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16. Abstract
Cylinder-to-cylinder mixture ratio distributions were measured for both the injected and carbureted versions of the AVCO-Lycoming 0-320 engine to determine the effects of non-uniform distribution on the exhaust emissions of carbon monoxide, hydrocarbons, and oxides of nitrogen. Data for both normal and lean-out conditions were obtained. An experimental Turbulent Flow Manifold for the carbureted engine was tested as a potential means for improved cylinder-to-cylinder distribution. Results showed improvements for the low power operating modes but deterioration for the high power modes. An analysis based on test results predicts that the EPA emission requirements can be met, for this engine, by improving mixture distribution and leaning both the taxi-out and approach modes. Improvements in fuel economy are also predicted.

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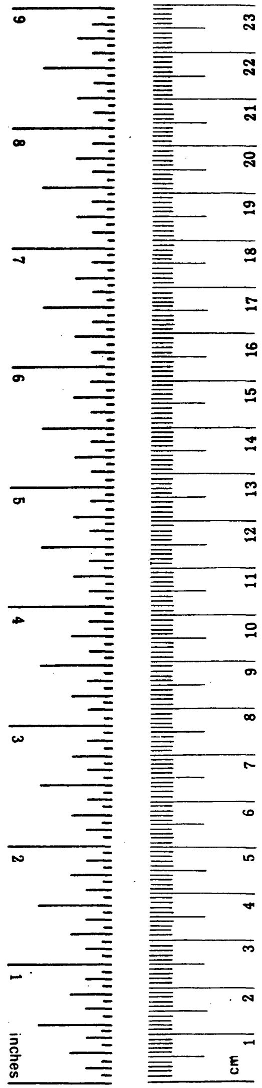
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

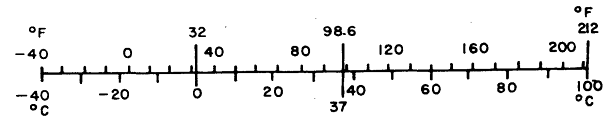
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



PREFACE

This investigation was conducted by personnel of the Aerospace Engineering and Mechanical Engineering Departments of The University of Michigan, Ann Arbor, Michigan under Contract No. DOTFA74NA-1102. Professor J.A. Nicholls served as Project Director with Professor W. Mirsky as the Principal Investigator. Students, R. Pace and R. Ponsonby, assisted in the very early stages of this study. Assistance in the form of discussions of the Turbulent Flow Manifold (TFM) concept with Mr. F.J. Marsee and Mr. R.M. Olree of the Ethyl Corporation Research Laboratories, Detroit, Michigan, is gratefully acknowledged. The contract was administered by the National Aviation Facilities Experimental Center, Atlantic City, New Jersey.

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INTRODUCTION

Purpose

This investigation was undertaken to obtain experimental data on the cylinder-to-cylinder distribution of air/fuel mixture ratios and the corresponding exhaust emissions from a typical small-aircraft piston engine. This information, together with curves showing variation of pollutant concentrations with mixture ratio, can be used to predict potential improvements of emissions resulting from improved mixture distribution.

The Turbulent Flow Manifold (TFM) concept was tested as a possible practical means for reducing emissions by improving the cylinder-to-cylinder mixture distribution.

Background

The Environmental Protection Agency (EPA) has published regulatory standards for exhaust emissions from new aircraft piston engines manufactured on or after December 31, 1979 (reference 1). These standards are:

Hydrocarbons	0.0019	pound/rated	power/cycle		
Carbon Monoxide	0.042	"	"	"	"
Oxides of Nitrogen	0.0015	"	"	"	"

Emission levels are based on a time-weighted five-mode test cycle consisting of:

Taxi/idle (out)	12.0	minutes (time-in-mode)
Takeoff	0.3	"
Climbout	5.0	"
Approach	6.0	"
Taxi/idle (in)	4.0	"

Extensive testing of a current small-aircraft piston engine (AVCO LYCOMING LIO-320-B1A) has demonstrated that, in general, the standards for oxides of nitrogen (NO_x) are easily met, hydrocarbon (HC) levels are marginal and that carbon monoxide (CO) levels are about 1.6 times the allowable level (reference 2). Compliance with these standards will require operating and/or design modifications which have been carefully considered and tested so that safety requirements are not compromised.

The major cause of high CO emissions is the rich mixture ratios used in these engines, primarily for engine cooling and suppression of detonation. Air/fuel ratios in the range 10:1 to 12.5:1 are normal, whereas the chemically correct ratio is about 15:1. Since sufficient oxygen (O_2) for complete combustion is not supplied, the fuel-carbon burns to CO rather than carbon dioxide (CO_2). However, the air/fuel ratios cannot be increased to control emissions without considering the simultaneous effects on cylinder head temperature, possible detonation, and increased levels of NO_x. All piston engines have slight differences in the amounts of air and fuel delivered to each cylinder, thereby giving rise to differences in delivered cylinder mixture ratios. This is largely responsible for the differences in cylinder head temperatures and CO emissions, since both are dependent upon mixture ratio. Therefore, any attempt to lean the overall mixture while limiting the cylinder with the maximum head temperature will cause the remaining cylinders to continue to run overly rich and to generate excessive amounts of CO. The magnitude of this effect and the extent of possible CO reduction will depend on the spread of cylinder-to-cylinder air/fuel ratios and the degree to which this spread can be reduced by the application of new design features.

In this investigation, measurements of cylinder-to-cylinder air/fuel ratio variations were made on the AVCO-Lycoming 320 engine, for both the injected and carbureted engines. Tests were conducted for all modes of the 7-mode cycle using normal and several lean-out mixture ratios.

An experimental TFM, constructed at The University of Michigan, was then tested to determine the potential for reducing cylinder-to-cylinder mixture variations and the related exhaust emissions.

Results from all tests were used to plot pollutant concentration against mixture ratio calculated from exhaust products. These curves provide the information necessary to determine the change in pollutant level from a given cylinder or engine that will result from a change in mixture ratio. The dependence of cylinder head temperature and brake specific fuel consumption on mixture ratio were also measured and plotted.

Turbulent Flow Manifold

The TFM concept was developed at the Ethyl Corporation Research Laboratories as a means for decreasing the cylinder-to-cylinder variation of air/fuel ratios in piston engines (references 3 and 4). Experimental models have been built and tested for automotive applications, and these have generally shown improvements in mixture distribution. Figure 1, taken from reference 4, shows the principal features of the TFM as used in automotive test applications. However considerable modifications were required for the 0-320 aircraft engine. The resulting design, shown schematically in figure 2, was used in all tests covered in this investigation.

The principal features of the TFM are:

1. A carburetor system having basically good spray and mixture characteristics. The more non-uniform the initial mixture, the more difficult is the task that the TFM must perform.
2. A high length-to-diameter (ℓ/d) ratio for the passageway immediately downstream of the throttle plate. An $\ell/d = 3$ or higher is recommended. This provides the necessary mixing length for the eddies which are formed just downstream of the throttle plate (see reference 3,

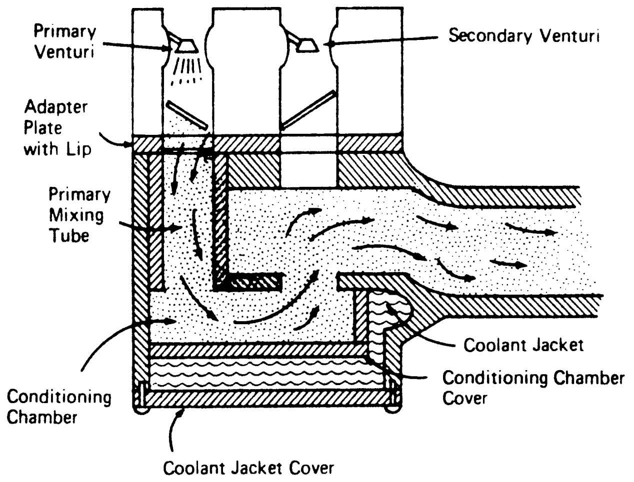

Figure 1. Schematic Diagram of the Turbulent Flow Manifold (TFM) Concept from Reference 4.

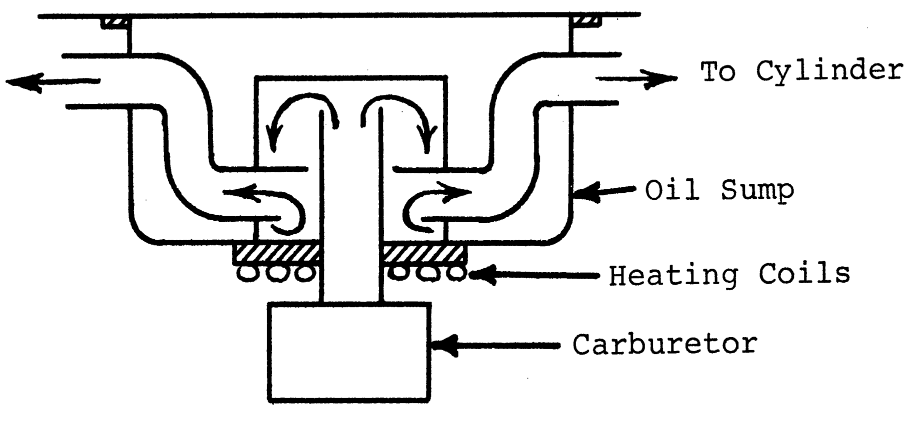

Figure 2. Schematic Diagram of the TFM used on the 0-320 Aircraft Engine.

figures 3 and 4). With short passageways, the eddies form a highly distorted and directional flow and could cause an unevenly divided flow of fuel to the various cylinders.

