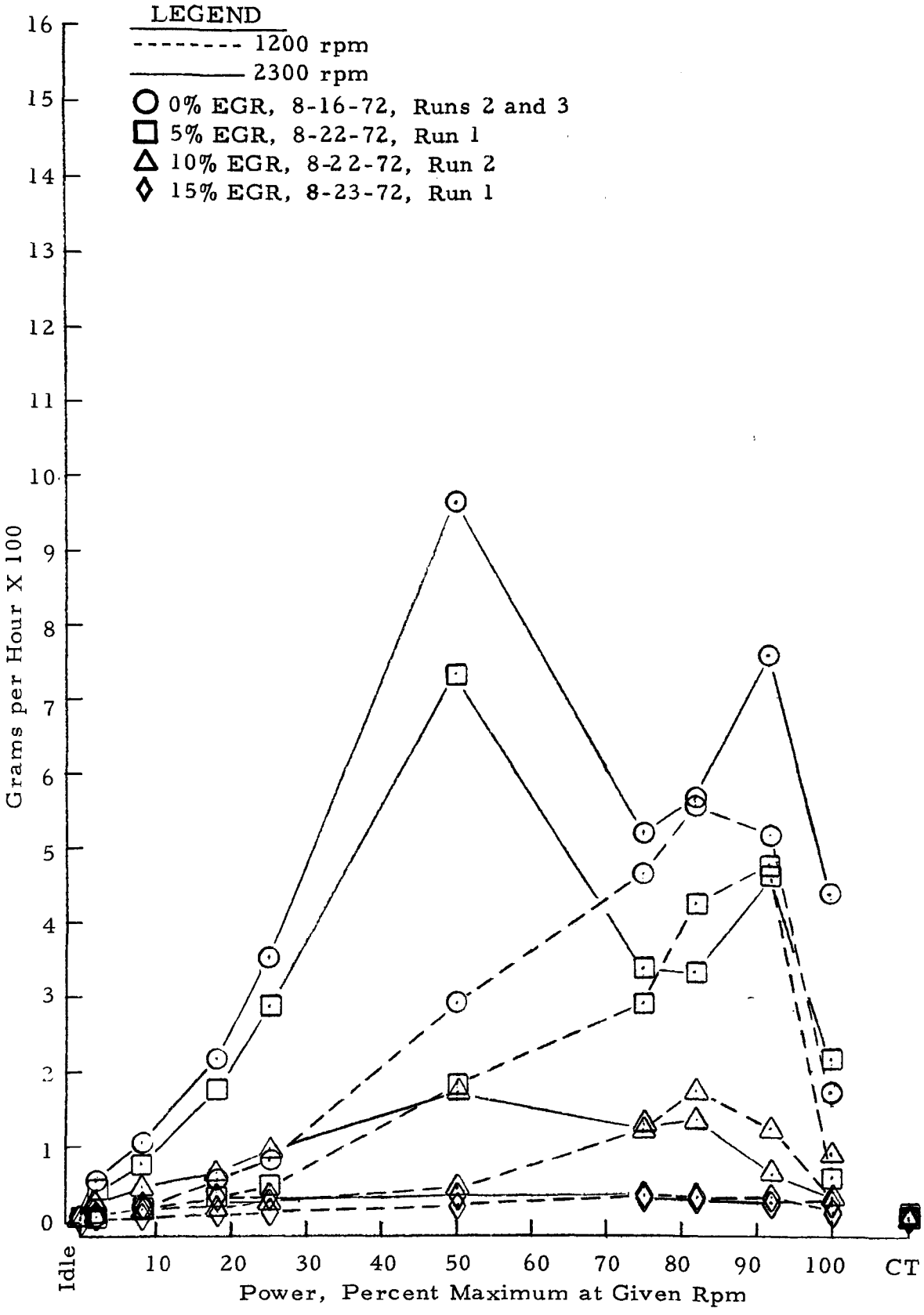


FIGURE S-3. EFFECT OF LABORATORY EGR ON NO_x (AS NO_2) EMISSION RATE ENGINE 1-3, 23 MODE TEST

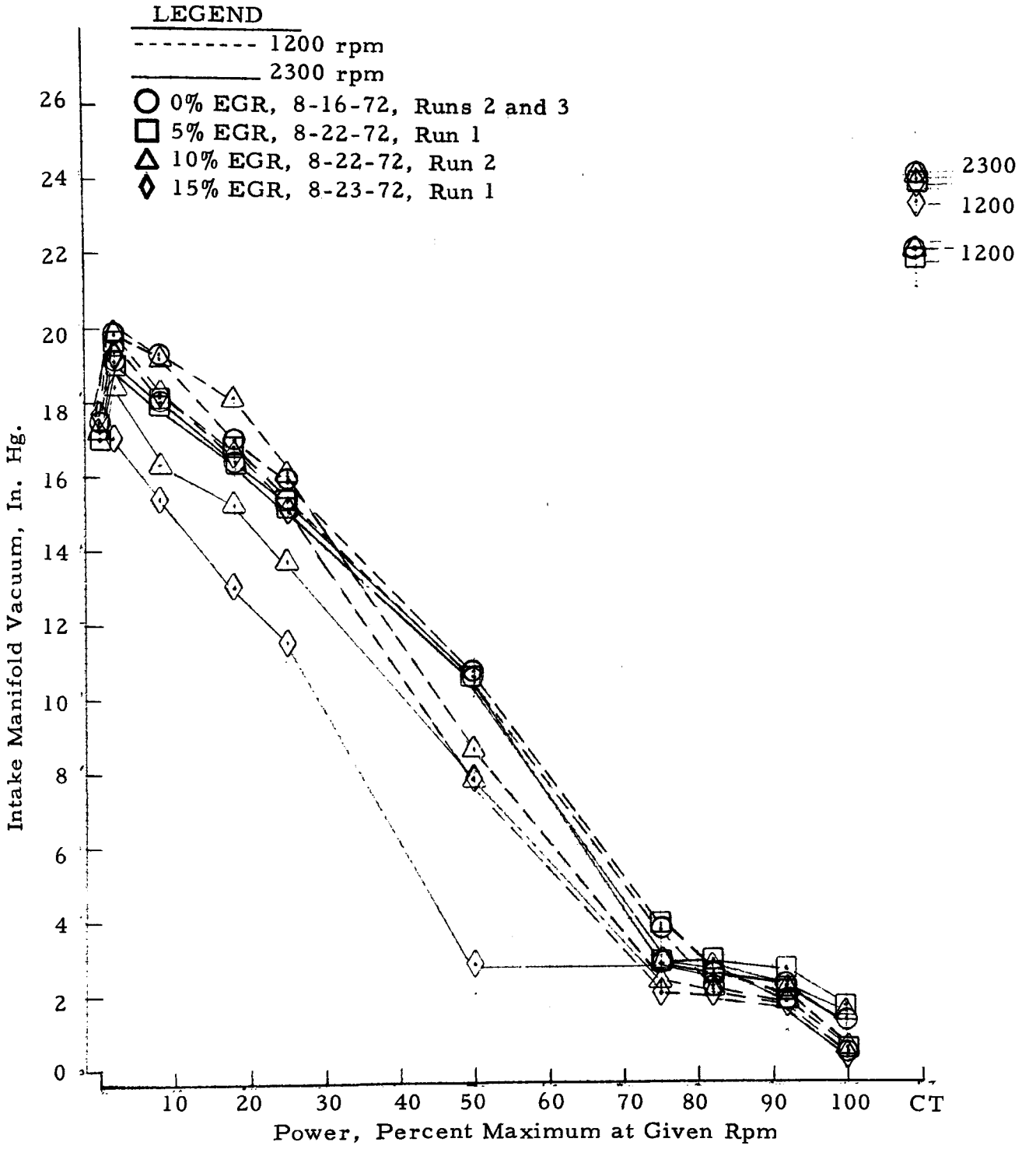


FIGURE S-4. MANIFOLD VACUUM AS A FUNCTION OF POWER
ENGINE 1-3, 23 MODE TEST

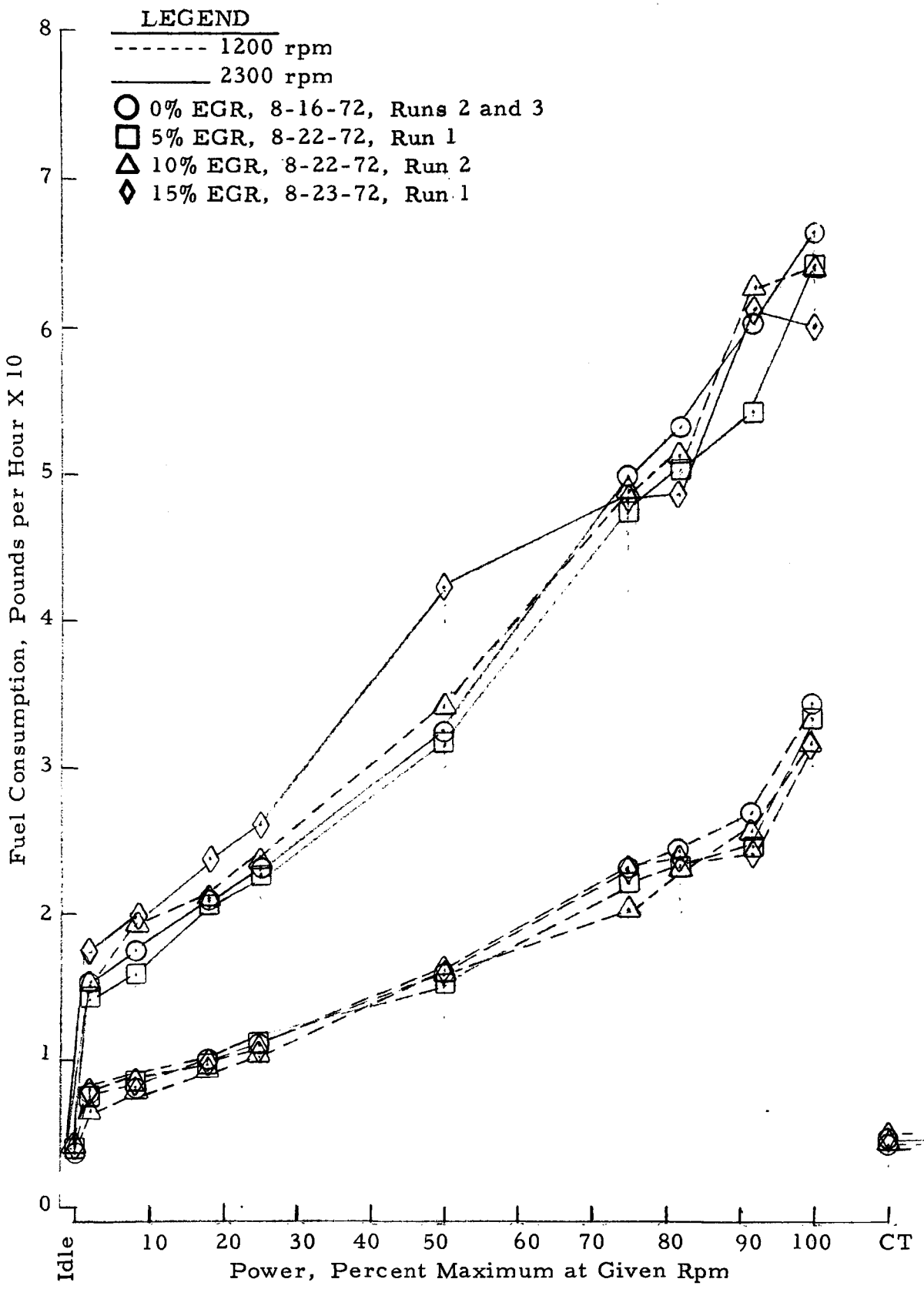


FIGURE S-5. FUEL CONSUMPTION AS A FUNCTION OF POWER
ENGINE 1-3, 23 MODE TEST

APPENDIX T

ENGINE 1-3

EFFECT OF EXHAUST MANIFOLD AIR INJECTION ON EMISSIONS

(23 MODE MASS RESULTS)

ENGINE 1-3

EFFECT OF EXHAUST MANIFOLD

AIR INJECTION ON EMISSIONS

TABULAR DATA

PROJECT 11-2877-01 CONTROL TECHNOLOGY
8-24-72 RUN-1 ENG.1-3 72 VERSION 15 BTDC [600 RPM STD JETS W/AIR

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.9	3.1	18.2	0	3304	2.600	9.37	33
2	1200	5.0	1	20.4	6.3	23.8	0	761	.210	9.25	57
3	1200	20.0	5	19.4	7.4	22.9	0	1242	.180	9.50	184
4	1200	44.0	10	17.7	9.1	23.5	0	1644	.100	9.50	575
5	1200	62.0	14	15.9	10.6	22.8	0	1746	.070	9.78	820
6	1200	124.0	28	10.1	16.2	22.1	0	1879	.070	9.93	1688
7	1200	185.0	42	3.9	22.4	20.6	0	1564	.100	10.89	1813
8	1200	203.0	46	2.3	23.8	20.1	0	1523	.100	11.13	1987
9	1200	227.0	52	1.9	25.7	18.6	0	1894	.470	11.84	2225
10	1200	247.0	56	.4	33.5	15.3	0	2953	4.260	10.43	863
11	600	0.0	0	18.7	3.0	18.0	0	3608	2.780	9.14	39
12	1200	0.0	0	23.0	3.4	30.0	0	41408	.180	2.93	7
13	2300	262.0	115	1.4	66.0	14.6	0	1776	4.070	11.72	815
14	2300	241.0	106	2.3	58.5	15.4	0	843	2.280	12.71	1575
15	2300	215.0	94	2.5	52.0	17.0	0	150	.580	12.71	1250
16	2300	197.0	86	2.7	48.7	18.2	0	217	.350	11.92	1237
17	2300	131.0	57	10.0	33.1	20.1	0	829	.180	11.24	2850
18	2300	66.0	29	14.8	23.2	22.3	0	672	.150	9.93	1337
19	2300	47.0	21	16.3	20.4	23.3	0	555	.130	9.37	835
20	2300	21.0	9	17.9	17.4	24.8	0	704	.100	8.93	440
21	2300	5.0	2	19.3	14.5	26.5	0	4570	.100	8.04	205
22	600	0.0	0	18.5	3.8	20.1	0	2504	1.630	9.25	46
23	2300	0.0	0	23.9	4.2	38.1	0	54591	.020	.16	5

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	37.8	600	1.2	.070	0.0	I	R	R	R
2	0.0	22.8	127	5.7	.060	.1	0.0	19.97	111.3	5.0
3	0.0	42.5	124	20.9	.060	.3	0.0	9.31	27.2	4.6
4	0.0	69.5	85	80.7	.050	.5	0.0	6.91	8.5	8.0
5	0.0	83.7	68	130.6	.030	.4	0.0	5.91	4.8	9.2
6	0.0	135.5	102	404.1	.060	1.7	0.0	4.78	3.6	14.3
7	0.0	142.6	184	548.5	0.000	0.0	0.0	3.37	4.4	13.0
8	0.0	144.5	192	625.8	.040	1.9	0.0	3.12	4.1	13.5
9	0.0	176.6	885	688.9	0.000	0.0	0.0	3.41	17.1	13.3
10	0.0	299.5	8726	290.4	0.000	0.0	0.0	5.31	154.6	5.1
11	0.0	40.0	622	1.4	.070	0.0	I	R	R	R
12	0.0	880.7	77	.5	.120	0.0	I	R	R	R
13	0.0	333.1	15414	507.3	.025	2.9	0.0	2.90	134.3	4.4
14	0.0	148.3	8107	920.5	.055	5.8	0.0	1.41	76.8	8.7
15	0.0	26.6	2077	735.7	.035	3.3	0.0	.28	22.1	7.8
16	0.0	39.0	1271	738.4	.060	5.2	0.0	.45	14.7	8.6
17	0.0	108.2	475	1235.0	.060	3.4	0.0	1.89	8.3	21.5
18	0.0	69.7	314	460.5	0.000	0.0	0.0	2.41	10.9	15.9
19	0.0	53.7	254	268.5	.065	1.3	0.0	2.61	12.4	13.0
20	0.0	61.1	175	126.7	0.000	0.0	0.0	6.64	19.0	13.8
21	0.0	349.6	155	52.1	0.000	0.0	0.0	159.68	70.6	23.8
22	0.0	38.8	510	2.4	.080	0.0	I	R	R	R
23	0.0	1844.3	14	.5	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	10.409	GRAM/BHP HR
	CO	44.742	GRAM/BHP HR
	NO2	10.624	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.667	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-23-72 RUN-3 ENG.1-3 72-VERSION W/AIR TDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	16.2	3.2	21.6	0	1876	.310	10.89	65
2	1200	4.0	1	19.6	6.8	25.1	0	436	.130	9.50	57
3	1200	17.0	4	18.8	8.3	25.0	0	871	.150	9.50	130
4	1200	38.0	9	16.8	9.4	24.5	0	1015	.130	9.78	265
5	1200	53.0	12	15.1	10.5	24.0	0	1138	.130	10.09	350
6	1200	105.0	24	10.4	15.3	23.1	0	1362	.100	10.55	820
7	1200	158.0	36	2.0	23.8	20.5	0	756	.180	11.84	1212
8	1200	172.0	39	1.8	24.7	19.7	0	704	.310	12.34	1300
9	1200	193.0	44	1.7	27.4	18.0	0	727	.740	12.94	1150
10	1200	210.0	48	.3	31.8	15.9	0	1085	2.730	12.59	530
11	600	0.0	0	16.5	3.4	20.6	0	1940	.700	11.01	68
12	1200	0.0	0	21.5	3.8	30.7	0	31956	.210	4.03	10
13	2300	232.0	102	1.3	64.3	15.3	0	933	3.700	12.71	560
14	2300	213.0	93	2.2	59.5	15.2	0	1151	4.020	12.34	840
15	2300	190.0	83	2.4	54.3	16.4	0	260	1.770	13.48	855
16	2300	174.0	76	2.6	50.5	17.9	0	42	.470	13.33	635
17	2300	116.0	51	10.5	31.2	20.7	0	205	.210	11.72	1750
18	2300	58.0	25	14.8	21.4	22.3	0	190	.150	10.89	800
19	2300	42.0	18	15.8	20.6	23.4	0	200	.130	10.43	540
20	2300	19.0	8	17.4	17.6	25.1	0	180	.100	9.64	300
21	2300	5.0	2	18.5	15.2	26.8	0	477	.100	9.03	157
22	600	0.0	0	16.7	3.4	21.7	0	1737	.520	11.01	70
23	2300	0.0	0	23.4	4.0	42.8	0	53629	.070	.19	6

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	23.9	80	2.8	.070	0.0	I	R	R	R
2	0.0	13.9	84	6.0	.060	.1	0.0	15.20	91.6	6.6
3	0.0	33.7	117	16.7	.060	.2	0.0	8.67	30.2	4.3
4	0.0	43.2	112	37.5	.050	.4	0.0	4.98	12.9	4.3
5	0.0	52.5	121	53.6	.030	.4	0.0	4.33	10.0	4.4
6	0.0	87.6	130	175.2	.060	1.4	0.0	3.65	5.4	7.3
7	0.0	67.4	325	359.3	0.000	0.0	0.0	1.87	9.0	10.0
8	0.0	62.0	552	380.1	.040	1.6	0.0	1.58	14.0	9.7
9	0.0	65.7	1351	345.0	0.000	0.0	0.0	1.49	30.6	7.8
10	0.0	101.4	5156	164.5	0.000	0.0	0.0	2.11	107.5	3.4
11	0.0	25.1	183	2.9	.070	0.0	I	R	R	R
12	0.0	740.8	98	.8	.120	0.0	I	R	R	R
13	0.0	164.9	13209	328.6	.025	2.5	0.0	1.62	130.0	3.2
14	0.0	188.6	13303	456.9	.055	5.1	0.0	2.02	142.6	4.9
15	0.0	41.9	5765	457.7	.035	2.9	0.0	.50	69.3	5.5
16	0.0	7.0	1575	349.8	.060	4.6	0.0	.09	20.7	4.6
17	0.0	24.3	502	688.0	.060	3.0	0.0	.48	9.9	13.5
18	0.0	16.7	266	233.1	0.000	0.0	0.0	.66	10.5	9.2
19	0.0	17.7	232	158.3	.065	1.2	0.0	.96	12.6	8.6
20	0.0	14.7	165	81.5	0.000	0.0	0.0	1.77	19.9	9.8
21	0.0	35.8	152	39.3	0.000	0.0	0.0	16.37	69.3	17.9
22	0.0	22.9	138	3.1	.080	0.0	I	R	R	R
23	0.0	1730.5	46	.6	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	9.845	GRAM/BHP HR
	CO	63.782	GRAM/BHP HR
	NO2	6.523	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.768	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY
8-23-72 RUN-2 ENG.1-3 72-VERSION STD. TIMING +JETS W/AIR

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.5	3.6	19.8	0	2735	1.410	9.93	41
2	1200	5.0	1	20.0	6.5	24.0	0	761	.180	9.25	54
3	1200	18.0	4	19.2	7.3	24.2	0	936	.150	9.37	141
4	1200	41.0	9	17.3	9.5	24.1	0	1350	.100	9.50	440
5	1200	57.0	13	15.8	10.8	23.9	0	1461	.100	9.64	575
6	1200	114.0	26	10.5	15.0	22.9	0	1696	.070	10.09	1275
7	1200	171.0	39	3.1	22.7	20.9	0	1137	.130	11.13	1450
8	1200	187.0	43	1.9	23.9	20.1	0	1185	.180	11.48	1650
9	1200	210.0	48	1.7	27.3	18.0	0	1234	.810	12.34	1600
10	1200	228.0	52	.3	31.9	15.5	0	1901	3.380	11.60	675
11	600	0.0	0	17.6	3.5	19.3	0	2563	1.940	9.78	46
12	1200	0.0	0	22.3	3.5	30.7	0	38627	.210	3.04	7
13	2300	250.0	109	1.3	67.3	14.9	0	1137	3.660	12.34	715
14	2300	230.0	101	2.2	59.8	14.8	0	1463	3.700	12.22	1125
15	2300	205.0	90	2.4	53.5	16.2	0	383	1.480	12.94	1050
16	2300	188.0	82	2.5	50.2	17.2	0	105	.520	13.06	855
17	2300	125.0	55	10.0	33.2	19.9	0	375	.210	11.48	2250
18	2300	63.0	28	14.9	22.5	21.8	0	313	.150	10.43	1000
19	2300	45.0	20	16.2	20.2	23.0	0	309	.130	9.93	680
20	2300	20.0	9	17.5	17.8	24.2	0	261	.100	9.50	370
21	2300	5.0	2	19.2	14.0	26.3	0	1539	.130	8.54	167
22	600	0.0	0	17.4	3.6	20.2	0	2432	1.770	9.64	49
23	2300	0.0	0	24.0	3.5	45.1	0	49082	.050	.13	6

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	38.5	400	1.9	.070	0.0	I	R	R	R
2	0.0	23.6	113	5.6	.060	.1	0.0	20.66	98.7	4.9
3	0.0	32.2	104	16.1	.060	.2	0.0	7.84	25.4	3.9
4	0.0	59.8	89	64.7	.050	.5	0.0	6.38	9.5	6.9
5	0.0	72.4	100	94.6	.030	.4	0.0	5.56	7.7	7.3
6	0.0	111.7	93	278.8	.060	1.6	0.0	4.29	3.6	10.7
7	0.0	103.0	238	435.8	0.000	0.0	0.0	2.64	6.1	11.2
8	0.0	109.1	335	504.2	.040	1.7	0.0	2.55	7.8	11.8
9	0.0	115.1	1526	495.6	0.000	0.0	0.0	2.40	31.8	10.3
10	0.0	181.4	6512	213.8	0.000	0.0	0.0	3.48	125.0	4.1
11	0.0	34.0	519	2.0	.070	0.0	I	R	R	R
12	0.0	862.2	95	.5	.120	0.0	I	R	R	R
13	0.0	215.3	14006	449.7	.025	2.7	0.0	1.97	127.9	4.1
14	0.0	247.0	12619	630.6	.055	5.5	0.0	2.45	125.3	6.3
15	0.0	64.3	5018	585.1	.035	3.1	0.0	.72	55.9	6.5
16	0.0	17.5	1760	475.6	.060	4.9	0.0	.21	21.4	5.8
17	0.0	48.1	545	959.2	.060	3.3	0.0	.88	10.0	17.5
18	0.0	30.1	291	319.3	0.000	0.0	0.0	1.09	10.6	11.6
19	0.0	28.1	238	205.0	.065	1.3	0.0	1.43	12.1	10.4
20	0.0	21.9	169	103.0	0.000	0.0	0.0	2.50	19.3	11.8
21	0.0	110.8	189	40.0	0.000	0.0	0.0	50.59	86.3	18.3
22	0.0	34.1	501	2.3	.080	0.0	I	R	R	R
23	0.0	1531.4	32	.6	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	9.842	GRAM/BHP HR
	CO	60.338	GRAM/BHP HR
	NO2	8.303	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.712	LB/BHP HR

ENGINE 1-3

EFFECT OF EXHAUST MANIFOLD

AIR INJECTION ON EMISSIONS

GRAPHED RESULTS

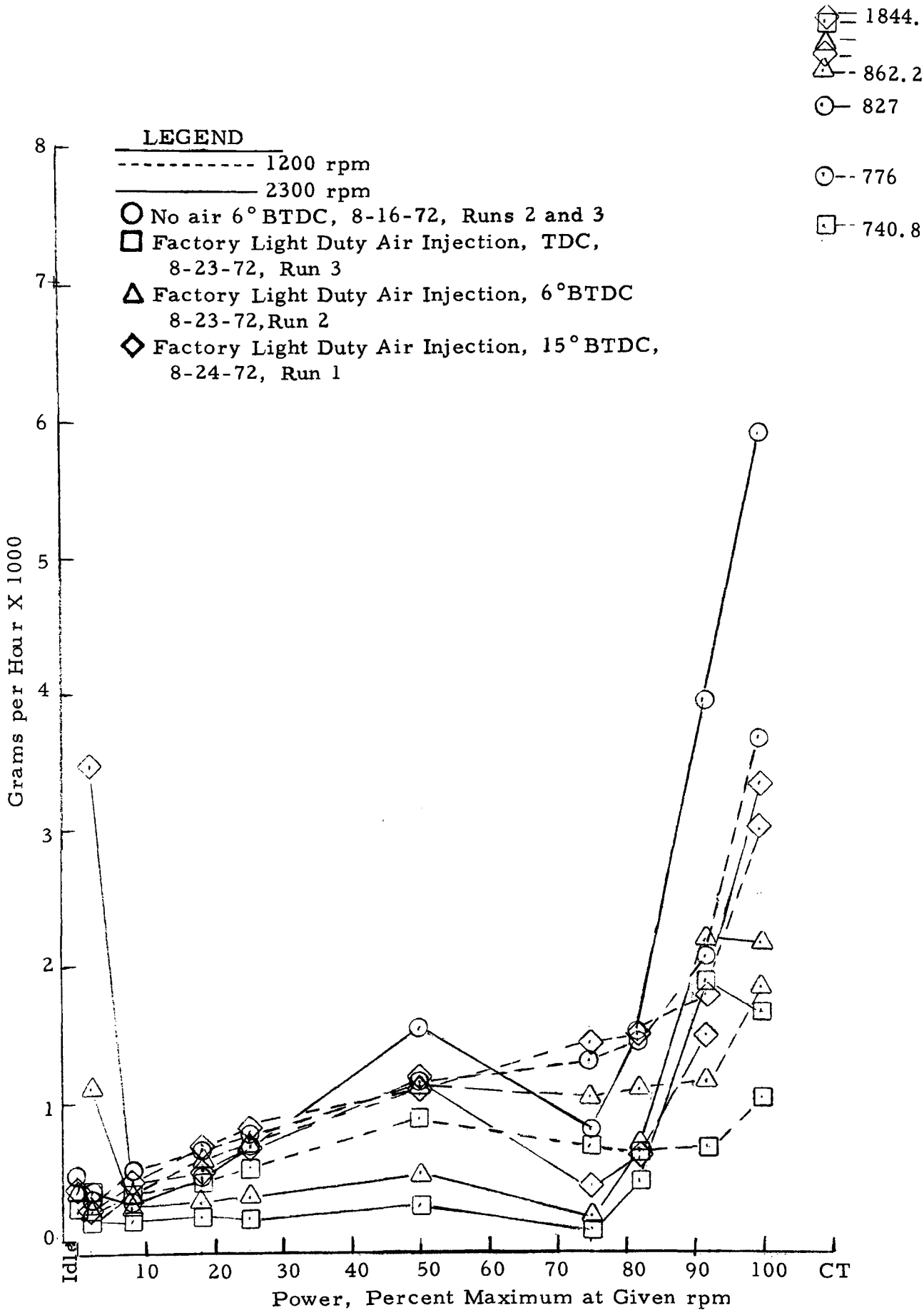


FIGURE T-1. EFFECT OF EXHAUST MANIFOLD AIR INJECTION ON HC EMISSION RATE
ENGINE 1-3, 23 MODE TEST

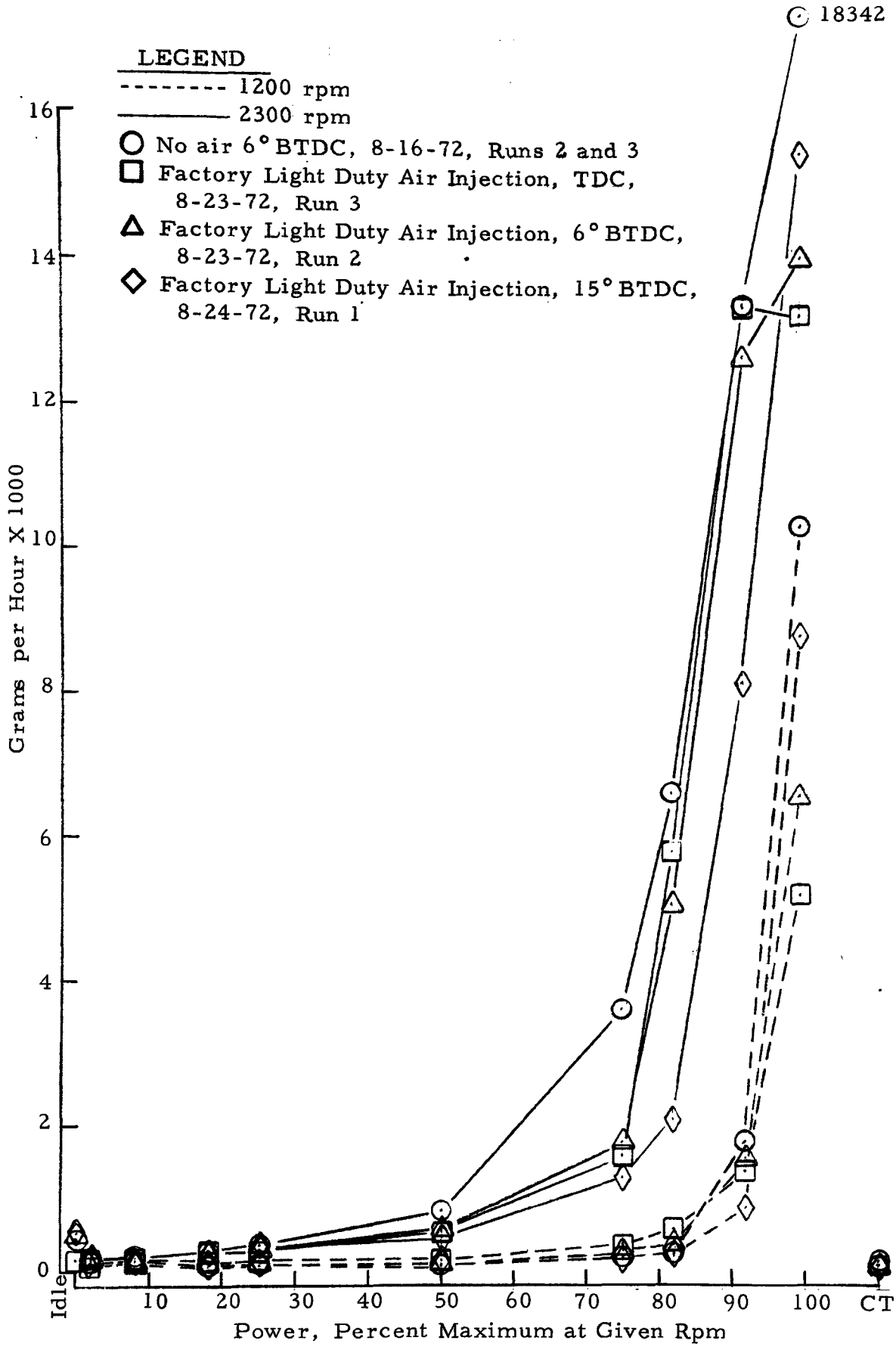


FIGURE T-2. EFFECT OF EXHAUST MANIFOLD AIR INJECTION ON CO EMISSION RATE
ENGINE 1-3, 23 MODE TEST

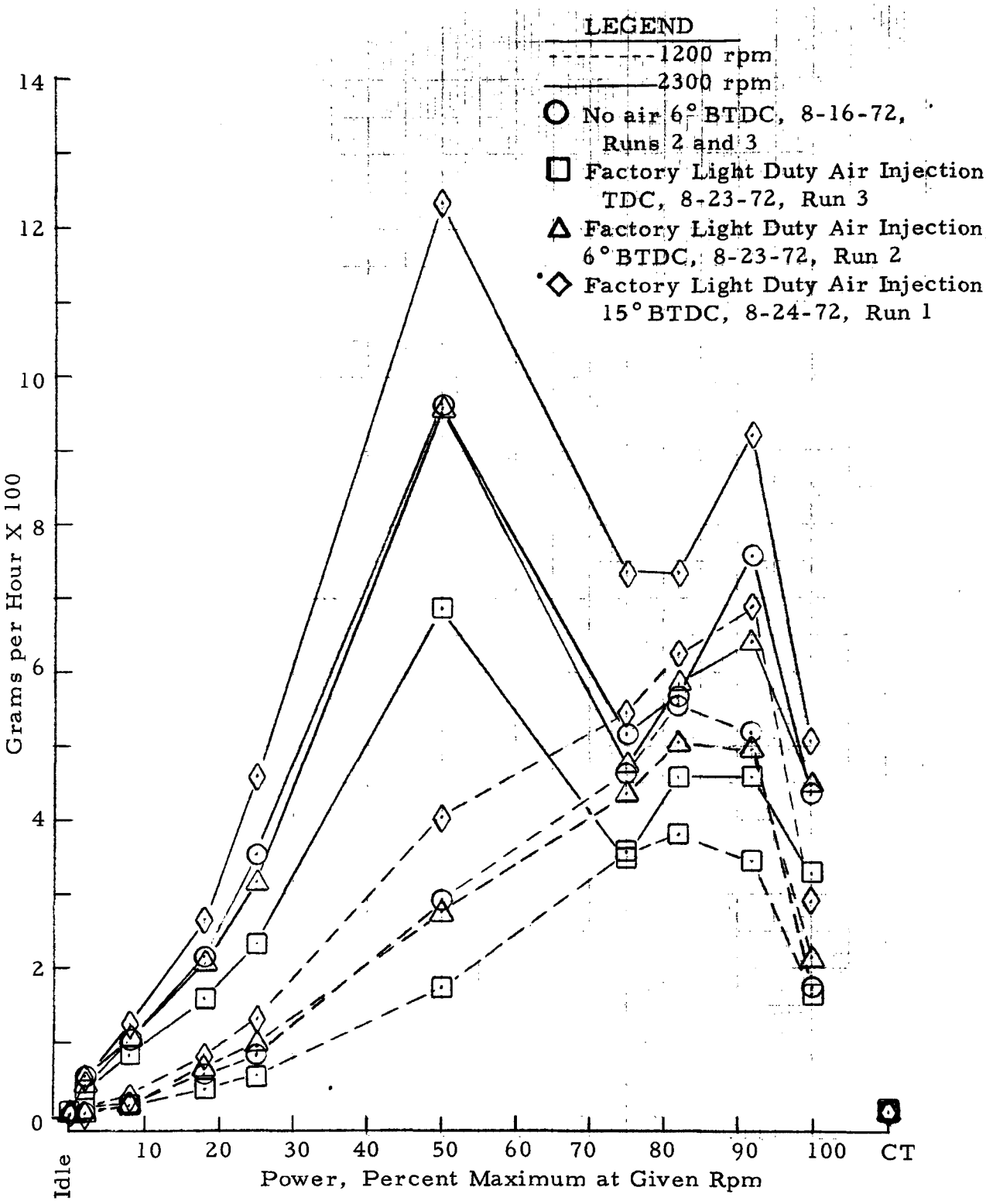


FIGURE T-3. EFFECT OF EXHAUST MANIFOLD AIR INJECTION ON NO_x (AS NO_2) EMISSION RATE ENGINE 1-3, 23 MODE TEST

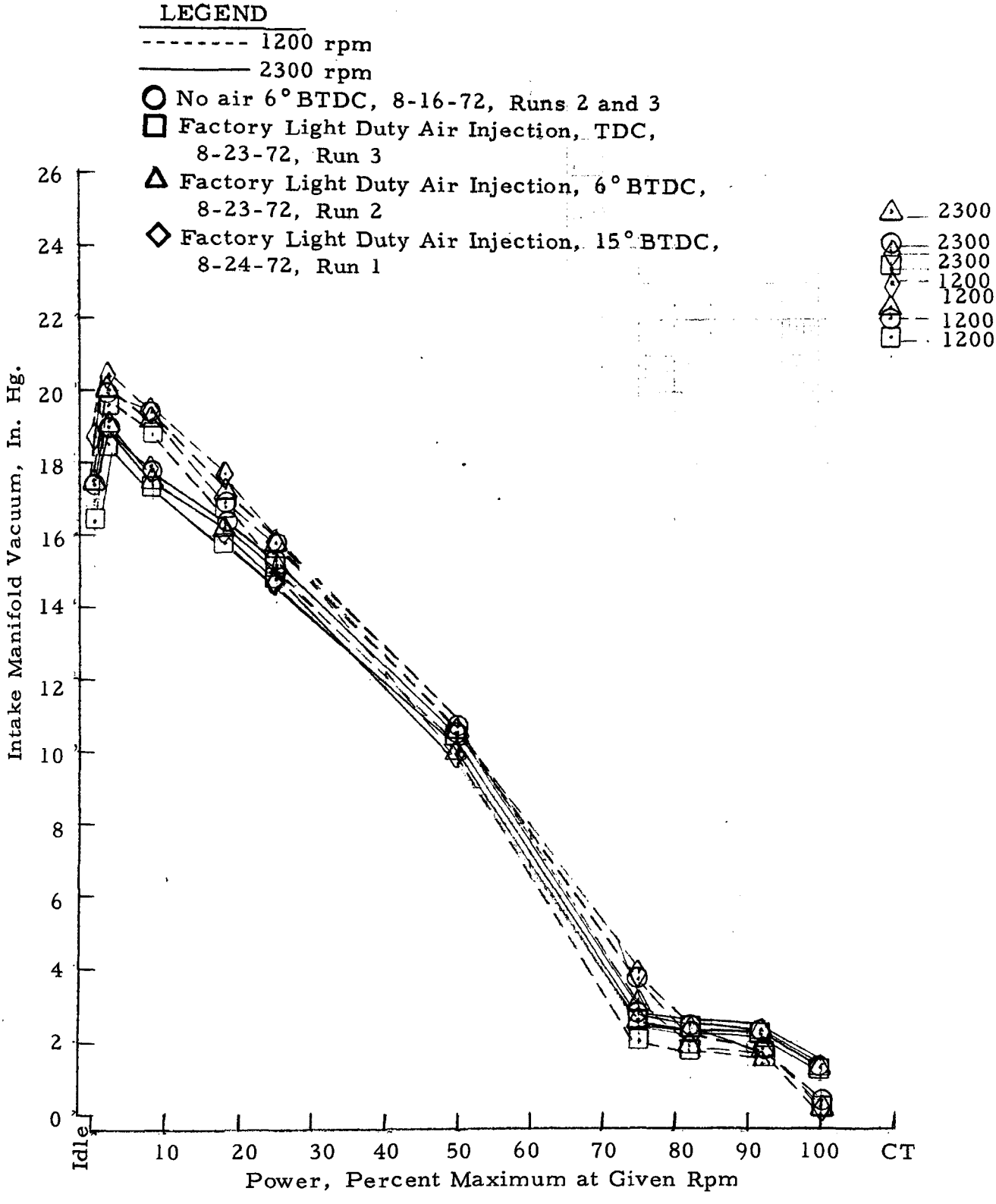


FIGURE T-4. MANIFOLD VACUUM AS A FUNCTION OF POWER
ENGINE 1-3, 23 MODE TEST

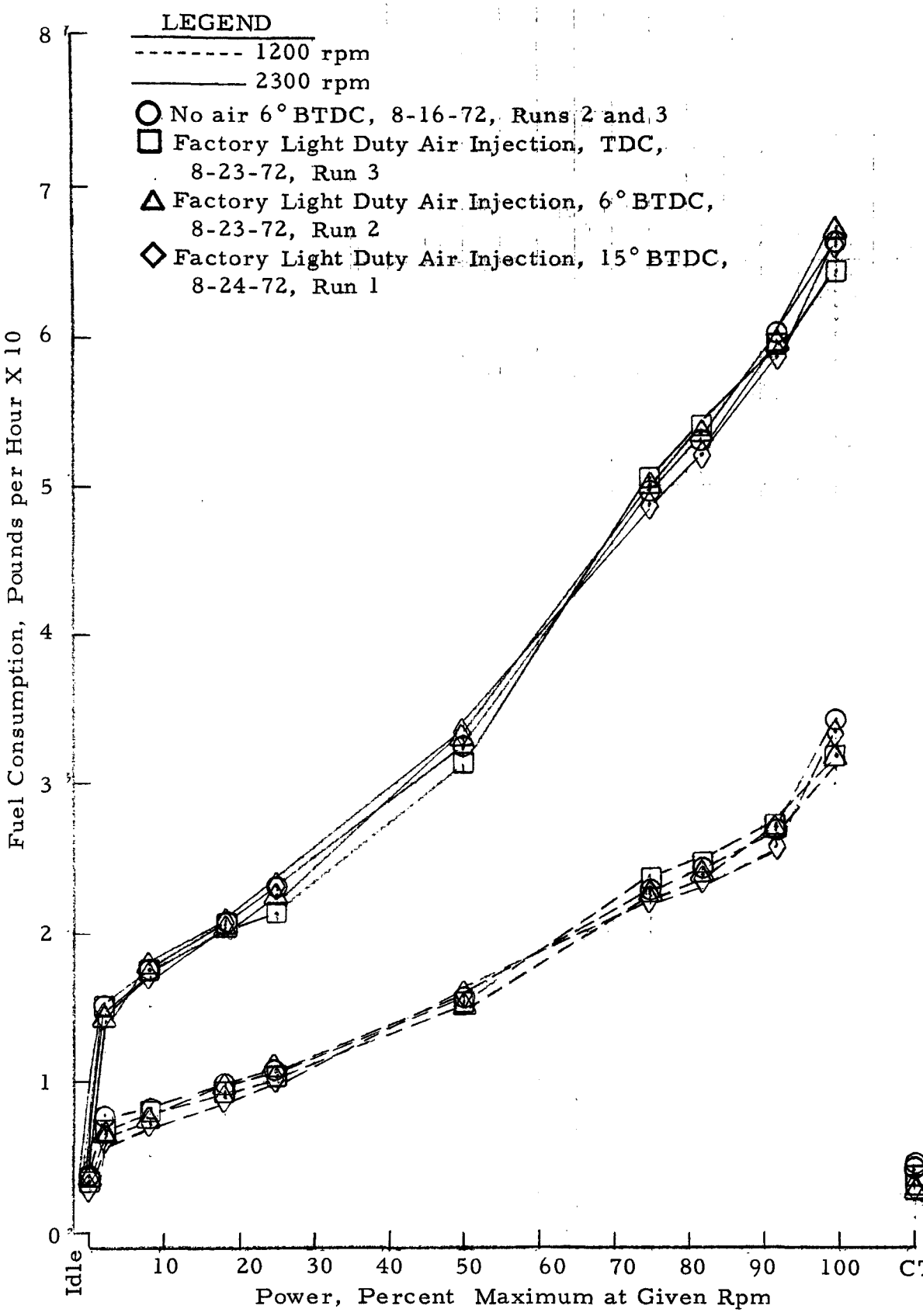


FIGURE T-5. FUEL CONSUMPTION AS A FUNCTION OF POWER
ENGINE 1-3, 23 MODE TEST

APPENDIX U

ENGINE 1-3

EFFECT OF OXIDATION CATALYST ON EMISSIONS

(23 MODE MASS RESULTS)

ENGINE 1-3

EFFECT OF OXIDATION CATALYST ON EMISSIONS

TABULAR DATA

(BEFORE CATALYST)

PROJECT 11-2877-01 CONTROL TECHNOLOGY
8-24-72 RUN-2 ENG.1-3 72 VERSION 6 BTDC O-CAT STD TIM W/AIR BEFORE

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.5	4.0	17.6	0	2191	1.160	10.66	31
2	1200	5.0	1	19.8	6.6	20.6	0	383	.180	10.09	66
3	1200	19.0	4	19.5	7.1	20.5	0	641	.180	10.09	100
4	1200	42.0	10	18.3	8.5	20.2	0	1009	.180	10.25	270
5	1200	59.0	13	16.6	10.2	19.9	0	1152	.100	10.43	515
6	1200	118.0	27	10.0	16.0	19.5	0	1572	.070	10.66	1313
7	1200	177.0	40	2.3	23.2	18.0	0	998	.130	11.60	1438
8	1200	194.0	44	1.9	24.6	17.2	0	623	.210	11.92	1662
9	1200	217.0	50	1.6	27.9	15.1	0	503	.930	13.18	1387
10	1200	236.0	54	.3	32.5	13.3	0	1490	4.070	11.72	560
11	600	0.0	0	17.5	3.9	16.8	0	2201	1.800	10.55	44
12	1200	0.0	0	22.1	4.2	26.7	0	23559	.250	4.84	8
13	2300	242.0	106	1.3	66.9	12.1	0	2983	6.370	10.78	410
14	2300	223.0	98	2.2	60.2	12.6	0	2249	5.240	11.36	760
15	2300	198.0	87	2.4	54.3	13.7	0	1052	3.010	12.47	1875
16	2300	182.0	80	2.5	52.1	14.4	0	751	2.140	12.71	685
17	2300	121.0	53	10.1	32.6	17.9	0	421	.150	11.48	1875
18	2300	61.0	27	14.7	23.6	19.8	0	253	.100	10.55	750
19	2300	44.0	19	15.7	21.8	20.1	0	216	.100	10.25	545
20	2300	19.0	8	17.6	18.1	21.1	0	136	.070	9.64	260
21	2300	5.0	2	18.7	15.8	22.1	0	542	.100	9.03	176
22	600	0.0	0	17.7	4.1	17.4	0	1937	1.770	9.78	42
23	2300	0.0	0	23.8	4.5	35.6	0	53186	.050	.33	8

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	33.0	353	1.6	.070	0.0	I	R	R	R
2	0.0	11.1	106	6.4	.060	.1	0.0	9.74	92.4	5.6
3	0.0	20.0	113	10.3	.060	.3	0.0	4.60	26.1	2.4
4	0.0	36.9	133	32.8	.050	.5	0.0	3.85	13.9	3.4
5	0.0	50.1	88	74.3	.030	.4	0.0	3.72	6.5	5.5
6	0.0	104.8	94	290.5	.060	1.6	0.0	3.89	3.5	10.8
7	0.0	88.7	234	424.6	0.000	0.0	0.0	2.19	5.8	10.5
8	0.0	57.0	388	505.2	.040	1.8	0.0	1.29	8.8	11.4
9	0.0	45.0	1679	411.7	0.000	0.0	0.0	.91	33.9	8.3
10	0.0	137.8	7604	172.0	0.000	0.0	0.0	2.56	141.0	3.2
11	0.0	31.0	512	2.1	.070	0.0	I	R	R	R
12	0.0	602.8	129	.6	.120	0.0	I	R	R	R
13	0.0	518.9	22379	236.7	.025	2.6	0.0	4.90	211.2	2.2
14	0.0	365.1	17179	409.5	.055	5.4	0.0	3.74	175.9	4.2
15	0.0	166.2	9609	983.8	.035	3.0	0.0	1.92	110.8	11.3
16	0.0	118.9	6845	360.1	.060	4.8	0.0	1.49	85.9	4.5
17	0.0	53.3	384	788.6	.060	3.2	0.0	1.01	7.2	14.9
18	0.0	25.3	203	249.7	0.000	0.0	0.0	.95	7.6	9.3
19	0.0	20.6	193	172.5	.065	1.3	0.0	1.07	10.0	9.0
20	0.0	11.5	119	72.9	0.000	0.0	0.0	1.38	14.3	8.8
21	0.0	42.3	158	45.7	0.000	0.0	0.0	19.32	72.0	20.9
22	0.0	30.7	566	2.2	.080	0.0	I	R	R	R
23	0.0	1905.1	36	.9	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	10.368	GRAM/BHP HR
	CO	98.659	GRAM/BHP HR
	NO2	7.481	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.745	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-25-72 RUN-1 ENG.1-3 1972 VER B O-CAT W/AIR 6 BTDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.5	3.9	17.7	0	2340	1.340	11.01	58
2	1200	5.0	1	19.9	7.6	20.7	0	346	.210	10.43	55
3	1200	18.0	4	19.2	8.2	20.5	0	704	.210	10.55	122
4	1200	41.0	9	17.8	9.4	20.2	0	991	.150	10.78	325
5	1200	58.0	13	16.0	10.9	20.4	0	1034	.130	10.66	430
6	1200	115.0	26	10.2	15.3	19.7	0	1456	.130	11.01	988
7	1200	173.0	40	2.1	24.2	18.0	0	585	.150	12.22	1250
8	1200	189.0	43	1.8	25.8	17.0	0	442	.280	12.71	1462
9	1200	212.0	48	1.7	27.5	15.7	0	379	.550	13.77	1412
10	1200	230.0	53	.3	33.4	13.4	0	1231	4.020	12.22	505
11	600	0.0	0	17.6	4.0	17.2	0	1899	1.660	11.01	42
12	1200	0.0	0	22.0	4.3	27.8	0	27130	.250	4.45	8
13	2300	242.0	106	1.3	66.4	12.2	0	2695	6.440	10.78	420
14	2300	223.0	98	1.7	59.1	12.8	0	1967	5.030	11.92	845
15	2300	198.0	87	2.3	54.5	13.7	0	929	3.190	12.71	763
16	2300	182.0	80	2.4	51.7	14.3	0	628	2.210	13.18	675
17	2300	121.0	53	10.1	32.7	17.6	0	334	.180	12.22	1938
18	2300	61.0	27	14.6	24.0	19.6	0	226	.100	11.01	850
19	2300	44.0	19	15.9	21.3	20.0	0	173	.100	10.78	570
20	2300	19.0	8	17.5	18.1	20.8	0	493	.070	10.25	300
21	2300	5.0	2	18.8	15.4	22.1	0	696	.070	9.37	180
22	600	0.0	0	17.5	4.0	17.8	0	1749	1.410	10.55	44
23	2300	0.0	0	23.8	4.4	40.4	0	47636	.050	.26	4

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	32.9	381	2.7	.070	0.0	I	R	R	R
2	0.0	11.2	137	5.9	.060	.1	0.0	9.78	119.9	5.2
3	0.0	24.2	146	14.0	.060	.2	0.0	5.88	35.4	3.4
4	0.0	38.3	117	41.7	.050	.5	0.0	4.09	12.5	4.5
5	0.0	46.9	119	64.8	.030	.4	0.0	3.54	9.0	4.9
6	0.0	89.5	161	201.6	.060	1.6	0.0	3.41	6.1	7.7
7	0.0	51.7	268	366.5	0.000	0.0	0.0	1.31	6.8	9.3
8	0.0	39.7	508	436.0	.040	1.7	0.0	.92	11.8	10.1
9	0.0	33.0	965	407.4	0.000	0.0	0.0	.68	19.9	8.4
10	0.0	114.0	7519	155.2	0.000	0.0	0.0	2.17	143.1	3.0
11	0.0	26.8	473	2.0	.070	0.0	I	R	R	R
12	0.0	713.8	133	.7	.120	0.0	I	R	R	R
13	0.0	464.2	22403	240.1	.025	2.6	0.0	4.38	211.4	2.3
14	0.0	307.5	15885	438.6	.055	5.4	0.0	3.15	162.7	4.5
15	0.0	143.6	9961	391.3	.035	3.0	0.0	1.66	114.9	4.5
16	0.0	95.3	6775	340.1	.060	4.8	0.0	1.20	85.0	4.3
17	0.0	39.9	434	767.4	.060	3.2	0.0	.75	8.2	14.5
18	0.0	22.1	198	276.0	0.000	0.0	0.0	.83	7.4	10.3
19	0.0	15.4	179	167.8	.065	1.3	0.0	.80	9.3	8.7
20	0.0	39.0	112	78.9	0.000	0.0	0.0	4.69	13.5	9.5
21	0.0	51.1	104	43.9	0.000	0.0	0.0	23.35	47.4	20.0
22	0.0	26.2	426	2.2	.080	0.0	I	R	R	R
23	0.0	1873.9	40	.6	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	10.480	GRAM/BHP HR
	CO	96.753	GRAM/BHP HR
	NO2	6.324	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.752	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-25-72 RUN-3 ENG.1-3 1972 VER B O-CAT W/AIR MODI TDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	16.7	3.8	17.9	0	1965	1.050	10.89	51
2	1200	4.0	1	20.0	7.6	22.2	0	413	.130	9.37	50
3	1200	16.0	4	19.1	8.5	21.3	0	541	.150	9.93	138
4	1200	37.0	8	17.5	9.6	20.8	0	679	.130	10.09	275
5	1200	52.0	12	15.9	10.7	20.8	0	701	.130	10.25	390
6	1200	103.0	24	10.4	15.6	20.2	0	1153	.100	10.55	850
7	1200	155.0	35	1.8	23.5	18.4	0	344	.100	11.72	1088
8	1200	169.0	39	1.7	25.0	17.5	0	295	.150	12.22	1288
9	1200	190.0	43	1.6	27.4	15.9	0	212	.350	13.33	1313
10	1200	206.0	47	.3	32.8	13.6	0	917	3.520	12.34	500
11	600	0.0	0	16.8	3.9	17.3	0	1895	1.590	10.78	59
12	1200	0.0	0	22.0	4.2	27.2	0	26115	.280	4.54	16
13	2300	222.0	97	1.3	65.7	13.2	0	792	4.160	11.84	315
14	2300	204.0	89	2.1	58.3	14.2	0	214	2.110	12.94	705
15	2300	182.0	80	2.3	54.2	15.2	0	74	.850	12.94	620
16	2300	167.0	73	2.4	51.5	15.8	0	67	.470	12.94	555
17	2300	111.0	49	10.5	32.0	19.7	0	368	.130	10.43	1538
18	2300	56.0	25	14.9	23.5	20.9	0	246	.100	9.78	600
19	2300	40.0	18	15.7	21.6	20.7	0	196	.070	9.37	500
20	2300	18.0	8	17.2	18.6	20.7	0	135	.070	9.14	275
21	2300	4.0	2	18.3	16.5	20.9	0	184	.070	8.93	188
22	600	0.0	0	16.7	3.8	16.8	0	1814	1.520	9.93	48
23	2300	0.0	0	23.7	4.6	25.5	0	54621	.050	.19	5

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	27.9	301	2.4	.070	0.0	I	R	R	R
2	0.0	14.9	95	6.0	.060	.1	0.0	16.34	103.8	6.6
3	0.0	20.6	115	17.4	.060	.2	0.0	5.63	31.5	4.8
4	0.0	28.7	111	38.6	.050	.4	0.0	3.40	13.1	4.6
5	0.0	32.6	122	60.1	.030	.4	0.0	2.74	10.3	5.1
6	0.0	75.8	133	185.5	.060	1.4	0.0	3.22	5.6	7.9
7	0.0	30.9	182	324.8	0.000	0.0	0.0	.87	5.1	9.2
8	0.0	27.0	277	391.1	.040	1.5	0.0	.70	7.2	10.1
9	0.0	19.2	641	395.4	0.000	0.0	0.0	.44	14.8	9.1
10	0.0	85.6	6632	154.8	0.000	0.0	0.0	1.82	140.9	3.3
11	0.0	26.7	452	2.8	.070	0.0	I	R	R	R
12	0.0	669.5	145	1.4	.120	0.0	I	R	R	R
13	0.0	146.8	15575	193.8	.025	2.4	0.0	1.51	160.2	2.0
14	0.0	37.6	7479	410.7	.055	4.9	0.0	.42	83.7	4.6
15	0.0	13.3	3059	366.8	.035	2.8	0.0	.17	38.4	4.6
16	0.0	11.7	1653	320.8	.060	4.4	0.0	.16	22.6	4.4
17	0.0	50.4	360	699.4	.060	2.9	0.0	1.04	7.4	14.4
18	0.0	26.4	217	214.4	0.000	0.0	0.0	1.08	8.9	8.7
19	0.0	20.3	146	171.9	.065	1.1	0.0	1.16	8.4	9.8
20	0.0	12.3	129	83.5	0.000	0.0	0.0	1.56	16.4	10.6
21	0.0	15.3	117	51.8	0.000	0.0	0.0	8.72	67.0	29.6
22	0.0	26.9	455	2.4	.080	0.0	I	R	R	R
23	0.0	1998.7	37	.6	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	10.079	GRAM/BHP HR
	CO	52.584	GRAM/BHP HR
	NO2	6.434	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.818	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-25-72 RUN-2 ENG.1-3 1972 VER B O-CAT W/AIR MODI 6 BTDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.7	4.1	18.1	0	1970	1.200	10.66	41
2	1200	4.0	1	20.0	7.2	21.3	0	334	.180	9.93	59
3	1200	18.0	4	19.4	8.1	21.4	0	611	.150	9.78	145
4	1200	40.0	9	18.2	9.2	21.1	0	820	.130	9.93	360
5	1200	56.0	13	16.2	10.8	20.7	0	867	.100	10.43	520
6	1200	111.0	25	10.8	15.7	19.9	0	1200	.100	10.78	1125
7	1200	167.0	38	2.7	23.6	18.5	0	599	.130	11.72	1200
8	1200	182.0	42	1.9	24.5	18.1	0	528	.130	11.92	1375
9	1200	204.0	47	1.7	26.7	16.4	0	404	.390	12.71	1575
10	1200	222.0	51	.3	33.7	13.5	0	1137	3.790	12.22	570
11	600	0.0	0	17.6	4.0	17.3	0	1828	1.840	10.56	45
12	1200	0.0	0	22.8	4.4	27.4	0	24074	.210	4.84	22
13	2300	236.0	103	1.3	66.7	13.2	0	909	4.160	12.09	385
14	2300	217.0	95	1.9	66.4	12.5	0	1155	5.670	11.13	270
15	2300	194.0	85	2.4	53.3	15.0	0	111	1.010	13.33	760
16	2300	177.0	78	2.5	50.2	15.7	0	61	.470	13.06	600
17	2300	118.0	52	10.4	32.0	19.5	0	429	.150	10.66	1800
18	2300	59.0	26	14.8	23.0	20.5	0	279	.100	10.09	800
19	2300	42.0	18	16.0	21.3	21.1	0	229	.070	9.64	550
20	2300	19.0	8	17.6	18.3	22.1	0	166	.050	9.14	290
21	2300	5.0	2	18.5	16.0	23.1	0	405	.050	8.68	195
22	600	0.0	0	17.5	4.0	18.2	0	1830	1.450	9.64	44
23	2300	0.0	0	23.8	4.5	38.3	0	51113	.050	.19	6

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	30.4	374	2.1	.070	0.0	I	R	R	R
2	0.0	10.7	117	6.3	.060	.1	0.0	11.75	128.1	6.9
3	0.0	22.5	111	17.7	.060	.2	0.0	5.47	27.1	4.3
4	0.0	33.7	108	49.2	.050	.5	0.0	3.69	11.8	5.4
5	0.0	40.0	93	79.7	.030	.4	0.0	3.13	7.3	6.2
6	0.0	77.7	131	241.8	.060	1.5	0.0	3.06	5.2	9.5
7	0.0	53.9	236	358.1	0.000	0.0	0.0	1.41	6.2	9.4
8	0.0	48.5	241	419.2	.040	1.7	0.0	1.17	5.8	10.1
9	0.0	37.2	726	481.9	0.000	0.0	0.0	.80	15.6	10.3
10	0.0	107.8	7258	179.4	0.000	0.0	0.0	2.12	143.1	3.5
11	0.0	26.4	536	2.2	.070	0.0	I	R	R	R
12	0.0	644.3	114	2.0	.120	0.0	I	R	R	R
13	0.0	168.3	15559	236.7	.025	2.6	0.0	1.63	150.5	2.3
14	0.0	205.7	20393	159.6	.055	5.2	0.0	2.16	214.6	1.7
15	0.0	18.7	3437	425.1	.035	3.0	0.0	.22	40.5	5.0
16	0.0	10.2	1597	335.1	.060	4.7	0.0	.13	20.6	4.3
17	0.0	57.4	405	799.3	.060	3.1	0.0	1.11	7.8	15.5
18	0.0	28.5	206	271.2	0.000	0.0	0.0	1.10	8.0	10.5
19	0.0	22.7	140	181.3	.065	1.2	0.0	1.24	7.6	9.9
20	0.0	15.0	91	86.8	0.000	0.0	0.0	1.80	10.9	10.4
21	0.0	33.5	84	53.6	0.000	0.0	0.0	15.32	38.2	24.5
22	0.0	29.5	471	2.4	.080	0.0	I	R	R	R
23	0.0	1949.7	39	.8	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	9.719	GRAM/BHP HR
	CO	79.677	GRAM/BHP HR
	NO2	6.141	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.782	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-28-72 RUN-1 ENG.1-3 72 VERSION 15 BTDC 600 RPM B W/AIR MOD O-CAT

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	20.2	4.0	18.3	0	1446	1.590	10.55	26
2	1200	5.0	1	20.9	7.1	21.9	0	443	.280	9.78	54
3	1200	20.0	5	19.9	8.5	21.1	0	975	.550	9.78	132
4	1200	44.0	10	18.6	9.7	20.6	0	1373	.250	10.43	660
5	1200	62.0	14	16.5	10.9	20.7	0	1372	.100	10.43	1012
6	1200	123.0	28	10.4	16.1	20.2	0	1671	.070	10.66	2075
7	1200	185.0	42	4.0	22.6	19.5	0	1148	.100	11.13	1987
8	1200	202.0	46	2.0	24.5	18.9	0	1082	.100	11.13	2350
9	1200	226.0	52	1.6	26.7	17.0	0	1040	.550	12.22	2450
10	1200	246.0	56	.3	34.1	13.9	0	228	5.240	10.09	660
11	600	0.0	0	19.3	3.8	16.6	0	2520	2.870	10.09	33
12	1200	0.0	0	23.0	3.8	32.0	0	26607	.150	3.45	9
13	2300	256.0	112	1.3	66.3	13.4	0	1196	4.300	11.92	565
14	2300	236.0	103	2.1	59.9	14.0	0	612	2.920	12.71	1112
15	2300	210.0	92	2.3	52.3	15.7	0	150	.770	13.18	1250
16	2300	192.0	84	2.5	48.7	16.7	0	126	.310	12.59	1237
17	2300	128.0	56	10.3	32.4	19.5	0	738	.150	10.78	3000
18	2300	64.0	28	14.9	23.2	20.7	0	438	.100	10.25	1475
19	2300	46.0	20	16.3	20.6	21.7	0	321	.070	9.64	900
20	2300	20.0	9	18.0	17.1	22.4	0	283	.070	9.37	495
21	2300	5.0	2	19.1	14.8	23.5	0	1060	.100	8.75	280
22	600	0.0	0	19.0	3.7	17.5	0	2686	2.400	9.25	37
23	2300	0.0	0	24.4	4.0	46.5	0	43044	.020	.09	7

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	21.4	474	1.3	.070	0.0	I	R	R	R
2	0.0	14.1	180	5.8	.060	.1	0.0	12.35	157.8	5.0
3	0.0	36.1	411	16.3	.060	.3	0.0	7.89	89.9	3.6
4	0.0	55.9	205	89.1	.050	.5	0.0	5.56	20.4	8.9
5	0.0	63.6	94	155.8	.030	.4	0.0	4.49	6.6	11.0
6	0.0	112.0	95	461.7	.060	1.7	0.0	3.98	3.4	16.4
7	0.0	103.7	183	596.3	0.000	0.0	0.0	2.45	4.3	14.1
8	0.0	106.0	198	764.7	.040	1.8	0.0	2.30	4.3	16.6
9	0.0	97.8	1045	765.2	0.000	0.0	0.0	1.89	20.2	14.8
10	0.0	23.0	10664	220.8	0.000	0.0	0.0	.41	189.7	3.9
11	0.0	32.9	756	1.4	.070	0.0	I	R	R	R
12	0.0	732.5	83	.8	.120	0.0	I	R	R	R
13	0.0	220.1	15987	345.2	.025	2.8	0.0	1.96	142.6	3.1
14	0.0	106.0	10214	639.6	.055	5.7	0.0	1.03	98.8	6.2
15	0.0	25.4	2642	705.0	.035	3.2	0.0	.28	28.7	7.7
16	0.0	21.5	1071	702.9	.060	5.0	0.0	.26	12.7	8.4
17	0.0	98.5	405	1330.3	.060	3.4	0.0	1.76	7.2	23.7
18	0.0	44.4	205	495.8	0.000	0.0	0.0	1.58	7.3	17.7
19	0.0	30.8	136	286.6	.065	1.3	0.0	1.53	6.7	14.2
20	0.0	23.2	116	134.6	0.000	0.0	0.0	2.64	13.2	15.4
21	0.0	79.5	151	69.7	0.000	0.0	0.0	36.29	69.2	31.8
22	0.0	37.8	683	1.7	.080	0.0	I	R	R	R
23	0.0	1769.2	17	1.0	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	9.189	GRAM/BHP HR
	CO	52.054	GRAM/BHP HR
	NO2	10.613	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.695	LB/BHP HR

ENGINE 1-3

EFFECT OF OXIDATION CATALYST ON EMISSIONS

TABULAR DATA

(AFTER CATALYST)

PROJECT 11-2877-01 CONTROL TECHNOLOGY
8-24-72 RUN-2 ENG.1-3 72 VERSION 6 BTDC O-CATSTD TIM W/AIR AFTER

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.5	4.0	18.8	0	398	.050	11.36	39
2	1200	5.0	1	19.8	6.6	21.2	0	349	.020	9.93	70
3	1200	19.0	4	19.5	7.1	21.1	0	132	.020	9.93	109
4	1200	42.0	10	18.3	8.5	20.7	0	224	.020	10.25	260
5	1200	59.0	13	16.6	10.2	20.8	0	262	.020	10.09	450
6	1200	118.0	27	10.0	16.0	19.9	0	374	.020	10.66	1100
7	1200	177.0	40	2.3	23.2	18.2	0	288	.050	11.48	1387
8	1200	194.0	44	1.9	24.6	17.4	0	286	.050	12.09	1612
9	1200	217.0	50	1.6	27.9	15.3	0	282	.250	13.63	1262
10	1200	236.0	54	.3	32.5	13.5	0	1086	2.920	12.59	650
11	600	0.0	0	17.5	3.9	17.7	0	389	.250	11.92	53
12	1200	0.0	0	22.1	4.2	27.0	0	5926	.050	7.00	8
13	2300	242.0	106	1.3	66.9	12.4	0	2571	5.560	11.24	520
14	2300	223.0	98	2.2	60.2	13.0	0	1811	3.980	12.22	913
15	2300	198.0	87	2.4	54.3	14.2	0	359	1.590	13.48	838
16	2300	182.0	80	2.5	52.1	15.3	0	37	.310	13.33	640
17	2300	121.0	53	10.1	32.6	18.0	0	111	.020	11.60	1787
18	2300	61.0	27	14.7	23.6	20.2	0	79	.020	10.25	630
19	2300	44.0	19	15.7	21.8	20.7	0	72	.020	9.93	460
20	2300	19.0	8	17.6	18.1	22.1	0	50	.020	9.14	215
21	2300	5.0	2	18.7	15.8	23.2	0	297	.020	8.75	140
22	600	0.0	0	17.7	4.1	19.4	0	304	.050	8.84	52
23	2300	0.0	0	23.8	4.5	40.5	0	718	.180	4.64	7

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	6.3	16	2.1	.070	0.0	I	R	R	R
2	0.0	10.5	12	7.0	.060	.1	0.0	9.17	10.6	6.1
3	0.0	4.3	13	11.7	.060	.3	0.0	.99	3.0	2.7
4	0.0	8.4	15	32.3	.050	.5	0.0	.88	1.6	3.4
5	0.0	12.0	18	68.2	.030	.4	0.0	.89	1.4	5.1
6	0.0	25.3	27	247.3	.060	1.6	0.0	.94	1.0	9.2
7	0.0	26.2	92	419.2	0.000	0.0	0.0	.65	2.3	10.4
8	0.0	26.3	93	490.9	.040	1.8	0.0	.59	2.1	11.1
9	0.0	25.7	460	381.2	0.000	0.0	0.0	.52	9.3	7.7
10	0.0	102.5	5567	203.7	0.000	0.0	0.0	1.90	103.2	3.8
11	0.0	5.6	73	2.5	.070	0.0	I	R	R	R
12	0.0	147.7	25	.6	.120	0.0	I	R	R	R
13	0.0	457.4	19981	307.1	.025	2.6	0.0	4.32	188.5	2.9
14	0.0	301.9	13402	505.0	.055	5.4	0.0	3.09	137.2	5.2
15	0.0	58.5	5237	453.4	.035	3.0	0.0	.67	60.4	5.2
16	0.0	6.5	1085	368.0	.060	4.8	0.0	.08	13.6	4.6
17	0.0	14.1	51	754.5	.060	3.2	0.0	.27	1.0	14.2
18	0.0	8.3	42	217.9	0.000	0.0	0.0	.31	1.6	8.2
19	0.0	7.2	40	151.7	.065	1.3	0.0	.37	2.1	7.9
20	0.0	4.5	36	63.9	0.000	0.0	0.0	.54	4.3	7.7
21	0.0	24.2	33	37.9	0.000	0.0	0.0	11.06	15.0	17.3
22	0.0	6.3	21	3.6	.080	0.0	I	R	R	R
23	0.0	30.0	152	1.0	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	2.287	GRAM/BHP HR
	CO	61.065	GRAM/BHP HR
	NO2	6.776	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.745	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-25-72 RUN-1 ENG.1-3 1972 VER A O-CAT W/AIR 6 BTDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.5	3.9	18.8	0	421	.050	11.72	47
2	1200	5.0	1	19.9	7.6	21.1	0	93	.050	10.25	60
3	1200	18.0	4	19.2	8.2	20.8	0	170	.050	10.55	127
4	1200	41.0	9	17.8	9.4	20.5	0	225	.050	10.66	305
5	1200	58.0	13	16.0	10.9	20.7	0	242	.050	10.55	410
6	1200	115.0	26	10.2	15.3	20.0	0	353	.050	11.01	925
7	1200	173.0	40	2.1	24.2	18.2	0	258	.070	11.92	1162
8	1200	189.0	43	1.8	25.8	17.2	0	238	.070	12.71	1425
9	1200	212.0	48	1.7	27.5	16.0	0	240	.100	14.05	1375
10	1200	230.0	53	.3	33.4	13.8	0	1036	3.240	13.06	605
11	600	0.0	0	17.6	4.0	18.3	0	413	.050	12.47	51
12	1200	0.0	0	22.0	4.3	30.6	0	7929	.050	7.09	8
13	2300	242.0	106	1.3	66.4	12.6	0	2315	5.560	11.48	555
14	2300	223.0	98	1.7	59.1	13.4	0	1255	3.610	12.71	1012
15	2300	198.0	87	2.3	54.5	14.3	0	371	1.800	13.63	863
16	2300	182.0	80	2.4	51.7	15.1	0	45	.520	14.05	640
17	2300	121.0	53	10.1	32.7	17.7	0	93	.020	12.22	1875
18	2300	61.0	27	14.6	24.0	19.7	0	81	.020	10.89	720
19	2300	44.0	19	15.9	21.3	20.3	0	69	.020	10.25	465
20	2300	19.0	8	17.5	18.1	21.2	0	51	.020	9.78	235
21	2300	5.0	2	18.8	15.4	22.6	0	433	.020	8.93	144
22	600	0.0	0	17.5	4.0	18.7	0	305	.020	11.60	52
23	2300	0.0	0	23.8	4.4	44.0	0	12546	.180	4.74	4

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	6.3	15	2.3	.070	0.0	I	R	R	R
2	0.0	3.1	34	6.7	.060	.1	0.0	2.73	29.6	5.8
3	0.0	6.0	35	14.8	.060	.2	0.0	1.45	8.6	3.6
4	0.0	9.0	40	40.2	.050	.5	0.0	.96	4.3	4.3
5	0.0	11.2	47	63.3	.030	.4	0.0	.85	3.5	4.8
6	0.0	22.1	63	192.1	.060	1.6	0.0	.84	2.4	7.3
7	0.0	23.6	129	352.6	0.000	0.0	0.0	.60	3.3	8.9
8	0.0	21.7	129	432.4	.040	1.7	0.0	.50	3.0	10.0
9	0.0	21.1	178	401.7	0.000	0.0	0.0	.44	3.7	8.3
10	0.0	95.7	6045	185.5	0.000	0.0	0.0	1.82	115.0	3.5
11	0.0	6.0	15	2.5	.070	0.0	I	R	R	R
12	0.0	194.9	25	.7	.120	0.0	I	R	R	R
13	0.0	403.7	19586	321.3	.025	2.6	0.0	3.81	184.8	3.0
14	0.0	204.5	11887	548.0	.055	5.4	0.0	2.09	121.7	5.6
15	0.0	59.4	5811	457.7	.035	3.0	0.0	.68	67.0	5.3
16	0.0	7.2	1690	341.9	.060	4.8	0.0	.09	21.2	4.3
17	0.0	11.3	49	753.8	.060	3.2	0.0	.21	.9	14.2
18	0.0	8.1	40	238.3	0.000	0.0	0.0	.30	1.5	8.9
19	0.0	6.5	38	145.1	.065	1.3	0.0	.34	2.0	7.5
20	0.0	4.3	34	65.3	0.000	0.0	0.0	.51	4.1	7.9
21	0.0	33.6	31	37.1	0.000	0.0	0.0	15.36	14.3	16.9
22	0.0	4.7	6	2.7	.080	0.0	I	R	R	R
23	0.0	405.5	118	.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	3.128	GRAM/BHP HR
	CO	59.899	GRAM/BHP HR
	NO2	6.627	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.752	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-25-72 RUN-3 ENG.1-3 1972 VER A O-CAT W/AIR MODI TDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	16.7	3.8	19.1	0	349	.050	11.48	57
2	1200	4.0	1	20.0	7.6	22.6	0	136	.050	9.37	54
3	1200	16.0	4	19.1	8.5	22.1	0	137	.050	9.64	135
4	1200	37.0	8	17.5	9.6	21.6	0	147	.050	9.93	260
5	1200	52.0	12	15.9	10.7	21.4	0	173	.050	9.93	350
6	1200	103.0	24	10.4	15.6	20.3	0	242	.050	10.66	775
7	1200	155.0	35	1.8	23.5	18.5	0	155	.050	11.72	963
8	1200	169.0	39	1.7	25.0	17.7	0	139	.050	12.22	1213
9	1200	190.0	43	1.6	27.4	16.2	0	113	.070	13.18	1175
10	1200	260.0	59	.3	32.8	13.5	0	675	2.780	12.71	480
11	600	0.0	0	16.8	3.9	18.3	0	349	.070	11.72	65
12	1200	0.0	0	22.0	4.2	27.2	0	4342	.050	7.37	16
13	2300	222.0	97	1.3	65.7	13.6	0	436	3.100	12.71	380
14	2300	204.0	89	2.1	58.3	14.7	0	53	.640	13.77	790
15	2300	182.0	80	2.3	54.2	15.9	0	54	.050	13.06	650
16	2300	167.0	73	2.4	51.5	16.5	0	53	.050	12.71	550
17	2300	111.0	49	10.5	32.0	19.2	0	108	.020	10.78	1400
18	2300	56.0	25	14.9	23.5	20.8	0	82	.020	9.64	535
19	2300	40.0	18	15.7	21.6	20.8	0	70	.020	9.37	400
20	2300	18.0	8	17.2	18.6	21.1	0	53	.020	8.93	235
21	2300	4.0	2	18.3	16.5	21.5	0	85	.020	8.68	160
22	600	0.0	0	16.7	3.8	17.6	0	331	.050	11.24	56
23	2300	0.0	0	23.7	4.6	33.9	0	303	.150	4.64	4

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	5.2	15	2.8	.070	0.0	I	R	R	R
2	0.0	5.0	37	6.6	.060	.1	0.0	5.43	40.4	7.2
3	0.0	5.5	40	17.8	.060	.2	0.0	1.49	11.0	4.9
4	0.0	6.4	44	37.6	.050	.4	0.0	.76	5.2	4.4
5	0.0	8.4	49	56.4	.030	.4	0.0	.71	4.1	4.7
6	0.0	15.9	67	169.6	.060	1.4	0.0	.68	2.8	7.2
7	0.0	14.0	91	289.2	0.000	0.0	0.0	.40	2.6	8.2
8	0.0	12.8	93	371.8	.040	1.5	0.0	.33	2.4	9.6
9	0.0	10.6	133	365.6	0.000	0.0	0.0	.24	3.1	8.4
10	0.0	64.5	5370	152.4	0.000	0.0	0.0	1.09	90.4	2.6
11	0.0	5.2	21	3.2	.070	0.0	I	R	R	R
12	0.0	105.3	24	1.3	.120	0.0	I	R	R	R
13	0.0	81.9	11771	237.2	.025	2.4	0.0	.84	121.1	2.4
14	0.0	9.8	2372	481.2	.055	4.9	0.0	.11	26.5	5.4
15	0.0	10.1	189	404.5	.035	2.8	0.0	.13	2.4	5.1
16	0.0	9.6	185	334.2	.060	4.4	0.0	.13	2.5	4.6
17	0.0	14.5	54	624.1	.060	2.9	0.0	.30	1.1	12.8
18	0.0	9.0	45	195.8	0.000	0.0	0.0	.37	1.8	8.0
19	0.0	7.3	42	138.5	.065	1.1	0.0	.41	2.4	7.9
20	0.0	5.0	38	73.5	0.000	0.0	0.0	.63	4.8	9.3
21	0.0	7.3	35	45.7	0.000	0.0	0.0	4.19	19.8	26.1
22	0.0	5.0	15	2.8	.080	0.0	I	R	R	R
23	0.0	13.1	131	.6	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	.978	GRAM/BHP HR
	CO	21.208	GRAM/BHP HR
	NO2	6.374	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.818	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-25-72 RUN-2 ENG.1-3 1972 VER A O-CAT W/AIR MODI 6 BTDC