3. A flow section which creates a moderately abrupt change in flow direction so as to centrifuge the larger fuel drops from the mixture. Thus, the remaining smaller drops are better able to follow the airflow in the intake manifold and provide a more uniform mixture to the various cylinders.
4. A chamber to collect and evaporate these large drops which have been removed from the mixture and to reintroduce this fuel, as a vapor, back into the mixture. This is accomplished by heating the base of the fuel collection chamber to 140° Fahrenheit (a value recommended by the personnel at Ethyl).

EXPERIMENTAL WORK

Experimental Equipment

Engine Test Facility - Two views of the small aircraft piston engine test facility are shown in figures 3 and 4. The test engine, an AVCO-Lycoming LIO-320-B1A (later modified for subsequent tests) was mounted on a dynamometer test stand and mechanically coupled to a 350 horsepower (hp) eddy current dynamometer rated at 5,000 revolutions per minute (RPM). A solid state control system provided either speed or load control or any combination thereof.

Cooling air was supplied by an overhead mounted centrifugal blower with a capacity of 10,000 cubic feet per minute (CFM) at 10 inches water (in. H_2O). Pressure was controlled by a manually positioned damper while temperature control, over a limited range, was obtained by automatically mixing proper amounts of outside air

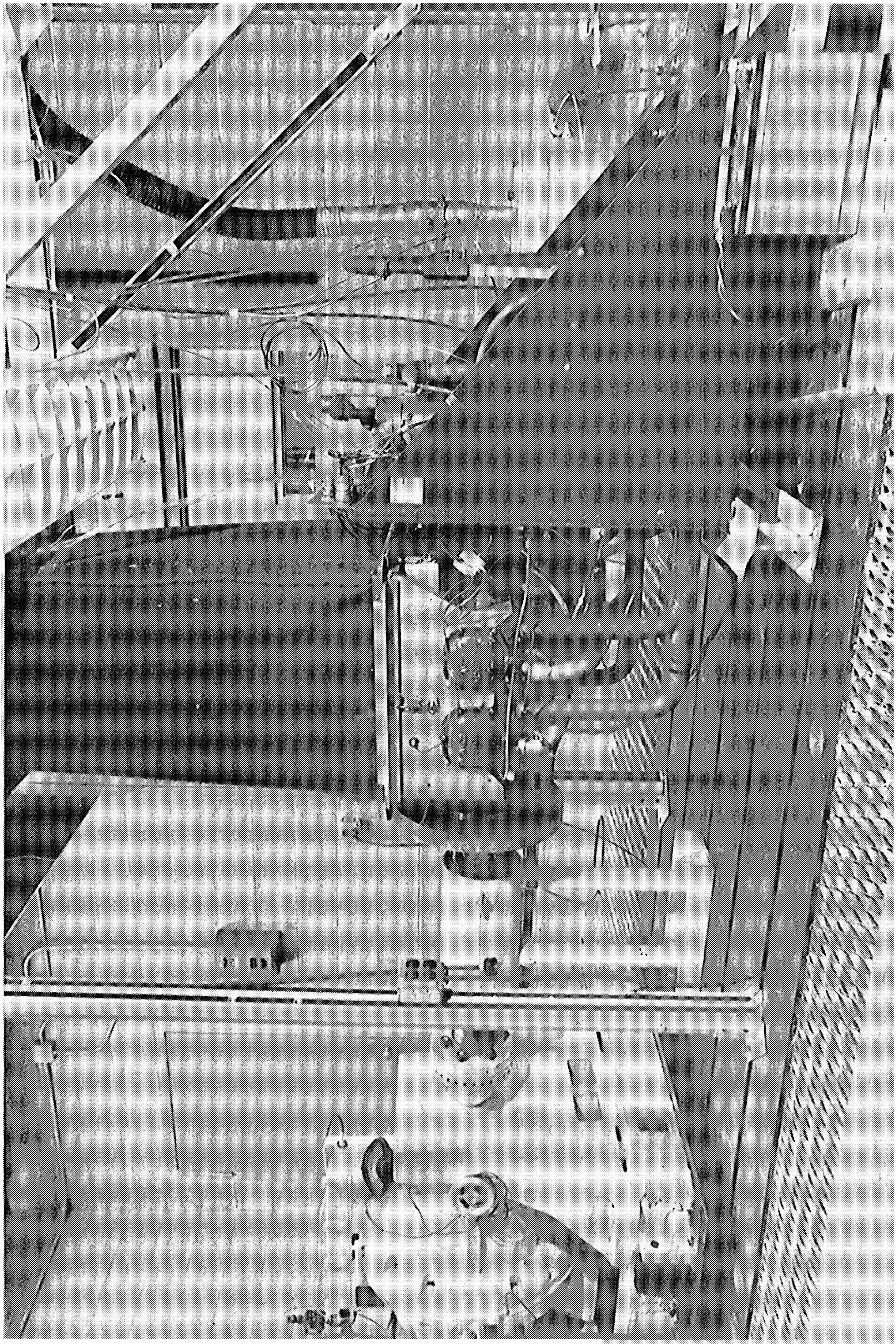

Figure 3. Engine Test Facility

Figure 4. Engine Control Room

with heated test cell air, using a temperature controlled damper valve. The temperature was limited to the range between outside air temperature and test cell temperature.

Engine induction air was bled directly from the cooling air supply to minimize temperature differences between induction air and cooling air. Induction airflow rate was measured with a calibrated 2 inch Meriam laminar flow meter which provided large pressure drop readings even at low flow rates. To compensate for the effect of these pressure drops on intake manifold pressure, especially at high airflow rates, a supersonic injector using a 3,000 pounds per square inch (psi) building air supply was used to boost the engine inlet total pressure. In all tests this pressure was set to ambient pressure.

Engine exhaust was collected in a common manifold from which the total exhaust gas sample was taken. The sampling probe was located 18 inches downstream from the Y-junction formed by the manifolds from the two banks of cylinders. An extension pipe of larger diameter carried the exhaust to an external vertical stack which was used to separate the exhaust from the induction air intake system and prevent contamination. Possible sources of air leakage into the exhaust system, including slip joints, sample probe fittings, and exhaust pipe mounting flanges, were sealed and checked.

Four additional sampling probes were used to obtain exhaust samples from each of the four cylinders. These were located 3 3/8 inches downstream from the exhaust pipe mounting pads, a compromised location to get far enough downstream from the exhaust valve to avoid the high concentration of hydrocarbons that is present in the last portion of the exhausted gases and far enough upstream from the junction with the exhaust stream from the neighboring cylinder to avoid contamination by that stream. A shutoff valve in each of the five sample lines made it possible to change to any desired sample during engine operation.

Fuel flow rate was measured using an electric timer and a weight and balance system. For a continuous visual check of the fuel flow, two rotameters with different flow ranges were installed in series and monitored during testing.

Recordings of the following pressure and temperature measurements were made during a test run.

Pressures	Temperatures
1. Air meter ΔP	1. Cylinder head (4)
2. Air meter, static	2. Exhaust gas (5)
3. Engine intake air, total	3. Cooling air
4. Engine manifold	4. Induction air
5. Fuel	5. Induction air, dew point
6. Cooling air, total	6. Fuel intake
7. Engine oil	7. Oil
8. Injector	8. Dynamometer cooling water
9. Barometric	9. Ambient (barometer)

Emission Measurement Console - A modified Scott Laboratories Emission Measurement Console, Model 108-H, was used for this study. The unit is shown in figure 4 and consists of the following major analytical components:

1. Beckman Model 864 Infrared Analyzer for O_2
2. Beckman Model 865 Infrared Analyzer for CO
3. Beckman Model 741 Oxygen Analyzer
4. Scott Model 125 Chemiluminescence Analyzer for NO/NO_x
5. Scott Model 415 Flame Ionization Detector (FID) Hydrocarbon (HC) Analyzer

Concentration measurements of CO_2, CO and O_2 were "dry" measurements since the sample gas for these instruments passed through a water trap before entering the analytical instrument. The flow to the HC and NO/NO_x instruments bypassed the water trap, resulting in "wet" measurements.

Test Conditions

Three configurations of the AVCO-Lycoming 0-320 engine were tested.

1. Standard LIO-320-B1A (fuel injected engine)
2. Carbureted engine, standard manifold (carburetor: Marvel-Schebler MA-4SPA)
3. Carbureted engine, turbulent flow manifold

All three configurations were tested using the different modes of the test cycle shown below. The cycle is based on the EPA test procedure described in reference 1, except for a separation of the idle and taxi modes.

	Mode	Power (Percent)	Speed (RPM)	Time in Mode (Minutes)
1.	Idle out	---	700	1.0
2.	Taxi out	---	1200	11.0
3.	Takeoff	100	2700	0.3
4.	Climb	80	2430	5.0
5.	Approach	40	2350	6.0
6.	Taxi in	---	1200	3.0
7.	Idle in	---	700	1.0

Lean out tests were run with the carbureted engine using both the standard and turbulent flow manifolds to obtain emission data over an extended range of air/fuel ratios. These runs were made at essentially stabilized conditions corresponding to the idle, taxi, takeoff, climb and approach modes. Test results were used to show the effects of mixture ratio on pollutant concentrations, cylinder head temperature, and brake specific fuel consumption.

RESULTS AND DISCUSSION

Experimental Results

Results are shown plotted in appendix A. Figure A-1 gives results for the fuel injected LIO-320 B1A and shows calculated air/fuel ratios for each cylinder for the first five modes of the 7-mode test cycle.

Figures A-2 - A-6 show similar baseline results for the carbureted engine. Two runs were made with the normal manifold and three runs with the turbulent flow manifold. A complete 7-mode cycle was run for each of these tests, and overall air/fuel ratio values, plotted versus "E" in the figures, were also calculated.

Figures A-7 - A-16 present lean-out data for the carbureted engine and show calculated air/fuel ratios, at different mixture settings, for each cylinder and total exhaust. Results for each operating mode appear in a separate figure. Plots for both the normal and turbulent flow manifolds are included.

Figures A-17 - A-24 show the effects of mixture ratio on cylinder head temperatures for the various operating modes. The separate curves, representing the different modes, are labeled as follows: idle (1), taxi (2), takeoff (3), climb (4) and approach (5). Each figure is for a single cylinder and both normal and turbulent flow manifold results are given.

Figures A-25 and A-26 show engine brake specific fuel consumption (BSFC) as a function of overall mixture ratio. Results for only the takeoff (3), climb (4) and approach (5) modes are presented, since the values at the idle and taxi modes were not considered significant. Curves are shown for the normal and turbulent flow manifolds.

Figures A-27 - A-31 show the effect of mixture ratio on the exhaust products CO, HC, NO_x, O_2 and CO_2. All test data from the carbureted engine (both normal and turbulent flow manifold, individual cylinder, and total exhaust data) appear in these figures. After the plots were made, the data for those points falling outside the main band were examined for possible errors. In cases where errors were found the points are circled in the figures. To separate the modal effects on NO_x in figure A-29 the various points are identified with the following mode symbols: idle (I), taxi (T), takeoff (O), climb (C) and approach (A).

Discussion of Results

A large number of tests of the 0-320 engine have shown that the major exhaust pollutant from these engines is CO and that the levels are approximately 160% of the EPA standard of 0.042 pound/rated power/cycle. The contribution to this total by the various operating modes varies greatly, and typical results from the University of Michigan and NASA-Lewis (reference 4) are shown below (see Case A, this section).

	Michigan Runs 69-75 (Percent)	NASA Cycle Run 329 (Percent)
Idle-out	1.3	1.4
Taxi-out	30.3	28.1
Takeoff	5.8	5.1
Climb	62.8	58.2
Approach	52.4	61.2
Taxi-in	7.8	7.3
Idle-in	1.3	1.3
	161.7	162.6

It is clear that the major contribution is due to the climb, approach and taxi-out modes. Therefore, effects to reduce CO emissions should focus on these modes.

When considering the potential benefits to emissions reduction through improved mixture management one cannot consider only the positive aspects of improved cylinder-to-cylinder distribution and better control of absolute levels of air/fuel ratio, but must also consider the possible negative effects on both NO_x emission and increased cylinder head temperature.

Results of this investigation indicate potential reductions in emissions through the use of improved mixture distribution and a change in mixture ratios for some of the operating modes. This is brought out below through the use of a few examples.

In appendix B, expressions are derived which give pollutant mass per rated horsepower per cycle in terms of the exhaust concentrations of the pollutants for each of the modes. The expressions for CO and NO_x are given by:

$$MPC(CO) = 8.0786 * 10^{-6} \sum_{i=1}^{7} [\dot{V}_i * TIM_i * X(CO)_i]$$

and

$$MPC(NO_x) = 1.3270 * 10^{-5} \sum_{i=1}^{7} [\dot{V}_i * TIM_i * X(NO_x)_i]$$

where MPC = mass per cycle , $\dot{V}_i$ = exhaust volume flow rate , TIM = time in mode. The expression for CO is now applied to a number of cases to indicate a potential means for substantial reduction in the CO emissions.

Case A: Standard Carbureted Engine (runs 69-75, appendix C) -

In this case we take the emission results measured in the total exhaust in the standard carbureted engine test and calculate the normal output of CO from this engine. The contributions of the various modes to the EPA standard are obtained directly from the computation and the final result is compared with the EPA standard.

In the expression below, we have substituted the modal values for the exhaust volume flow rates, the time-in-modes, and the dry-to-wet water correction factors which allow usage of the dry concentrations of CO obtained directly from the computer output (appendix C), using the program FAA described in reference 2.

$$\begin{aligned} MPC(CO) = 8.0786 * 10^{-6} [&952.329 * 1 * 0.86661 * X(COD)_1 \\ &+ 1638.132 * 11 * 0.87142 * X(COD)_2 \\ &+ 13886.210 * 0.3 * 0.86651 * X(COD)_3 \\ &+ 10206.350 * 5 * 0.86676 * X(COD)_4 \\ &+ 6313.937 * 6 * 0.86717 * X(COD)_5 \\ &+ 1652.663 * 3 * 0.87022 * X(COD)_6 \\ &+ 946.534 * 1 * 0.86405 * X(COD)_7] \end{aligned}$$

Combining terms, and giving the results in terms of the model contributions, we get:

Mode	CO Contribution (lbm/hp/mode)	Fraction EPA Std
1	$6.6673 * 10^{-3} * 0.084033 = 0.00056$	0.0133
2	$1.2685 * 10^{-1} * 0.100445 = 0.01274$	0.3033
3	$2.9162 * 10^{-2} * 0.083451 = 0.00243$	0.0579
4	$3.5733 * 10^{-1} * 0.073866 = 0.02639$	0.6284
5	$2.6539 * 10^{-1} * 0.082949 = 0.02201$	0.5241
6	$3.4855 * 10^{-2} * 0.094069 = 0.00328$	0.0781
7	$6.6071 * 10^{-3} * 0.081518 = 0.00054$	0.0128
	lbm CO/hp/cycle = 0.06795	1.6179

These results show the total output of CO in pounds CO per rated horsepower for the 7-mode cycle, which agrees with the computer output value of 0.06796 (appendix C). When compared with the EPA Standard of 0.042, the result is shown to be 1.62 times the Standard. As indicated previously, the major contributions are from the taxi-out, climb, and approach modes.

<u>Case B</u>: Uniform Mixture Distribution for Modes 2, 4, and 5 at the Lowest Measured CO Concentrations -

The reduction in CO emissions due to a uniform cylinder-to-cylinder mixture distribution in a normal engine for modes 2, 4, and 5 is considered next. It is assumed that all cylinders for each mode operate at the leanest mixture ratio (lowest CO) measured for that mode. The results for this case become:

Mode	CO Contribution (lbm/hp/mode)	Fraction EPA Std
1	0.00056	0.0133
2	$1.2685 * 10^{-1} * 0.082369 = 0.01045$	0.2488
3	0.00243	0.0579
4	$3.5733 * 10^{-1} * 0.065928 = 0.02356$	0.5609
5	$2.6539 * 10^{-1} * 0.077146 = 0.02047$	0.4875
6	0.00328	0.0781
7	0.00054	0.0128
	lbm CO/hp/cycle = 0.06129	1.4593

The result is a slight reduction in the CO emission, from a factor of 1.62 to 1.46 times the EPA standard.

Case C: Lean Approach Mode -

An examination of figures A-17 through A-20, for the approach mode, shows that cylinder head temperatures for all cylinders are well below the maximum allowable temperature of 435°F for all mixture ratios. This fact, together with the strong dependence of CO on mixture ratio shown in figure A-27, suggests the possibility of operating as in Case B, but leaning the mixture for the approach mode to 0.07 (fuel/air ratio) where the value of X(CO) is approximately 0.012. Converting X(CO) to a dry value by dividing by KDW, we get:

Mode	CO Contribution (lbm/hp/mode)		Fraction EPA Std
1		0.00056	0.0133
2		0.01045	0.2488
3		0.00243	0.0579
4		0.02356	0.5609
5	$2.6539 * 10^{-1} * (\frac{0.012}{.86717}) =$	0.00367	0.0874
6		0.00328	0.0781
7		0.00054	0.0128
	lbm CO/hp/cycle =	0.04449	1.0592

Thus a substantial reduction in CO has resulted and the level is only 6 percent above the EPA Standard.

Case D: Lean Approach and Taxi-out Modes -

In considering the possible leaning of other modes, figures A-17 - A.20 show that the mode 4 cylinder head temperatures are already close to the limiting value, so that leaning in mode 4 is to be avoided. However, the same figures show that some leaning in mode 2 may be possible but may require some slight improvement in air cooling. These curves also show some slight reduction in cylinder head temperature with lowering of the fuel air ratio below 0.07. Assuming that a value of 0.07 can be used with or without some improvement in engine cooling, the resulting CO levels become:

Mode	CO Contribution (lbm/hp/mode)		Fraction EPA Std
1		0.00056	0.0133
2	$1.2685 \times 10^{-1} * (\frac{.012}{.87142}) =$	0.00175	0.0416
3		0.00243	0.0579
4		0.02356	0.5609
5		0.00367	0.0874
6		0.00328	0.0781
7		0.00054	0.0128
	lbm CO/hp/cycle =	0.03579	0.8520

In this case the CO level is only 85 percent of the EPA allowed level.

A similar check of the NO_x levels shows the fraction of NO_x Standard increases from 0.32 to 0.78.

Mode	Normal	Case D
1	.0006	.0006
2	.0491	.1036
3	.0098	.0098
4	.1607	.1607
5	.0922	.5027
6	.0039	.0039
7	.0007	.0007
	0.3170	0.7820

These results indicate that operation of the engine with improved cylinder-to-cylinder distribution and using a fuel air ratio of 0.07 for the taxi-out and approach modes will generate emission levels well within the EPA Standards. The expected values for CO and NO_x are:

CO	85% of EPA Std
NO_x	78% of EPA Std

This can be accomplished without excessive cylinder head temperature except at the taxi-out mode where the limiting temperature may be closely approached. These same changes can be expected to decrease the hydrocarbon emissions as well, since figure A-28 shows a slight decrease in hydrocarbons with leaning in this fuel/air ratio region.

Turbulent Flow Manifold - Test results with the TFM show good improvement in the cylinder-to-cylinder mixture ratios for the idle, taxi, and approach modes. However, results for the high power takeoff and climb modes show a large increase in mixture ratio spread. This is believed due to the centrifugal action on a large portion of the fuel in the air stream, causing the fuel droplets to strike the wall and form erratic streams on the chamber surface. Similar effects were also detected in some of the work at the Ethyl Laboratories. With design improvements it should be possible to get more uniform distribution even at the high power modes and thus improve the fuel and air management over the entire test cycle.

Fuel Economy - Figures A-25 and A-26 show potential improvements in fuel economy when leaning the mixture ratio. It is interesting to note that a considerable deterioration of the fuel economy results from the poor cylinder-to-cylinder distribution in mode 3 with the TFM.