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.7	4.1	19.2	0	420	.050	11.36	50
2	1200	4.0	1	20.0	7.2	22.0	0	112	.020	9.78	64
3	1200	18.0	4	19.4	8.1	22.0	0	156	.020	9.64	142
4	1200	40.0	9	18.2	9.2	21.5	0	200	.020	10.09	320
5	1200	56.0	13	16.2	10.8	21.4	0	219	.020	10.09	430
6	1200	111.0	25	10.8	15.7	20.4	0	302	.020	10.66	1037
7	1200	167.0	38	2.7	23.6	18.6	0	222	.050	11.72	1125
8	1200	182.0	42	1.9	24.5	18.2	0	228	.050	11.92	1287
9	1200	204.0	47	1.7	26.7	16.5	0	213	.070	13.06	1500
10	1200	222.0	51	.3	33.7	13.7	0	820	2.870	12.94	600
11	600	0.0	0	17.6	4.0	18.2	0	328	.050	11.92	54
12	1200	0.0	0	22.8	4.4	27.1	0	5392	.050	7.28	23
13	2300	236.0	103	1.3	66.7	13.5	0	476	3.150	12.71	425
14	2300	217.0	95	1.9	66.4	13.1	0	621	4.120	12.09	345
15	2300	194.0	85	2.4	53.3	15.8	0	37	.070	13.48	775
16	2300	177.0	78	2.5	50.2	16.8	0	40	.020	12.47	625
17	2300	118.0	52	10.4	32.0	18.9	0	120	.020	11.13	1762
18	2300	59.0	26	14.8	23.0	20.8	0	88	.020	9.93	685
19	2300	42.0	18	16.0	21.3	21.6	0	75	.020	9.37	475
20	2300	19.0	8	17.6	18.3	22.8	0	57	.020	8.93	245
21	2300	5.0	2	18.5	16.0	23.8	0	205	.020	8.54	159
22	600	0.0	0	17.5	4.0	18.9	0	320	.020	11.01	53
23	2300	0.0	0	23.8	4.5	45.2	0	936	.180	4.11	4

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	6.8	16	2.7	.070	0.0	I	R	R	R
2	0.0	3.7	13	7.1	.060	.1	0.0	4.09	14.7	7.7
3	0.0	5.9	15	17.9	.060	.2	0.0	1.44	3.7	4.4
4	0.0	8.2	17	43.8	.050	.5	0.0	.90	1.8	4.8
5	0.0	10.6	20	69.0	.030	.4	0.0	.83	1.5	5.4
6	0.0	20.1	27	228.9	.060	1.5	0.0	.79	1.1	9.0
7	0.0	20.1	92	339.1	0.000	0.0	0.0	.53	2.4	8.9
8	0.0	21.1	94	395.9	.040	1.7	0.0	.51	2.3	9.5
9	0.0	19.6	130	458.6	0.000	0.0	0.0	.42	2.8	9.8
10	0.0	78.8	5576	191.6	0.000	0.0	0.0	1.55	109.9	3.8
11	0.0	5.0	15	2.7	.070	0.0	I	R	R	R
12	0.0	136.8	26	1.9	.120	0.0	I	R	R	R
13	0.0	90.5	12102	268.4	.025	2.6	0.0	.88	117.1	2.6
14	0.0	114.9	15404	212.0	.055	5.2	0.0	1.21	162.1	2.2
15	0.0	6.6	252	459.0	.035	3.0	0.0	.08	3.0	5.4
16	0.0	7.3	74	378.2	.060	4.7	0.0	.09	.9	4.9
17	0.0	15.6	53	760.7	.060	3.1	0.0	.30	1.0	14.7
18	0.0	9.3	42	238.2	0.000	0.0	0.0	.36	1.6	9.2
19	0.0	7.7	42	162.1	.065	1.2	0.0	.42	2.3	8.8
20	0.0	5.3	37	75.4	0.000	0.0	0.0	.64	4.5	9.1
21	0.0	17.3	34	44.6	0.000	0.0	0.0	7.92	15.6	20.4
22	0.0	5.2	7	2.9	.080	0.0	I	R	R	R
23	0.0	43.6	169	.6	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	1.427	GRAM/BHP HR
	CO	49.603	GRAM/BHP HR
	NO2	6.215	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.782	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY
8-28-72 RUN-1 ENG.1-3 72 VERSION 15 BTDC 600 RPM A W/AIR MOD O-CAT

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	20.2	4.0	19.1	0	325	.050	11.72	34
2	1200	5.0	1	20.9	7.1	22.7	0	118	.020	9.64	60
3	1200	20.0	5	19.9	8.5	21.5	0	184	.020	10.25	148
4	1200	44.0	10	18.6	9.7	21.1	0	291	.020	10.55	605
5	1200	62.0	14	16.5	10.9	21.3	0	310	.020	10.25	925
6	1200	123.0	28	10.4	16.1	20.5	0	396	.050	10.78	1863
7	1200	185.0	42	4.0	22.6	19.4	0	332	.050	11.36	1900
8	1200	202.0	46	2.0	24.5	19.0	0	382	.050	11.48	2113
9	1200	226.0	52	1.6	26.7	17.1	0	446	.070	12.47	2250
10	1200	246.0	56	.3	34.1	13.7	0	1750	3.470	12.47	810
11	600	0.0	0	19.3	3.8	17.4	0	417	.050	12.71	41
12	1200	0.0	0	23.0	3.8	30.7	0	4770	.020	6.47	9
13	2300	256.0	112	1.3	66.3	13.7	0	587	3.330	12.94	615
14	2300	236.0	103	2.1	59.9	14.5	0	188	1.450	13.77	1313
15	2300	210.0	92	2.3	52.3	16.6	0	40	.050	12.94	1275
16	2300	192.0	84	2.5	48.7	17.7	0	40	.020	12.09	1200
17	2300	128.0	56	10.3	32.4	19.1	0	229	.020	11.01	2900
18	2300	64.0	28	14.9	23.2	21.0	0	151	.020	10.09	1225
19	2300	46.0	20	16.3	20.6	22.1	0	114	.020	9.64	738
20	2300	20.0	9	18.0	17.1	23.3	0	601	.020	8.93	400
21	2300	5.0	2	19.1	14.8	24.5	0	1079	.020	8.54	230
22	600	0.0	0	19.0	3.7	18.0	0	394	.020	11.84	48
23	2300	0.0	0	24.4	4.0	51.6	0	3485	.130	3.40	18

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	5.0	16	1.7	.070	0.0	I	R	R	R
2	0.0	3.9	13	6.6	.060	.1	0.0	3.43	11.8	5.8
3	0.0	6.9	15	18.4	.060	.3	0.0	1.51	3.3	4.0
4	0.0	12.1	17	83.4	.050	.5	0.0	1.20	1.7	8.3
5	0.0	14.9	19	147.4	.030	.4	0.0	1.05	1.4	10.4
6	0.0	26.6	68	415.6	.060	1.7	0.0	.95	2.4	14.8
7	0.0	29.7	90	565.1	0.000	0.0	0.0	.70	2.1	13.4
8	0.0	36.7	97	673.9	.040	1.8	0.0	.79	2.1	14.6
9	0.0	43.0	136	718.9	0.000	0.0	0.0	.83	2.6	13.9
10	0.0	168.0	6728	258.1	0.000	0.0	0.0	2.99	119.7	4.6
11	0.0	5.6	14	1.8	.070	0.0	I	R	R	R
12	0.0	118.0	10	.7	.120	0.0	I	R	R	R
13	0.0	108.1	12389	376.1	.025	2.8	0.0	.96	110.5	3.4
14	0.0	33.6	5222	777.2	.055	5.7	0.0	.32	50.5	7.5
15	0.0	7.4	184	772.8	.035	3.2	0.0	.08	2.0	8.4
16	0.0	7.3	74	726.5	.060	5.0	0.0	.09	.9	8.6
17	0.0	30.5	54	1280.2	.060	3.4	0.0	.54	1.0	22.8
18	0.0	15.7	42	422.7	0.000	0.0	0.0	.56	1.5	15.1
19	0.0	11.1	39	236.7	.065	1.3	0.0	.55	1.9	11.8
20	0.0	51.7	35	114.3	0.000	0.0	0.0	5.91	4.0	13.1
21	0.0	83.6	31	59.1	0.000	0.0	0.0	38.17	14.3	27.0
22	0.0	5.6	6	2.2	.080	0.0	I	R	R	R
23	0.0	163.0	123	2.8	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	1.437	GRAM/BHP HR
	CO	24.241	GRAM/BHP HR
	NO2	10.587	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.695	LB/BHP HR

ENGINE 1-3

EFFECT OF OXIDATION CATALYST ON EMISSIONS

GRAPHED RESULTS

(AFTER CATALYST)

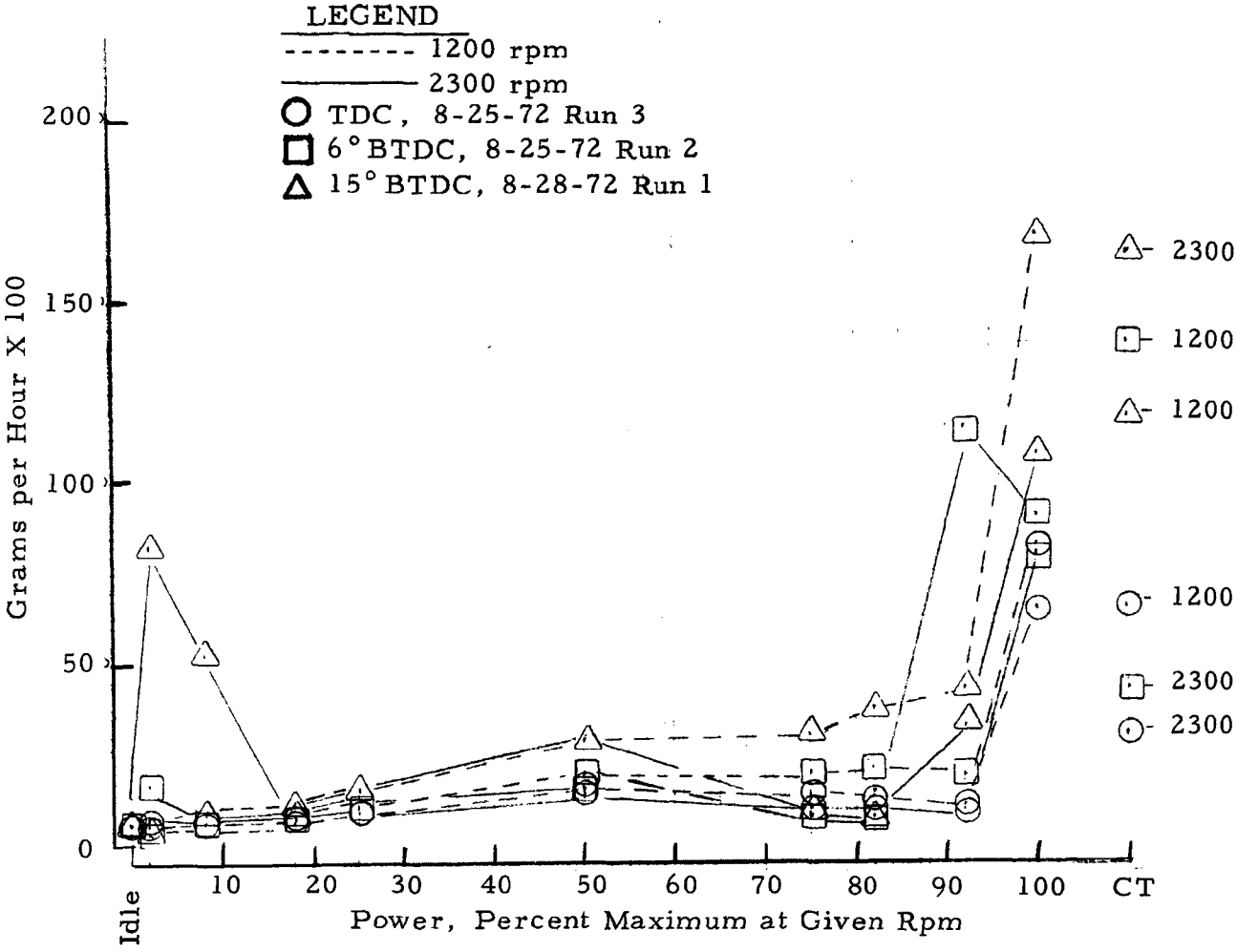


FIGURE U-1. EFFECT OF POWER ON HC EMISSION RATE AFTER CATALYST, MODIFIED AIR INJECTION ENGINE 1-3, 23 MODE TEST

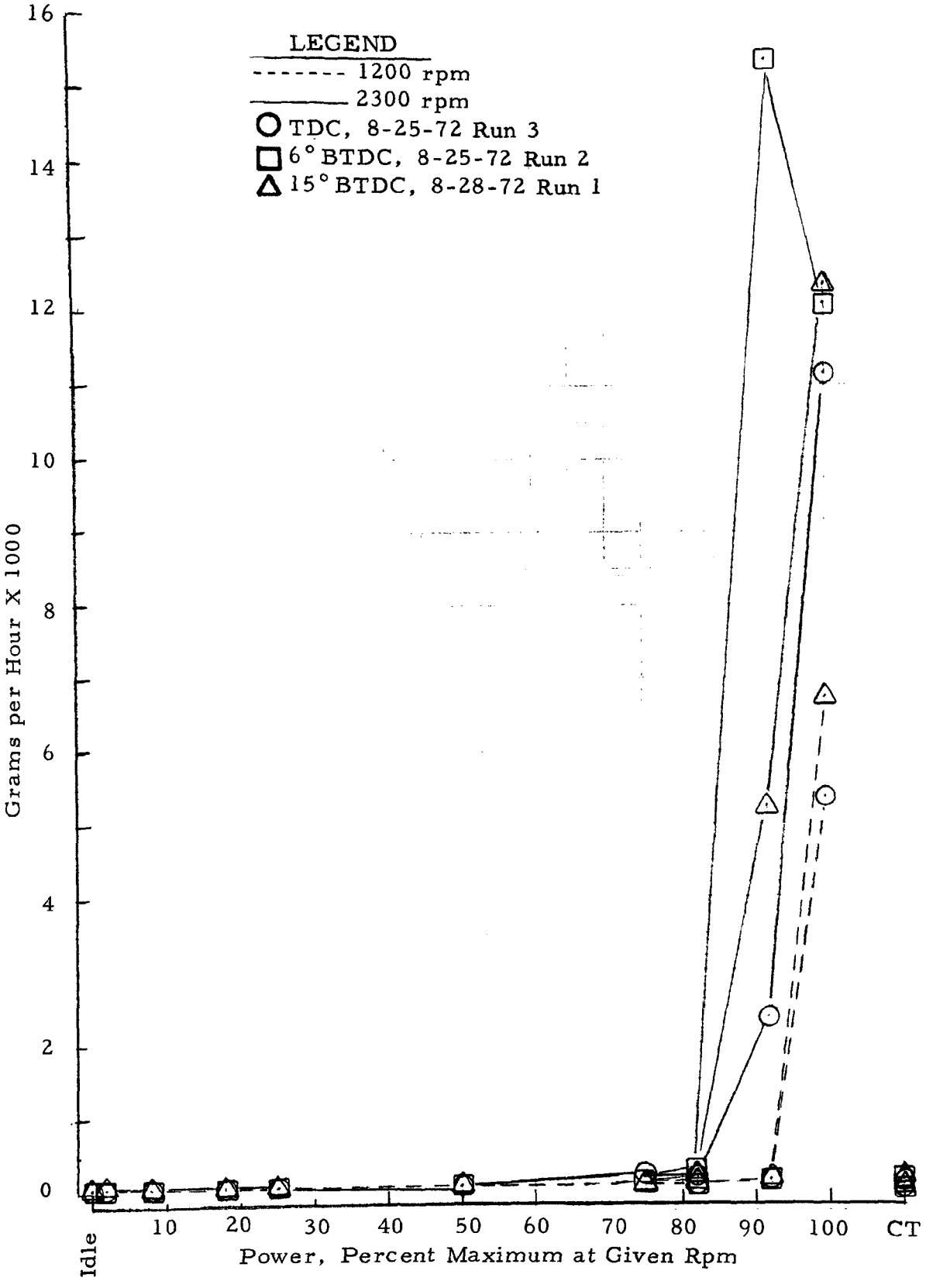


FIGURE U-2. EFFECT OF POWER ON CO EMISSIONS RATE AFTER CATALYST, MODIFIED AIR INJECTION ENGINE 1-3, 23 MODE TEST

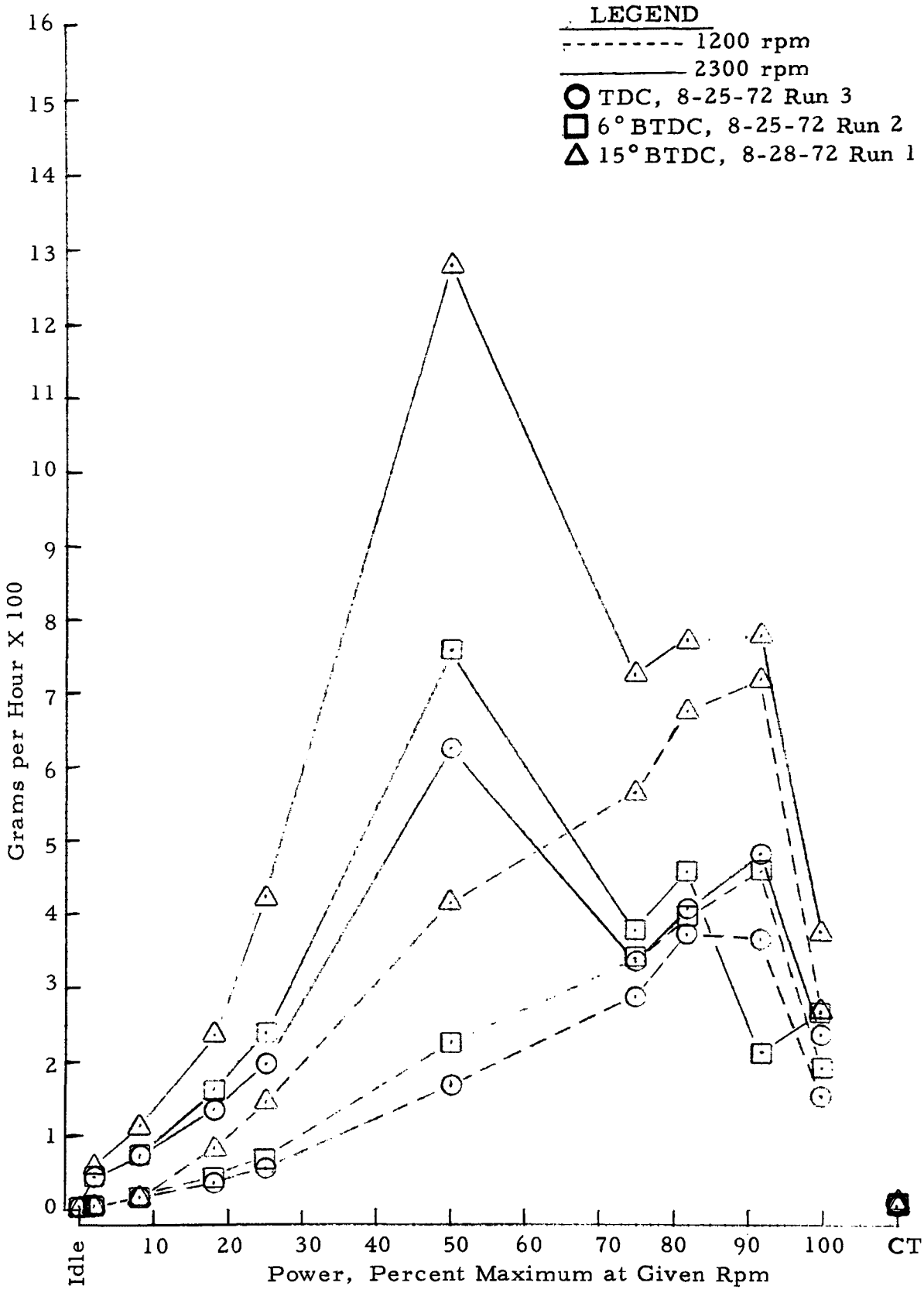


FIGURE U-3. EFFECT OF POWER ON NO_x (AS NO_2) EMISSION RATE AFTER CATALYST, MODIFIED AIR INJECTION ENGINE 1-3, 23 MODE TEST

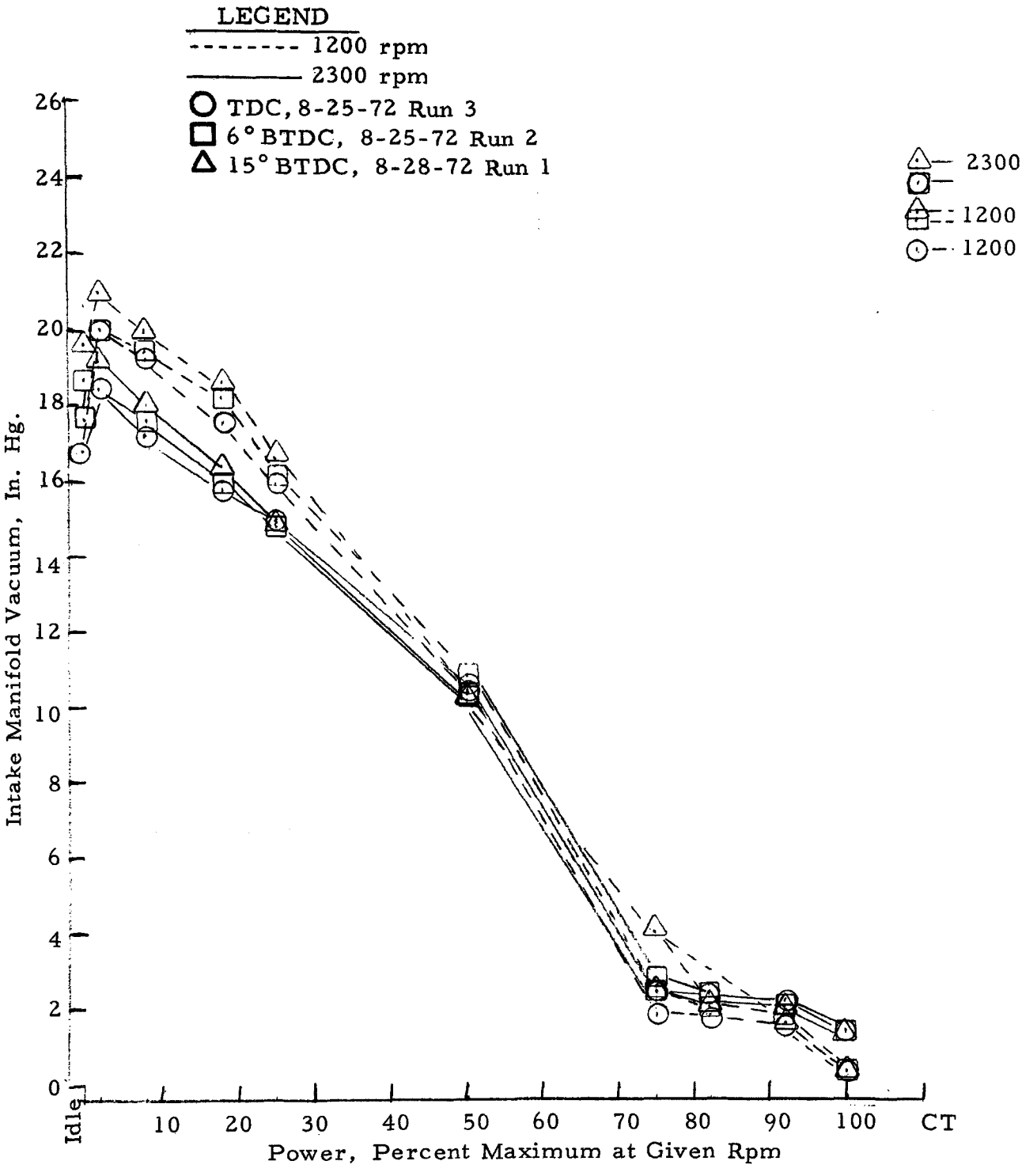


FIGURE U-4. MANIFOLD VACUUM AS A FUNCTION OF POWER
ENGINE 1-3, 23 MODE TEST

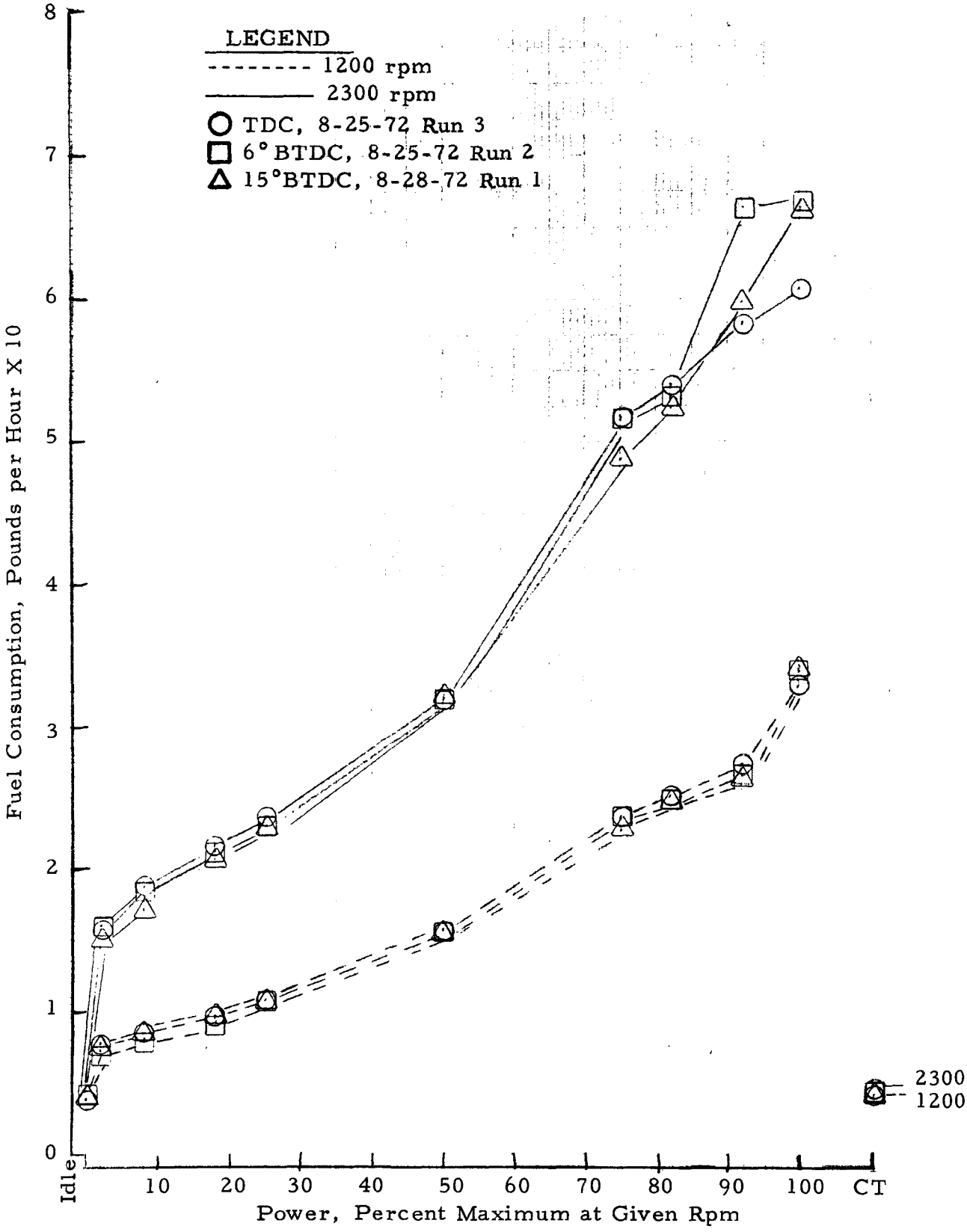


FIGURE U-5. FUEL CONSUMPTION AS A FUNCTION OF POWER
ENGINE 1-3, 23 MODE TEST

APPENDIX V

ENGINE 1-3

EFFECT OF VARIOUS COMBINATIONS ON EMISSIONS

(23 MODE MASS RESULTS)

ENGINE 1-3

EFFECT OF VARIOUS COMBINATIONS ON EMISSIONS

TABULAR DATA

BEFORE CATALYST

PROJECT 11-2877-01 CONTROL TECHNOLOGY
8-31-72 RUN-1 ENG.1-3 72 VER. 15 BTDC AIR MODI.0.063 JETS O-Cat B

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	19.7	3.9	18.4	0	2498	1.840	10.09	26
2	1200	5.0	1	20.9	7.0	22.5	0	377	.390	9.50	50
3	1200	18.0	4	19.9	8.1	21.9	0	657	.520	9.78	99
4	1200	41.0	9	18.7	9.2	21.4	0	1153	.350	10.25	450
5	1200	58.0	13	17.6	10.4	20.0	0	1482	.890	10.55	680
6	1200	115.0	26	13.1	15.8	17.8	0	2225	1.660	11.24	1475
7	1200	173.0	40	8.4	22.6	16.5	0	2592	2.480	11.24	1175
8	1200	189.0	43	7.3	23.8	16.7	0	254	2.480	11.24	1125
9	1200	212.0	48	4.7	27.2	15.8	0	1644	2.360	12.09	820
10	1200	230.0	53	.5	41.4	11.5	0	6168	10.800	6.91	73
11	600	0.0	0	19.6	4.0	17.2	0	2488	2.690	10.09	6
12	1200	0.0	0	23.0	4.0	31.1	0	31754	.180	3.35	5
13	2300	248.0	109	1.8	76.7	11.8	0	3034	9.500	8.54	113
14	2300	228.0	100	3.3	60.5	13.7	0	1128	4.740	11.60	840
15	2300	203.0	89	5.2	55.2	13.8	0	754	4.070	12.34	680
16	2300	186.0	81	6.8	50.8	14.0	0	609	3.420	12.71	700
17	2300	124.0	54	11.3	38.7	15.3	0	176	1.230	13.33	565
18	2300	62.0	27	16.2	26.2	16.9	0	71	.520	12.47	580
19	2300	45.0	20	17.7	21.8	17.9	0	127	.470	11.92	480
20	2300	20.0	9	19.4	17.0	19.2	0	93	.210	11.24	290
21	2300	5.0	2	20.5	13.9	22.6	0	403	.180	9.37	151
22	600	0.0	0	19.8	3.9	19.7	0	1828	1.550	9.37	35
23	2300	0.0	0	24.1	4.2	245.1	0	4518	.100	.33	4

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	36.3	540	1.3	.070	0.0	I	R	R	R
2	0.0	12.0	252	5.3	.060	.1	0.0	10.54	220.6	4.6
3	0.0	23.3	372	11.6	.060	.2	0.0	5.66	90.5	2.8
4	0.0	44.9	275	58.2	.050	.5	0.0	4.79	29.4	6.2
5	0.0	60.3	732	91.9	.030	.4	0.0	4.55	55.2	6.9
6	0.0	121.5	1831	267.5	.060	1.6	0.0	4.63	69.7	10.2
7	0.0	190.1	3674	286.1	0.000	0.0	0.0	4.81	92.9	7.2
8	0.0	19.9	3935	293.3	.040	1.7	0.0	.46	91.1	6.8
9	0.0	138.8	4025	229.8	0.000	0.0	0.0	2.86	83.1	4.7
10	0.0	632.0	22354	25.0	0.000	0.0	0.0	12.03	425.4	.5
11	0.0	34.6	757	.3	.070	0.0	I	R	R	R
12	0.0	859.2	98	.5	.120	0.0	I	R	R	R
13	0.0	575.4	36397	70.8	.025	2.7	0.0	5.30	335.1	.7
14	0.0	188.2	15970	465.2	.055	5.5	0.0	1.88	159.9	4.7
15	0.0	114.6	12487	342.9	.035	3.1	0.0	1.29	140.5	3.9
16	0.0	86.7	9832	330.8	.060	4.9	0.0	1.06	120.7	4.1
17	0.0	21.2	2992	225.9	.060	3.3	0.0	.39	55.1	4.2
18	0.0	6.5	960	176.1	0.000	0.0	0.0	.24	35.4	6.5
19	0.0	10.1	757	127.1	.065	1.3	0.0	.51	38.4	6.4
20	0.0	6.3	285	64.8	0.000	0.0	0.0	.71	32.6	7.4
21	0.0	26.5	239	33.0	0.000	0.0	0.0	12.09	109.2	15.1
22	0.0	29.1	499	1.9	.080	0.0	I	R	R	R
23	0.0	976.1	436	3.1	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	8.684	GRAM/BHP HR
	CO	140.829	GRAM/BHP HR
	NO2	4.597	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.759	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY
8-31-72 RUN-2 ENG.1-3 72 VER. B 6 BTDC 0.063 JETS MODI.AIR O-Cat

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.5	4.0	17.3	0	2614	2.640	9.50	33
2	1200	4.0	1	20.2	7.2	22.6	0	261	.100	9.25	57
3	1200	17.0	4	19.0	8.4	21.7	0	632	.180	9.50	177
4	1200	38.0	9	18.0	9.5	21.1	0	853	.130	9.93	365
5	1200	53.0	12	17.7	10.2	19.7	0	896	.640	10.09	350
6	1200	105.0	24	13.8	15.2	17.5	0	1822	1.590	10.43	890
7	1200	158.0	36	9.5	21.5	13.9	0	24697	2.360	10.55	1000
8	1200	172.0	39	8.0	23.0	16.0	0	2016	2.400	10.55	888
9	1200	193.0	44	4.9	27.4	15.1	0	520	1.630	12.47	570
10	1200	210.0	48	.5	40.8	11.2	0	5246	10.140	7.09	76
11	600	0.0	0	18.8	4.1	14.1	0	2015	2.320	9.25	41
12	1200	0.0	0	22.2	4.1	30.6	0	25909	.250	3.68	13
13	2300	236.0	103	1.8	76.0	11.6	0	2323	9.500	8.75	100
14	2300	217.0	95	2.0	80.0	11.1	0	1252	10.800	7.56	64
15	2300	194.0	85	4.3	57.2	13.5	0	690	4.260	11.92	545
16	2300	177.0	78	6.5	51.9	13.7	0	607	3.700	12.09	510
17	2300	118.0	52	11.8	37.6	15.1	0	130	.970	12.94	420
18	2300	59.0	26	16.1	26.2	16.9	0	73	.420	12.34	395
19	2300	42.0	18	17.5	22.5	17.9	0	94	.280	11.72	310
20	2300	19.0	8	19.1	18.2	18.9	0	84	.070	11.01	222
21	2300	5.0	2	20.2	15.4	20.7	0	60	.050	9.93	140
22	600	0.0	0	18.5	4.0	18.5	0	1780	1.520	9.14	39
23	2300	0.0	0	23.9	4.3	29.1	0	48612	.020	.23	5

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	38.2	780	1.6	.070	0.0	I	R	R	R
2	0.0	9.1	70	6.6	.060	.1	0.0	9.94	77.0	7.2
3	0.0	24.7	142	23.0	.060	.2	0.0	6.36	36.6	5.9
4	0.0	36.2	112	51.5	.050	.4	0.0	4.17	12.8	5.9
5	0.0	38.3	553	49.7	.030	.4	0.0	3.16	45.7	4.1
6	0.0	103.0	1815	167.0	.060	1.4	0.0	4.29	75.6	7.0
7	0.0	1566.1	3023	210.5	0.000	0.0	0.0	43.38	83.7	5.8
8	0.0	159.9	3846	233.7	.040	1.6	0.0	4.07	97.9	5.9
9	0.0	45.7	2892	166.2	0.000	0.0	0.0	1.04	65.6	3.8
10	0.0	546.8	21351	26.3	0.000	0.0	0.0	11.40	445.0	.5
11	0.0	31.8	740	2.2	.070	0.0	I	R	R	R
12	0.0	738.9	144	1.2	.120	0.0	I	R	R	R
13	0.0	433.3	35794	61.9	.025	2.6	0.0	4.19	346.3	.6
14	0.0	245.7	42827	42.0	.055	5.2	0.0	2.59	450.7	.4
15	0.0	110.1	13741	288.9	.035	3.0	0.0	1.30	161.7	3.4
16	0.0	90.2	11101	251.5	.060	4.7	0.0	1.16	143.2	3.2
17	0.0	15.9	2400	170.8	.060	3.1	0.0	.31	46.4	3.3
18	0.0	6.8	790	122.1	0.000	0.0	0.0	.26	30.6	4.7
19	0.0	8.0	481	87.5	.065	1.2	0.0	.44	26.1	4.8
20	0.0	6.2	105	55.0	0.000	0.0	0.0	.75	12.7	6.6
21	0.0	4.2	71	32.5	0.000	0.0	0.0	1.92	32.3	14.8
22	0.0	29.8	514	2.2	.080	0.0	I	R	R	R
23	0.0	1855.1	15	.6	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	10.908	GRAM/BHP HR
	CO	211.348	GRAM/BHP HR
	NO2	2.972	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.853	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-28-72 RUN-2 ENG.1-3 72 VERS STD.TIME + JETS B W/AIR TAILORED EGR O-Cat

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.1	4.1	18.3	0	2215	1.520	10.09	48
2	1200	4.0	1	19.6	7.6	22.8	0	413	.150	9.25	59
3	1200	18.0	4	19.1	8.1	22.4	0	582	.150	9.37	109
4	1200	40.0	9	17.1	9.5	21.9	0	818	.130	9.64	200
5	1200	56.0	13	15.0	11.3	21.9	0	872	.100	9.64	235
6	1200	156.0	36	1.9	24.2	17.7	0	517	.280	11.84	565
7	1200	167.0	38	1.8	25.4	16.7	0	443	.420	12.59	620
8	1200	182.0	42	1.7	26.9	15.5	0	494	.930	12.94	465
9	1200	204.0	47	.5	33.3	13.2	0	1917	5.560	10.09	205
10	1200	222.0	51	.5	34.4	12.3	0	1699	6.710	7.65	400
11	600	0.0	0	18.5	4.2	18.0	0	1839	2.020	9.64	39
12	1200	0.0	0	22.3	4.3	32.1	0	27139	.210	3.45	8
13	2300	220.0	96	1.7	62.1	13.6	0	939	3.930	11.72	285
14	2300	202.0	88	1.7	60.5	13.2	0	1041	4.500	11.01	163
15	2300	180.0	79	2.4	56.8	13.3	0	815	4.120	11.01	176
16	2300	165.0	72	2.6	52.0	14.2	0	282	2.020	11.84	231
17	2300	110.0	48	3.0	43.4	17.0	0	1987	.250	11.01	330
18	2300	55.0	24	13.3	24.2	19.8	0	371	.100	8.84	280
19	2300	40.0	18	15.0	21.4	19.5	0	249	.070	8.84	265
20	2300	18.0	8	16.6	18.7	19.1	0	259	.070	8.60	180
21	2300	4.0	2	17.8	16.2	19.1	0	1338	.100	8.48	104
22	600	0.0	0	18.0	4.0	16.6	0	1951	1.340	9.03	44
23	2300	0.0	0	24.0	4.4	22.8	0	46119	.050	.23	7