CONCLUSIONS

1. The carbureted version of the AVCO-Lycoming 0-320 engine has a cylinder-to-cylinder air/fuel ratio variation of about 1 air/fuel ratio for all seven modes of the test cycle.
2. The injected engine shows a greater spread in cylinder-to-cylinder mixture distribution, especially at light loads. A maximum difference of slightly over two air/fuel ratios occurred at idle.
3. Predictions show that the 0-320 can be made to pass EPA emission standards by operating both the taxi-out and approach modes at a fuel/air ratio of 0.07 and by slight improvements in cylinder-to-cylinder mixture distribution.

4. The TFM shows good improvement in mixture distribution at light loads but causes large differences in distribution at heavy loads. Further development of the concept, with emphasis on the high power runs, could yield promising results in terms of better fuel-air management and hence lower emissions.
5. Improvements in fuel-air management to lower emissions also results in substantial improvements in fuel economy at the high power operating modes.

REFERENCES

1. Federal Register, Vol. 38, No. 136, Part II, July 17, 1971.

2. Mirsky, W., Pace, R., Ponsonby, R., Nicholls, J.A., and Geister, D.E., "Critical Assessment of Emissions from Aircraft Piston Engines," FAA Report: FAA-RD-78-82.

3. Adams, W.E., Marsee, F.J., and Lenane, D.L., "Lead-Compatible Emission Controls — A Route to Improved Fuel Economy," National Petroleum Refiners Association Paper No. F&L-74-60, Houston, November 7-8, 1974.

4. Adams, W.E., Marsee, F.J., Olree, R.M., and Hamilton, J.C., "Emissions, Fuel Economy, and Durability of Lean Burn Systems," Ethyl Corporation Research Laboratories, Report 76-3, February, 1976.

5. Meng, P.R., Skorobatckyi, M., Cosgrove, D.V., and Kempke, E.E., "Emissions of an AVCO-Lycoming 0-320-DlAD Air Cooled Light Aircraft Engine as a Function of Fuel-Air Ratio, Timing, and Air Temperature and Humidity," NASA TM X-73500, August, 1976.

APPENDIX A

Experimental Results

APPENDIX A

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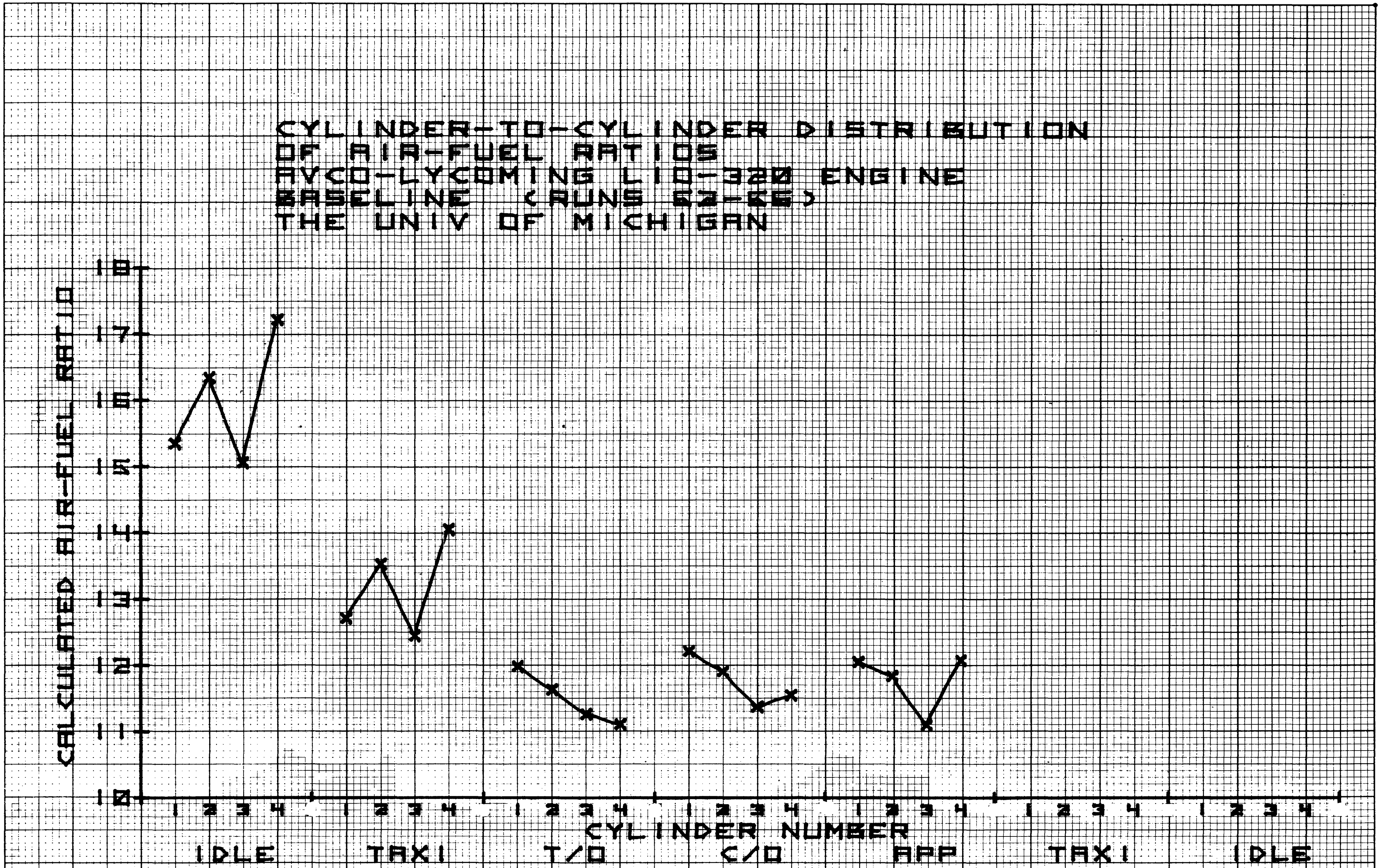

Figure A-1. Air-Fuel Variation, Injected Engine, Baseline Data

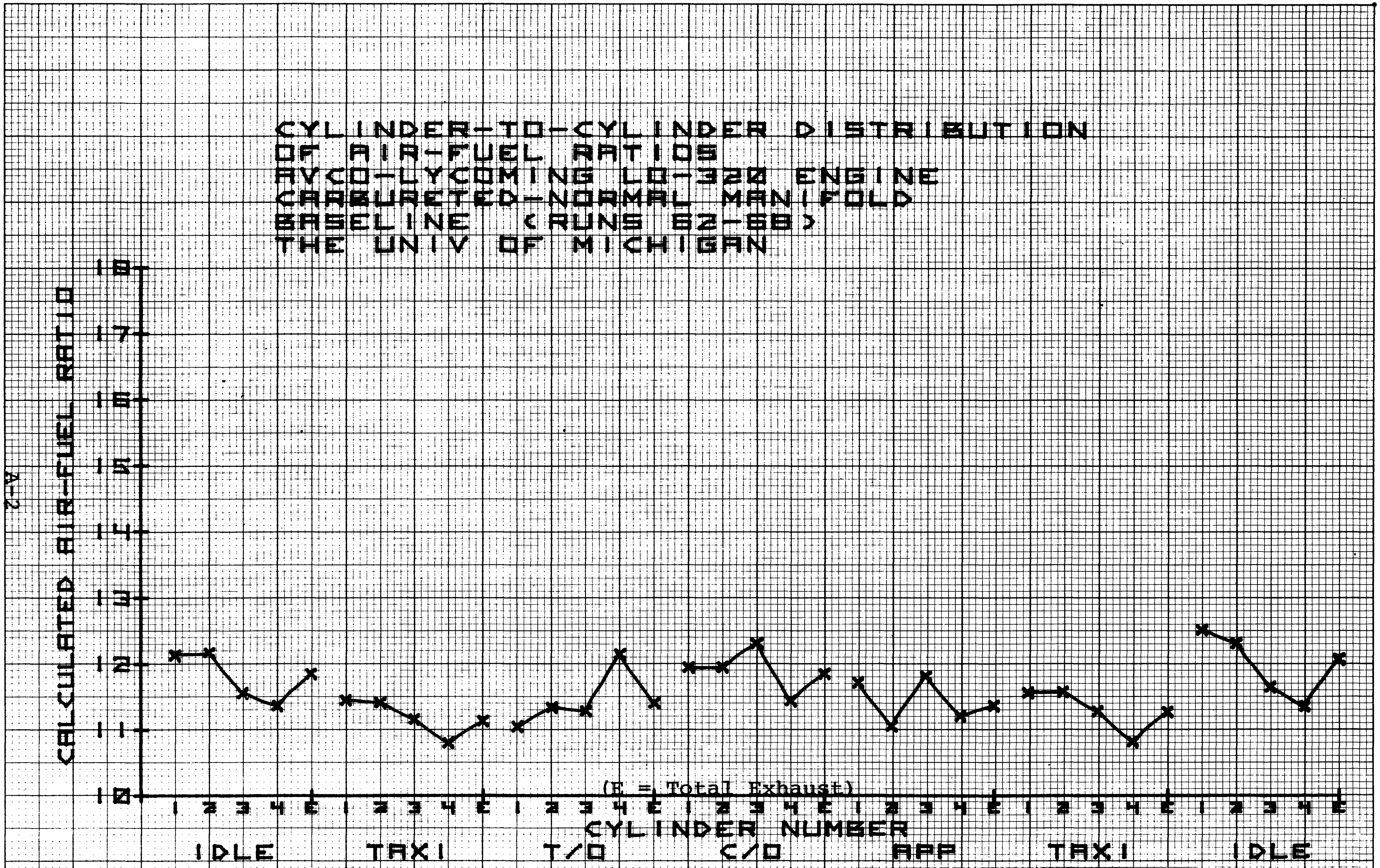

Figure A-2. Air-Fuel Variation, Carbureted Engine, Baseline Data

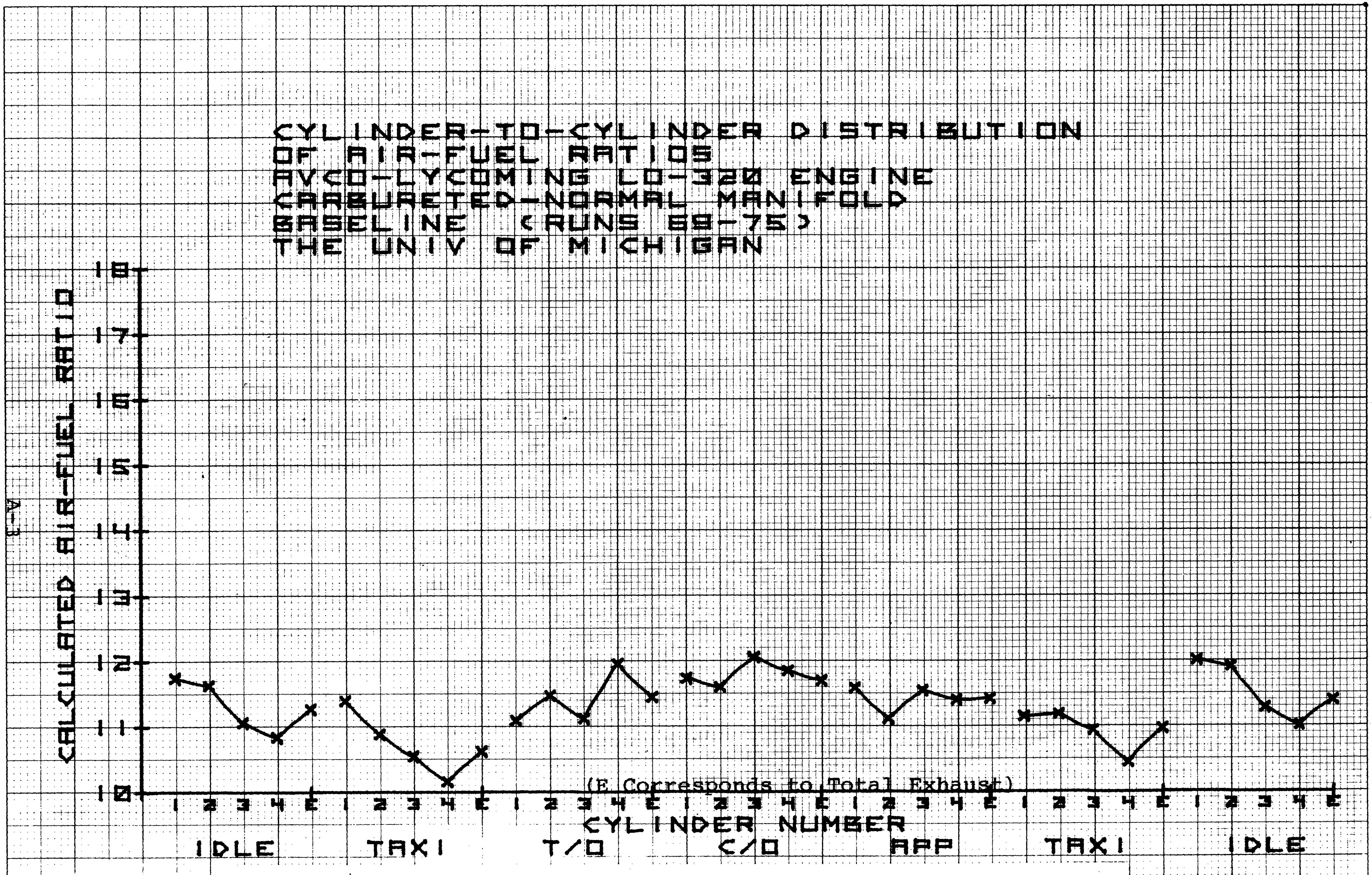

Figure A-3. Air-Fuel Variation, Carbureted Engine, Baseline Data

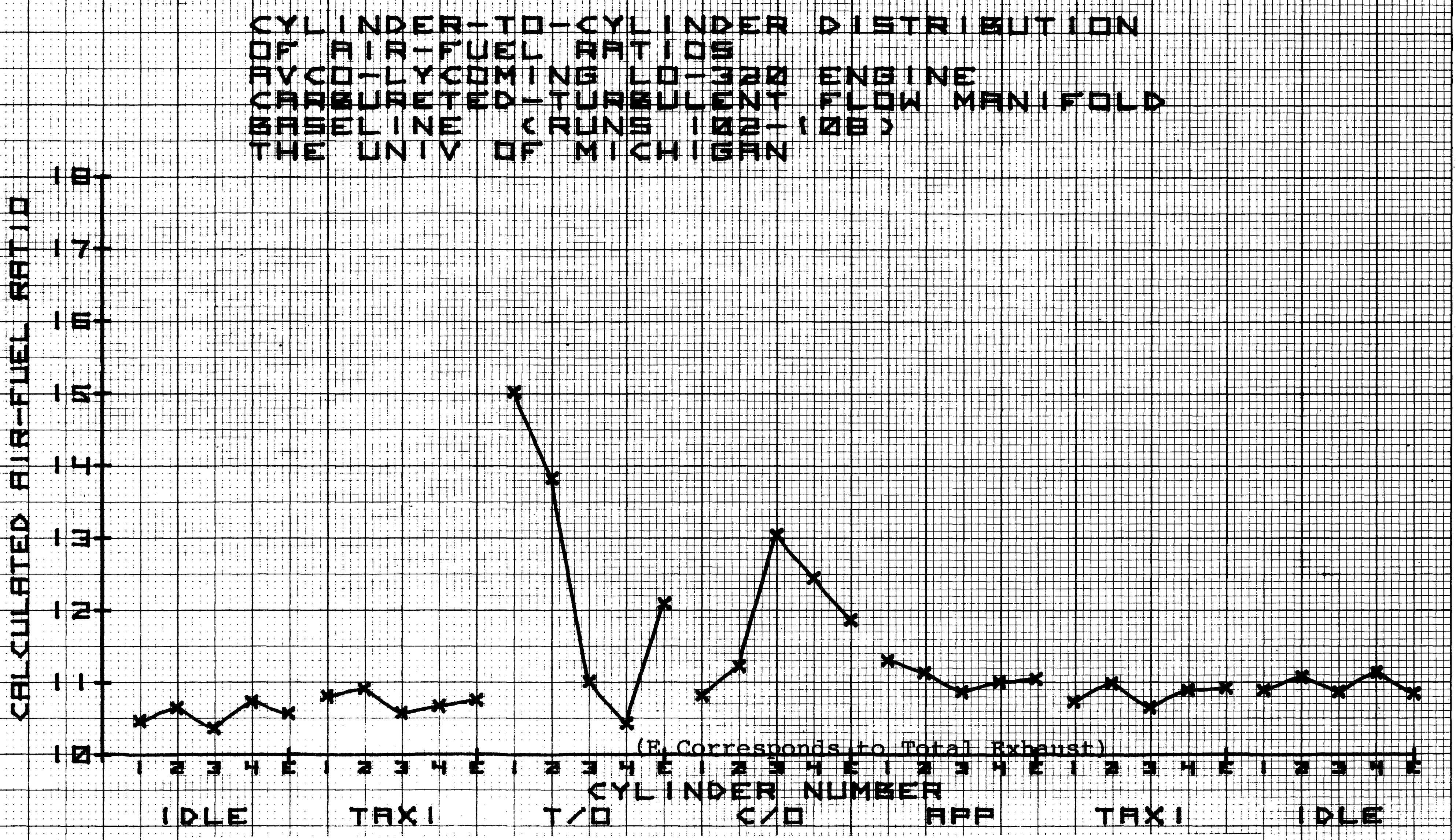