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	34.8	483	2.5	.070	0.0	I	R	R	R
2	0.0	15.1	111	7.2	.060	.1	0.0	16.50	121.1	7.9
3	0.0	22.3	116	13.8	.060	.2	0.0	5.43	28.3	3.4
4	0.0	35.8	115	29.0	.050	.5	0.0	3.91	12.6	3.2
5	0.0	45.5	105	40.7	.030	.4	0.0	3.55	8.2	3.2
6	0.0	46.6	510	169.2	.060	2.1	0.0	1.31	14.3	4.7
7	0.0	39.1	749	181.7	0.000	0.0	0.0	1.02	19.6	4.8
8	0.0	43.3	1647	135.3	.040	1.7	0.0	1.04	39.6	3.3
9	0.0	182.8	10709	64.9	0.000	0.0	0.0	3.92	229.7	1.4
10	0.0	182.5	14556	142.6	0.000	0.0	0.0	3.60	287.0	2.8
11	0.0	29.6	656	2.1	.070	0.0	I	R	R	R
12	0.0	830.5	130	.8	.120	0.0	I	R	R	R
13	0.0	168.0	14204	169.3	.025	2.4	0.0	1.74	147.4	1.8
14	0.0	182.9	15976	94.8	.055	4.9	0.0	2.07	180.6	1.1
15	0.0	138.1	14096	99.1	.035	2.8	0.0	1.75	178.8	1.3
16	0.0	47.9	6930	130.4	.060	4.3	0.0	.66	95.9	1.8
17	0.0	341.5	868	188.2	.060	2.9	0.0	7.09	18.0	3.9
18	0.0	45.3	247	113.7	0.000	0.0	0.0	1.88	10.3	4.7
19	0.0	27.0	154	95.6	.065	1.1	0.0	1.54	8.8	5.5
20	0.0	25.3	138	58.3	0.000	0.0	0.0	3.21	17.5	7.4
21	0.0	112.9	170	29.0	0.000	0.0	0.0	64.43	97.2	16.6
22	0.0	33.5	465	2.5	.080	0.0	I	R	R	R
23	0.0	1881.6	41	.9	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	11.733	GRAM/BHP HR
	CO	105.345	GRAM/BHP HR
	NO2	2.503	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.855	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-30-72 RUN-1 ENG.1-3 72 VER. TDC STD JETS AIR MODI. EGR TAILORED B O-Cat

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.4	4.4	19.0	0	1343	1.090	9.78	51
2	1200	4.0	1	19.5	7.9	22.4	0	326	.150	9.37	61
3	1200	16.0	4	19.0	8.4	22.0	0	431	.150	9.64	90
4	1200	36.0	8	17.0	9.6	21.3	0	673	.130	10.09	230
5	1200	51.0	12	15.7	11.3	21.5	0	678	.100	9.93	232
6	1200	101.0	23	8.6	16.4	21.0	0	1007	.100	10.09	330
7	1200	152.0	35	2.0	24.7	16.9	0	162	.210	12.59	460
8	1200	166.0	38	.6	33.4	12.9	0	1522	5.450	11.13	106
9	1200	186.0	42	2.0	26.3	16.3	0	154	.310	12.71	1212
10	1200	202.0	46	.5	34.7	13.1	0	1205	4.880	11.13	265
11	600	0.0	0	17.4	4.3	18.5	0	1437	1.160	10.25	52
12	1200	0.0	0	21.7	4.6	28.2	0	27579	.210	4.19	18
13	2300	205.0	90	1.8	63.6	13.1	0	954	4.840	11.36	200
14	2300	189.0	83	1.7	62.7	13.0	0	957	4.740	11.01	175
15	2300	168.0	74	1.7	60.0	12.9	0	1055	5.030	10.78	96
16	2300	154.0	67	1.7	60.0	12.9	0	1152	5.080	10.09	80
17	2300	103.0	45	2.9	44.9	16.8	0	610	.280	11.60	190
18	2300	51.0	22	9.5	28.6	21.6	0	1409	.130	8.93	125
19	2300	37.0	16	11.8	25.3	22.9	0	811	.100	8.75	107
20	2300	16.0	7	14.8	21.3	22.7	0	595	.100	8.75	100
21	2300	4.0	2	17.5	16.9	23.3	0	432	.070	8.60	127
22	600	0.0	0	17.2	4.1	20.1	0	1158	.610	9.37	64
23	2300	0.0	0	23.6	4.8	39.9	0	50631	.050	.23	4

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	24.4	399	3.1	.070	0.0	I	R	R	R
2	0.0	12.2	114	7.7	.060	.1	0.0	13.40	124.4	8.4
3	0.0	16.7	117	11.6	.060	.2	0.0	4.57	32.1	3.2
4	0.0	28.5	111	32.3	.050	.4	0.0	3.46	13.5	3.9
5	0.0	34.4	103	39.2	.030	.3	0.0	2.95	8.8	3.4
6	0.0	72.8	146	79.2	.060	1.4	0.0	3.15	6.3	3.4
7	0.0	14.2	371	133.5	0.000	0.0	0.0	.41	10.7	3.8
8	0.0	137.8	9968	31.9	.040	1.5	0.0	3.63	262.8	.8
9	0.0	14.1	573	368.4	0.000	0.0	0.0	.33	13.5	8.7
10	0.0	117.6	9619	85.8	0.000	0.0	0.0	2.55	208.4	1.9
11	0.0	24.3	396	2.9	.070	0.0	I	R	R	R
12	0.0	803.9	124	1.7	.120	0.0	I	R	R	R
13	0.0	169.0	17309	117.6	.025	2.2	0.0	1.88	192.8	1.3
14	0.0	171.7	17185	104.3	.055	4.6	0.0	2.07	207.6	1.3
15	0.0	180.3	17375	54.5	.035	2.6	0.0	2.45	236.2	.7
16	0.0	205.1	18271	47.3	.060	4.0	0.0	3.04	270.9	.7
17	0.0	104.1	965	107.6	.060	2.7	0.0	2.31	21.4	2.4
18	0.0	198.7	370	58.5	0.000	0.0	0.0	8.89	16.6	2.6
19	0.0	104.3	260	45.9	.065	1.1	0.0	6.43	16.0	2.8
20	0.0	64.5	219	36.0	0.000	0.0	0.0	9.21	31.3	5.1
21	0.0	38.0	124	37.2	0.000	0.0	0.0	21.70	71.0	21.3
22	0.0	21.3	227	3.9	.080	0.0	I	R	R	R
23	0.0	2063.2	41	.5	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	13.486	GRAM/BHP HR
	CO	174.200	GRAM/BHP HR
	NO2	1.601	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.993	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-29-72 RUN-1 ENG.1-3 72 VER. STD TIM.+JETS MODI.AIR+EGR TAILORED B O-Cat

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.8	4.0	17.5	0	2255	2.050	10.25	38
2	1200	5.0	1	19.6	7.4	22.3	0	177	.150	9.50	50
3	1200	18.0	4	18.9	8.3	21.9	0	622	.130	9.64	110
4	1200	41.0	9	17.5	9.4	21.4	0	869	.100	9.93	260
5	1200	58.0	13	16.1	10.6	21.5	0	983	.100	9.93	360
6	1200	115.0	26	9.9	15.8	20.8	0	1337	.100	10.25	1063
7	1200	173.0	40	2.6	23.6	19.2	0	702	.100	11.36	1363
8	1200	189.0	43	2.0	25.5	17.1	0	939	.310	12.47	1125
9	1200	212.0	48	1.0	29.3	13.0	0	1790	5.840	10.09	160
10	1200	230.0	53	.5	34.8	13.1	0	1607	5.190	10.78	375
11	600	0.0	0	18.4	4.1	18.1	0	1704	1.730	9.78	40
12	1200	0.0	0	22.5	4.3	30.4	0	26410	.180	3.68	8
13	2300	222.0	97	1.7	61.8	13.4	0	938	4.120	11.48	260
14	2300	204.0	89	1.7	60.0	13.1	0	1140	4.500	10.66	155
15	2300	182.0	80	1.7	59.0	12.8	0	1366	4.980	9.93	104
16	2300	167.0	73	2.1	59.6	12.3	0	2299	5.960	8.68	85
17	2300	111.0	49	2.9	42.5	16.0	0	929	.280	11.13	213
18	2300	56.0	25	11.1	25.2	18.0	0	802	.100	8.93	127
19	2300	40.0	18	13.4	22.6	18.0	0	449	.070	8.84	138
20	2300	18.0	8	15.6	19.6	18.1	0	541	.070	8.75	135
21	2300	4.0	2	18.0	15.4	18.6	0	808	.070	8.34	98
22	600	0.0	0	17.9	4.0	16.5	0	1869	1.050	9.03	45
23	2300	0.0	0	24.0	4.4	18.4	0	44311	.020	.13	4

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	32.7	600	1.9	.070	0.0	I	R	R	R
2	0.0	6.1	105	5.8	.060	.1	0.0	5.38	92.1	5.1
3	0.0	23.8	101	14.0	.060	.2	0.0	5.79	24.4	3.4
4	0.0	36.6	85	36.4	.050	.5	0.0	3.91	9.1	3.9
5	0.0	46.7	96	56.7	.030	.4	0.0	3.52	7.2	4.3
6	0.0	91.4	138	241.1	.060	1.6	0.0	3.48	5.3	9.2
7	0.0	65.2	188	420.3	0.000	0.0	0.0	1.65	4.7	10.6
8	0.0	84.4	563	335.6	.040	1.7	0.0	1.95	13.0	7.8
9	0.0	147.7	9733	43.8	0.000	0.0	0.0	3.05	200.9	.9
10	0.0	157.2	10259	121.8	0.000	0.0	0.0	2.99	195.2	2.3
11	0.0	27.1	556	2.1	.070	0.0	I	R	R	R
12	0.0	792.4	109	.8	.120	0.0	I	R	R	R
13	0.0	167.6	14866	154.2	.025	2.4	0.0	1.72	152.9	1.6
14	0.0	203.2	16197	91.7	.055	4.9	0.0	2.27	181.3	1.0
15	0.0	242.9	17892	61.3	.035	2.8	0.0	3.05	224.5	.8
16	0.0	418.0	21888	51.3	.060	4.4	0.0	5.72	299.3	.7
17	0.0	155.6	948	118.2	.060	2.9	0.0	3.20	19.5	2.4
18	0.0	100.6	253	53.1	0.000	0.0	0.0	4.10	10.3	2.2
19	0.0	51.4	162	52.3	.065	1.1	0.0	2.94	9.2	3.0
20	0.0	54.2	142	44.9	0.000	0.0	0.0	6.87	18.0	5.7
21	0.0	66.5	116	26.6	0.000	0.0	0.0	37.96	66.4	15.2
22	0.0	33.0	375	2.6	.080	0.0	I	R	R	R
23	0.0	1930.5	18	.6	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	12.716	GRAM/BHP HR
	CO	149.368	GRAM/BHP HR
	NO2	2.508	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.862	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-30-72 RUN-2 ENG.1-3 72 VER. B STD JETS 15 BTDC MODI.AIR O-Cat EGR TAID.

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	DRY CONCENTRATION ALDE.	HC	CO	CO2	NO
1	600	0.0	0	18.8	4.0	18.6	0	2364	1.940	8.84	29
2	1200	5.0	1	19.9	7.7	23.3	0	888	.250	8.68	58
3	1200	19.0	4	19.4	8.1	23.0	0	770	.180	9.03	107
4	1200	43.0	10	17.2	9.6	22.0	0	1056	.130	9.50	420
5	1200	60.0	14	16.0	10.6	21.9	0	1242	.130	9.50	540
6	1200	120.0	27	9.4	16.0	21.1	0	1530	.100	9.93	900
7	1200	180.0	41	2.0	24.2	17.9	0	1110	.490	11.36	820
8	1200	197.0	45	1.9	25.1	17.1	0	1183	.700	11.84	830
9	1200	221.0	50	2.0	25.2	17.7	0	1067	.470	11.60	2500
10	1200	240.0	55	.5	34.7	13.3	0	2597	6.250	9.03	380
11	600	0.0	0	19.0	3.9	17.9	0	2074	2.140	9.64	34
12	1200	0.0	0	22.8	4.0	32.4	0	30647	.180	3.08	5
13	2300	236.0	103	1.7	62.6	13.2	0	1146	4.690	11.13	370
14	2300	217.0	95	1.7	61.1	12.9	0	1468	5.350	10.55	213
15	2300	194.0	85	1.6	58.7	12.8	0	1999	5.900	9.50	102
16	2300	177.0	78	2.5	49.1	14.5	0	311	1.910	12.09	260
17	2300	118.0	52	3.7	36.1	17.8	0	1216	.350	11.01	400
18	2300	59.0	26	14.0	22.4	21.3	0	360	.150	9.78	370
19	2300	42.0	18	15.5	20.0	21.6	0	447	.130	9.64	270
20	2300	19.0	8	17.1	17.7	22.4	0	684	.100	9.25	202
21	2300	5.0	2	18.0	15.8	23.4	0	5507	.150	8.48	115
22	600	0.0	0	18.9	4.0	18.6	0	2097	1.700	9.50	36
23	2300	0.0	0	24.2	4.1	46.8	0	40642	.050	.33	3

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	38.9	645	1.6	.070	0.0	I	R	R	R
2	0.0	34.4	196	7.5	.060	.1	0.0	30.09	171.2	6.6
3	0.0	30.5	144	14.1	.060	.3	0.0	7.02	33.1	3.3
4	0.0	47.3	117	62.4	.050	.5	0.0	4.81	12.0	6.3
5	0.0	61.2	129	88.4	.030	.4	0.0	4.46	9.4	6.4
6	0.0	109.0	144	213.0	.060	1.6	0.0	3.98	5.3	7.8
7	0.0	101.8	908	249.8	0.000	0.0	0.0	2.48	22.1	6.1
8	0.0	106.4	1272	247.8	.040	1.8	0.0	2.36	28.3	5.5
9	0.0	100.2	891	779.2	0.000	0.0	0.0	1.98	17.6	15.4
10	0.0	263.0	12788	127.8	0.000	0.0	0.0	4.80	233.2	2.3
11	0.0	30.6	638	1.7	.070	0.0	I	R	R	R
12	0.0	879.2	104	.5	.120	0.0	I	R	R	R
13	0.0	204.3	16882	218.9	.025	2.6	0.0	1.98	163.3	2.1
14	0.0	253.6	18665	121.8	.055	5.2	0.0	2.67	196.4	1.3
15	0.0	341.2	20342	58.1	.035	3.0	0.0	4.02	239.4	.7
16	0.0	49.3	6124	137.0	.060	4.7	0.0	.64	79.0	1.8
17	0.0	173.4	1008	189.4	.060	3.1	0.0	3.35	19.5	3.7
18	0.0	36.7	309	125.2	0.000	0.0	0.0	1.42	12.0	4.8
19	0.0	41.3	243	82.9	.065	1.2	0.0	2.25	13.2	4.5
20	0.0	58.3	172	57.3	0.000	0.0	0.0	7.01	20.7	6.9
21	0.0	429.9	237	29.8	0.000	0.0	0.0	196.34	108.0	13.6
22	0.0	33.3	546	1.9	.080	0.0	I	R	R	R
23	0.0	1700.7	42	.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	11.513	GRAM/BHP HR
	CO	116.460	GRAM/BHP HR
	NO2	2.844	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.766	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY
8-31-72 RUN-3 ENG.1-3 72 VER. B STD TIM + JETS HOT TAID EGR O-CatNO AIR

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.8	3.8	14.9	0	3069	2.080	12.71	61
2	1200	5.0	1	19.8	7.6	16.5	0	1083	.350	13.48	154
3	1200	18.0	4	19.0	8.2	16.5	0	949	.280	13.77	155
4	1200	41.0	9	17.2	9.7	17.1	0	1224	.150	13.18	500
5	1200	58.0	13	16.0	10.6	17.4	0	1191	.150	13.18	670
6	1200	115.0	26	9.7	15.9	18.0	0	1364	.130	12.59	1112
7	1200	173.0	40	2.6	23.3	17.2	0	911	.150	13.33	1500
8	1200	189.0	43	1.9	25.6	15.5	0	1569	1.050	13.77	1250
9	1200	212.0	48	1.9	27.3	15.0	0	1726	1.450	14.05	1900
10	1200	230.0	53	.5	34.3	12.4	0	3303	6.640	10.55	415
11	600	0.0	0	17.9	3.9	14.3	0	3440	3.380	12.47	53
12	1200	0.0	0	22.5	3.9	20.4	0	40302	.250	6.30	11
13	2300	230.0	101	1.7	63.4	12.4	0	2729	6.440	11.01	310
14	2300	212.0	93	1.7	61.9	12.2	0	2993	7.020	10.55	165
15	2300	189.0	83	1.6	60.2	11.9	0	3251	7.620	9.78	93
16	2300	173.0	76	2.1	61.4	11.3	0	4421	8.840	8.84	82
17	2300	115.0	50	2.7	46.0	14.5	0	1161	2.320	12.59	145
18	2300	58.0	25	10.7	25.6	17.1	0	1005	.150	12.47	136
19	2300	41.0	18	12.9	21.4	17.2	0	112	.130	12.47	120
20	2300	18.0	8	15.3	20.3	17.4	0	200	.100	11.92	163
21	2300	5.0	2	17.9	15.8	18.0	0	999	.130	11.72	132
22	600	0.0	0	17.8	3.9	15.2	0	2855	2.020	12.09	58
23	2300	0.0	0	23.8	4.3	19.7	0	35058	.250	7.37	10

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	35.0	480	2.3	.070	0.0	I	R	R	R
2	0.0	26.8	175	12.6	.060	.1	0.0	23.44	153.1	11.1
3	0.0	25.0	149	13.5	.060	.2	0.0	6.07	36.2	3.3
4	0.0	40.0	99	54.3	.050	.5	0.0	4.27	10.6	5.8
5	0.0	42.6	108	79.5	.030	.4	0.0	3.21	8.2	6.0
6	0.0	76.5	147	207.2	.060	1.6	0.0	2.91	5.6	7.9
7	0.0	70.9	236	387.8	0.000	0.0	0.0	1.79	6.0	9.8
8	0.0	121.7	1644	321.8	.040	1.7	0.0	2.82	38.1	7.5
9	0.0	136.4	2314	498.4	0.000	0.0	0.0	2.82	47.8	10.3
10	0.0	293.3	11911	122.4	0.000	0.0	0.0	5.58	226.7	2.3
11	0.0	37.6	746	1.9	.070	0.0	I	R	R	R
12	0.0	673.9	84	.6	.120	0.0	I	R	R	R
13	0.0	442.9	21109	167.0	.025	2.5	0.0	4.40	209.6	1.7
14	0.0	470.4	22281	86.1	.055	5.1	0.0	5.07	240.0	.9
15	0.0	500.8	23713	47.6	.035	2.9	0.0	6.05	286.5	.6
16	0.0	679.5	27443	41.8	.060	4.5	0.0	8.97	362.2	.6
17	0.0	161.2	6508	66.8	.060	3.0	0.0	3.20	129.2	1.3
18	0.0	91.7	277	41.3	0.000	0.0	0.0	3.61	10.9	1.6
19	0.0	8.6	202	30.7	.065	1.2	0.0	.48	11.3	1.7
20	0.0	15.3	154	41.3	0.000	0.0	0.0	1.94	19.6	5.2
21	0.0	59.9	157	26.4	0.000	0.0	0.0	27.35	71.9	12.0
22	0.0	35.1	501	2.4	.080	0.0	I	R	R	R
23	0.0	614.6	89	.6	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	10.401	GRAM/BHP HR
	CO	205.424	GRAM/BHP HR
	NO2	2.176	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.852	LB/BHP HR

ENGINE 1-3

EFFECT OF VARIOUS COMBINATIONS ON EMISSIONS

TABULAR DATA

AFTER CATALYST

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-31-72 RUN-1 ENG.1-3 72 VER. 15 BTDC AIR MODI.0.063 JETS O-Cat A

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	19.7	3.9	19.1	0	411	.050	11.92	34
2	1200	5.0	1	20.9	7.0	23.2	0	97	.100	9.64	58
3	1200	18.0	4	19.9	8.1	22.3	0	162	.050	10.25	109
4	1200	41.0	9	18.7	9.2	21.8	0	261	.100	10.43	455
5	1200	58.0	13	17.6	10.4	20.6	0	334	.100	11.13	665
6	1200	115.0	26	13.1	15.8	18.1	0	548	.130	12.71	1563
7	1200	173.0	40	8.4	22.6	16.5	0	707	.350	13.77	1138
8	1200	189.0	43	7.3	23.8	16.2	0	690	.440	13.77	1013
9	1200	212.0	48	4.7	27.2	15.6	0	592	.740	14.31	650
10	1200	230.0	53	.5	41.4	11.5	0	4962	9.500	8.60	113
11	600	0.0	0	19.6	4.0	17.9	0	412	.070	12.71	34
12	1200	0.0	0	23.0	4.0	31.5	0	3267	.100	6.64	6
13	2300	248.0	109	1.8	76.7	12.2	0	2022	8.010	9.64	160
14	2300	228.0	100	3.3	60.5	14.3	0	433	2.730	13.06	1050
15	2300	203.0	89	5.2	55.2	14.4	0	332	2.250	13.48	805
16	2300	186.0	81	6.8	50.8	14.5	0	283	1.980	13.48	820
17	2300	124.0	54	11.3	38.7	15.1	0	82	.740	14.05	610
18	2300	62.0	27	16.2	26.2	16.9	0	38	.100	12.94	555
19	2300	45.0	20	17.7	21.8	18.1	0	40	.050	12.09	490
20	2300	20.0	9	19.4	17.0	20.4	0	45	.050	10.78	305
21	2300	5.0	2	20.5	13.9	23.6	0	217	.050	9.14	158
22	600	0.0	0	19.8	3.9	20.3	0	314	.050	11.01	47
23	2300	0.0	0	24.1	4.2	49.4	0	2618	.250	3.74	3

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	6.1	15	1.7	.070	0.0	I	R	R	R
2	0.0	3.2	66	6.3	.060	.1	0.0	2.77	57.6	5.5
3	0.0	5.8	36	12.9	.060	.2	0.0	1.40	8.7	3.1
4	0.0	10.3	80	59.7	.050	.5	0.0	1.10	8.5	6.4
5	0.0	14.0	85	92.5	.030	.4	0.0	1.06	6.4	7.0
6	0.0	30.5	146	288.4	.060	1.6	0.0	1.16	5.6	11.0
7	0.0	51.0	511	272.9	0.000	0.0	0.0	1.29	12.9	6.9
8	0.0	52.2	672	254.3	.040	1.7	0.0	1.21	15.6	5.9
9	0.0	48.4	1221	176.2	0.000	0.0	0.0	1.00	25.2	3.6
10	0.0	501.0	19379	37.9	0.000	0.0	0.0	9.53	368.8	.7
11	0.0	5.8	20	1.6	.070	0.0	I	R	R	R
12	0.0	83.9	52	.5	.120	0.0	I	R	R	R
13	0.0	394.0	31533	103.5	.025	2.7	0.0	3.63	290.3	1.0
14	0.0	75.1	9558	604.2	.055	5.5	0.0	.75	95.7	6.1
15	0.0	52.8	7219	424.5	.035	3.1	0.0	.59	81.2	4.8
16	0.0	42.2	5950	405.0	.060	4.9	0.0	.52	73.1	5.0
17	0.0	9.7	1773	240.2	.060	3.3	0.0	.18	32.7	4.4
18	0.0	3.5	184	167.9	0.000	0.0	0.0	.13	6.8	6.2
19	0.0	3.3	82	132.5	.065	1.3	0.0	.17	4.2	6.7
20	0.0	3.2	72	72.1	0.000	0.0	0.0	.37	8.2	8.2
21	0.0	14.9	69	35.9	0.000	0.0	0.0	6.78	31.6	16.4
22	0.0	5.0	16	2.5	.080	0.0	I	R	R	R
23	0.0	117.3	226	.4	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	1.699	GRAM/BHP HR
	CO	83.523	GRAM/BHP HR
	NO2	5.268	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.759	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY
8-31-72 RUN-2 ENG.1-3 72 VER. A 6 BTDC 0.063 JETS MODI.AIR O-Cat

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.5	4.0	18.2	0	328	.020	11.92	42
2	1200	4.0	1	20.2	7.2	22.9	0	80	.020	9.25	60
3	1200	17.0	4	19.0	8.4	22.1	0	146	.020	9.64	186
4	1200	38.0	9	18.0	9.5	21.9	0	183	.020	9.64	350
5	1200	53.0	12	17.7	10.2	20.4	0	202	.020	10.43	360
6	1200	105.0	24	13.8	15.2	17.8	0	383	.050	11.92	1062
7	1200	158.0	36	9.5	21.5	16.2	0	471	.180	12.94	930
8	1200	172.0	39	8.0	23.0	15.9	0	428	.350	13.06	800
9	1200	193.0	44	4.9	27.4	15.1	0	252	.810	13.18	450
10	1200	210.0	48	.5	40.8	11.4	0	3764	8.630	8.48	99
11	600	0.0	0	18.8	4.1	18.6	0	282	.070	11.24	55
12	1200	0.0	0	22.2	4.1	29.9	0	3160	.100	6.64	12
13	2300	236.0	103	1.8	76.0	11.9	0	1582	8.010	9.64	111
14	2300	217.0	95	2.0	80.0	11.2	0	1933	9.910	8.60	72
15	2300	194.0	85	4.3	57.2	14.2	0	303	2.480	12.82	630
16	2300	177.0	78	6.5	51.9	14.3	0	282	2.180	12.94	560
17	2300	118.0	52	11.8	37.6	15.2	0	75	.420	13.63	440
18	2300	59.0	26	16.1	26.2	17.0	0	51	.020	12.71	370
19	2300	42.0	18	17.5	22.5	17.9	0	42	.020	11.92	340
20	2300	19.0	8	19.1	18.2	15.7	0	38	.020	10.55	250
21	2300	5.0	2	20.2	15.4	21.6	0	37	.020	9.25	145
22	600	0.0	0	18.5	4.0	19.2	0	311	.020	10.66	52
23	2300	0.0	0	23.9	4.3	39.5	0	908	.070	3.95	3

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	5.0	6	2.1	.070	0.0	I	R	R	R
2	0.0	2.8	14	7.0	.060	.1	0.0	3.09	15.6	7.7
3	0.0	5.7	16	24.3	.060	.2	0.0	1.48	4.1	6.3
4	0.0	8.1	18	51.7	.050	.4	0.0	.94	2.1	6.0
5	0.0	8.9	18	52.8	.030	.4	0.0	.74	1.5	4.4
6	0.0	22.0	58	202.4	.060	1.4	0.0	.92	2.4	8.4
7	0.0	34.9	269	228.7	0.000	0.0	0.0	.97	7.5	6.3
8	0.0	33.2	548	206.0	.040	1.6	0.0	.85	14.0	5.2
9	0.0	22.3	1451	132.5	0.000	0.0	0.0	.51	32.9	3.0
10	0.0	398.4	18450	34.8	0.000	0.0	0.0	8.30	384.5	.7
11	0.0	4.6	23	3.0	.070	0.0	I	R	R	R
12	0.0	83.3	53	1.1	.120	0.0	I	R	R	R
13	0.0	306.3	31322	71.3	.025	2.6	0.0	2.96	303.1	.7
14	0.0	374.9	38839	46.4	.055	5.2	0.0	3.95	408.7	.5
15	0.0	51.2	8479	354.0	.035	3.0	0.0	.60	99.8	4.2
16	0.0	43.8	6844	288.9	.060	4.7	0.0	.56	88.3	3.7
17	0.0	9.0	1029	177.2	.060	3.1	0.0	.18	19.9	3.4
18	0.0	4.8	38	114.6	0.000	0.0	0.0	.19	1.5	4.4
19	0.0	3.6	35	96.5	.065	1.2	0.0	.20	1.9	5.2
20	0.0	3.0	32	64.8	0.000	0.0	0.0	.36	3.8	7.8
21	0.0	2.8	30	36.3	0.000	0.0	0.0	1.27	13.9	16.6
22	0.0	5.3	7	2.9	.080	0.0	I	R	R	R
23	0.0	43.1	67	.5	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	2.140	GRAM/BHP HR
	CO	156.636	GRAM/BHP HR
	NO2	3.280	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.853	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-28-72 RUN-2 ENG.1-3 72 VERS.STD.TIME.+ JETS A W/AIR TAILORED EGR O-Cat

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.1	4.1	19.7	0	386	.050	11.01	53
2	1200	4.0	1	19.6	7.6	23.3	0	128	.050	9.14	65
3	1200	18.0	4	19.1	8.1	23.0	0	141	.050	9.37	105
4	1200	40.0	9	17.1	9.5	22.5	0	201	.050	9.50	178
5	1200	56.0	13	15.0	11.3	22.4	0	212	.050	9.64	205
6	1200	156.0	36	1.9	24.2	17.8	0	217	.070	12.22	555
7	1200	167.0	38	1.8	25.4	16.9	0	213	.100	12.71	580
8	1200	182.0	42	1.7	26.9	15.8	0	208	.250	13.33	370
9	1200	204.0	47	.5	33.3	13.4	0	1290	4.160	11.72	230
10	1200	222.0	51	.5	34.4	13.5	0	1178	3.840	11.72	450
11	600	0.0	0	18.5	4.2	19.0	0	348	.050	11.24	50
12	1200	0.0	0	22.3	4.3	33.0	0	392	.050	6.38	8
13	2300	220.0	96	1.7	62.1	13.7	0	460	3.150	12.22	285
14	2300	202.0	88	1.7	60.5	13.5	0	553	3.470	11.60	159
15	2300	180.0	79	2.4	56.8	13.8	0	396	2.600	11.72	178
16	2300	165.0	72	2.6	52.0	14.9	0	68	.420	12.59	233
17	2300	110.0	48	3.0	43.4	18.0	0	225	.100	10.55	285
18	2300	55.0	24	13.3	24.2	19.5	0	102	.020	9.03	260
19	2300	40.0	18	15.0	21.4	19.4	0	79	.020	8.75	225
20	2300	18.0	8	16.6	18.7	19.6	0	95	.020	8.48	154
21	2300	4.0	2	17.8	16.2	19.6	0	593	.050	8.34	89
22	600	0.0	0	18.0	4.0	17.3	0	321	.050	10.43	52
23	2300	0.0	0	24.0	4.4	33.2	0	2174	.150	3.68	5

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	6.5	17	2.9	.070	0.0	I	R	R	R
2	0.0	4.8	38	8.1	.060	.1	0.0	5.25	41.4	8.8
3	0.0	5.5	39	13.6	.060	.2	0.0	1.34	9.6	3.3
4	0.0	9.1	45	26.6	.050	.5	0.0	.99	5.0	2.9
5	0.0	11.2	53	35.9	.030	.4	0.0	.88	4.2	2.8
6	0.0	19.4	126	164.3	.060	2.1	0.0	.54	3.5	4.6
7	0.0	19.1	181	172.9	0.000	0.0	0.0	.50	4.8	4.5
8	0.0	18.7	453	110.2	.040	1.7	0.0	.45	10.9	2.7
9	0.0	121.7	7929	72.0	0.000	0.0	0.0	2.61	170.1	1.5
10	0.0	117.3	7720	148.7	0.000	0.0	0.0	2.31	152.2	2.9
11	0.0	5.9	17	2.8	.070	0.0	I	R	R	R
12	0.0	11.8	30	.8	.120	0.0	I	R	R	R
13	0.0	84.1	11627	172.9	.025	2.4	0.0	.87	120.7	1.8
14	0.0	100.3	12718	95.8	.055	4.9	0.0	1.13	143.8	1.1
15	0.0	71.1	9423	106.0	.035	2.8	0.0	.90	119.5	1.3
16	0.0	12.4	1537	140.2	.060	4.3	0.0	.17	21.3	1.9
17	0.0	41.5	373	174.5	.060	2.9	0.0	.86	7.7	3.6
18	0.0	12.3	49	104.6	0.000	0.0	0.0	.51	2.0	4.3
19	0.0	8.7	45	82.6	.065	1.1	0.0	.50	2.6	4.7
20	0.0	9.5	40	51.0	0.000	0.0	0.0	1.20	5.1	6.5
21	0.0	51.5	88	25.7	0.000	0.0	0.0	29.43	50.1	14.7
22	0.0	5.5	17	3.0	.080	0.0	I	R	R	R
23	0.0	107.2	149	.8	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	1.130	GRAM/BHP HR
	CO	63.750	GRAM/BHP HR
	NO2	2.412	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.855	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-30-72 RUN-1 ENG.1-3 72 VER. TDC STD JETS AIR MODI. EGR TAILORED A

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.4	4.4	19.8	0	242	.050	10.89	61
2	1200	4.0	1	19.5	7.9	22.8	0	87	.050	9.37	63
3	1200	16.0	4	19.0	8.4	22.5	0	109	.050	9.50	92
4	1200	36.0	8	17.0	9.6	22.1	0	173	.050	9.78	213
5	1200	51.0	12	15.7	11.3	21.7	0	184	.050	9.93	218
6	1200	101.0	23	8.6	16.4	20.7	0	263	.050	10.43	330
7	1200	152.0	35	2.0	24.7	17.6	0	104	.050	10.25	475
8	1200	166.0	38	.6	33.4	13.1	0	1197	4.690	11.60	108
9	1200	186.0	42	2.0	26.3	16.5	0	101	.070	12.94	1138
10	1200	202.0	46	.5	34.7	13.3	0	959	4.210	11.84	290
11	600	0.0	0	17.4	4.3	19.3	0	268	.050	11.01	62
12	1200	0.0	0	21.7	4.6	27.7	0	4748	.050	7.18	18
13	2300	205.0	90	1.8	63.6	13.5	0	480	3.610	11.92	213
14	2300	189.0	83	1.7	62.7	13.5	0	502	3.560	11.72	176
15	2300	168.0	74	1.7	60.0	13.3	0	547	3.840	11.24	90
16	2300	154.0	67	1.7	60.0	13.3	0	654	4.020	10.89	73
17	2300	103.0	45	2.9	44.9	17.9	0	72	.050	11.13	184
18	2300	51.0	22	9.5	28.6	21.2	0	397	.020	9.37	128
19	2300	37.0	16	11.8	25.3	21.9	0	223	.020	9.25	113
20	2300	16.0	7	14.8	21.3	22.8	0	184	.020	8.84	96
21	2300	4.0	2	17.5	16.9	23.8	0	243	.020	8.54	101
22	600	0.0	0	17.2	4.1	20.9	0	213	.020	9.78	68
23	2300	0.0	0	23.6	4.8	45.4	0	365	.130	4.36	3

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	4.4	18	3.7	.070	0.0	I	R	R	R
2	0.0	3.3	38	7.9	.060	.1	0.0	3.62	42.0	8.7
3	0.0	4.3	40	12.2	.060	.2	0.0	1.19	11.0	3.3
4	0.0	7.7	45	31.3	.050	.4	0.0	.93	5.4	3.8
5	0.0	9.4	52	37.1	.030	.3	0.0	.81	4.4	3.2
6	0.0	18.6	72	77.6	.060	1.4	0.0	.81	3.1	3.4
7	0.0	11.3	110	171.4	0.000	0.0	0.0	.33	3.2	4.9
8	0.0	110.5	8747	33.1	.040	1.5	0.0	2.91	230.6	.9
9	0.0	9.2	130	346.2	0.000	0.0	0.0	.22	3.0	8.1
10	0.0	93.5	8290	93.9	0.000	0.0	0.0	2.03	179.6	2.0
11	0.0	4.7	18	3.6	.070	0.0	I	R	R	R
12	0.0	128.6	27	1.6	.120	0.0	I	R	R	R
13	0.0	89.0	13504	131.0	.025	2.2	0.0	.99	150.4	1.5
14	0.0	93.2	13341	108.4	.055	4.6	0.0	1.13	161.2	1.3
15	0.0	98.4	13949	53.7	.035	2.6	0.0	1.34	189.6	.7
16	0.0	118.9	14758	44.0	.060	4.0	0.0	1.76	218.8	.7
17	0.0	13.1	184	111.2	.060	2.7	0.0	.29	4.1	2.5
18	0.0	54.6	56	58.5	0.000	0.0	0.0	2.44	2.5	2.6
19	0.0	27.5	50	46.3	.065	1.1	0.0	1.70	3.1	2.9
20	0.0	20.0	44	34.7	0.000	0.0	0.0	2.86	6.3	4.9
21	0.0	21.7	36	29.9	0.000	0.0	0.0	12.38	20.6	17.1
22	0.0	4.0	8	4.3	.080	0.0	I	R	R	R
23	0.0	17.5	126	.5	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	2.112	GRAM/BHP HR
	CO	134.315	GRAM/BHP HR
	NO2	1.628	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.993	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-29-72 RUN-1 ENG.1-3 72 VER. STD TIM.+JETS MODI.AIR+EGR TAILORED A O-Cat

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.8	4.0	18.5	0	366	.050	11.84	46
2	1200	5.0	1	19.6	7.4	22.8	0	177	.050	9.37	50
3	1200	18.0	4	18.9	8.3	22.4	0	153	.050	9.64	100
4	1200	41.0	9	17.5	9.4	22.3	0	205	.050	9.64	215
5	1200	58.0	13	16.1	10.6	22.2	0	219	.020	9.64	315
6	1200	115.0	26	9.9	15.8	21.1	0	328	.020	10.25	930
7	1200	173.0	40	2.6	23.6	18.9	0	2268	.020	11.48	1225
8	1200	189.0	43	2.0	25.5	17.1	0	210	.050	12.59	1063
9	1200	212.0	48	1.0	29.3	13.0	0	1426	4.880	11.36	178
10	1200	230.0	53	.5	34.8	13.4	0	1122	3.790	11.84	450
11	600	0.0	0	18.4	4.1	19.0	0	313	.050	11.24	49
12	1200	0.0	0	22.5	4.3	32.7	0	482	.020	6.30	8
13	2300	222.0	97	1.7	61.8	13.6	0	507	3.190	11.92	280
14	2300	204.0	89	1.7	60.0	13.5	0	597	3.330	11.36	168
15	2300	182.0	80	1.7	59.0	13.3	0	771	3.790	10.66	113
16	2300	167.0	73	2.1	59.6	12.8	0	1256	4.690	9.50	93
17	2300	111.0	49	2.9	42.5	16.0	0	131	.050	10.66	219
18	2300	56.0	25	11.1	25.2	17.8	0	228	.020	9.37	150
19	2300	40.0	18	13.4	22.6	18.0	0	133	.020	8.93	141
20	2300	18.0	8	15.6	19.6	18.3	0	189	.020	8.75	128
21	2300	4.0	2	18.0	15.4	18.8	0	829	.020	8.24	83
22	600	0.0	0	17.9	4.0	17.3	0	290	.020	10.09	51
23	2300	0.0	0	24.0	4.4	29.8	0	2146	.150	3.56	3

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	5.6	15	2.3	.070	0.0	I	R	R	R
2	0.0	6.3	36	5.9	.060	.1	0.0	5.52	31.4	5.2
3	0.0	5.9	39	12.9	.060	.2	0.0	1.44	9.5	3.1
4	0.0	9.0	44	31.3	.050	.5	0.0	.96	4.7	3.3
5	0.0	10.9	20	51.9	.030	.4	0.0	.82	1.5	3.9
6	0.0	22.9	28	214.8	.060	1.6	0.0	.87	1.1	8.2
7	0.0	207.0	37	371.3	0.000	0.0	0.0	5.24	.9	9.4
8	0.0	19.2	92	322.4	.040	1.7	0.0	.44	2.1	7.5
9	0.0	115.7	7997	47.9	0.000	0.0	0.0	2.39	165.1	1.0
10	0.0	112.5	7677	149.8	0.000	0.0	0.0	2.14	146.1	2.9
11	0.0	5.1	17	2.7	.070	0.0	I	R	R	R
12	0.0	14.8	12	.8	.120	0.0	I	R	R	R
13	0.0	93.8	11915	171.9	.025	2.4	0.0	.96	122.6	1.8
14	0.0	110.2	12412	102.9	.055	4.9	0.0	1.23	138.9	1.2
15	0.0	142.0	14104	69.1	.035	2.8	0.0	1.78	177.0	.9
16	0.0	237.1	17891	58.3	.060	4.4	0.0	3.24	244.6	.8
17	0.0	23.5	182	130.7	.060	2.9	0.0	.48	3.7	2.7
18	0.0	27.7	49	60.5	0.000	0.0	0.0	1.13	2.0	2.5
19	0.0	15.2	46	53.5	.065	1.1	0.0	.87	2.6	3.1
20	0.0	19.1	41	43.0	0.000	0.0	0.0	2.43	5.2	5.5
21	0.0	69.4	34	23.1	0.000	0.0	0.0	39.62	19.3	13.2
22	0.0	5.2	7	3.0	.080	0.0	I	R	R	R
23	0.0	109.1	154	.5	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	1.871	GRAM/BHP HR
	CO	112.208	GRAM/BHP HR
	NO2	2.513	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.862	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY
8-30-72 RUN-2 ENG.1-3 72 VER. A STD JETS 15 BTDC MODI.AIR O-Cat EGR TAID.