Figure A-4. Air-Fuel Variation, Turbulent Flow Manifold, Baseline Data

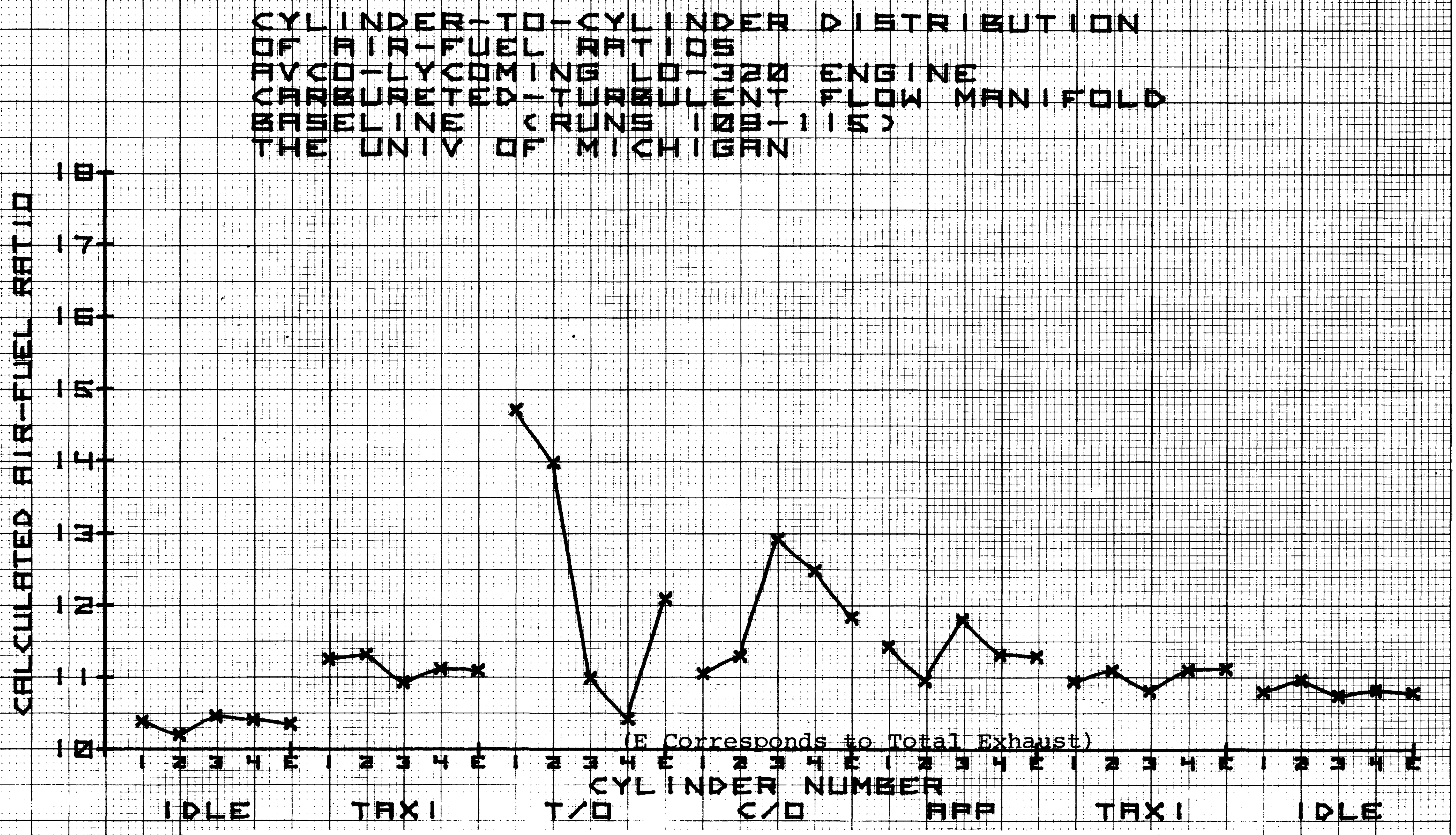

Figure A-5. Air-Fuel Variation, Turbulent Flow Manifold, Baseline Data

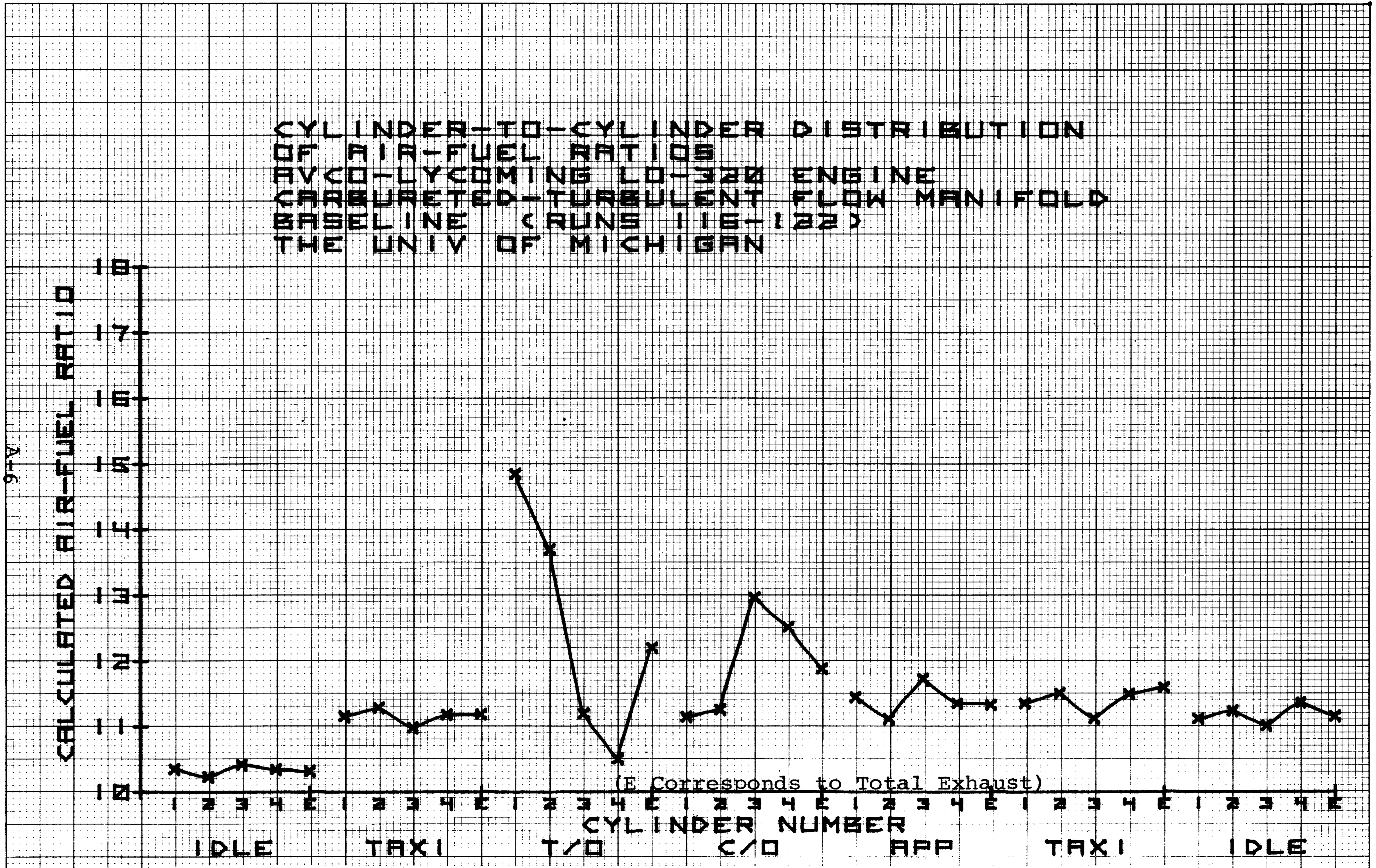

Figure A-6. Air-Fuel Variation, Turbulent Flow Manifold, Baseline Data

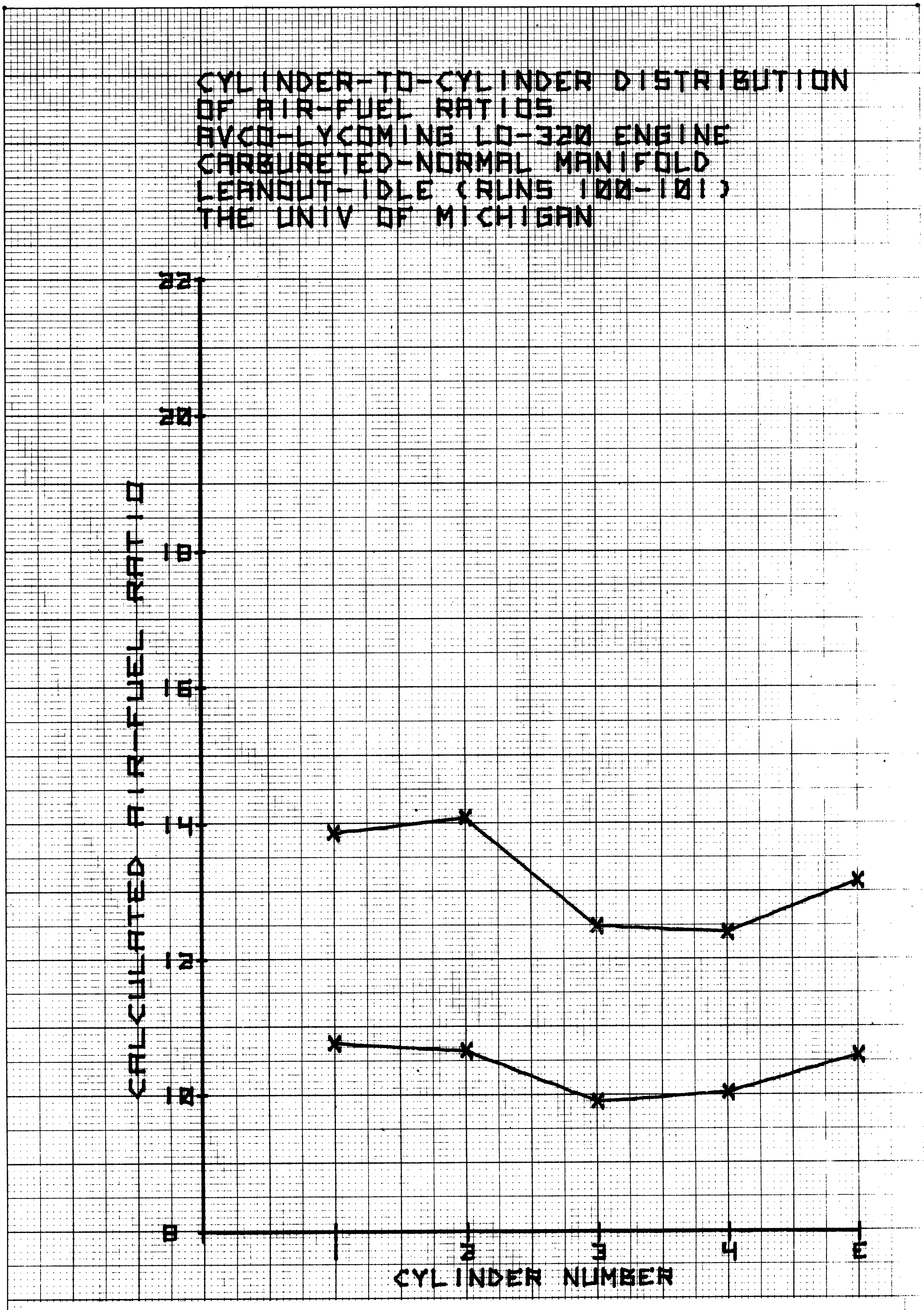

Figure A-7. Air-Fuel Variation, Carbureted Engine, Leanout, Idle

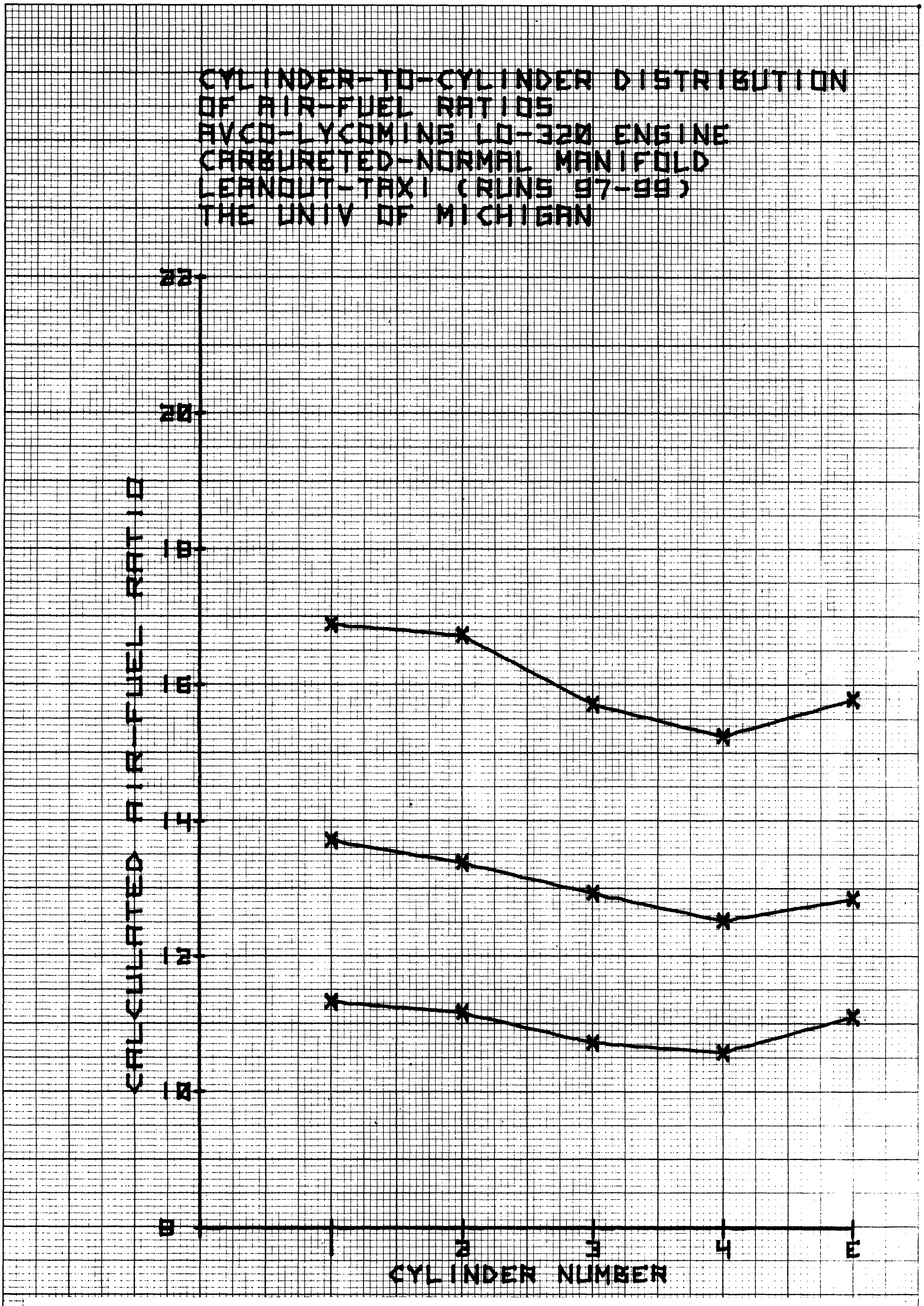

Figure A-8. Air-Fuel Variation, Carbureted Engine, Leanout, Taxi

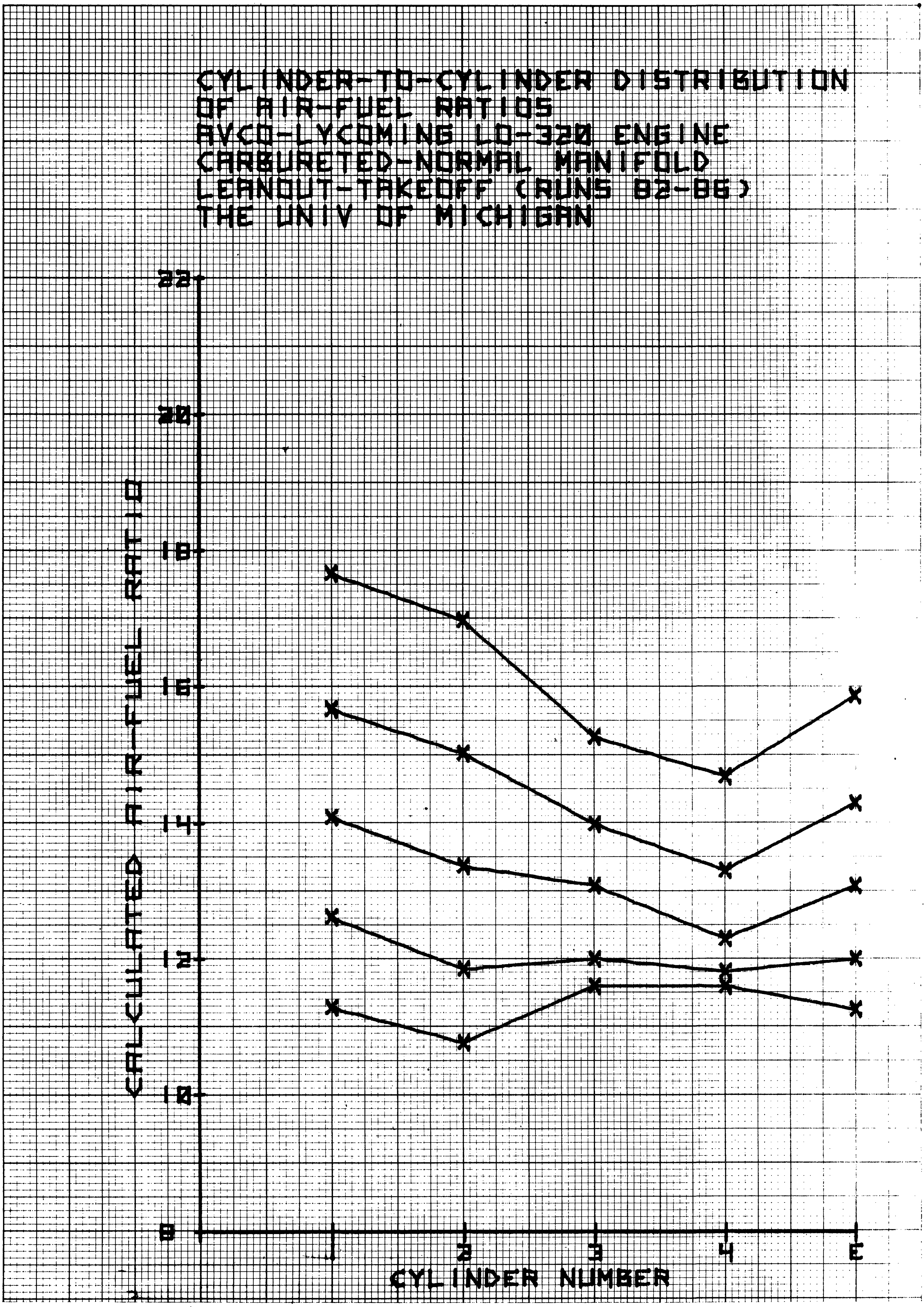

Figure A-9. Air-Fuel Variation, Carbureted Engine, Leanout, Takeoff