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.8	4.0	19.3	0	463	.050	11.01	39
2	1200	5.0	1	19.9	7.7	23.7	0	206	.050	8.93	61
3	1200	19.0	4	19.4	8.1	23.2	0	204	.050	9.14	111
4	1200	43.0	10	17.2	9.6	22.6	0	261	.050	9.37	395
5	1200	60.0	14	16.0	10.6	22.4	0	294	.050	9.37	510
6	1200	120.0	27	9.4	16.0	21.2	0	377	.050	10.09	795
7	1200	180.0	41	2.0	24.2	17.9	0	414	.100	11.92	860
8	1200	197.0	45	1.9	25.1	17.1	0	427	.100	12.22	79
9	1200	221.0	50	2.0	25.2	17.7	0	437	.100	11.92	2400
10	1200	240.0	55	.5	34.7	13.2	0	2013	4.540	11.01	560
11	600	0.0	0	19.0	3.9	18.7	0	382	.050	11.48	42
12	1200	0.0	0	22.8	4.0	32.0	0	3650	.050	6.21	6
13	2300	236.0	103	1.7	62.6	13.6	0	610	3.380	11.84	420
14	2300	217.0	95	1.7	61.1	13.3	0	915	4.070	11.48	275
15	2300	194.0	85	1.6	58.7	13.0	0	1165	4.450	10.89	130
16	2300	177.0	78	2.5	49.1	15.2	0	36	.350	12.82	270
17	2300	118.0	52	3.7	36.1	18.7	0	339	.100	10.89	340
18	2300	59.0	26	14.0	22.4	21.3	0	116	.050	9.93	370
19	2300	42.0	18	15.5	20.0	22.2	0	177	.050	9.50	250
20	2300	19.0	8	17.1	17.7	23.2	0	287	.050	8.93	180
21	2300	5.0	2	18.0	15.8	24.1	0	2429	.050	8.54	113
22	600	0.0	0	18.9	4.0	19.2	0	356	.050	11.13	42
23	2300	0.0	0	24.2	4.1	51.7	0	4439	.100	3.40	3

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	7.6	17	2.1	.070	0.0	I	R	R	R
2	0.0	8.0	39	7.9	.060	.1	0.0	6.99	34.3	6.9
3	0.0	8.1	40	14.7	.060	.3	0.0	1.87	9.3	3.4
4	0.0	12.0	47	60.5	.050	.5	0.0	1.22	4.7	6.2
5	0.0	14.9	51	86.2	.030	.4	0.0	1.09	3.7	6.3
6	0.0	26.9	72	188.2	.060	1.6	0.0	.98	2.6	6.9
7	0.0	37.7	184	259.9	0.000	0.0	0.0	.92	4.5	6.3
8	0.0	39.3	186	24.2	.040	1.8	0.0	.87	4.1	.5
9	0.0	41.4	191	755.0	0.000	0.0	0.0	.82	3.8	15.0
10	0.0	201.2	9164	185.8	0.000	0.0	0.0	3.67	167.1	3.4
11	0.0	5.8	15	2.1	.070	0.0	I	R	R	R
12	0.0	100.0	28	.5	.120	0.0	I	R	R	R
13	0.0	113.4	12687	259.1	.025	2.6	0.0	1.10	122.8	2.5
14	0.0	162.1	14567	161.8	.055	5.2	0.0	1.71	153.3	1.7
15	0.0	200.6	15485	74.4	.035	3.0	0.0	2.36	182.3	.9
16	0.0	6.1	1195	151.5	.060	4.7	0.0	.08	15.4	2.0
17	0.0	50.4	300	167.7	.060	3.1	0.0	.98	5.8	3.2
18	0.0	11.8	103	124.9	0.000	0.0	0.0	.46	4.0	4.8
19	0.0	16.8	96	78.7	.065	1.2	0.0	.91	5.2	4.3
20	0.0	25.6	90	53.3	0.000	0.0	0.0	3.07	10.8	6.4
21	0.0	197.1	82	30.4	0.000	0.0	0.0	90.00	37.4	13.9
22	0.0	5.8	16	2.3	.080	0.0	I	R	R	R
23	0.0	209.3	95	.5	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	2.229	GRAM/BHP HR
	CO	73.307	GRAM/BHP HR
	NO2	2.542	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.766	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

8-31-72 RUN-3 ENG.1-3 72 VER. A STD TIM + JETS HOT TAID EGR O-Cat NO AIR

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.8	3.8	15.8	0	2547	.810	13.48	57
2	1200	5.0	1	19.8	7.6	16.9	0	146	.050	13.48	89
3	1200	18.0	4	19.0	8.2	16.8	0	165	.050	13.77	148
4	1200	41.0	9	17.2	9.7	17.5	0	213	.050	13.18	465
5	1200	58.0	13	16.0	10.6	17.8	0	213	.050	12.94	640
6	1200	115.0	26	9.7	15.9	18.3	0	280	.050	12.71	940
7	1200	173.0	40	2.6	23.3	17.3	0	245	.050	13.18	1363
8	1200	189.0	43	1.9	25.6	15.6	0	563	.390	14.53	1063
9	1200	212.0	48	1.9	27.3	15.2	0	850	.770	14.42	1450
10	1200	230.0	53	.5	34.3	12.7	0	3180	5.900	11.01	505
11	600	0.0	0	17.9	3.9	15.4	0	3036	1.660	12.94	48
12	1200	0.0	0	22.5	3.9	21.9	0	5645	.020	9.50	12
13	2300	230.0	101	1.7	63.4	12.5	0	4982	5.670	11.48	365
14	2300	212.0	93	1.7	61.9	12.5	0	2665	6.130	11.01	199
15	2300	189.0	83	1.6	60.2	12.3	0	2807	6.500	10.55	108
16	2300	173.0	76	2.1	61.4	11.8	0	3421	7.620	9.64	92
17	2300	115.0	50	2.7	46.0	15.1	0	317	1.010	13.18	123
18	2300	58.0	25	10.7	25.6	17.0	0	235	.050	12.59	133
19	2300	41.0	18	12.9	21.4	17.2	0	112	.050	12.71	121
20	2300	18.0	8	15.3	20.3	17.6	0	71	.050	11.92	155
21	2300	5.0	2	17.9	15.8	18.3	0	521	.050	11.72	119
22	600	0.0	0	17.8	3.9	16.0	0	2404	.850	12.59	57
23	2300	0.0	0	23.8	4.3	22.2	0	10067	.070	8.68	10

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	30.2	194	2.2	.070	0.0	I	R	R	R
2	0.0	3.7	26	7.5	.060	.1	0.0	3.26	22.5	6.6
3	0.0	4.4	27	13.2	.060	.2	0.0	1.08	6.6	3.2
4	0.0	7.1	34	51.3	.050	.5	0.0	.76	3.6	5.5
5	0.0	7.9	37	78.5	.030	.4	0.0	.59	2.8	5.9
6	0.0	15.8	57	176.0	.060	1.6	0.0	.60	2.2	6.7
7	0.0	19.5	81	360.8	0.000	0.0	0.0	.49	2.0	9.1
8	0.0	43.7	611	273.6	.040	1.7	0.0	1.01	14.1	6.3
9	0.0	68.9	1261	390.3	0.000	0.0	0.0	1.42	26.0	8.1
10	0.0	287.2	10763	151.4	0.000	0.0	0.0	5.47	204.8	2.9
11	0.0	36.0	398	1.9	.070	0.0	I	R	R	R
12	0.0	99.0	7	.7	.120	0.0	I	R	R	R
13	0.0	811.9	18664	197.5	.025	2.5	0.0	8.06	185.3	2.0
14	0.0	429.8	19974	106.6	.055	5.1	0.0	4.63	215.1	1.1
15	0.0	442.3	20688	56.5	.035	2.9	0.0	5.34	249.9	.7
16	0.0	541.3	24355	48.3	.060	4.5	0.0	7.14	321.5	.6
17	0.0	46.5	2993	59.9	.060	3.0	0.0	.92	59.4	1.2
18	0.0	21.5	93	40.5	0.000	0.0	0.0	.85	3.6	1.6
19	0.0	8.5	77	30.5	.065	1.2	0.0	.47	4.3	1.7
20	0.0	5.5	78	39.6	0.000	0.0	0.0	.69	9.9	5.0
21	0.0	31.6	61	24.0	0.000	0.0	0.0	14.43	28.0	10.9
22	0.0	31.1	222	2.4	.080	0.0	I	R	R	R
23	0.0	201.2	28	.7	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	5.480	GRAM/BHP HR
	CO	169.778	GRAM/BHP HR
	NO2	2.086	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.852	LB/BHP HR

ENGINE 1-3

EFFECT OF VARIOUS COMBINATIONS ON EMISSIONS

GRAPHED RESULTS

OF AFTER CATALYST WITH HOT EGR

PER SCHEDULE A, WITH AIR INJECTION

AND STANDARD CARBURETOR

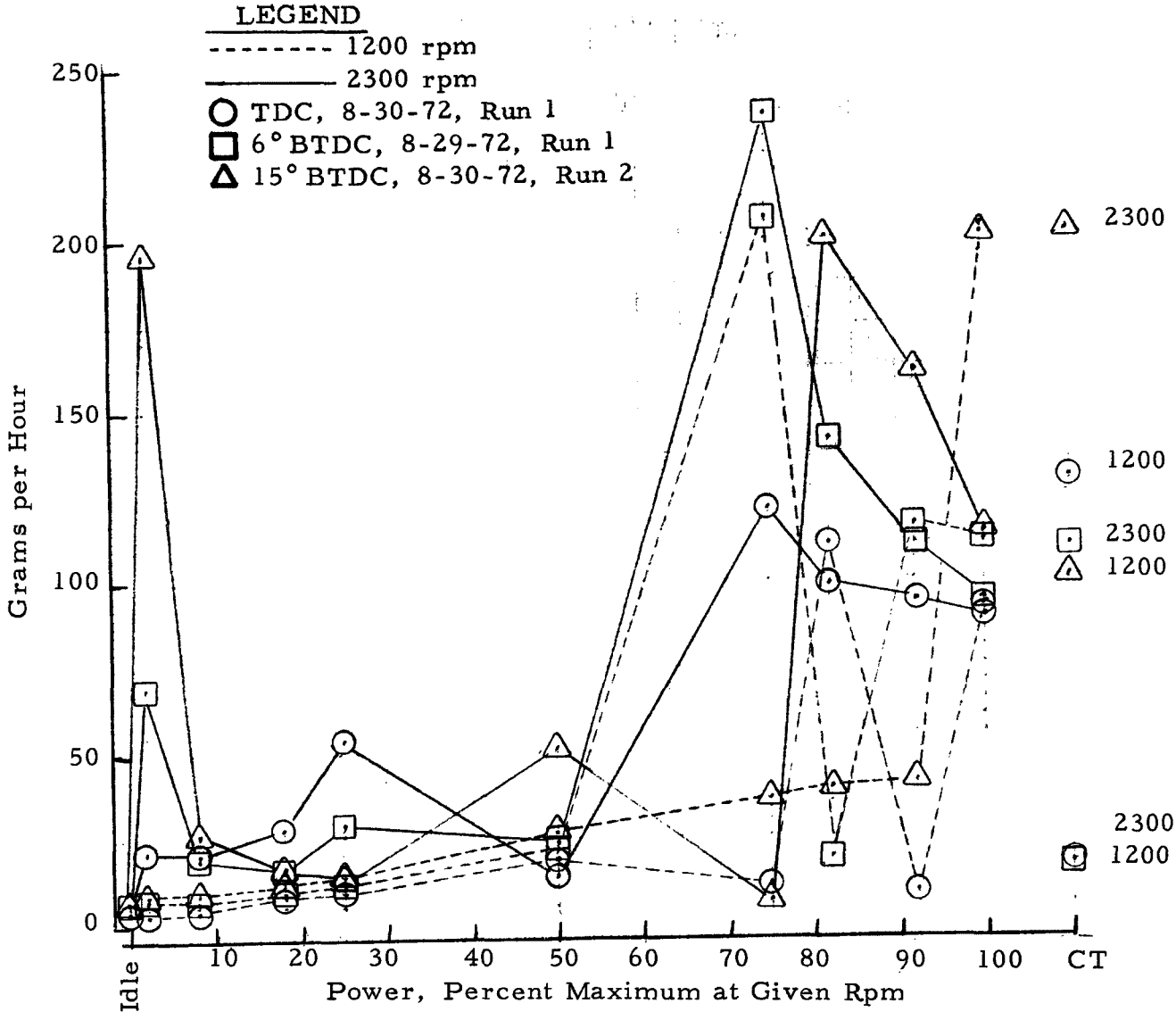


FIGURE V-1. EFFECT OF POWER ON HC EMISSION RATE AFTER CATALYST, HOT EGR SCHEDULE A, MODIFIED AIR ENGINE 1-3, 23 MODE TEST

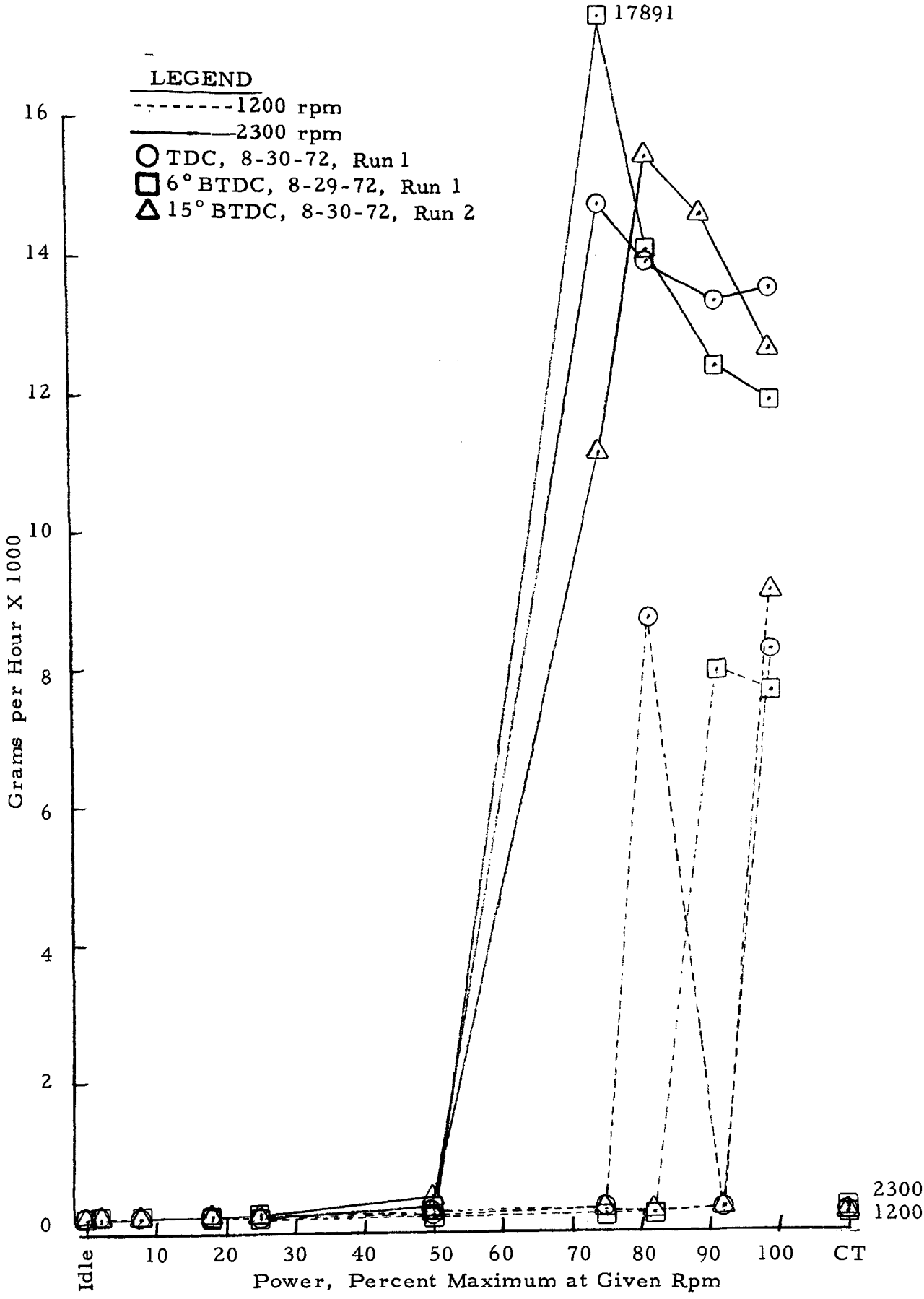


FIGURE V-2. EFFECT OF POWER ON CO EMISSION RATE AFTER CATALYST, HOT EGR SCHEDULE A, MODIFIED AIR ENGINE 1-3, 23 MODE TEST

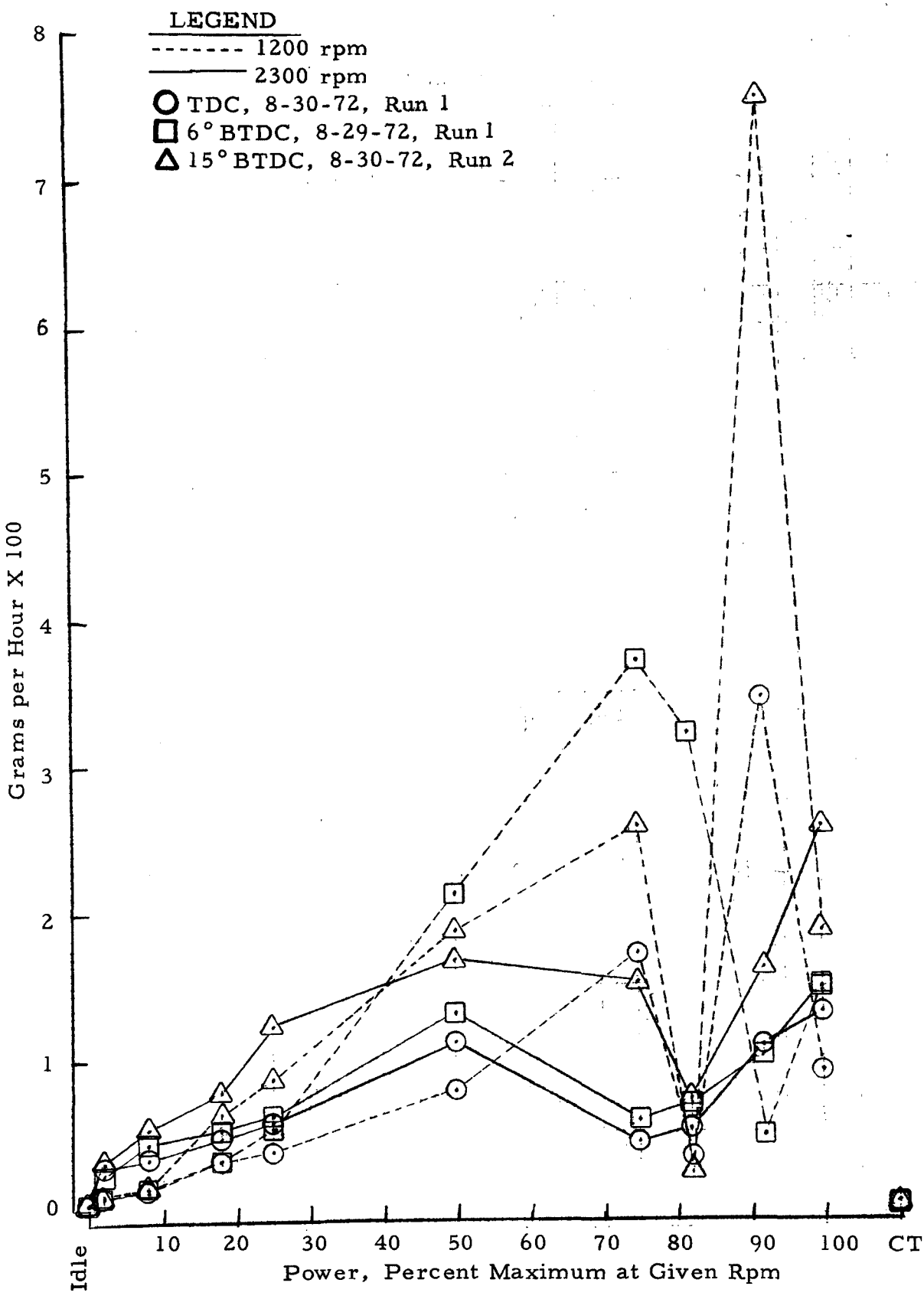


FIGURE V-3. EFFECT OF POWER ON NO_x (AS NO_2) EMISSION RATE AFTER CATALYST, HOT EGR SCHEDULE A, MODIFIED AIR ENGINE 1-3, 23 MODE TEST

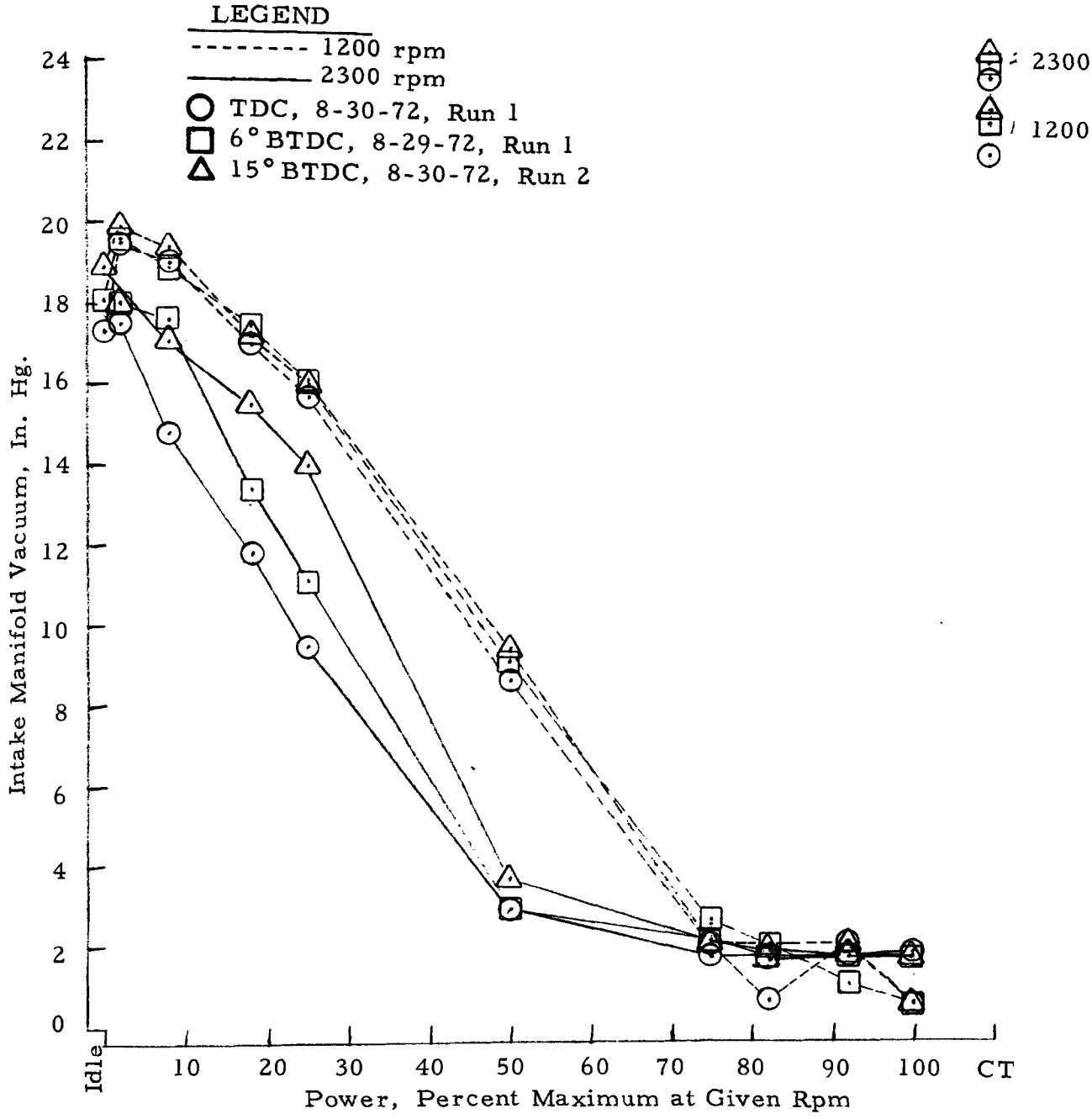


FIGURE V-4. MANIFOLD VACUUM AS A FUNCTION OF POWER
ENGINE 1-3, 23 MODE TEST

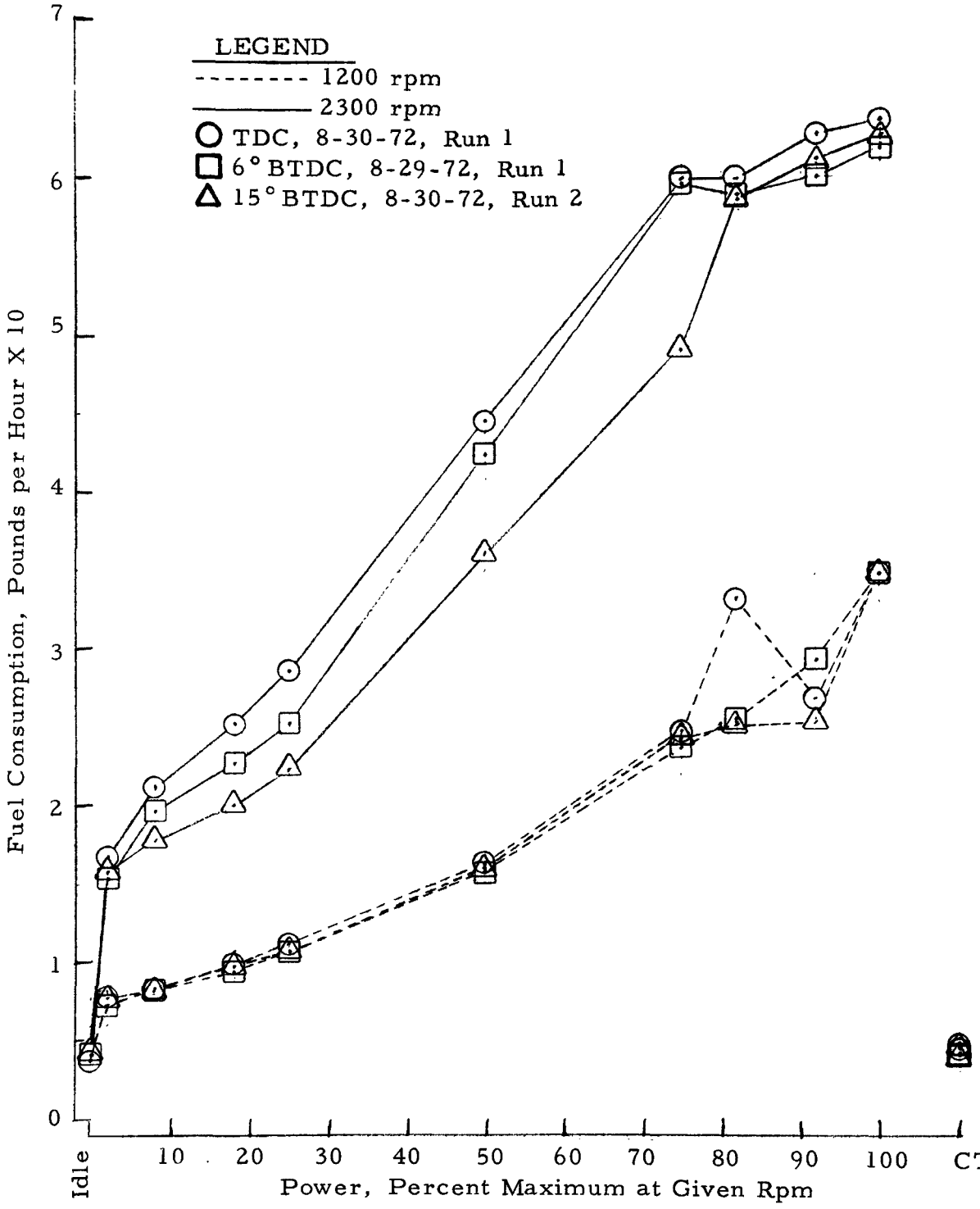


FIGURE V-5. FUEL CONSUMPTION AS A FUNCTION OF POWER
ENGINE 1-3, 23 MODE TEST

APPENDIX W

ENGINE 1-3

EFFECT OF "BEST COMBINATION" ON EMISSIONS

ENGINE 1-3

EFFECT OF "BEST COMBINATION" ON EMISSIONS

TABULAR 23 MODE DATA

BEFORE AND AFTER CATALYST

PROJECT 11-2877-01 CONTROL TECHNOLOGY

9-05-72 RUN-1 ENG.1-3 72 VER.MODI AIR + EGR STD JETS + TIM B O—CAT

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.0	4.2	20.3	0	1769	1.200	10.25	37
2	1200	4.0	1	19.7	7.8	22.9	0	454	.180	10.09	76
3	1200	17.0	4	19.2	8.3	22.9	0	531	.180	10.09	121
4	1200	39.0	9	17.7	9.3	21.9	0	781	.100	10.66	295
5	1200	55.0	13	15.8	11.0	21.9	0	829	.100	10.55	385
6	1200	109.0	25	9.5	15.8	21.3	0	1235	.070	11.01	570
7	1200	164.0	37	2.3	23.7	19.2	0	519	.130	12.47	1087
8	1200	179.0	41	1.8	25.2	17.4	0	383	.350	13.33	770
9	1200	201.0	46	1.8	26.1	17.6	0	377	.350	13.06	1875
10	1200	218.0	50	.5	34.8	13.7	0	1641	5.350	11.48	360
11	600	0.0	0	18.3	4.3	19.0	0	1713	1.870	10.25	425
12	1200	0.0	0	22.2	4.3	32.3	0	34299	.210	3.20	10
13	2300	216.0	95	1.7	62.8	13.6	0	990	4.640	12.47	275
14	2300	199.0	87	2.5	54.8	14.5	0	335	2.400	13.33	695
15	2300	177.0	78	2.6	50.3	15.9	0	90	.890	12.94	620
16	2300	162.0	71	2.7	48.2	16.9	0	84	.440	12.59	590
17	2300	108.0	47	2.6	44.7	17.0	0	252	.390	12.47	190
18	2300	54.0	24	11.5	25.4	23.3	0	661	.150	8.93	188
19	2300	39.0	17	13.3	23.5	21.2	0	526	.130	10.25	163
20	2300	17.0	7	15.9	18.8	21.1	0	496	.100	10.89	138
21	2300	4.0	2	16.9	17.8	21.5	0	723	.150	10.09	127
22	600	0.0	0	17.9	4.2	18.6	0	1936	1.520	10.66	42
23	2300	0.0	0	23.6	4.5	32.3	0	52694	.070	.33	6

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	29.0	397	2.0	.070	0.0	I	R	R	R
2	0.0	15.6	125	8.7	.060	.1	0.0	17.05	136.5	9.5
3	0.0	19.4	133	14.7	.060	.2	0.0	4.99	34.1	3.8
4	0.0	30.4	79	38.1	.050	.4	0.0	3.41	8.8	4.3
5	0.0	38.6	94	59.4	.030	.4	0.0	3.07	7.5	4.7
6	0.0	79.0	90	121.1	.060	1.5	0.0	3.17	3.6	4.9
7	0.0	44.1	223	306.8	0.000	0.0	0.0	1.18	6.0	8.2
8	0.0	31.9	589	213.0	.040	1.6	0.0	.78	14.4	5.2
9	0.0	33.2	622	548.0	0.000	0.0	0.0	.72	13.6	11.9
10	0.0	152.4	10038	111.0	0.000	0.0	0.0	3.06	201.5	2.2
11	0.0	27.2	599	22.4	.070	0.0	I	R	R	R
12	0.0	978.1	121	1.0	.120	0.0	I	R	R	R
13	0.0	163.9	15515	151.1	.025	2.4	0.0	1.73	164.0	1.6
14	0.0	52.8	7645	363.9	.055	4.8	0.0	.61	87.7	4.2
15	0.0	14.9	2964	339.4	.035	2.7	0.0	.19	38.2	4.4
16	0.0	14.1	1490	328.5	.060	4.3	0.0	.20	21.0	4.6
17	0.0	39.6	1240	99.3	.060	2.8	0.0	.84	26.2	2.1
18	0.0	83.3	382	78.4	0.000	0.0	0.0	3.52	16.1	3.3
19	0.0	53.8	268	55.1	.065	1.1	0.0	3.15	15.7	3.2
20	0.0	38.3	156	35.3	0.000	0.0	0.0	5.14	21.0	4.7
21	0.0	56.6	237	33.1	0.000	0.0	0.0	32.29	135.4	18.9
22	0.0	29.8	473	2.1	.080	0.0	I	R	R	R
23	0.0	1897.2	51	.8	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	11.765	GRAM/BHP HR
	CO	56.894	GRAM/BHP HR
	NO2	3.936	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.846	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

9-06-72 RUN-1 ENG.1-3 72 VER.MODI AIR HOT EGR STD JETS+TIM B O—CAT

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.7	4.0	19.3	0	1781	1.410	10.09	43
2	1200	5.0	1	19.5	7.6	23.6	0	436	.130	9.64	54
3	1200	18.0	4	18.6	8.6	23.5	0	687	.100	9.64	134
4	1200	41.0	9	17.1	9.7	22.5	0	790	.070	10.43	225
5	1200	57.0	13	15.0	11.5	22.5	0	931	.050	10.25	300
6	1200	114.0	26	9.0	16.4	21.8	0	1351	.050	10.55	620
7	1200	171.0	39	1.9	24.1	19.3	0	668	.130	11.92	1000
8	1200	187.0	43	1.6	27.6	15.9	0	488	1.050	13.48	610
9	1200	210.0	48	1.8	25.7	17.4	0	438	.310	12.94	1813
10	1200	228.0	52	.5	34.3	13.7	0	1772	5.290	11.01	325
11	600	0.0	0	17.9	4.1	19.6	0	1539	1.160	10.43	56
12	1200	0.0	0	22.0	4.3	31.4	0	30302	.150	3.74	23
13	2300	216.0	95	1.7	62.4	13.5	0	1040	4.450	12.34	230
14	2300	199.0	87	2.5	54.1	14.6	0	223	1.840	13.48	680
15	2300	177.0	78	2.7	49.6	15.7	0	76	.700	13.18	470
16	2300	162.0	71	2.8	47.8	16.4	0	74	.350	12.94	555
17	2300	108.0	47	2.7	43.6	16.9	0	738	.280	12.47	213
18	2300	54.0	24	12.4	25.2	22.3	0	489	.130	9.25	205
19	2300	39.0	17	13.9	22.4	22.4	0	435	.130	9.37	155
20	2300	17.0	7	16.0	19.6	22.9	0	326	.100	9.14	142
21	2300	4.0	2	17.2	17.4	23.6	0	758	.100	8.84	107
22	600	0.0	0	17.8	4.0	20.4	0	1507	.740	9.64	61
23	2300	0.0	0	23.4	4.4	35.6	0	55721	.070	.36	6

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	27.7	443	2.2	.070	0.0	I	R	R	R
2	0.0	15.3	92	6.3	.060	.1	0.0	13.41	80.7	5.5
3	0.0	27.3	80	17.7	.060	.2	0.0	6.64	19.5	4.3
4	0.0	32.9	59	31.1	.050	.5	0.0	3.51	6.3	3.3
5	0.0	46.7	51	50.0	.030	.4	0.0	3.59	3.9	3.8
6	0.0	93.6	70	142.6	.060	1.6	0.0	3.59	2.7	5.5
7	0.0	60.3	237	299.5	0.000	0.0	0.0	1.54	6.1	7.7
8	0.0	41.9	1821	173.9	.040	1.7	0.0	.98	42.6	4.1
9	0.0	38.4	549	527.7	0.000	0.0	0.0	.80	11.4	11.0
10	0.0	167.3	10090	101.9	0.000	0.0	0.0	3.21	193.7	2.0
11	0.0	24.4	371	3.0	.070	0.0	I	R	R	R
12	0.0	854.1	85	2.2	.120	0.0	I	R	R	R
13	0.0	174.2	15060	127.9	.025	2.4	0.0	1.84	159.2	1.4
14	0.0	35.6	5945	361.1	.055	4.8	0.0	.41	68.2	4.1
15	0.0	12.3	2291	252.8	.035	2.7	0.0	.16	29.6	3.3
16	0.0	12.1	1153	300.4	.060	4.3	0.0	.17	16.2	4.2
17	0.0	113.8	872	109.1	.060	2.8	0.0	2.41	18.4	2.3
18	0.0	59.3	318	82.5	0.000	0.0	0.0	2.51	13.5	3.5
19	0.0	46.3	280	54.8	.065	1.1	0.0	2.71	16.4	3.2
20	0.0	31.2	194	45.4	0.000	0.0	0.0	4.19	26.0	6.1
21	0.0	66.3	177	31.2	0.000	0.0	0.0	37.88	101.0	17.8
22	0.0	26.0	258	3.5	.080	0.0	I	R	R	R
23	0.0	1852.9	47	.7	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	11.082	GRAM/BHP HR
	CO	49.101	GRAM/BHP HR
	NO2	3.596	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.833	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY
9-06-72 RUN-2 ENG.1-3 72 VER.MODI AIR HOT EGR STD JETS+TIM B O—CAT

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.7	4.0	18.2	0	1971	1.700	9.93	41
2	1200	5.0	1	19.6	7.6	23.2	0	347	.100	9.03	56
3	1200	18.0	4	18.5	8.5	23.0	0	678	.100	9.14	125
4	1200	41.0	9	16.9	9.6	22.8	0	870	.070	9.37	250
5	1200	57.0	13	16.2	10.5	22.7	0	926	.130	9.50	360
6	1200	114.0	26	9.5	15.8	22.1	0	1460	.050	9.64	640
7	1200	171.0	39	2.4	23.4	20.0	0	683	.050	11.01	1200
8	1200	187.0	43	1.8	25.3	18.1	0	464	.250	11.92	1300
9	1200	210.0	48	1.8	27.0	17.2	0	430	.350	12.34	1862
10	1200	228.0	52	.5	33.4	13.6	0	1678	5.140	11.01	380
11	600	0.0	0	18.0	4.1	19.6	0	1695	1.230	9.64	50
12	1200	0.0	0	22.0	4.3	28.1	0	29589	.100	4.03	6
13	2300	218.0	95	1.7	62.3	13.5	0	997	4.260	12.22	270
14	2300	201.0	88	2.5	53.6	14.8	0	205	1.660	13.48	710
15	2300	179.0	78	2.7	50.2	15.6	0	85	.700	13.18	610
16	2300	164.0	72	2.8	46.7	16.6	0	119	.280	12.71	675
17	2300	109.0	48	2.7	43.4	16.4	0	672	.280	12.71	215
18	2300	55.0	24	12.5	24.4	21.8	0	468	.130	9.37	220
19	2300	39.0	17	14.2	21.7	22.2	0	408	.130	9.37	175
20	2300	17.0	7	16.0	19.0	22.7	0	347	.100	9.14	132
21	2300	4.0	2	17.2	17.2	24.0	0	757	.100	8.75	120
22	600	0.0	0	17.7	4.0	20.1	0	1644	.740	9.64	58
23	2300	0.0	0	23.6	4.4	37.4	0	54170	.050	.29	7

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	0.0	30.2	527	2.1	.070	0.0	I	R	R	R
2	0.0	13.1	76	7.0	.060	.1	0.0	11.43	66.5	6.1
3	0.0	28.1	84	17.2	.060	.2	0.0	6.83	20.3	4.2
4	0.0	39.8	65	37.9	.050	.5	0.0	4.24	6.9	4.0
5	0.0	45.3	129	58.5	.030	.4	0.0	3.48	9.9	4.5
6	0.0	106.4	74	154.8	.060	1.6	0.0	4.08	2.8	5.9
7	0.0	65.2	96	380.0	0.000	0.0	0.0	1.67	2.5	9.7
8	0.0	43.6	474	405.4	.040	1.7	0.0	1.02	11.1	9.5
9	0.0	41.4	680	594.8	0.000	0.0	0.0	.86	14.2	12.4
10	0.0	155.8	9640	117.1	0.000	0.0	0.0	2.99	185.0	2.2
11	0.0	28.6	419	2.8	.070	0.0	I	R	R	R
12	0.0	814.1	56	.6	.120	0.0	I	R	R	R
13	0.0	169.9	14667	152.8	.025	2.4	0.0	1.78	153.6	1.6
14	0.0	32.9	5378	378.0	.055	4.8	0.0	.37	61.1	4.3
15	0.0	13.9	2318	332.0	.035	2.7	0.0	.18	29.6	4.2
16	0.0	19.4	921	365.1	.060	4.3	0.0	.27	12.8	5.1
17	0.0	101.3	853	107.6	.060	2.9	0.0	2.12	17.9	2.3
18	0.0	54.2	304	84.7	0.000	0.0	0.0	2.25	12.6	3.5
19	0.0	42.1	271	59.9	.065	1.1	0.0	2.46	15.9	3.5
20	0.0	32.3	188	40.9	0.000	0.0	0.0	4.34	25.2	5.5
21	0.0	66.2	177	34.8	0.000	0.0	0.0	37.79	100.8	19.9
22	0.0	28.3	257	3.3	.080	0.0	I	R	R	R
23	0.0	1878.0	35	.7	.060	0.0	I	R	R	R

CYCLE COMPOSITE			
	HC	10.890	GRAM/BHP HR
	CO	44.193	GRAM/BHP HR
	NO2	4.397	GRAM/BHP HR
	ALDE	0.000	GRAM/BHP HR
	BSFC	.813	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

9-05-72 RUN-1 ENG.1-3 72 VER.MODI AIR + EGR STD JETS + TIM A O—CAT

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.0	4.2	21.6	15	359	.100	11.13	46
2	1200	4.0	1	19.7	7.8	23.6	15	135	.020	9.93	95
3	1200	17.0	4	19.2	8.3	23.5	14	156	.020	9.93	139
4	1200	39.0	9	17.7	9.3	22.6	15	225	.020	10.43	270
5	1200	55.0	13	15.8	11.0	22.5	22	228	.020	10.55	350
6	1200	109.0	25	9.5	15.8	21.4	37	309	.020	11.01	495
7	1200	164.0	37	2.3	23.7	19.3	41	222	.050	12.34	1013
8	1200	179.0	41	1.8	25.2	17.6	34	196	.070	13.33	760
9	1200	201.0	46	1.8	26.1	17.9	32	209	.070	13.06	1700
10	1200	218.0	50	.5	34.8	13.9	34	1068	4.070	11.92	430
11	600	0.0	0	18.3	4.3	19.5	26	353	.070	11.92	55
12	1200	0.0	0	22.2	4.3	31.9	24	4567	.070	6.64	10
13	2300	216.0	95	1.7	62.8	13.9	25	495	3.520	12.94	270
14	2300	199.0	87	2.5	54.8	15.2	23	60	.670	13.91	715
15	2300	177.0	78	2.6	50.3	16.9	20	50	.100	12.94	595
16	2300	162.0	71	2.7	48.2	18.0	14	42	.100	12.22	595
17	2300	108.0	47	2.6	44.7	18.1	14	40	.050	12.22	195
18	2300	54.0	24	11.5	25.4	22.3	15	223	.050	9.50	179
19	2300	39.0	17	13.3	23.5	20.9	6	147	.050	11.01	156
20	2300	17.0	7	15.9	18.8	21.7	7	212	.050	10.43	123
21	2300	4.0	2	16.9	17.8	22.1	18	355	.070	9.78	108
22	600	0.0	0	17.9	4.2	19.8	12	291	.100	11.60	66
23	2300	0.0	0	23.6	4.5	38.6	19	969	.210	4.94	5

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	.5	6.1	34	2.6	.070	0.0	R	R	R	R
2	1.1	4.8	14	11.2	.060	.1	1.2	5.26	15.7	12.3
3	1.2	5.9	15	17.4	.060	.2	.3	1.52	3.9	4.5
4	1.3	9.1	16	36.1	.050	.4	.1	1.02	1.8	4.1
5	2.2	10.8	19	54.7	.030	.4	.2	.86	1.5	4.4
6	5.1	20.0	26	106.5	.060	1.5	.2	.80	1.1	4.3
7	7.7	19.2	87	291.3	0.000	0.0	.2	.51	2.3	7.8
8	6.2	16.7	120	214.9	.040	1.6	.2	.41	2.9	5.3
9	6.1	18.8	127	508.1	0.000	0.0	.1	.41	2.8	11.1
10	7.3	104.7	8062	140.0	0.000	0.0	.1	2.10	161.9	2.8
11	.9	5.7	23	3.0	.070	0.0	R	R	R	R
12	1.4	124.3	38	.9	.120	0.0	R	R	R	R
13	9.4	85.5	12269	154.7	.025	2.4	.1	.90	129.7	1.6
14	8.6	10.3	2306	404.5	.055	4.8	.1	.12	26.5	4.6
15	7.4	8.8	353	345.5	.035	2.7	.1	.11	4.6	4.5
16	5.3	7.5	358	350.4	.060	4.3	.1	.11	5.1	4.9
17	5.0	6.6	167	106.9	.060	2.8	.1	.14	3.5	2.3
18	4.0	26.9	122	71.5	0.000	0.0	.2	1.14	5.1	3.0
19	1.3	14.1	97	49.9	.065	1.1	.1	.83	5.7	2.9
20	1.3	17.2	82	33.2	0.000	0.0	.2	2.31	11.0	4.5
21	3.2	29.0	115	29.3	0.000	0.0	1.8	16.53	65.9	16.7
22	.4	4.7	33	3.6	.080	0.0	R	R	R	R
23	1.6	37.7	165	.6	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	1.185	GRAM/BHP HR
	CO	23.053	GRAM/BHP HR
	NO2	4.027	GRAM/BHP HR
	ALDE	.130	GRAM/BHP HR
	BSFC	.846	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY
9-06-72 RUN-1 ENG.1-3 72 VER.MODI AIR HOT EGR STD JETS+TIM A O—CAT

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.7	4.0	20.4	15	351	.020	11.13	53
2	1200	5.0	1	19.5	7.6	24.5	15	163	.020	9.37	64
3	1200	18.0	4	18.6	8.6	23.8	16	180	.020	9.78	143
4	1200	41.0	9	17.1	9.7	23.4	16	235	.020	9.93	225
5	1200	57.0	13	15.0	11.5	23.0	29	262	.020	10.09	290
6	1200	114.0	26	9.0	16.4	21.9	34	382	.020	10.66	550
7	1200	171.0	39	1.9	24.1	19.4	54	273	.020	12.22	980
8	1200	187.0	43	1.6	27.6	16.1	35	309	.350	14.05	505
9	1200	210.0	48	1.8	25.7	17.6	30	252	.020	13.18	1700
10	1200	228.0	52	.5	34.3	13.8	46	1267	4.210	12.22	400
11	600	0.0	0	17.9	4.1	20.3	22	329	.020	11.36	63
12	1200	0.0	0	22.0	4.3	30.9	25	5533	.020	6.91	22
13	2300	216.0	95	1.7	62.4	13.8	24	575	3.380	12.82	230
14	2300	199.0	87	2.5	54.1	15.4	19	49	.180	14.18	690
15	2300	177.0	78	2.7	49.6	16.7	23	39	.070	12.94	475
16	2300	162.0	71	2.8	47.8	17.6	20	44	.050	12.47	570
17	2300	108.0	47	2.7	43.6	17.6	13	122	.070	12.09	199
18	2300	54.0	24	12.4	25.2	21.8	20	147	.050	9.64	200
19	2300	39.0	17	13.9	22.4	22.2	10	120	.050	9.64	159
20	2300	17.0	7	16.0	19.6	23.6	10	114	.050	8.93	130
21	2300	4.0	2	17.2	17.4	26.9	19	387	.050	7.94	43
22	600	0.0	0	17.8	4.0	21.0	14	274	.050	10.25	71
23	2300	0.0	0	23.4	4.4	43.5	14	678	.180	4.54	4

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	.5	5.7	7	2.9	.070	0.0	R	R	R	R
2	1.2	6.0	15	7.8	.060	.1	1.1	5.23	13.0	6.8
3	1.4	7.2	16	18.9	.060	.2	.3	1.74	3.9	4.6
4	1.5	10.4	18	33.0	.050	.5	.2	1.11	1.9	3.5
5	3.2	13.5	21	49.5	.030	.4	.2	1.04	1.6	3.8
6	5.2	26.5	28	126.7	.060	1.6	.2	1.02	1.1	4.9
7	10.4	24.3	36	289.9	0.000	0.0	.3	.62	.9	7.4
8	6.5	26.8	613	145.5	.040	1.7	.2	.63	14.4	3.4
9	5.6	22.3	36	497.5	0.000	0.0	.1	.46	.7	10.4
10	9.2	119.1	7991	124.8	0.000	0.0	.2	2.29	153.4	2.4
11	.8	5.4	7	3.4	.070	0.0	R	R	R	R
12	1.4	144.2	11	1.9	.120	0.0	R	R	R	R
13	8.9	100.1	11887	132.9	.025	2.4	.1	1.06	125.7	1.4
14	6.9	8.3	621	391.3	.055	4.8	.1	.10	7.1	4.5
15	8.6	6.8	244	272.6	.035	2.7	.1	.09	3.2	3.5
16	7.6	7.5	175	327.6	.060	4.3	.1	.11	2.5	4.6
17	4.5	19.9	230	107.3	.060	2.8	.1	.42	4.9	2.3
18	5.0	17.3	119	78.2	0.000	0.0	.2	.73	5.0	3.3
19	2.2	12.6	106	55.3	.065	1.1	.1	.73	6.2	3.2
20	2.1	11.2	100	42.7	0.000	0.0	.3	1.51	13.4	5.7
21	3.9	38.0	99	14.0	0.000	0.0	2.3	21.70	56.7	8.0
22	.5	4.8	18	4.1	.080	0.0	R	R	R	R
23	1.2	28.3	152	.6	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	1.341	GRAM/BHP HR
	CO	18.352	GRAM/BHP HR
	NO2	3.697	GRAM/BHP HR
	ALDE	.135	GRAM/BHP HR
	BSFC	.833	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY

9-06-72 RUN-2 ENG.1-3 72 VER.MODI AIR HOT EGR STD JETS+TIM A O—CAT

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.7	4.0	19.4	19	374	.020	11.36	50
2	1200	5.0	1	19.6	7.6	23.9	14	114	.020	8.93	65
3	1200	18.0	4	18.5	8.5	23.9	15	184	.020	9.03	131
4	1200	41.0	9	16.9	9.6	23.7	15	242	.020	9.14	230
5	1200	57.0	13	16.2	10.5	23.8	27	258	.020	9.14	330
6	1200	114.0	26	9.5	15.8	22.4	31	392	.020	9.64	580
7	1200	171.0	39	2.4	23.4	20.1	45	268	.020	11.01	1138
8	1200	187.0	43	1.8	25.3	18.5	37	250	.020	11.92	1213
9	1200	210.0	48	1.8	27.0	17.6	34	254	.020	12.34	1725
10	1200	228.0	52	.5	33.4	13.9	38	1181	3.890	11.92	430
11	600	0.0	0	18.0	4.1	20.8	26	324	.020	10.55	65
12	1200	0.0	0	22.0	4.3	29.7	20	5198	.020	6.56	12
13	2300	218.0	95	1.7	62.3	13.9	21	482	3.100	12.82	300
14	2300	201.0	88	2.5	53.6	15.7	22	61	.150	13.91	720
15	2300	179.0	78	2.7	50.2	16.5	21	55	.070	12.94	570
16	2300	164.0	72	2.8	46.7	17.7	16	60	.050	11.92	670
17	2300	109.0	48	2.7	43.4	17.4	10	109	.070	12.22	210
18	2300	55.0	24	12.5	24.4	21.4	15	131	.050	9.93	210
19	2300	39.0	17	14.2	21.7	22.3	8	123	.050	9.37	169
20	2300	17.0	7	16.0	19.0	23.4	8	135	.050	8.93	119
21	2300	4.0	2	17.2	17.2	24.6	19	335	.050	8.60	98
22	600	0.0	0	17.7	4.0	21.0	11	310	.050	10.09	69
23	2300	0.0	0	23.6	4.4	46.7	15	1351	.150	4.11	4

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	.7	5.9	6	2.6	.070	0.0	R	R	R	R
2	1.2	4.4	16	8.3	.060	.1	1.0	3.83	13.6	7.3
3	1.4	7.8	17	18.5	.060	.2	.3	1.90	4.2	4.5
4	1.6	11.5	19	36.2	.050	.5	.2	1.22	2.0	3.9
5	3.0	13.4	21	56.8	.030	.4	.2	1.03	1.6	4.4
6	5.0	29.0	30	142.3	.060	1.6	.2	1.11	1.1	5.5
7	9.4	25.7	39	362.7	0.000	0.0	.2	.66	1.0	9.3
8	7.6	24.0	39	386.3	.040	1.7	.2	.56	.9	9.0
9	7.2	25.1	40	566.3	0.000	0.0	.2	.52	.8	11.8
10	7.8	112.3	7474	135.8	0.000	0.0	.1	2.16	143.5	2.6
11	1.0	5.7	7	3.8	.070	0.0	R	R	R	R
12	1.2	142.8	11	1.1	.120	0.0	R	R	R	R
13	7.9	85.3	11082	176.3	.025	2.4	.1	.89	116.1	1.8
14	8.3	10.5	524	413.2	.055	4.8	.1	.12	5.9	4.7
15	7.8	9.6	247	331.1	.035	2.7	.1	.12	3.2	4.2
16	6.0	10.6	179	393.5	.060	4.3	.1	.15	2.5	5.5
17	3.5	17.5	226	111.6	.060	2.9	.1	.37	4.7	2.3
18	3.7	14.5	112	77.2	0.000	0.0	.2	.60	4.6	3.2
19	1.8	12.8	105	58.6	.065	1.1	.1	.75	6.2	3.4
20	1.7	13.0	97	37.9	0.000	0.0	.2	1.74	13.0	5.1
21	3.6	30.1	91	29.2	0.000	0.0	2.1	17.17	51.8	16.7
22	.4	5.5	18	4.1	.080	0.0	R	R	R	R
23	1.5	61.4	138	.6	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	1.412	GRAM/BHP HR
	CO	16.057	GRAM/BHP HR
	NO2	4.532	GRAM/BHP HR
	ALDE	.129	GRAM/BHP HR
	BSFC	.813	LB/BHP HR

ENGINE 1-3

EFFECT OF "BEST COMBINATION" ON EMISSIONS

GRAPHED RESULTS OF 23 MODE TESTS

(AFTER CATALYST)

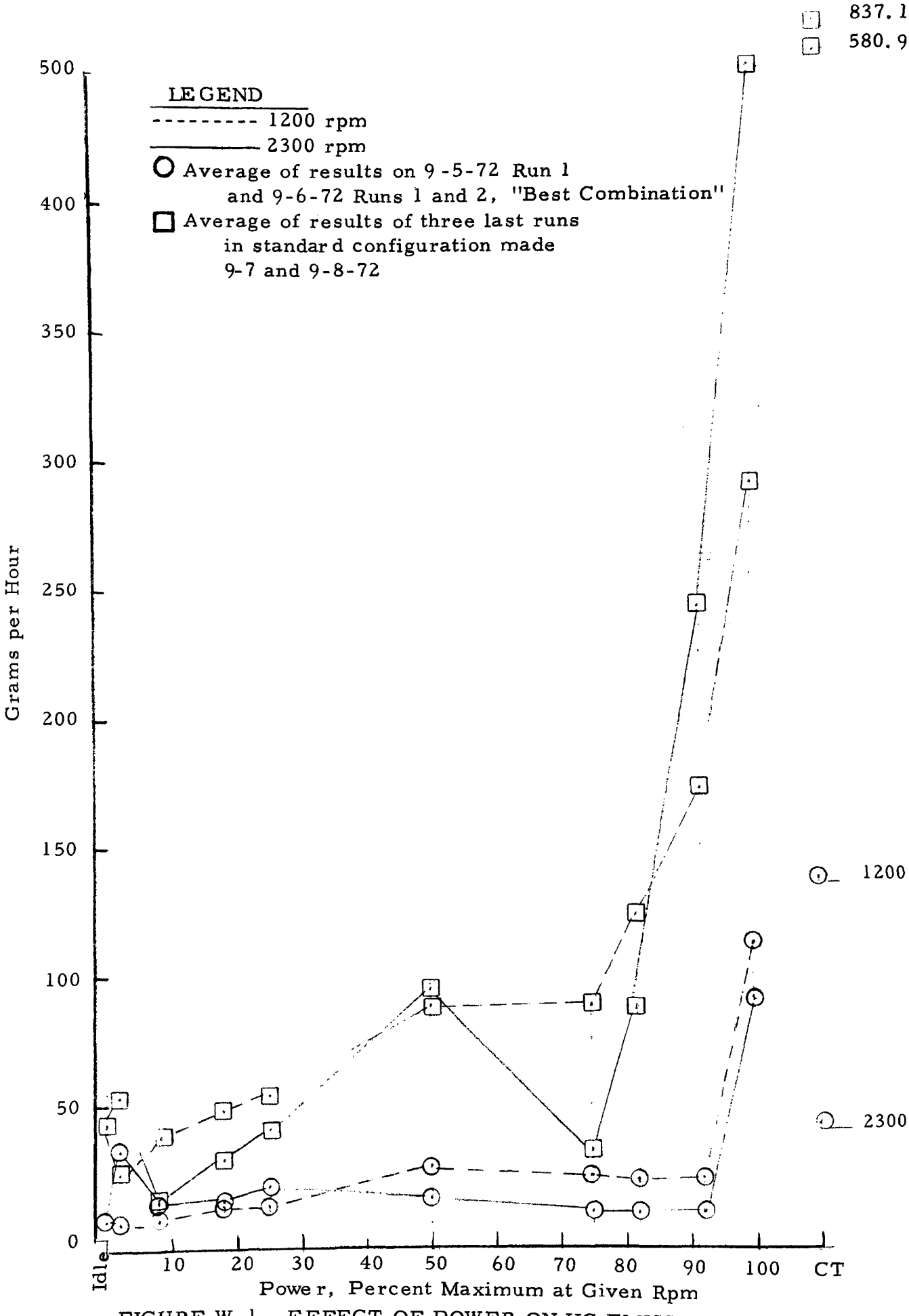


FIGURE W-1. EFFECT OF POWER ON HC EMISSION RATE "BEST COMBINATION" ENGINE 1-3, 23 MODE TEST

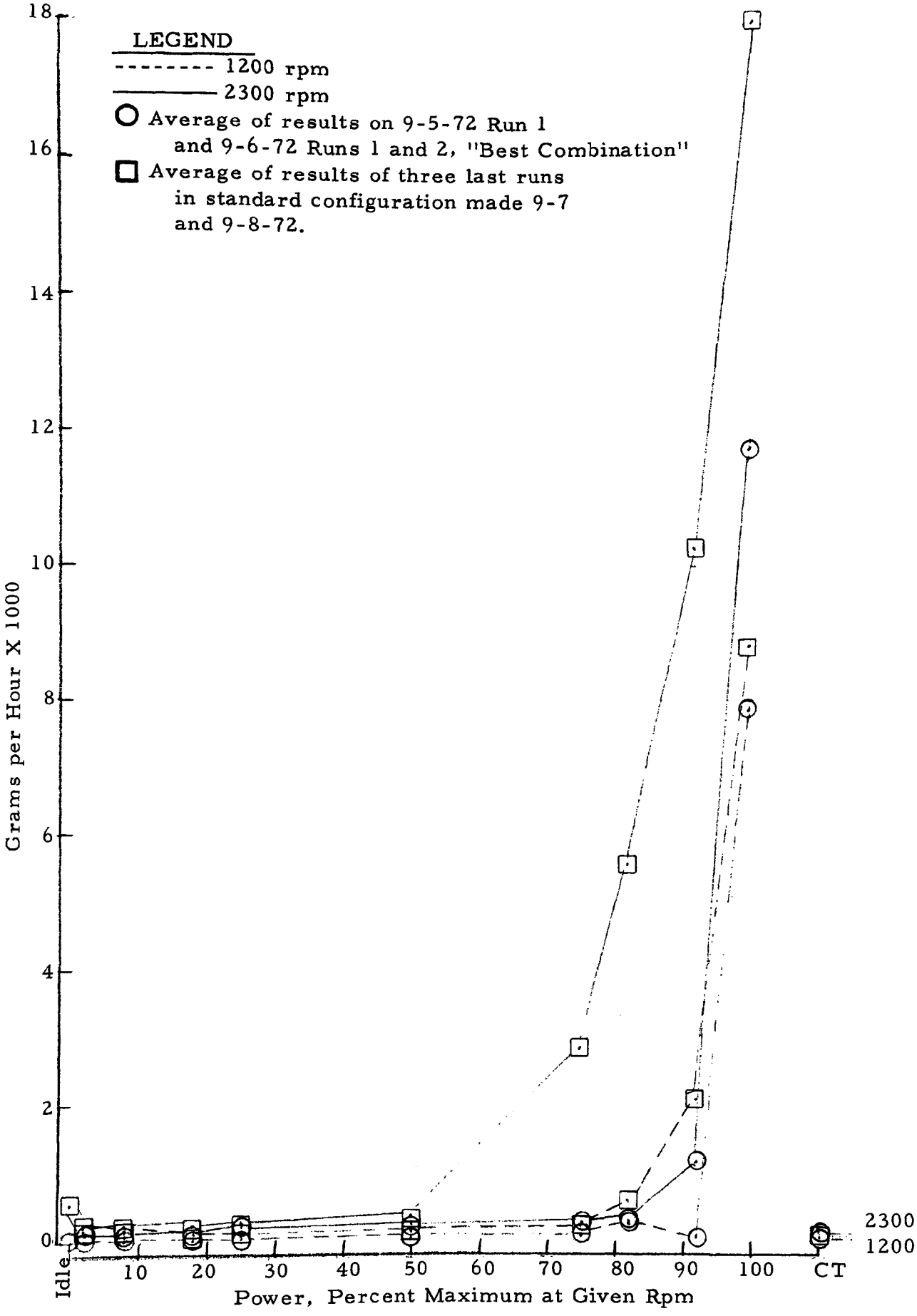


FIGURE W-2. EFFECT OF POWER ON CO EMISSION RATE
"BEST COMBINATION"
ENGINE 1-3, 23 MODE TEST

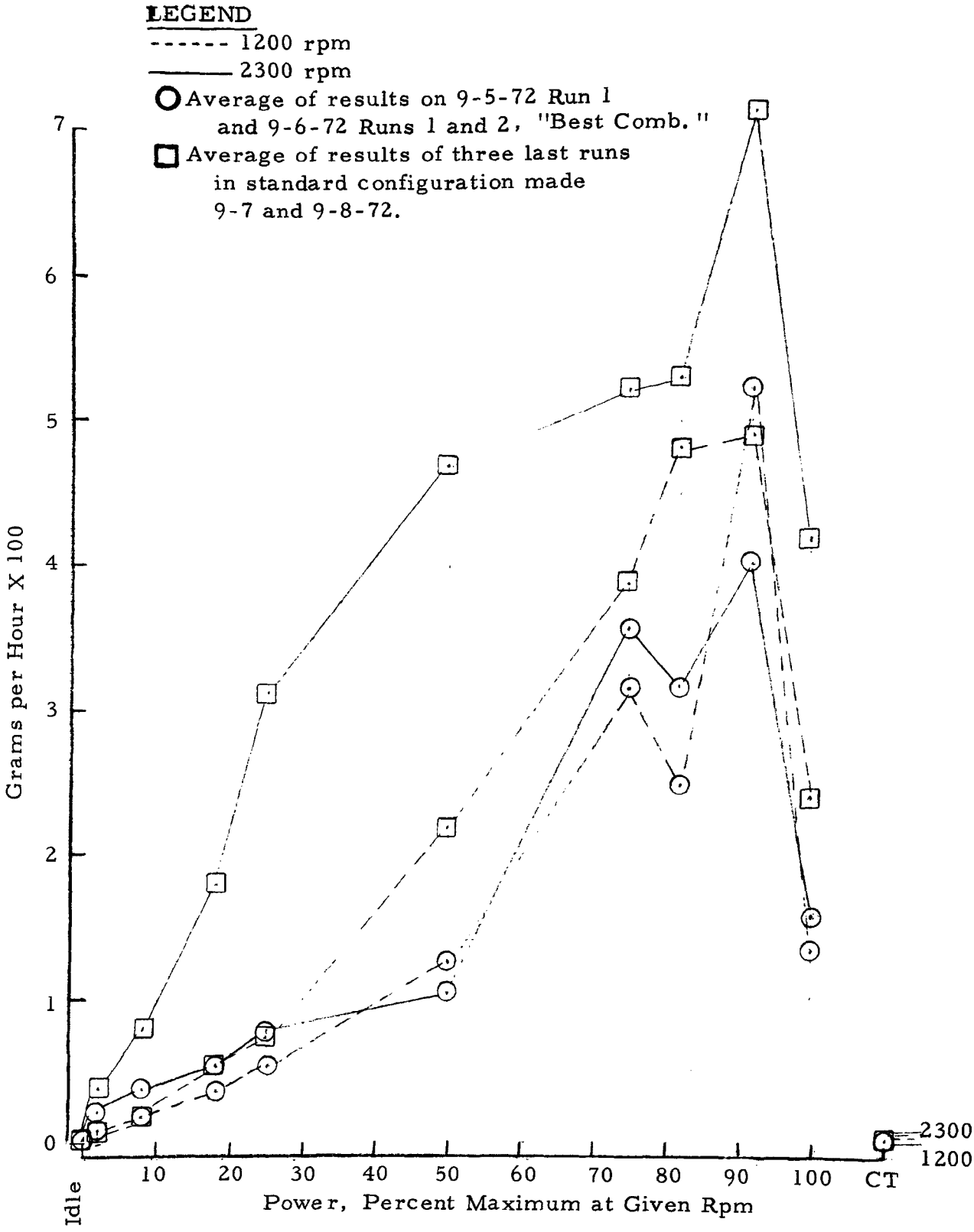


FIGURE W-3. EFFECT OF POWER ON NO_x (AS NO_2) EMISSION RATE
"BEST COMBINATION"
ENGINE 1-3, 23 MODE TEST

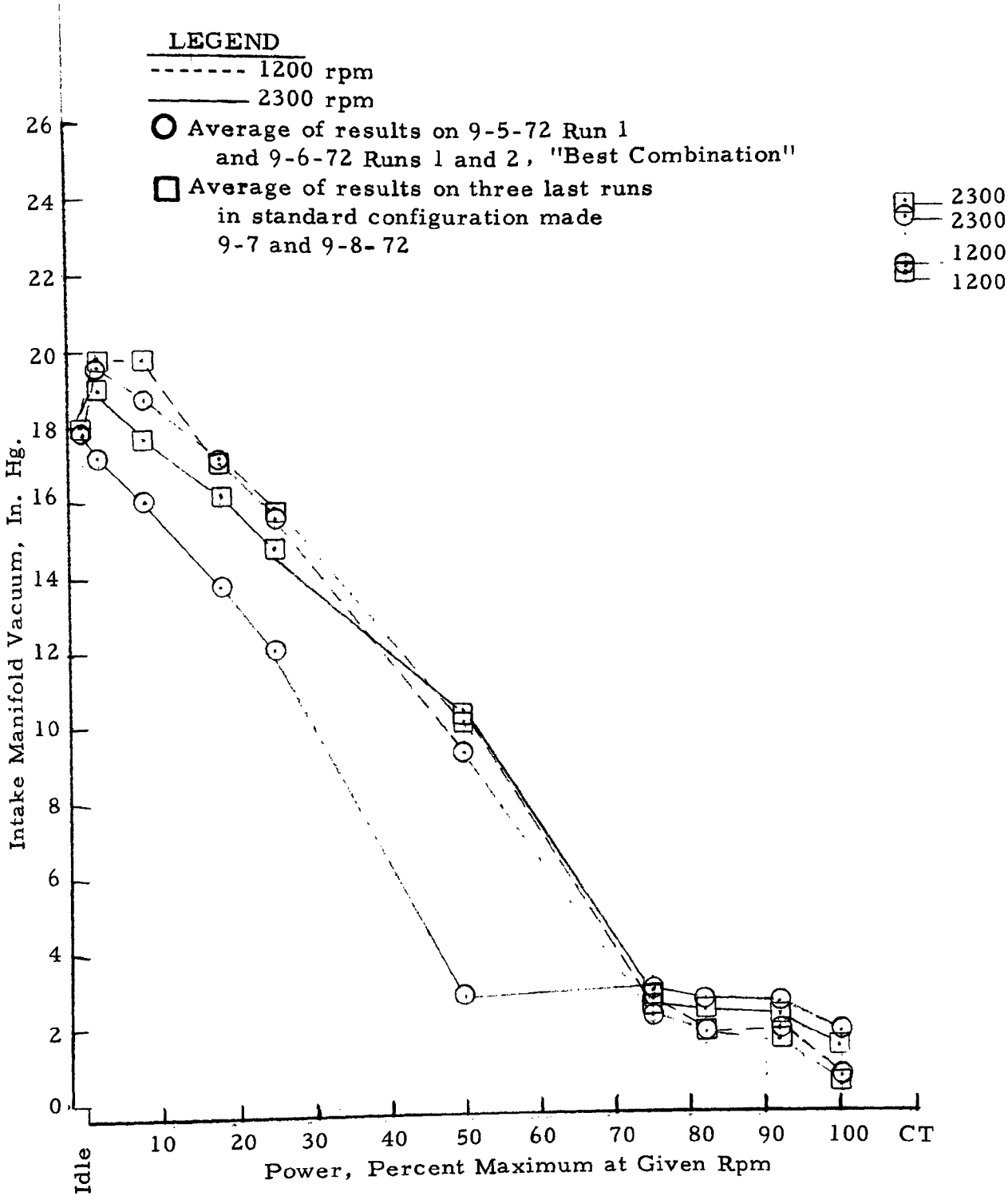


FIGURE W-4. MANIFOLD VACUUM AS A FUNCTION OF POWER
ENGINE 1-3, 23 MODE TEST

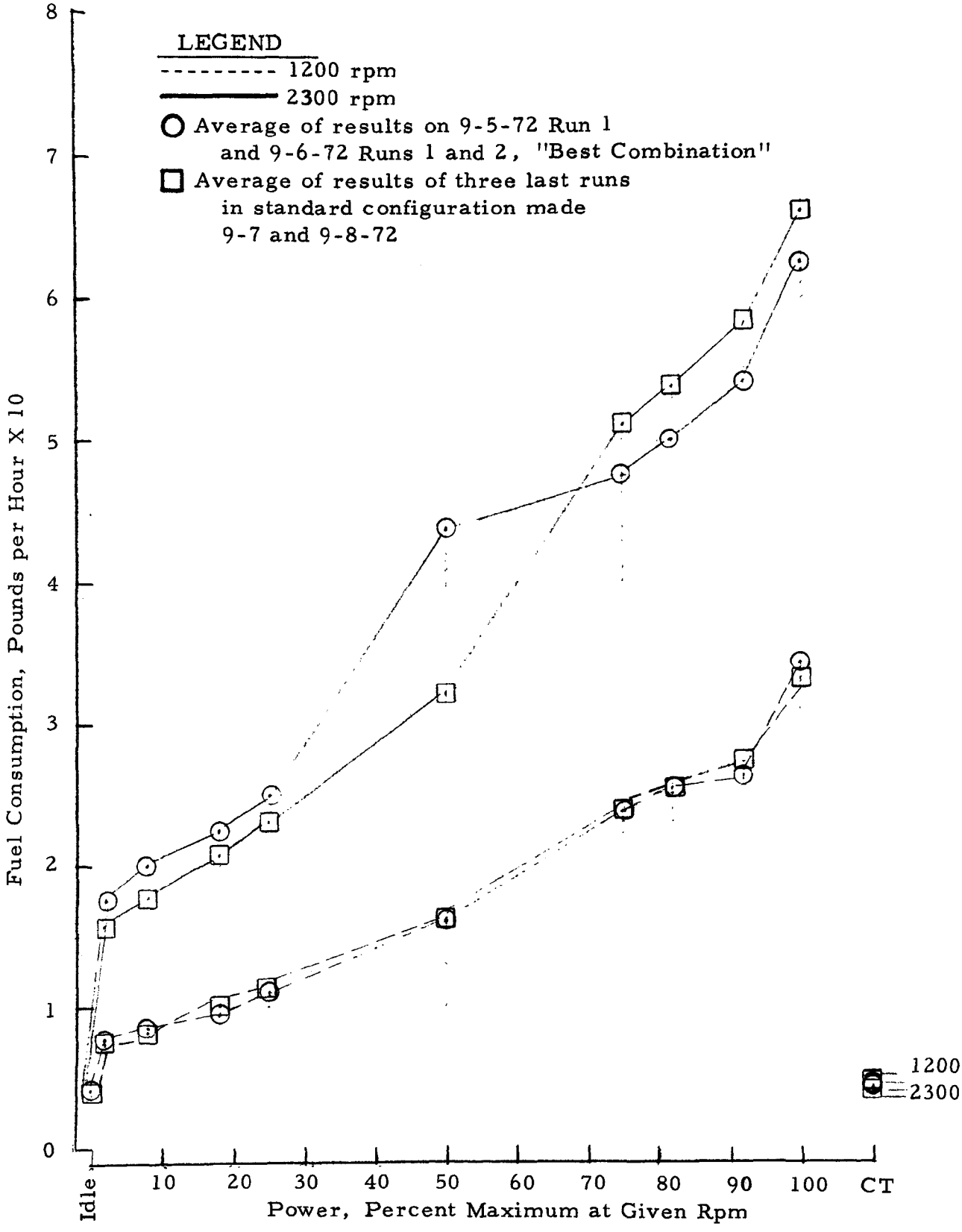


FIGURE W-5. FUEL CONSUMPTION AS A FUNCTION OF POWER
ENGINE 1-3, 23 MODE TEST

ENGINE 1-3

EFFECT OF "BEST COMBINATION" ON EMISSIONS

TABULAR NINE-MODE FTP DATA

CONCENTRATION AND CALIFORNIA ARB MASS

9-1-72 1-3 RUN 1 K =1.038 HUM = 86 GR/LB

	FEDERAL MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
	1 IDLE	46	.045	11.750	77	1.227	56	.055	94	.036	2.031	.002	3.400
	2 16'HG	340	.052	9.640	90	1.445	491	.075	130	.089	43.732	.007	11.576
	3 10'HG	37	.054	11.790	628	1.223	45	.066	768	.257	11.629	.017	197.373
	4 16'HG	30	.029	10.190	438	1.416	42	.041	620	.089	3.782	.004	55.216
	5 19'HG	31	.025	8.980	152	1.606	50	.040	244	.047	2.341	.002	11.477
	6 16'HG	32	.030	10.350	493	1.394	45	.042	687	.089	3.971	.004	61.177
	7 3'HG	29	.069	12.830	597	1.124	33	.078	671	.283	9.228	.022	189.968
	8 16'HG	29	.032	10.510	582	1.373	40	.044	799	.089	3.545	.004	71.142
	9 C.T.	427	.094	6.440	91	2.087	891	.196	190	.021	18.713	.004	3.988
	SUM----------(CYCLE COMPOSITE)----------										98.971	.065	605.316
CYCLE 2													
	1 IDLE	46	.045	11.750	77	1.227	56	.055	94	.036	2.031	.002	3.400
	2 16'HG	35	.023	10.290	400	1.402	49	.032	561	.089	4.369	.003	49.926
	3 10'HG	39	.034	11.760	567	1.227	48	.042	696	.257	12.296	.011	178.772
	4 16'HG	34	.021	10.510	478	1.373	47	.029	657	.089	4.156	.003	58.430
	5 19'HG	45	.022	9.030	169	1.595	72	.035	270	.047	3.374	.002	12.671
	6 16'HG	35	.025	10.670	512	1.353	47	.034	693	.089	4.213	.003	61.634
	7 3'HG	31	.051	12.280	700	1.175	36	.060	823	.283	10.309	.017	232.795
	8 16'HG	31	.023	10.290	562	1.403	43	.032	788	.089	3.871	.003	70.175
	9 C.T.	384	.082	6.260	89	2.159	829	.177	192	.021	17.411	.004	4.035
	SUM----------(CYCLE COMPOSITE)----------										62.031	.046	671.838
CYCLE 3													
	1 IDLE	41	.020	11.530	211	1.252	51	.025	264	.036	1.848	.001	9.508
	2 16'HG	34	.022	10.180	515	1.418	48	.031	730	.089	4.290	.003	64.981
	3 10'HG	27	.031	11.350	472	1.273	34	.039	601	.257	8.830	.010	154.362
	4 16'HG	27	.020	9.980	547	1.447	39	.029	792	.089	3.478	.003	70.455
	5 19'HG	28	.020	8.840	183	1.633	46	.033	299	.047	2.149	.002	14.044
	6 16'HG	29	.020	10.280	532	1.405	41	.028	747	.089	3.626	.003	66.517
	7 3'HG	28	.048	12.230	695	1.180	33	.057	820	.283	9.353	.016	232.162
	8 16'HG	27	.020	10.420	582	1.386	37	.028	807	.089	3.331	.002	71.810
	9 C.T.	364	.070	6.260	110	2.168	789	.152	238	.021	16.572	.003	5.008
	SUM----------(CYCLE COMPOSITE)----------										53.477	.042	688.848
CYCLE 4													
	1 IDLE	41	.020	11.530	211	1.252	51	.025	264	.036	1.848	.001	9.508
	2 16'HG	33	.020	10.110	552	1.428	47	.029	788	.089	4.193	.003	70.144
	3 10'HG	36	.033	11.550	514	1.249	45	.041	642	.257	11.560	.011	165.046
	4 16'HG	33	.020	9.970	522	1.448	48	.029	756	.089	4.252	.003	67.259
	5 19'HG	54	.020	8.730	183	1.648	89	.033	302	.047	4.183	.002	14.175
	6 16'HG	35	.021	10.120	552	1.426	50	.030	787	.089	4.442	.003	70.057
	7 3'HG	29	.044	12.220	674	1.181	34	.052	796	.283	9.696	.015	225.347
	8 16'HG	36	.020	9.770	628	1.477	53	.030	927	.089	4.731	.003	82.538
	9 C.T.	332	.064	5.640	127	2.404	798	.154	305	.021	16.764	.003	6.413
	SUM----------(CYCLE COMPOSITE)----------										61.668	.041	710.486
	AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------										80.501	.056	638.577
	AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------										57.573	.042	699.667

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(80.501) + 0.65*(57.573) =	65.598	PPM
CO	0.35*(.056) + 0.65*(.042) =	.047	PERCENT
NO	0.35*(638.577) + 0.65*(699.667) =	678.286	PPM
	CORRECTED NO =	704.040	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

9-1-72 1-3 RUN 2 K =1.038 HUM = 86 GR/LB

	FEDERAL MODE	CONCENTRATION HC	CO	AS CO2	MEASURED NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
	1 IDLE	45	.053	12.090	109	1.142	54	.063	130	.036	1.931	.002	4.677
	2 16'HG	30	.056	10.990	386	1.312	39	.073	506	.089	3.503	.007	45.078
	3 10'HG	31	.072	12.470	628	1.156	36	.083	726	.257	9.213	.021	186.630
	4 16'HG	26	.052	10.870	567	1.327	35	.069	753	.089	3.071	.006	66.982
	5 19'HG	27	.052	9.720	175	1.483	40	.077	260	.047	1.882	.004	12.201
	6 16'HG	31	.066	11.730	542	1.229	38	.081	666	.089	3.391	.007	59.293
	7 3'HG	24	.197	13.510	666	1.063	26	.210	708	.283	7.223	.059	200.444
	8 16'HG	42	.052	10.360	674	1.390	58	.072	937	.089	5.196	.006	83.383
	9 C.T.	367	.100	6.200	75	2.182	801	.218	164	.021	16.814	.005	3.436
	SUM----------(CYCLE COMPOSITE)----------										52.225	.118	662.123
CYCLE 2													
	1 IDLE	45	.053	12.090	109	1.192	54	.063	130	.036	1.931	.002	4.677
	2 16'HG	32	.049	10.720	478	1.345	43	.066	643	.089	3.831	.006	57.228
	3 10'HG	12	.062	12.060	567	1.198	14	.074	679	.257	3.694	.019	174.565
	4 16'HG	10	.047	10.580	552	1.366	14	.064	754	.089	1.216	.006	67.113
	5 19'HG	12	.041	9.300	170	1.554	19	.064	264	.047	.876	.003	12.413
	6 16'HG	17	.048	11.110	503	1.300	22	.062	654	.089	1.967	.006	58.205
	7 3'HG	19	.067	13.010	705	1.110	21	.074	782	.283	5.968	.021	221.445
	8 16'HG	34	.045	10.110	579	1.426	48	.064	826	.089	4.315	.006	73.477
	9 C.T.	318	.087	5.940	72	2.292	729	.199	165	.021	15.305	.004	3.465
	SUM----------(CYCLE COMPOSITE)----------										39.103	.072	672.587
CYCLE 3													
	1 IDLE	33	.044	12.020	107	1.201	40	.053	128	.036	1.426	.002	4.625
	2 16'HG	23	.049	11.330	365	1.274	29	.062	465	.089	2.608	.006	41.394
	3 10'HG	19	.049	10.960	493	1.318	25	.065	650	.257	6.434	.017	166.939
	4 16'HG	20	.044	9.750	552	1.481	30	.065	817	.089	2.635	.006	72.737
	5 19'HG	19	.041	9.470	157	1.525	29	.063	239	.047	1.361	.003	11.250
	6 16'HG	21	.063	11.950	559	1.208	25	.076	675	.089	2.258	.007	60.095
	7 3'HG	19	.061	12.710	689	1.136	22	.069	783	.283	6.110	.020	221.558
	8 16'HG	80	.044	9.350	582	1.533	123	.067	892	.089	10.915	.006	79.408
	9 C.T.	303	.079	5.810	62	2.348	711	.185	146	.021	14.937	.004	3.056
	SUM----------(CYCLE COMPOSITE)----------										48.685	.069	661.061
CYCLE 4													
	1 IDLE	33	.044	12.020	107	1.201	40	.053	128	.036	1.426	.002	4.625
	2 16'HG	28	.042	10.710	498	1.347	38	.057	671	.089	3.358	.005	59.721
	3 10'HG	29	.054	11.940	537	1.209	35	.065	649	.257	9.007	.017	166.784
	4 16'HG	27	.044	10.470	522	1.378	37	.061	719	.089	3.312	.005	64.027
	5 19'HG	38	.042	9.190	157	1.567	60	.066	246	.047	2.799	.003	11.565
	6 16'HG	27	.045	10.620	569	1.359	37	.061	773	.089	3.265	.005	68.808
	7 3'HG	25	.066	12.600	705	1.145	29	.076	807	.283	8.103	.021	228.512
	8 16'HG	28	.049	10.400	625	1.387	39	.068	867	.089	3.456	.006	77.148
	9 C.T.	322	.088	5.860	59	2.319	747	.204	137	.021	15.683	.004	2.874
	SUM----------(CYCLE COMPOSITE)----------										50.410	.069	684.063
	AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------										45.664	.095	667.355
	AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------										49.547	.069	672.562

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(45.664) + 0.65*(49.547) =	48.188	PPM
CO	0.35*(.095) + 0.65*(.069) =	.078	PERCENT
NO	0.35*(667.355) + 0.65*(672.562) =	670.740	PPM
	CORRECTED NO =	696.208	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

9-5-72 1-3 RUN I K = .752 HUM = 21 GR/LB

	FEDERAL MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
1	IDLE	38	.021	11.790	78	1.225	47	.026	96	.036	1.675	.001	3.438
2	16'HG	25	.020	10.200	330	1.416	35	.028	467	.089	3.152	.003	41.601
3	10'HG	27	.030	11.370	572	1.270	34	.038	727	.257	8.815	.010	186.747
4	16'HG	21	.020	9.920	399	1.457	31	.029	581	.089	2.723	.003	51.736
5	19'HG	20	.020	8.850	130	1.633	33	.033	212	.047	1.535	.002	9.975
6	16'HG	22	.020	9.920	402	1.457	32	.029	586	.089	2.852	.003	52.119
7	3'HG	23	.049	12.020	587	1.201	28	.059	705	.283	7.820	.017	199.576
8	16'HG	28	.020	9.950	459	1.451	41	.029	666	.089	3.617	.003	59.292
9	C.T.	264	.073	6.000	47	2.294	606	.167	108	.021	12.716	.004	2.264
SUM	(CYCLE COMPOSITE)										44.905	.043	606.748
CYCLE 2													
1	IDLE	38	.021	11.790	78	1.225	47	.026	96	.036	1.675	.001	3.438
2	16'HG	13	.022	11.000	377	1.315	17	.029	496	.089	1.522	.003	44.129
3	10'HG	10	.021	10.910	373	1.326	13	.028	495	.257	3.409	.007	127.156
4	16'HG	9	.020	9.180	458	1.576	14	.032	722	.089	1.262	.003	64.246
5	19'HG	10	.020	9.750	156	1.484	15	.030	232	.047	.697	.001	10.881
6	16'HG	32	.047	11.250	405	1.282	41	.060	519	.089	3.652	.005	46.219
7	3'HG	9	.143	12.960	612	1.112	10	.159	680	.283	2.832	.045	192.570
8	16'HG	278	.020	7.630	527	1.826	508	.037	962	.089	45.182	.003	85.652
9	C.T.	272	.071	6.040	52	2.277	619	.162	118	.021	13.004	.003	2.486
SUM	(CYCLE COMPOSITE)										73.236	.072	576.777
CYCLE 3													
1	IDLE	28	.020	11.800	183	1.225	34	.024	224	.036	1.234	.001	8.068
2	16'HG	20	.021	10.010	348	1.444	29	.030	502	.089	2.570	.003	44.721
3	10'HG	21	.022	11.140	377	1.298	27	.029	489	.257	7.004	.007	125.732
4	16'HG	19	.020	9.420	478	1.534	29	.031	733	.089	2.595	.003	65.272
5	19'HG	21	.020	8.810	183	1.640	34	.033	300	.047	1.618	.002	14.104
6	16'HG	24	.024	10.720	512	1.348	32	.032	690	.089	2.879	.003	61.419
7	3'HG	22	.043	12.160	612	1.188	26	.051	727	.283	7.397	.014	205.759
8	16'HG	31	.020	9.840	567	1.467	45	.029	832	.089	4.048	.003	74.034
9	C.T.	312	.066	6.070	110	2.252	702	.149	248	.021	14.752	.003	5.201
SUM	(CYCLE COMPOSITE)										44.097	.038	604.310
CYCLE 4													
1	IDLE	28	.020	11.800	183	1.225	34	.024	224	.036	1.234	.001	8.068
2	16'HG	22	.020	10.110	498	1.429	31	.029	712	.089	2.799	.003	63.356
3	10'HG	24	.021	11.180	458	1.293	31	.027	592	.257	7.974	.007	152.164
4	16'HG	21	.020	9.970	527	1.450	30	.029	764	.089	2.709	.003	67.991
5	19'HG	20	.020	8.830	251	1.636	33	.033	411	.047	1.538	.002	19.303
6	16'HG	22	.020	10.050	570	1.438	32	.029	820	.089	2.816	.003	72.947
7	3'HG	20	.103	12.400	674	1.163	23	.120	784	.283	6.580	.034	221.738
8	16'HG	18	.020	9.930	597	1.456	26	.029	869	.089	2.332	.003	77.357
9	C.T.	377	.070	6.330	157	2.141	807	.150	336	.021	16.951	.003	7.059
SUM	(CYCLE COMPOSITE)										44.933	.057	689.984
AVERAGE SUM	(COMPOSITE VALUES FOR CYCLES 1 AND 2)										59.070	.057	591.762
AVERAGE SUM	(COMPOSITE VALUES FOR CYCLES 3 AND 4)										44.515	.047	647.147

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(59.070) + 0.65*(44.515) =	49.609	PPM
CO	0.35*(.057) + 0.65*(.047) =	.051	PERCENT
NO	0.35*(591.762) + 0.65*(647.147) =	627.762	PPM
	CORRECTED NO =	471.781	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

9-1-72 1-3 RUN 1 K = 1.03 HUM = 86 GR/LB

MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1														
1 IDLE	46	.045	11.75	77	11.845	1816	8	14	4	.232	1.8	3	.9	0
2 16 HG	340	.052	9.64	90	10.059	8490	310	89	25	.077	23.9	7	1.9	18
3 10 HG	37	.054	11.79	628	11.884	12167	41	112	213	.147	6.0	16	31.4	38
4 16 HG	30	.029	10.19	438	10.251	8490	27	49	120	.077	2.1	4	9.3	18
5 19 HG	31	.025	8.98	152	9.038	5902	22	33	33	.057	1.2	2	1.9	3
6 16 HG	32	.030	10.35	493	10.415	8490	28	49	133	.077	2.2	4	10.3	18
7 3 HG	29	.069	12.83	597	12.930	18705	45	202	287	.113	5.1	23	32.4	57
8 16 HG	29	.032	10.51	582	10.573	8490	25	52	155	.077	1.9	4	11.9	18
9 C.T.	427	.094	6.44	91	6.995	1907	126	52	8	.143	18.0	7	1.2	0
SUM----------(CYCLE COMPOSITE)----------											3.5	4	5.7	
CYCLE 2														
1 IDLE	46	.045	11.75	77	11.845	1816	8	14	4	.232	1.8	3	.9	0
2 16 HG	35	.023	10.29	400	10.351	8490	31	38	109	.077	2.4	3	8.4	18
3 10 HG	39	.034	11.76	567	11.836	12167	43	71	194	.147	6.4	10	28.4	38
4 16 HG	34	.021	10.51	478	10.568	8490	30	34	127	.077	2.3	3	9.8	18
5 19 HG	45	.022	9.03	169	9.101	5902	32	29	36	.057	1.8	2	2.1	3
6 16 HG	35	.025	10.67	512	10.733	8490	30	40	134	.077	2.3	3	10.4	18
7 3 HG	31	.051	12.28	700	12.364	18705	51	156	352	.113	5.7	18	39.7	57
8 16 HG	31	.023	10.29	562	10.346	8490	27	38	153	.077	2.1	3	11.8	18
9 C.T.	384	.082	6.26	89	6.757	1907	117	47	8	.143	16.7	7	1.2	0
SUM----------(CYCLE COMPOSITE)----------											2.3	3	6.4	
CYCLE 3														
1 IDLE	41	.020	11.53	211	11.594	1816	7	6	11	.232	1.6	1	2.5	0
2 16 HG	34	.022	10.18	515	10.239	8490	30	37	142	.077	2.3	3	10.9	18
3 10 HG	27	.031	11.35	472	11.410	12167	31	67	167	.147	4.6	10	24.6	38
4 16 HG	27	.020	9.98	547	10.029	8490	25	34	154	.077	1.9	3	11.8	18
5 19 HG	28	.020	8.84	183	8.890	5902	20	27	40	.057	1.1	2	2.3	3
6 16 HG	29	.020	10.28	532	10.331	8490	26	33	145	.077	2.0	3	11.2	18
7 3 HG	28	.048	12.23	695	12.308	18705	46	147	351	.113	5.2	17	39.6	57
8 16 HG	27	.020	10.42	582	10.469	8490	24	33	157	.077	1.8	3	12.1	18
9 C.T.	364	.070	6.26	110	6.723	1907	112	40	10	.143	15.9	6	1.5	0
SUM----------(CYCLE COMPOSITE)----------											2.1	3	6.6	
CYCLE 4														
1 IDLE	41	.020	11.53	211	11.594	1816	7	6	11	.232	1.6	1	2.5	0
2 16 HG	33	.020	10.11	552	10.166	8490	30	34	153	.077	2.3	3	11.8	18
3 10 HG	36	.033	11.55	514	11.622	12167	41	70	179	.147	6.0	10	26.3	38
4 16 HG	33	.020	9.97	522	10.026	8490	30	34	147	.077	2.3	3	11.3	18
5 19 HG	54	.020	8.73	183	8.808	5902	39	27	41	.057	2.2	2	2.3	3
6 16 HG	35	.021	10.12	552	10.179	8490	32	35	153	.077	2.4	3	11.8	18
7 3 HG	29	.044	12.22	674	12.295	18705	48	135	340	.113	5.4	15	38.5	57
8 16 HG	36	.020	9.77	628	9.829	8490	34	35	180	.077	2.6	3	13.9	18
9 C.T.	332	.064	5.64	127	6.063	1907	113	41	13	.143	16.1	6	1.9	0
SUM----------(CYCLE COMPOSITE)----------											2.3	3	6.8	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------											2.9	3	6.0	
AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------											2.2	3	6.7	

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(2.9) + 0.65(2.2) = 2.442 (MASS)
CO 0.35(3) + 0.65(3) = 2.9 (MASS)
NO2 0.35(6.0) + 0.65(6.7) = 6.448 (MASS)
CORRECTED NO2 = 6.656 (MASS)

9-1-72 1-3 RUN 2 K = 1.03 HUM = 86 GR/LB

	MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1															
	1 IDLE	45	.053	12.09	109	12.192	1816	7	16	5	.232	1.7	4	1.3	0
	2 16 HG	30	.056	10.99	386	11.078	8490	25	87	98	.077	1.9	7	7.6	18
	3 10 HG	31	.072	12.47	628	12.575	12167	32	141	202	.147	4.8	21	29.7	38
	4 16 HG	26	.052	10.87	567	10.950	8490	22	81	146	.077	1.7	6	11.2	18
	5 19 HG	27	.052	9.72	175	9.801	5902	18	63	35	.057	1.0	4	2.0	3
	6 16 HG	31	.066	11.73	542	11.829	8490	24	96	129	.077	1.9	7	9.9	18
	7 3 HG	24	.197	13.51	666	13.733	18705	35	542	301	.113	4.0	61	34.0	57
	8 16 HG	42	.052	10.36	674	10.457	8490	37	85	182	.077	2.8	7	14.0	18
	9 C.T.	367	.100	6.20	75	6.696	1907	113	58	7	.143	16.1	8	1.0	0
	SUM----------(CYCLE COMPOSITE)----------											2.0	7	6.2	
CYCLE 2															
	1 IDLE	45	.053	12.09	109	12.192	1816	7	16	5	.232	1.7	4	1.3	0
	2 16 HG	32	.049	10.72	478	10.804	8490	27	78	125	.077	2.1	6	9.6	18
	3 10 HG	12	.062	12.06	567	12.135	12167	13	126	189	.147	1.9	18	27.7	38
	4 16 HG	10	.047	10.58	552	10.638	8490	9	76	146	.077	.7	6	11.3	18
	5 19 HG	12	.041	9.30	170	9.354	5902	8	52	36	.057	.5	3	2.0	3
	6 16 HG	17	.048	11.11	503	11.176	8490	14	74	127	.077	1.1	6	9.8	18
	7 3 HG	19	.067	13.01	705	13.098	18705	29	193	334	.113	3.3	22	37.8	57
	8 16 HG	34	.045	10.11	579	10.192	8490	31	76	160	.077	2.4	6	12.3	18
	9 C.T.	318	.087	5.94	72	6.370	1907	103	53	7	.143	14.7	8	1.0	0
	SUM----------(CYCLE COMPOSITE)----------											1.6	4	6.4	
CYCLE 3															
	1 IDLE	33	.044	12.02	107	12.100	1816	5	13	5	.232	1.2	3	1.2	0
	2 16 HG	23	.049	11.33	365	11.404	8490	18	74	90	.077	1.4	6	6.9	18
	3 10 HG	19	.049	10.96	493	11.030	12167	23	109	181	.147	3.3	16	26.5	38
	4 16 HG	20	.044	9.75	552	9.816	8490	19	77	159	.077	1.4	6	12.2	18
	5 19 HG	19	.041	9.47	157	9.532	5902	13	51	32	.057	.7	3	1.8	3
	6 16 HG	21	.063	11.95	559	12.036	8490	16	90	131	.077	1.2	7	10.1	18
	7 3 HG	19	.061	12.71	689	12.792	18705	30	180	334	.113	3.4	20	37.8	57
	8 16 HG	80	.044	9.35	582	9.480	8490	77	80	173	.077	6.0	6	13.3	18
	9 C.T.	303	.079	5.81	62	6.216	1907	100	49	6	.143	14.4	7	.9	0
	SUM----------(CYCLE COMPOSITE)----------											1.9	4	6.3	
CYCLE 4															
	1 IDLE	33	.044	12.02	107	12.100	1816	5	13	5	.232	1.2	3	1.2	0
	2 16 HG	28	.042	10.71	498	10.782	8490	24	67	130	.077	1.8	5	10.0	18
	3 10 HG	29	.054	11.94	537	12.025	12167	32	110	180	.147	4.7	16	26.5	38
	4 16 HG	27	.044	10.47	522	10.543	8490	23	72	140	.077	1.8	6	10.7	18
	5 19 HG	38	.042	9.19	157	9.273	5902	26	54	33	.057	1.5	3	1.9	3
	6 16 HG	27	.045	10.62	569	10.694	8490	23	72	150	.077	1.8	6	11.5	18
	7 3 HG	25	.066	12.60	705	12.693	18705	40	196	345	.113	4.5	22	39.0	57
	8 16 HG	28	.049	10.40	625	10.479	8490	24	80	168	.077	1.9	6	12.9	18
	9 C.T.	322	.088	5.86	59	6.296	1907	105	54	6	.143	15.1	8	.8	0
	SUM----------(CYCLE COMPOSITE)----------											1.9	4	6.5	
	AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)----------											1.8	6	6.3	
	AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)----------											1.9	4	6.4	

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(1.8) + 0.65(1.9) = 1.866 (MASS)
CO 0.35(6) + 0.65(4) = 4.7 (MASS)
NO2 0.35(6.3) + 0.65(6.4) = 6.339 (MASS)
CORRECTED NO2 = 6.543 (MASS)

9-5-72 1-3 RUN I K = .76 HUM = 21 GR/LB

MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1														
1 IDLE	38	.021	11.79	78	11.852	1816	6	6	4	.232	1.5	2	.9	0
2 16 HG	25	.020	10.20	330	10.247	8490	22	33	91	.077	1.7	3	7.0	18
3 10 HG	27	.030	11.37	572	11.429	12167	31	65	202	.147	4.6	9	29.7	38
4 16 HG	21	.020	9.92	399	9.963	8490	19	34	113	.077	1.5	3	8.7	18
5 19 HG	20	.020	8.85	130	8.892	5902	14	27	29	.057	.8	2	1.6	3
6 16 HG	22	.020	9.92	402	9.964	8490	20	34	114	.077	1.6	3	8.8	18
7 3 HG	23	.049	12.02	587	12.094	18705	38	153	301	.113	4.3	17	34.1	57
8 16 HG	28	.020	9.95	459	10.000	8490	26	34	129	.077	2.0	3	10.0	18
9 C.T.	264	.073	6.00	47	6.358	1907	86	44	5	.143	12.2	6	.7	0
SUM----------(CYCLE COMPOSITE)----------											1.7	3	5.7	
CYCLE 2														
1 IDLE	38	.021	11.79	78	11.852	1816	6	6	4	.232	1.5	2	.9	0
2 16 HG	13	.022	11.00	377	11.036	8490	11	34	96	.077	.8	3	7.4	18
3 10 HG	10	.021	10.91	373	10.942	12167	12	47	138	.147	1.8	7	20.2	38
4 16 HG	9	.020	9.18	458	9.210	8490	9	37	140	.077	.7	3	10.8	18
5 19 HG	10	.020	9.75	156	9.781	5902	7	24	31	.057	.4	1	1.8	3
6 16 HG	32	.047	11.25	405	11.332	8490	26	71	101	.077	2.0	5	7.8	18
7 3 HG	9	.143	12.96	612	13.113	18705	14	412	290	.113	1.6	47	32.8	57
8 16 HG	278	.020	7.63	527	7.950	8490	321	43	187	.077	24.7	3	14.4	18
9 C.T.	272	.071	6.04	52	6.405	1907	87	43	5	.143	12.5	6	.7	0
SUM----------(CYCLE COMPOSITE)----------											2.6	4	5.5	
CYCLE 3														
1 IDLE	28	.020	11.80	183	11.850	1816	5	6	9	.232	1.1	1	2.2	0
2 16 HG	20	.021	10.01	348	10.053	8490	18	36	98	.077	1.4	3	7.5	18
3 10 HG	21	.022	11.14	377	11.185	12167	25	48	136	.147	3.6	7	20.0	38
4 16 HG	19	.020	9.42	478	9.461	8490	18	36	142	.077	1.4	3	11.0	18
5 19 HG	21	.020	8.81	183	8.853	5902	15	27	41	.057	.9	2	2.3	3
6 16 HG	24	.024	10.72	512	10.770	8490	20	38	134	.077	1.6	3	10.3	18
7 3 HG	22	.043	12.16	612	12.227	18705	36	133	311	.113	4.1	15	35.1	57
8 16 HG	31	.020	9.84	567	9.893	8490	29	35	162	.077	2.2	3	12.4	18
9 C.T.	312	.066	6.07	110	6.473	1907	99	39	11	.143	14.2	6	1.5	0
SUM----------(CYCLE COMPOSITE)----------											1.7	2	5.8	
CYCLE 4														
1 IDLE	28	.020	11.80	183	11.850	1816	5	6	9	.232	1.1	1	2.2	0
2 16 HG	22	.020	10.11	498	10.154	8490	20	34	138	.077	1.5	3	10.6	18
3 10 HG	24	.021	11.18	458	11.227	12167	28	46	165	.147	4.1	7	24.2	38
4 16 HG	21	.020	9.97	527	10.013	8490	19	34	148	.077	1.5	3	11.4	18
5 19 HG	20	.020	8.83	251	8.872	5902	14	27	55	.057	.8	2	3.2	3
6 16 HG	22	.020	10.05	570	10.094	8490	20	34	159	.077	1.5	3	12.3	18
7 3 HG	20	.103	12.40	674	12.525	18705	32	311	334	.113	3.6	35	37.8	57
8 16 HG	18	.020	9.93	597	9.969	8490	17	34	169	.077	1.3	3	13.0	18
9 C.T.	377	.070	6.33	157	6.807	1907	114	40	15	.143	16.3	6	2.1	0
SUM----------(CYCLE COMPOSITE)----------											1.8	3	6.6	

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 2.1 3 5.6

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 1.8 3 6.2

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(2.1) + 0.65(1.8) = 1.891 (MASS)
CO 0.35(3) + 0.65(3) = 3.1 (MASS)
NO2 0.35(5.6) + 0.65(6.2) = 5.970 (MASS)
CORRECTED NO2 = 4.546 (MASS)

APPENDIX X

ENGINE 1-3

FINAL EMISSION TESTS IN SAME CONFIGURATION

AT START OF CONTROL TECHNOLOGY STUDY

TABULAR DATA

EXPERIMENTAL 23 MODE MASS

NINE-MODE FTP CONCENTRATION

NINE-MODE CALIFORNIA ARB MASS

PROJECT 11-2877-01 CONTROL TECHNOLOGY
9-07-72 RUN-1 ENG.1-3 72 VERSION STD.JETS + TIMING

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	18.1	4.1	16.2	28	2864	2.080	11.24	46
2	1200	5.0	1	19.9	7.5	16.3	29	730	.440	12.94	81
3	1200	18.0	4	19.1	8.3	16.5	48	1146	.210	13.18	195
4	1200	41.0	9	17.1	10.1	17.4	41	1443	.100	12.71	480
5	1200	57.0	13	15.8	11.0	17.9	49	1228	.100	12.47	605
6	1200	114.0	26	10.1	16.1	18.5	64	1289	.100	11.92	1125
7	1200	171.0	39	2.6	23.8	17.5	129	973	.100	12.71	1450
8	1200	187.0	43	1.7	25.1	16.9	140	1299	.210	12.71	1638
9	1200	210.0	48	1.5	27.2	15.6	130	1920	1.050	12.94	1763
10	1200	228.0	52	.3	33.1	13.4	79	2933	4.740	11.48	825
11	600	0.0	0	17.9	4.0	15.1	50	3600	2.870	11.60	56
12	1200	0.0	0	22.0	4.2	19.7	58	43313	.350	5.75	8
13	2300	246.0	108	1.3	65.8	13.0	41	2742	5.350	11.36	780
14	2300	226.0	99	2.1	58.4	14.0	75	1441	3.290	12.22	1288
15	2300	202.0	88	2.3	53.9	14.9	58	619	1.940	12.71	963
16	2300	185.0	81	2.4	51.3	15.7	37	200	1.010	12.59	845
17	2300	123.0	54	10.4	32.1	16.6	39	800	.180	12.71	2550
18	2300	62.0	27	14.7	23.2	17.2	34	479	.180	12.09	1063
19	2300	44.0	19	16.1	20.8	17.6	31	317	.150	11.92	685
20	2300	20.0	9	17.6	17.8	18.0	24	189	.130	11.72	360
21	2300	5.0	2	18.9	17.1	18.6	34	775	.130	11.48	186
22	600	0.0	0	18.0	4.1	16.1	31	2835	1.910	11.36	66
23	2300	0.0	0	23.8	4.3	24.7	64	32468	.280	4.84	13

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	.8	39.1	574	2.1	.070	0.0	R	R	R	R
2	1.6	18.5	225	6.8	.060	.1	1.4	16.17	196.7	6.0
3	2.9	32.0	118	18.0	.060	.2	.7	7.77	28.8	4.4
4	3.1	51.0	71	56.4	.050	.5	.3	5.45	7.6	6.0
5	4.1	48.3	79	79.0	.030	.4	.3	3.71	6.1	6.1
6	8.3	77.5	121	224.5	.060	1.6	.3	2.97	4.7	8.6
7	23.3	81.4	169	402.6	0.000	0.0	.6	2.08	4.3	10.3
8	26.3	113.3	370	474.5	.040	1.7	.6	2.65	8.7	11.1
9	24.3	167.0	1845	509.2	0.000	0.0	.5	3.48	38.5	10.6
10	15.5	266.6	8706	249.0	0.000	0.0	.3	5.12	167.1	4.8
11	1.3	44.0	709	2.3	.070	0.0	R	R	R	R
12	2.3	791.1	129	.5	.120	0.0	R	R	R	R
13	15.5	481.9	18991	455.1	.025	2.7	.1	4.47	176.3	4.2
14	27.2	243.8	11246	723.6	.055	5.4	.3	2.46	113.6	7.3
15	20.8	102.8	6512	531.3	.035	3.1	.2	1.16	73.6	6.0
16	13.7	34.2	3486	479.3	.060	4.9	.2	.42	43.0	5.9
17	9.4	89.8	408	950.4	.060	3.2	.2	1.67	7.6	17.6
18	6.3	40.9	311	301.5	0.000	0.0	.2	1.51	11.4	11.1
19	5.3	24.7	236	177.3	.065	1.3	.3	1.28	12.3	9.2
20	3.5	12.8	179	81.3	0.000	0.0	.4	1.47	20.4	9.3
21	4.8	51.4	174	41.0	0.000	0.0	2.2	23.49	79.6	18.7
22	.9	38.9	529	3.0	.080	0.0	R	R	R	R
23	3.2	756.9	132	1.0	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	8.136	GRAM/BHP HR
	CO	70.910	GRAM/BHP HR
	NO2	8.267	GRAM/BHP HR
	ALDE	.285	GRAM/BHP HR
	BSFC	.740	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY
9-07-72 RUN-2 ENG.1-3 72 VERSION STD.JETS + TIMING

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.9	4.0	16.2	32	2787	1.550	12.09	54
2	1200	5.0	1	19.9	7.4	16.6	31	900	.310	13.18	81
3	1200	18.0	4	19.1	8.2	16.7	56	1282	.180	13.33	210
4	1200	41.0	9	17.2	9.8	17.4	47	1141	.130	12.71	470
5	1200	57.0	13	15.9	10.8	17.6	62	1341	.100	12.59	520
6	1200	114.0	26	10.1	16.0	18.1	68	1591	.100	12.09	1150
7	1200	171.0	39	2.6	23.6	17.4	96	1186	.150	12.71	1425
8	1200	187.0	43	1.7	25.4	16.3	122	1553	.490	13.06	1825
9	1200	210.0	48	1.5	27.3	15.3	108	2044	1.300	13.33	1762
10	1200	228.0	52	.3	32.9	13.3	91	3278	4.740	11.48	830
11	600	0.0	0	18.0	4.0	15.4	54	3115	2.140	12.22	63
12	1200	0.0	0	22.0	4.2	20.3	62	46768	.350	5.16	8
13	2300	246.0	108	1.3	66.0	12.8	46	2881	5.240	11.24	690
14	2300	226.0	99	2.2	58.3	13.9	78	1683	3.190	12.47	1225
15	2300	206.0	90	2.3	54.1	15.1	58	634	1.770	12.59	950
16	2300	185.0	81	2.4	50.9	16.2	33	20	770	12.59	925
17	2300	123.0	54	10.4	32.3	16.9	36	830	80	12.22	2500
18	2300	62.0	27	14.8	23.0	17.6	30	478	.150	11.84	1075
19	2300	44.0	19	16.2	20.8	18.1	28	335	.150	11.60	660
20	2300	20.0	9	17.7	17.6	18.7	20	211	.150	11.60	325
21	2300	5.0	2	19.0	15.1	19.1	30	1281	.130	11.13	175
22	600	0.0	0	18.0	4.1	16.0	26	3423	2.440	10.78	54
23	2300	0.0	0	23.9	4.3	24.2	70	38087	.250	4.45	6

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	.9	36.3	408	2.3	.070	0.0	R	R	R	R
2	1.6	22.2	155	6.6	.060	.1	1.4	19.47	135.5	5.8
3	3.3	35.0	99	19.0	.060	.2	.8	8.50	24.1	4.6
4	3.5	39.2	90	53.5	.050	.5	.4	4.18	9.6	5.7
5	5.1	51.2	77	65.9	.030	.4	.4	3.93	5.9	5.1
6	8.6	93.5	119	224.4	.060	1.6	.3	3.59	4.6	8.6
7	17.1	97.8	250	390.2	0.000	0.0	.4	2.50	6.4	10.0
8	22.2	130.6	832	509.4	.040	1.7	.5	3.06	19.5	11.9
9	19.5	170.6	2192	488.3	0.000	0.0	.4	3.56	45.7	10.2
10	17.7	295.6	8635	248.5	0.000	0.0	.3	5.67	165.8	4.8
11	1.4	38.5	535	2.6	.070	0.0	R	R	R	R
12	2.5	874.6	132	.5	.120	0.0	R	R	R	R
13	17.6	514.4	18898	409.0	.025	2.7	.2	4.77	175.4	3.8
14	28.2	281.2	10766	679.5	.055	5.4	.3	2.84	108.8	6.9
15	21.2	107.9	6083	536.6	.035	3.2	.2	1.20	67.4	5.9
16	12.4	35.9	2684	529.9	.060	4.9	.2	.44	33.1	6.5
17	9.1	97.5	427	974.2	.060	3.2	.2	1.81	7.9	18.1
18	5.6	41.4	263	309.3	0.000	0.0	.2	1.52	9.7	11.4
19	4.9	26.9	243	175.4	.065	1.3	.3	1.39	12.6	9.1
20	2.9	14.3	206	73.2	0.000	0.0	.3	1.63	23.5	8.4
21	3.9	77.0	158	34.9	0.000	0.0	1.8	35.18	72.1	16.0
22	.8	46.9	676	2.5	.080	0.0	R	R	R	R
23	3.5	873.1	116	.5	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	9.007	GRAM/BHP HR
	CO	67.178	GRAM/BHP HR
	NO2	8.319	GRAM/BHP HR
	ALDE	.283	GRAM/BHP HR
	BSFC	.736	LB/BHP HR

PROJECT 11-2877-01 CONTROL TECHNOLOGY
9-08-72 RUN-3 ENG.1-3 72 VERSION STD.JETS + TIMING

MODE	SPEED	DYNA. LOAD	HP	MAN. VAC.	FUEL LB/HR	A/F RATIO	ALDE.	DRY CONCENTRATION HC	CO	CO2	NO
1	600	0.0	0	17.9	4.0	16.0	33	3851	2.110	12.22	49
2	1200	5.0	1	19.9	7.6	16.3	30	1389	.520	13.48	93
3	1200	18.0	4	19.1	8.5	16.2	46	1467	.280	13.63	195
4	1200	41.0	9	17.1	10.0	16.9	43	1685	.150	13.18	470
5	1200	57.0	13	16.0	11.0	17.3	61	1659	.130	12.94	570
6	1200	114.0	26	10.1	16.1	18.2	72	1615	.100	12.22	1050
7	1200	171.0	39	2.7	23.7	17.4	135	1099	.150	12.94	1375
8	1200	187.0	43	1.7	25.3	16.6	121	1496	.350	13.18	1675
9	1200	210.0	48	1.5	27.5	15.4	120	2108	1.230	13.18	1675
10	1200	228.0	52	.3	33.2	13.3	83	3458	5.030	11.48	750
11	600	0.0	0	18.0	4.1	14.6	47	4028	3.330	11.24	56
12	1200	0.0	0	22.1	4.2	19.1	53	45114	.440	6.21	6
13	2300	246.0	108	1.3	66.1	13.1	39	3065	5.350	11.60	675
14	2300	226.0	99	2.1	58.2	14.5	69	1187	2.520	12.71	1287
15	2300	202.0	88	2.3	53.7	15.6	51	300	1.200	12.94	913
16	2300	185.0	81	2.4	51.2	16.2	35	149	.640	12.71	975
17	2300	123.0	54	10.5	31.9	16.8	35	849	.130	12.47	2600
18	2300	62.0	27	14.8	23.1	17.4	27	484	.180	12.09	1150
19	2300	44.0	19	16.3	20.5	17.8	24	339	.150	11.84	720
20	2300	20.0	9	17.8	17.7	18.1	22	219	.130	11.72	370
21	2300	5.0	2	19.0	15.0	18.6	34	553	.130	11.24	210
22	600	0.0	0	17.9	4.0	15.9	24	2775	1.870	11.24	62
23	2300	0.0	0	23.9	4.3	23.9	60	37515	.280	4.27	10

MODE	CALCULATED GRAM/HR ALDE.	HC	CO	NO2	WT. FAC.	WT. HP	BRAKE SPECIFIC GRAM/BHP-HR ALDE.	HC	CO	NO2
1	.9	47.5	526	2.0	.070	0.0	R	R	R	R
2	1.6	33.9	256	7.5	.060	.1	1.4	29.65	224.2	6.6
3	2.8	40.2	155	17.8	.060	.2	.7	9.79	37.7	4.3
4	3.2	56.6	102	52.4	.050	.5	.3	6.04	10.9	5.6
5	5.0	62.5	99	71.3	.030	.4	.4	4.80	7.6	5.5
6	9.2	94.5	118	204.0	.060	1.6	.4	3.63	4.5	7.8
7	23.7	89.5	247	371.8	0.000	0.0	.6	2.29	6.3	9.5
8	22.0	125.5	593	466.5	.040	1.7	.5	2.94	13.9	10.9
9	22.2	179.8	2120	474.4	0.000	0.0	.5	3.75	44.2	9.9
10	15.9	309.0	9078	222.5	0.000	0.0	.3	5.93	174.3	4.3
11	1.3	50.0	836	2.3	.070	0.0	R	R	R	R
12	2.0	770.0	152	.4	.120	0.0	R	R	R	R
13	14.6	532.6	18777	389.4	.025	2.7	.1	4.94	174.3	3.6
14	25.8	204.1	8755	734.9	.055	5.4	.3	2.06	88.5	7.4
15	19.0	51.5	4167	520.8	.035	3.1	.2	.58	47.1	5.9
16	13.2	25.9	2247	562.5	.060	4.9	.2	.32	27.7	6.9
17	8.6	96.8	300	984.7	.060	3.2	.2	1.80	5.6	18.3
18	4.9	41.2	309	324.8	0.000	0.0	.2	1.52	11.4	12.0
19	4.0	26.2	234	184.9	.065	1.3	.2	1.36	12.2	9.6
20	3.2	14.8	178	83.1	0.000	0.0	.4	1.69	20.3	9.5
21	4.3	32.9	156	41.5	0.000	0.0	2.0	15.03	71.4	19.0
22	.7	37.6	512	2.8	.080	0.0	R	R	R	R
23	3.0	881.4	133	.8	.060	0.0	R	R	R	R

CYCLE COMPOSITE			
	HC	8.407	GRAM/BHP HR
	CO	59.572	GRAM/BHP HR
	NO2	8.433	GRAM/BHP HR
	ALDE	.265	GRAM/BHP HR
	BSFC	.738	LB/BHP HR

9-8-72 1-3 RUN-2 K =1.060 HUM = 93 GR/LB

	FEDERAL MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
	1 IDLE	193	1.610	12.820	117	1.048	202	1.688	123	.036	7.283	.061	4.415
	2 16'HG	89	.180	12.950	628	1.104	98	.199	693	.089	8.743	.018	61.695
	3 10'HG	98	.180	13.770	2451	1.038	102	.187	2545	.257	26.149	.048	653.999
	4 16'HG	66	.190	13.180	726	1.086	72	.206	789	.089	6.382	.018	70.200
	5 19'HG	62	.150	12.920	212	1.110	69	.167	235	.047	3.235	.008	11.061
	6 16'HG	61	.210	13.060	768	1.096	67	.230	842	.089	5.950	.020	74.908
	7 3'HG	61	.770	13.160	1170	1.065	65	.820	1246	.283	18.391	.232	352.739
	8 16'HG	48	.180	13.180	800	1.088	52	.196	871	.089	4.650	.017	77.497
	9 C.T.	1723	.420	8.050	107	1.433	2469	.602	153	.021	51.839	.013	3.219
	SUM----------(CYCLE COMPOSITE)----------										132.621	.435	1309.734
CYCLE 2													
	1 IDLE	193	1.610	12.820	117	1.048	202	1.688	123	.036	7.283	.061	4.415
	2 16'HG	66	.180	12.940	737	1.107	73	.199	816	.089	6.501	.018	72.596
	3 10'HG	80	.180	13.330	2672	1.074	86	.193	2869	.257	22.072	.050	737.221
	4 16'HG	49	.180	13.060	763	1.098	54	.198	838	.089	4.789	.018	74.578
	5 19'HG	55	.150	12.750	237	1.125	62	.169	267	.047	2.909	.008	12.536
	6 16'HG	32	.190	12.960	820	1.108	35	.210	908	.089	3.155	.019	80.844
	7 3'HG	26	.700	13.180	1265	1.069	28	.749	1353	.283	7.869	.212	382.866
	8 16'HG	26	.210	13.180	980	1.089	28	.229	1067	.089	2.520	.020	94.996
	9 C.T.	1670	.440	8.250	125	1.411	2357	.621	176	.021	49.497	.013	3.705
	SUM----------(CYCLE COMPOSITE)----------										106.597	.418	1463.757
CYCLE 3													
	1 IDLE	152	1.700	12.820	170	1.048	159	1.782	178	.036	5.735	.064	6.415
	2 16'HG	53	.210	12.940	779	1.107	59	.232	862	.089	5.220	.021	76.727
	3 10'HG	71	.180	13.330	2622	1.074	76	.193	2817	.257	19.603	.050	723.947
	4 16'HG	40	.190	12.940	848	1.109	44	.211	940	.089	3.947	.019	83.677
	5 19'HG	34	.150	12.590	265	1.142	39	.171	303	.047	1.824	.008	14.218
	6 16'HG	35	.210	12.820	795	1.119	39	.235	889	.089	3.484	.021	79.146
	7 3'HG	43	.700	12.940	1223	1.087	47	.761	1330	.283	13.231	.215	376.306
	8 16'HG	31	.210	12.940	870	1.109	34	.233	965	.089	3.059	.021	85.846
	9 C.T.	1650	.340	7.820	133	1.484	2448	.505	197	.021	51.415	.011	4.144
	SUM----------(CYCLE COMPOSITE)----------										107.519	.429	1450.426
CYCLE 4													
	1 IDLE	152	1.700	12.820	170	1.048	159	1.782	178	.036	5.735	.064	6.415
	2 16'HG	61	.210	12.940	844	1.106	67	.232	933	.089	6.004	.021	83.075
	3 10'HG	71	.150	13.180	2774	1.088	77	.163	3017	.257	19.846	.042	775.394
	4 16'HG	40	.180	12.900	876	1.113	45	.200	975	.089	3.961	.018	86.738
	5 19'HG	52	.150	12.470	269	1.151	60	.173	310	.047	2.812	.008	14.548
	6 16'HG	40	.200	12.710	913	1.128	45	.226	1030	.089	4.016	.020	91.668
	7 3'HG	40	.670	12.820	1381	1.099	44	.736	1517	.283	12.437	.208	429.372
	8 16'HG	40	.180	12.700	886	1.130	45	.203	1001	.089	4.022	.018	89.096
	9 C.T.	1600	.410	7.810	134	1.488	2381	.610	199	.021	50.005	.013	4.188
	SUM----------(CYCLE COMPOSITE)----------										108.839	.412	1580.493

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 119.609 .427 1386.745

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 108.179 .420 1515.460

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(119.609) + 0.65*(108.179) =	112.179	PPM
CO	0.35*(.427) + 0.65*(.420) =	.423	PERCENT
NO	0.35*(1386.745) + 0.65*(1515.460) =	1470.410	PPM
	CORRECTED NO =	1558.557	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

9-8-72 1-3 RUN-2 K = 1.05 HUM = 93 GR/LB

MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(X)	HP
CYCLE 1														
1 IDLE	193	1.610	12.82	117	14.638	1861	26	413	5	.232	6.1	96	1.1	0
2 16 HG	89	.180	12.95	628	13.226	8354	61	230	132	.077	4.7	18	10.1	19
3 10 HG	98	.180	13.77	2451	14.056	13438	101	348	778	.147	14.9	51	114.4	51
4 16 HG	66	.190	13.18	726	13.441	8354	44	239	150	.077	3.4	18	11.5	19
5 19 HG	62	.150	12.92	212	13.137	5993	31	138	32	.057	1.7	8	1.8	3
6 16 HG	61	.210	13.06	768	13.336	8354	41	266	160	.077	3.2	20	12.3	19
7 3 HG	61	.770	13.16	1170	13.996	19522	92	2170	542	.113	10.4	245	61.2	68
8 16 HG	48	.180	13.18	800	13.412	8354	32	226	165	.077	2.5	17	12.7	19
9 C.T.	1723	.420	8.05	107	10.331	1998	360	164	7	.143	51.5	23	1.0	0
SUM----------(CYCLE COMPOSITE)----------											4.6	24	10.7	
CYCLE 2														
1 IDLE	193	1.610	12.82	117	14.638	1861	26	413	5	.232	6.1	96	1.1	0
2 16 HG	66	.180	12.94	737	13.191	8354	45	230	155	.077	3.5	18	11.9	19
3 10 HG	80	.180	13.33	2672	13.596	13438	85	359	877	.147	12.6	53	128.9	51
4 16 HG	49	.180	13.06	763	13.293	8354	33	229	159	.077	2.6	18	12.3	19
5 19 HG	55	.150	12.75	237	12.959	5993	27	140	36	.057	1.6	8	2.1	3
6 16 HG	32	.190	12.96	820	13.185	8354	22	243	172	.077	1.7	19	13.3	19
7 3 HG	26	.700	13.18	1265	13.908	19522	39	1985	590	.113	4.5	224	66.6	68
8 16 HG	26	.210	13.18	980	13.418	8354	17	264	203	.077	1.3	20	15.6	19
9 C.T.	1670	.440	8.25	125	10.494	1998	343	169	8	.143	49.1	24	1.1	0
SUM----------(CYCLE COMPOSITE)----------											3.9	23	12.0	
CYCLE 3														
1 IDLE	152	1.700	12.82	170	14.684	1861	21	435	7	.232	4.8	101	1.7	0
2 16 HG	53	.210	12.94	779	13.207	8354	36	268	164	.077	2.8	21	12.6	19
3 10 HG	71	.180	13.33	2622	13.587	13438	76	360	861	.147	11.1	53	126.6	51
4 16 HG	40	.190	12.94	848	13.173	8354	27	243	179	.077	2.1	19	13.7	19
5 19 HG	34	.150	12.59	265	12.777	5993	17	142	41	.057	1.0	8	2.4	3
6 16 HG	35	.210	12.82	795	13.068	8354	24	271	169	.077	1.9	21	13.0	19
7 3 HG	43	.700	12.94	1223	13.686	19522	66	2017	579	.113	7.5	228	65.4	68
8 16 HG	31	.210	12.94	870	13.183	8354	21	269	183	.077	1.6	21	14.1	19
9 C.T.	1650	.340	7.82	133	9.942	1998	358	138	9	.143	51.2	20	1.3	0
SUM----------(CYCLE COMPOSITE)----------											4.0	23	11.9	
CYCLE 4														
1 IDLE	152	1.700	12.82	170	14.684	1861	21	435	7	.232	4.8	101	1.7	0
2 16 HG	61	.210	12.94	844	13.216	8354	42	268	177	.077	3.2	21	13.6	19
3 10 HG	71	.150	13.18	2774	13.407	13438	77	304	923	.147	11.3	45	135.7	51
4 16 HG	40	.180	12.90	876	13.123	8354	28	231	185	.077	2.1	18	14.3	19
5 19 HG	52	.150	12.47	269	12.676	5993	27	143	42	.057	1.5	8	2.4	3
6 16 HG	40	.200	12.71	913	12.953	8354	28	261	195	.077	2.1	20	15.1	19
7 3 HG	40	.670	12.82	1381	13.533	19522	62	1952	661	.113	7.0	221	74.7	68
8 16 HG	40	.180	12.70	886	12.923	8354	28	235	190	.077	2.2	18	14.6	19
9 C.T.	1600	.410	7.81	134	9.948	1998	347	166	9	.143	49.6	24	1.3	0
SUM----------(CYCLE COMPOSITE)----------											4.0	22	12.3	

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 4.3 23 11.3

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 4.0 23 12.4

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(4.3) + 0.65(4.0) = 4.080 (MASS)
CO 0.35(23) + 0.65(23) = 22.9 (MASS)
NO2 0.35(11.3) + 0.65(12.4) = 12.015 (MASS)
CORRECTED NO2 = 12.612 (MASS)

9-8-72 1-3 RUN-3 K =1.060 HUM = 93 GR/LB

	FEDERAL MODE	CONCENTRATION HC	CO	AS CO2	MEASURED NO	DILUTION FACTOR	ADJUSTED HC	CO	NO	WEIGHTING FACTOR	WEIGHTED HC	CO	NO
CYCLE 1													
	1 IDLE	189	1.820	12.940	131	1.032	195	1.878	135	.036	7.020	.068	4.866
	2 16'HG	88	.210	12.940	784	1.109	97	.232	865	.089	8.643	.021	76.998
	3 10'HG	88	.190	13.200	2573	1.083	95	.206	2786	.257	24.491	.053	716.076
	4 16'HG	61	.210	12.940	843	1.106	67	.232	932	.089	6.004	.021	82.976
	5 19'HG	58	.150	12.820	237	1.119	65	.168	265	.047	3.050	.008	12.465
	6 16'HG	48	.210	12.790	778	1.120	54	.235	871	.089	4.784	.021	77.549
	7 3'HG	48	.770	12.940	1211	1.084	52	.835	1313	.283	14.725	.236	371.488
	8 16'HG	30	.210	12.940	878	1.109	33	.233	974	.089	2.960	.021	86.643
	9 C.T.	1714	.460	7.910	100	1.451	2488	.668	145	.021	52.238	.014	3.048
	SUM----------(CYCLE COMPOSITE)----------										123.915	.462	1432.107
CYCLE 2													
	1 IDLE	189	1.820	12.940	131	1.032	195	1.878	135	.036	7.020	.068	4.866
	2 16'HG	57	.210	12.660	721	1.130	64	.237	815	.089	5.735	.021	72.541
	3 10'HG	66	.200	12.940	2731	1.106	73	.221	3020	.257	18.759	.057	776.207
	4 16'HG	39	.210	12.710	864	1.128	44	.237	974	.089	3.915	.021	86.722
	5 19'HG	51	.150	12.680	237	1.132	58	.170	268	.047	2.713	.008	12.608
	6 16'HG	35	.210	12.940	869	1.108	39	.233	963	.089	3.452	.021	85.719
	7 3'HG	35	.770	12.940	1241	1.085	38	.836	1347	.283	10.748	.236	381.091
	8 16'HG	26	.220	12.940	875	1.109	29	.244	970	.089	2.566	.022	86.342
	9 C.T.	1719	.410	8.520	111	1.370	2356	.562	152	.021	49.467	.012	3.194
	SUM----------(CYCLE COMPOSITE)----------										104.374	.465	1509.290
CYCLE 3													
	1 IDLE	147	2.110	12.160	164	1.084	159	2.288	178	.036	5.738	.082	6.401
	2 16'HG	44	.210	12.340	747	1.161	51	.244	867	.089	4.545	.022	77.166
	3 10'HG	62	.150	12.750	2731	1.125	70	.169	3072	.257	17.921	.043	789.412
	4 16'HG	30	.200	12.820	805	1.119	34	.224	901	.089	2.989	.020	80.205
	5 19'HG	39	.150	12.710	251	1.130	44	.170	284	.047	2.072	.008	13.336
	6 16'HG	30	.210	12.710	854	1.129	34	.237	964	.089	3.013	.021	85.783
	7 3'HG	40	.740	12.750	1313	1.102	44	.815	1446	.283	12.470	.231	409.315
	8 16'HG	35	.210	12.820	963	1.119	39	.235	1077	.089	3.484	.021	95.871
	9 C.T.	1694	.430	8.690	133	1.351	2288	.581	180	.021	48.053	.012	3.773
	SUM----------(CYCLE COMPOSITE)----------										100.286	.460	1561.262
CYCLE 4													
	1 IDLE	147	2.110	12.160	164	1.084	159	2.288	178	.036	5.738	.082	6.401
	2 16'HG	60	.210	12.470	830	1.147	69	.241	952	.089	6.126	.021	84.741
	3 10'HG	70	.180	12.710	2739	1.126	79	.203	3085	.257	20.260	.052	792.731
	4 16'HG	44	.180	12.710	875	1.129	50	.203	988	.089	4.420	.018	87.891
	5 19'HG	42	.150	12.710	278	1.130	47	.170	314	.047	2.231	.008	14.766
	6 16'HG	35	.210	12.710	864	1.128	39	.237	975	.089	3.514	.021	86.751
	7 3'HG	47	.750	12.710	1350	1.104	52	.828	1490	.283	14.682	.234	421.729
	8 16'HG	31	.210	12.710	1014	1.129	35	.237	1144	.089	3.114	.021	101.846
	9 C.T.	1620	.440	8.690	148	1.360	2204	.599	201	.021	46.277	.013	4.228
	SUM----------(CYCLE COMPOSITE)----------										106.361	.471	1601.084

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 114.145 .463 1470.699

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 103.323 .466 1581.173

FOUR CYCLE COMPOSITE - REPORTED VALUES -

HC	0.35*(114.145) + 0.65*(103.323) =	107.111	PPM
CO	0.35*(.463) + 0.65*(.466) =	.465	PERCENT
NO	0.35*(1470.699) + 0.65*(1581.173) =	1542.507	PPM
	CORRECTED NO =	1634.977	PPM

DILUTION FACTOR = 14.5/(CO2+0.5*CO+10.8*HC)

9-8-72 1-3 RUN-3 K = 1.05 HUM = 93 GR/LB

MASS MODE	CONCENTRATION AS MEASURED HC	CO	CO2	NO	TOTAL CARBON	FUEL CONS.	ADJUSTED (MASS) HC	CO	NO2	WT. FACT.	WEIGHTED (MASS) HC	CO	NO2(K)	HP
CYCLE 1														
1 IDLE	189	1.820	12.94	131	14.964	1861	25	457	5	.232	5.9	106	1.3	0
2 16 HG	88	.210	12.94	784	13.245	8354	60	268	164	.077	4.6	21	12.6	19
3 10 HG	88	.190	13.20	2573	13.485	13438	95	382	851	.147	13.9	56	125.1	51
4 16 HG	61	.210	12.94	843	13.216	8354	42	268	177	.077	3.2	21	13.6	19
5 19 HG	58	.150	12.82	237	13.033	5993	29	139	36	.057	1.6	8	2.1	3
6 16 HG	48	.210	12.79	778	13.052	8354	33	272	165	.077	2.6	21	12.7	19
7 3 HG	48	.770	12.94	1211	13.762	19522	74	2206	570	.113	8.3	249	64.4	68
8 16 HG	30	.210	12.94	878	13.182	8354	21	269	185	.077	1.6	21	14.2	19
9 C.T.	1714	.460	7.91	100	10.221	1998	362	182	6	.143	51.7	26	.9	0
SUM----------(CYCLE COMPOSITE)----------											4.4	25	11.7	
CYCLE 2														
1 IDLE	189	1.820	12.94	131	14.964	1861	25	457	5	.232	5.9	106	1.3	0
2 16 HG	57	.210	12.66	721	12.932	8354	40	274	155	.077	3.1	21	11.9	19
3 10 HG	66	.200	12.94	2731	13.211	13438	73	411	922	.147	10.7	60	135.6	51
4 16 HG	39	.210	12.71	864	12.962	8354	27	273	185	.077	2.1	21	14.2	19
5 19 HG	51	.150	12.68	237	12.885	5993	26	141	37	.057	1.5	8	2.1	3
6 16 HG	35	.210	12.94	869	13.188	8354	24	269	183	.077	1.8	21	14.1	19
7 3 HG	35	.770	12.94	1241	13.748	19522	54	2209	585	.113	6.1	250	66.1	68
8 16 HG	26	.220	12.94	875	13.188	8354	18	282	184	.077	1.4	22	14.2	19
9 C.T.	1719	.410	8.52	111	10.787	1998	344	153	7	.143	49.2	22	1.0	0
SUM----------(CYCLE COMPOSITE)----------											3.9	25	12.3	
CYCLE 3														
1 IDLE	147	2.110	12.16	164	14.429	1861	20	550	7	.232	4.8	128	1.6	0
2 16 HG	44	.210	12.34	747	12.598	8354	32	281	164	.077	2.4	22	12.7	19
3 10 HG	62	.150	12.75	2731	12.967	13438	69	314	940	.147	10.2	46	138.1	51
4 16 HG	30	.200	12.82	805	13.052	8354	21	259	171	.077	1.6	20	13.2	19
5 19 HG	39	.150	12.71	251	12.902	5993	20	141	39	.057	1.1	8	2.2	3
6 16 HG	30	.210	12.71	854	12.952	8354	21	274	183	.077	1.6	21	14.1	19
7 3 HG	40	.740	12.75	1313	13.533	19522	62	2156	629	.113	7.0	244	71.1	68
8 16 HG	35	.210	12.82	963	13.068	8354	24	271	204	.077	1.9	21	15.7	19
9 C.T.	1694	.430	8.69	133	10.950	1998	334	158	8	.143	47.7	23	1.2	0
SUM----------(CYCLE COMPOSITE)----------											3.7	25	12.8	
CYCLE 4														
1 IDLE	147	2.110	12.16	164	14.429	1861	20	550	7	.232	4.8	128	1.6	0
2 16 HG	60	.210	12.47	830	12.745	8354	42	278	181	.077	3.3	21	13.9	19
3 10 HG	70	.180	12.71	2739	12.966	13438	78	377	942	.147	11.5	55	138.5	51
4 16 HG	44	.180	12.71	875	12.938	8354	31	235	188	.077	2.4	18	14.4	19
5 19 HG	42	.150	12.71	278	12.905	5993	21	141	43	.057	1.2	8	2.4	3
6 16 HG	35	.210	12.71	864	12.958	8354	24	273	185	.077	1.9	21	14.2	19
7 3 HG	47	.750	12.71	1350	13.511	19522	73	2189	648	.113	8.3	247	73.2	68
8 16 HG	31	.210	12.71	1014	12.953	8354	22	274	217	.077	1.7	21	16.7	19
9 C.T.	1620	.440	8.69	148	10.880	1998	321	163	9	.143	45.9	23	1.3	0
SUM----------(CYCLE COMPOSITE)----------											3.8	26	13.1	

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 1 AND 2)---------- 4.1 25 12.0

AVERAGE SUM---(COMPOSITE VALUES FOR CYCLES 3 AND 4)---------- 3.8 25 12.9

FOUR CYCLE COMPOSITE - REPORTED VALUES - HC 0.35(4.1) + 0.65(3.8) = 3.894 (MASS)
CO 0.35(25) + 0.65(25) = 25.3 (MASS)
NO2 0.35(12.0) + 0.65(12.9) = 12.589 (MASS)
CORRECTED NO2 = 13.221 (MASS)

APPENDIX Y

EXPERIMENTAL 23 MODE TEST PROCEDURE

FOR ENGINES IN HEAVY DUTY MOTOR VEHICLES

TEST PROCEDURE FOR HEAVY DUTY MOTOR VEHICLE ENGINES

§ 85.100 Introduction

(a) The procedures described in this subpart will be the test program to determine the conformity of new heavy duty engines with the applicable standards set forth in this part.

(b) The test procedure begins with a warm engine and consists of a prescribed sequence of engine operating conditions on an engine dynamometer with continuous examination of the exhaust gases. The test is applicable equally to uncontrolled engines and controlled engines equipped with means for preventing, controlling, or eliminating gaseous emissions.

(c) The test is designed to determine the brake specific emissions of hydrocarbons, carbon monoxide, and oxide of nitrogen when an engine is operated through a test cycle on an engine dynamometer. The test includes, in addition to three idle modes, one closed throttle and nine power modes at each of two speeds which span the typical operating range of heavy duty engines. The procedure requires the determination of the concentration of each pollutant, the exhaust flow, and the power output during each mode. The measured values

are weighted and used to calculate the grams of each pollutant emitted per brake horsepower hour.

(d) When an engine is tested for exhaust emissions or is operated for durability testing on an engine dynamometer, the complete engine shall be used with all standard accessories which might reasonably be expected to influence emissions to the atmosphere installed and functioning.

§ 85.101 Fuel Specifications

(a) For exhaust emission testing of gasoline fueled engines, fuel having specifications as shown in the table in § 85.71(a), or substantially equivalent specifications approved by the Administrator shall be used.

(b) For durability testing of gasoline fueled engines, fuel having specifications as shown in the table in § 85.71(b), or substantially equivalent specifications approved by the Administrator, shall be used. The octane rating of the fuel used shall be in the range recommended by the engine manufacturer. The specifications of the fuel to be used shall be reported in accordance with § 85.51(b)(3)

(c) For exhaust emission testing of engines which use diesel fuels, fuel having specifications as shown in the table in § 85.121(b), or substantially equivalent specifications approved by the Administrator shall be used.

(d) For durability testing of engines which use diesel fuels, fuel having specifications as shown in the table in § 85.121(c), or substantially equivalent specifications approved by the Administrator, shall be used. The octane rating of the fuel used shall be in the range recommended by the engine manufacturer. The specifications of the fuel to be used shall be reported in accordance with § 85.51(b)(3).

§ 85.102 Dynamometer Operation Cycle

(a)(1) The following twenty three mode cycle shall be used in dynamometer operation tests of heavy duty engines.

MODE NO.	ENGINE SPEED*	PERCENT LOAD	WEIGHTING FACTOR
1	Idle	0	~~6.0~~
2	Intermediate	2	6.0
3	"	8	6.0
4	"	18	5.0
5	"	25	3.0
6	"	50	6.0
7	"	75	0
8	"	82	4.0
9	"	92	0
10	"	100	0
11	Idle	0	~~6~~
12	Intermediate	C.T.	12
13	High	100	2.5
14	"	92	5.5
15	"	82	3.5
16	"	75	6.0
17	"	50	6.0
18	"	25	0
19	"	18	6.5
20	"	8	0
21	"	2	0

MODE NO.	ENGINE SPEED*	PERCENT LOAD	WEIGHTING FACTOR
22	Idle	0	~~6~~ 2
23	High	C.T.	6

* Engine Speed Definition:

	Engine Type	
	Spark Ignition	Compression Ignition
Intermediate	1200 rpm	Peak torque speed or 60% of rated, whichever is higher.
High	2300 rpm	Rated speed

(2) For each mode the engine dynamometer shall be operated at a constant speed within ± 50 r.p.m. of the specified speed and at the specified torque within ± 2 percent of maximum torque at that speed. For example, the torque for mode six (6) shall be between 48 and 52 percent of maximum torque measured at the intermediate test speed.

(b) The following equipment shall be used for emission testing of engines on engine dynamometers.

(1) An engine dynamometer with adequate characteristics to perform the test cycle described in § 85.102(a)

(2) An engine cooling system having sufficient capacity

to maintain the engine at normal operating temperatures during conduct of the prescribed engine tests.

(3) A chassis-type exhaust system or substantially equivalent exhaust system.

§ 85.104 Sampling and Analytical Systems for Measuring Exhaust Emissions

(a) Two separate sampling and analytical systems are used for emission testing under the regulations in this part. One system is used for the determination of hydrocarbon concentrations. The other system is used for the determination of the concentrations of nitric oxide, carbon monoxide, and carbon dioxide.

The system used for determining hydrocarbon concentrations includes a heated sampling line and a heated flame ionization detector analyzer (FID). When emission tests involve gasoline fueled engines, the sample line and analyzer are maintained at a temperature of 160°F ± 5°F to prevent the water vapor in the sample stream from condensing out and collecting in the system. When emission tests involve engines which use diesel type fuels, the temperature is maintained at 350°F ± 10°F to inhibit the accumulation of the lighter weight hydrocarbons in the system as a result of condensation and adsorption effects. Means are provided for purging the system with air when measurements are not being made.

The system used for determining the concentrations of the other pollutants includes:

(1) a water concending trap which is maintained at 36°F ± 4°F,

(2) a chemiluminescence (CL) NO analyzer,

(3) a nondispersive infrared (NDIR) CO analyzer and,

(4) a nondispersive (NDIR) CO_2 analyzer.

A converter is used upstream of the chemiluminescence analyzer to convert any NO_2 in the sample stream to NO. A bypass system is provided to permit the periodic checking of the converter efficiency. Means are provided for back flushing the cooling coil and sample line and for introducing air or NO and O_2 mixtures (for converter efficiency testing) into the analytical system.

Other types of analyzers may be used if they yield equivalent results and if they are approved by the Administrator.

(b) Schematic drawing. The following (Fig. 6) is a schematic drawing of the exhaust gas sampling and analytical system which shall be used for testing under the regulations in this subpart.

(c) Component description. The following components will be used in the exhaust gas analytical system for testing under the regulations of this part.

(1) Flowmeters (FL1, FL2, and FL3) to indicate the sample flow rate through the analyzers.

(2) Analyzers to determine hydrocarbon, carbon monoxide, carbon dioxide, and nitric oxide concentrations.

(3) A converter to convert any NO_2 present in the samples to NO before analysis.

(4) Flow control valves (N1, N2, N3, N4, N5, N6, N7, N8, N9, N10, N11, N13, and N14) to regulate the gas flow rates.

(5) Recorders (R1, R2, R3, and R4) or digital printers to provide permanent records of calibration, spanning, and sample measurements. In those facilities where computerized data acquisition systems are incorporated, the computer facilities printout may be used.

(6) Manifold (M1) to collect the expelled gases from analyzers.

(7) Pump (P2) to transfer expelled gases from the collection manifold to a vent external to the test room (optional).

(8) Selector valve (V8) to direct purge air through the HC analytical system.

(9) Selector valves (V1, V2, V5, V6) to direct samples, span gases, or zeroing gas to the analyzers.

(10) Selector valves (V3 and V4) to allow the sample, span, calibrating, or zeroing gases to bypass the converter.

(11) Pump (P1) to transfer samples from sample probe to analyzers.

(12) Filters (F1 and F2) to remove particulate matter.

(13) Selector valve (V9) to direct NO/O_2 mixtures to the converter for efficiency checks.

(14) Selector valve (V7) to backflush cooling coil with air.

(15) Cooling Coil (C1) to condense water vapor from sample.

(16) Refrigerated water bath to maintain cooling coil at 32 - 40°F.

(17) Thermometer for indicating bath temperature.

(18) Valve (N12) to drain water from cooling coil.

(19) Sample probes to extract exhaust gas sample downstream of muffler.

§ 85.105 Information

The following information shall be recorded:

(a) General

(1) Test number

(2) Date and time of day

(3) Instrument operator

(4) Engine operator

(5) Engine Identification - Date of manufacture - Number of hours of operation accumulated on engine - Engine family - engine displacement - timing - maximum observed torque at specified test engine speeds - idle r.p.m.

(6) All pertinent instrumentation information such as model name and serial numbers.

(7) Recorder charts. Identify zero traces - Calibration or span traces for each test mode - Start and finish of each test.

(8) Ambient temperature in dynamometer testing room.

(9) Engine intake, air temperature, and humidity.

(10) Barometric pressure.

(11) Observed engine torque for each mode.

(12) Other data as required by the Administrator.

(b) Spark ignition engines

(1) Number of carburetors and number of carburetor venturis or fuel injection system types.

(2) Advertised horsepower.

(3) Fuel consumption in gms/hr during each mode.

(c) Compression ignition engines

(1) Advertised rated and peak torque speeds.

(2) Exhaust pipe diameter.

(3) Exhaust system back pressure.

(4) Air aspiration system type.

(5) Air inlet restriction.

(6) Fuel injection system.

(7) Exhaust flow in c.f.m., or intake air flow in c.f.m. and fuel consumption in pounds per hour, for each mode.

§ 85.106 Calibration and Instrument Checks

(a) Calibrate the analytical assembly at least once every 30 days. Use the same flow rate as when analyzing samples.

(1) Adjust analyzers to optimize performance.

(2) Zero the hydrocarbon analyzer with zero grade air and the carbon monoxide, carbon dioxide, and oxides of nitrogen analyzers with zero grade nitrogen. The allowable zero gas impurity concentrations should not exceed 1 p.p.m. equivalent carbon response, 1 p.p.m. carbon monoxide, 300 p.p.m. (0.03 mole percent) carbon dioxide, and 0.1 p.p.m. nitric oxide.

(3) Set the CO and CO_2 analyzer gains to give the desired ranges. Select the desired attenuation scale of the HC analyzer and set the capillary flow rate by adjusting the back pressure regulator, to give the desired range. Select the desired scale of the NO_x analyzer and adjust the phototube high voltage supply to give the desired range.

(4) Calibrate the HC analyzer with propane (air diluent) gases having nominal concentrations equal to 50 and 100 percent of full scale. Calibrate the CO analyzer with carbon monoxide (nitrogen diluent) gases and the CO_2 analyzer with carbon dioxide (nitrogen diluent) gases having nominal concentrations equal to 10, 25, 40, 50, 60, 70, 85, and 100 percent of full scale. Calibrate the NO_x analyzer with nitric oxide

(nitrogen diluent) gases having nominal concentrations equal to 50 and 100 percent of full scale. The actual concentrations should be known to within ± 2 percent of the true values.

(5) Compare values obtained on the CO and CO_2 analyzers with previous calibration curves. Any significant change reflects some problem in the system. Locate and correct problem, and recalibrate. Use best judgment in selecting curves for data reduction.

(6) Check the NO_2 to NO converter efficiency by the following procedure:

(i) Fill a plastic bag with air (or oxygen) and NO span gas in proportions which result in a mix in the operating range of the analyzer. Provide enough oxygen for substantial conversion of NO to NO_2.

(ii) Knead bag and immediately connect the bag to the inlet at valve N13. Turn selector valve N7 as required and close valve V8. Alternately measure the NO and NO_x concentration at 1-minute intervals by alternately passing the sample through the converter and the bypass (close valves N6 and N9 to minimize pump down rate of bag). After several minutes of operation, the recording of NO and NO_x will resemble Figure 1c, Section

85.84, if the converter is efficient. Even though the amount of NO_2 increases with time, the total NO_x ($NO + NO_2$) remains constant. A decay of NO_x with time indicates the converter is not essentially 100 percent efficient and the cause should be determined before the instrument is used.

(iii) The converter efficiency should be checked at least once weekly and preferably once daily.

(b) HC, CO, CO_2, and NO_x measurements: Allow a minimum of 20 minutes warmup for the HC analyzer and 2 hours for the CO, CO_2, and NO_x analyzers. (Power is normally left on infrared and chemiluminescence analyzers; but when not in use, the chopper motors of the infrared analyzers are turned off and the phototube high voltage supply of the chemiluminescence analyzer is place in the standby position.) The following sequence of operations should be performed in conjunction with each series of measurements:

(1) Zero the analyzers. Obtain a stable zero on each amplifier meter and recorder. Recheck after tests.

(2) Introduce span gases and set the CO and CO_2 analyzer gains, the HC analyzer sample capillary flow rate, and the NO_x analyzer high voltage supply to match the calibration curves. In order to avoid corrections, span and calibrate at the same flow

rates used to analyze the test samples. Span gases should have concentrations equal to approximately 80 percent of full scale. If gain has shifted significantly on the CO or CO_2 analyzers, check tuning. If necessary, check calibration. Recheck after test. Show actual concentrations on chart.

(3) Check zeros; repeat the procedure in subparagraphs (1) and (2) of this paragraph if required.

(4) Check flow rates and pressures.

(5) Measure HC, CO, CO_2, and NO_x concentrations of samples. Care should be exercised to prevent moisture from condensing in the sample collection bag.

(6) Check zero and span points.

(c) For the purposes of this section, the term "zero grade air" includes artificial "air" consisting of a blend of nitrogen and oxygen with oxygen concentrations between 18 and 21 mole percent.

§ 85.107 Test Run

(a) The temperature of the air supplied to the engine shall be between 68°F and 86°F. The observed barometric pressure shall be between 28.5 inches and 31 inches Hq. Higher air temperature or lower barometric pressure may be used, if desired, but no allowance will be made for possible increased emissions because of such conditions.

(b) The following steps shall be taken for each test:

(1) Install instrumentation and sample probes as required.

(2) Start cooling system.

(3) Start the engine, warm it up and precondition it by running it at the lower specified test speed and maximum horsepower for 10 minutes or until all temperatures and pressures have reached equilibrium.

(4) Determine by experimentation the maximum torque at the specified test engine speeds and calculate the torque values for the specified test modes.

(5) Zero and span emission analyzers.

(6) Start the test sequence of § 85.102(a). Operate the engine for ten minutes in each mode as follows:

Minute	Mode Test Sequence
1st	Complete engine speed and load changes
2nd through 7th	Pass air through sample lines and analyzers
8th through 10th	Pass exhaust sample through the lines and analyzers and continuously record analyzer response.

(7) Read and record the data required for § 85.105 during the last five minutes of each test mode.

(8) Check and reset the zero and span settings of the emission analyzers at the end of the first CT mode (mode # 12) and at the end of the test or more often if required. If a change of over two percent of full scale response is observed, make necessary adjustments to the analyzers and repeat all test modes since the last zero and span.

(9) Backflush condensate trap and replace filters as required.

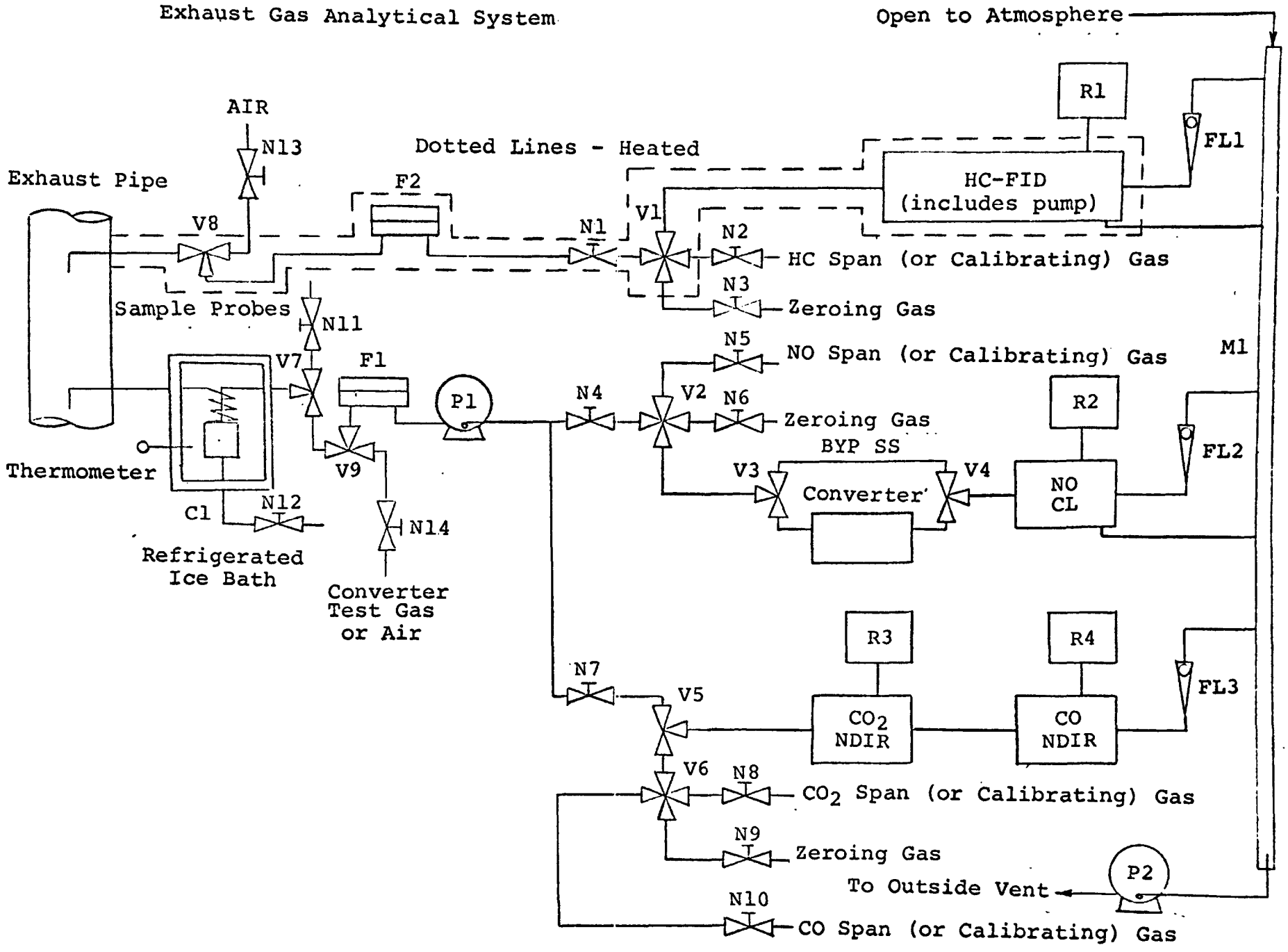
§ 85.108 Chart Reading

(a) Locate the last sixty seconds of each mode and determine the average chart reading for HC, CO, CO_2, and NO over the one minute period.

(b) Determine the concentration of HC, CO, CO_2, and NO during each mode from the average chart readings and corresponding calibration data.

Figure 6

Exhaust Gas Analytical System



Office of Air Programs
Ann Arbor, Michigan 48105

AFAE

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Corrections to the Experimental Heavy-Duty Test Procedure Presently Utilized at Southwest Research Institute and the Bureau of Mines

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In Section 85.102(a)(1) the weighting factors for mode numbers 1, 11, and 22 are revised to read as follows:

Mode No.	Engine Speed	% Load	Weighting Factors
1	Idle	0	7
11	Idle	0	7
22	Idle	0	8

In Section 85.107 paragraphs (6) and (7) are revised to read as follows:

(6) Start the test sequence of 85.102(a). Operate the engine for at least three minutes in each mode, completing the engine speed and load changes during the first minute.

(7) If additional time is required to read and record the data specified in Section 85,105, each mode may be extended to a maximum of ten minutes.

In Section 85.108 paragraph (a) is revised to read as follows:

(a) Locate the third minute of each mode and determine the average chart reading for HC, CO, CO_2 and NO over the one minute period.

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AFAE::JJMcFadden/JBozek:lpm 209, 340, 3/27/72

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