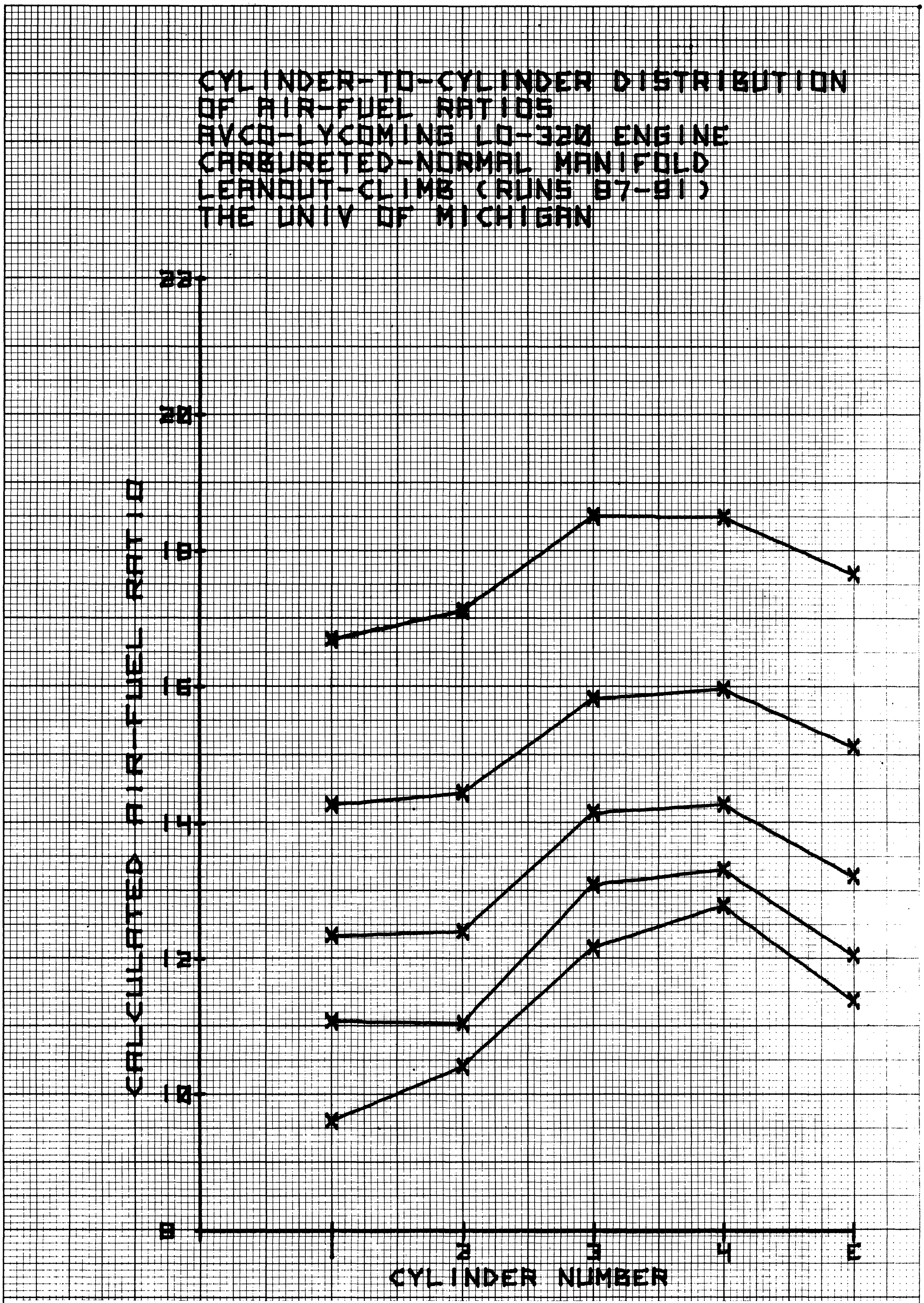

Figure A-10 Air-Fuel Variation, Carbureted Engine, Leanout, Climb

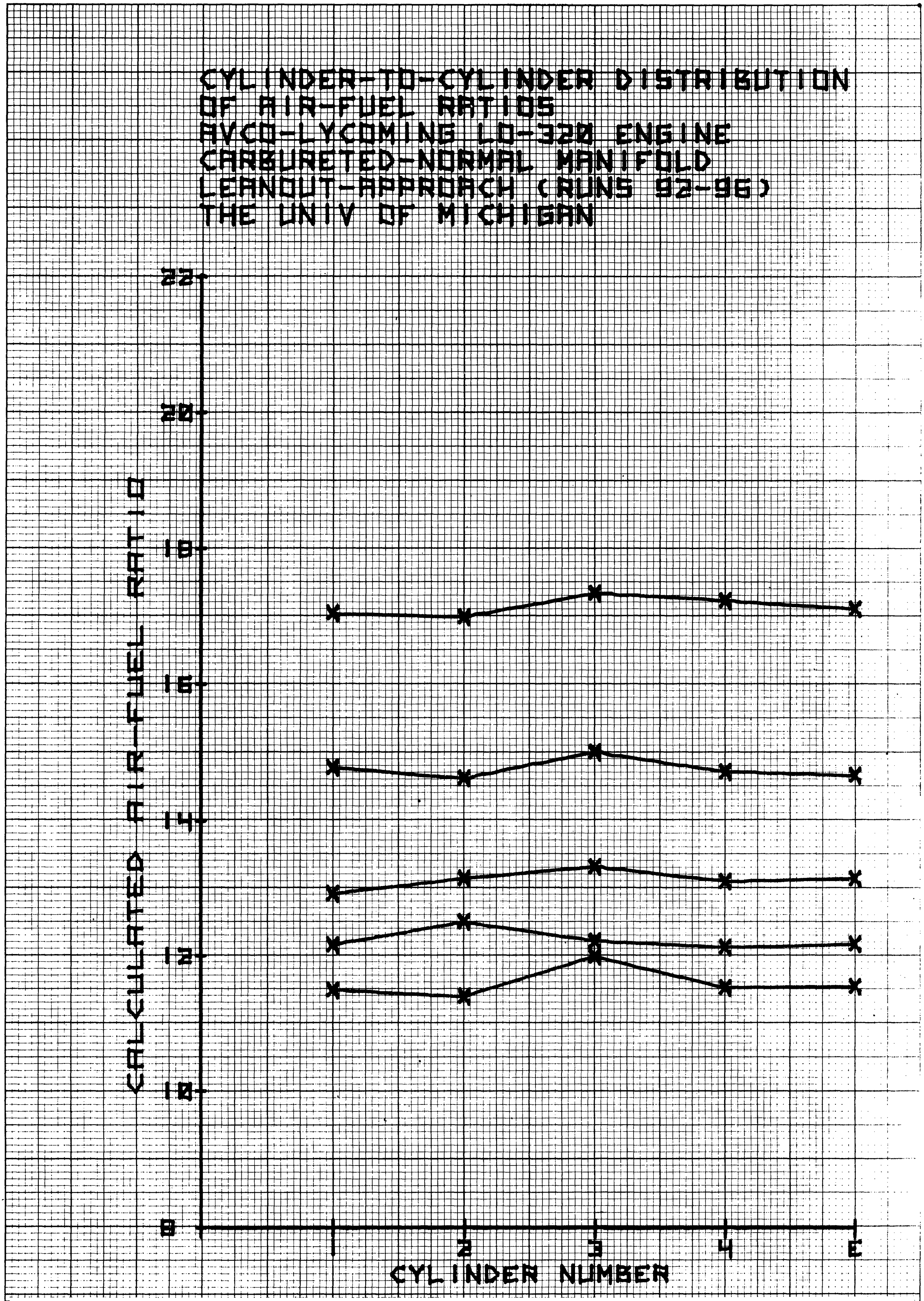

Figure A-11. Air-Fuel Variation, Carbureted Engine, Leanout, Approach

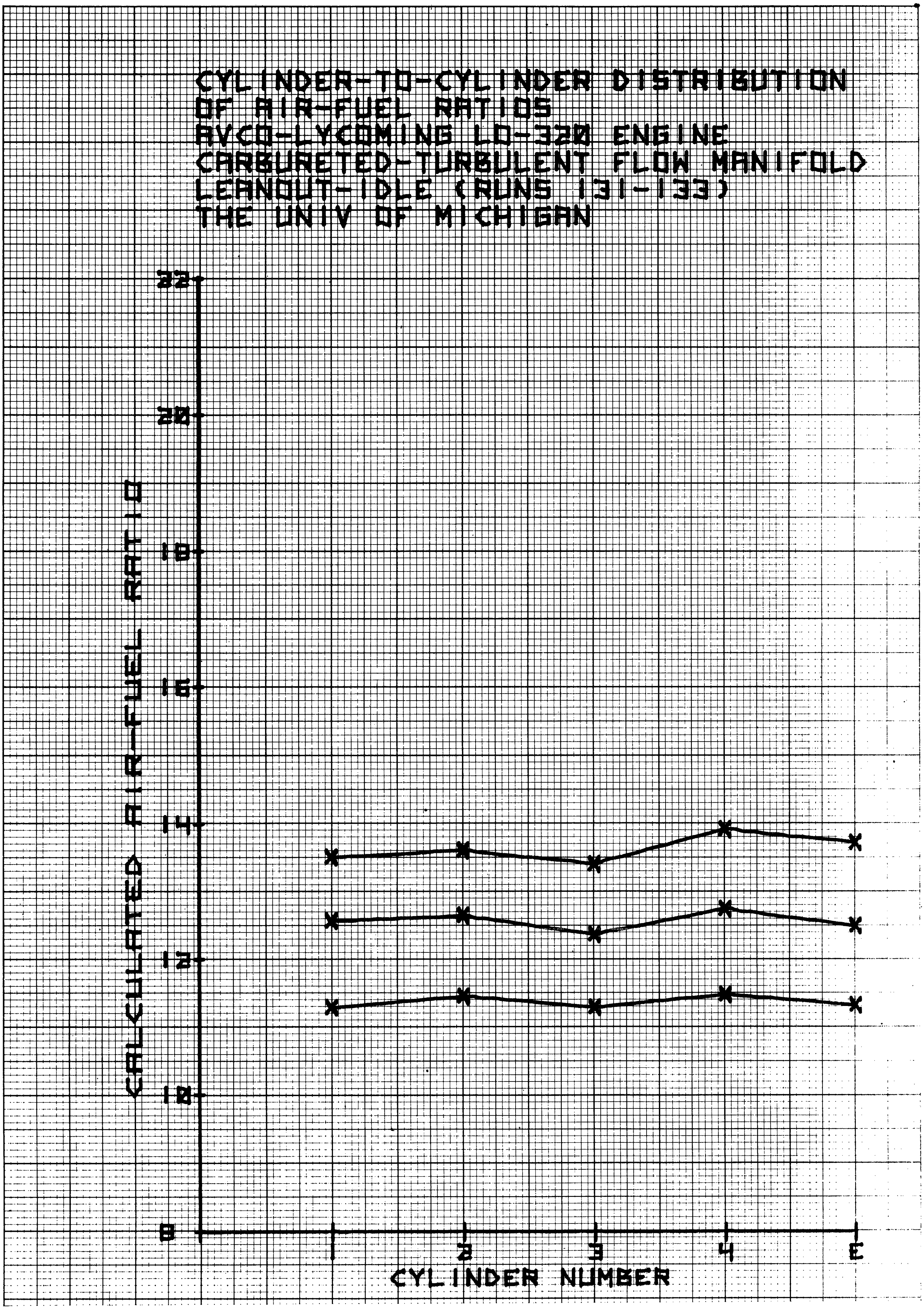

Figure A-12. Air-Fuel Variation, Turbulent Flow Manifold, Leanout, Idle

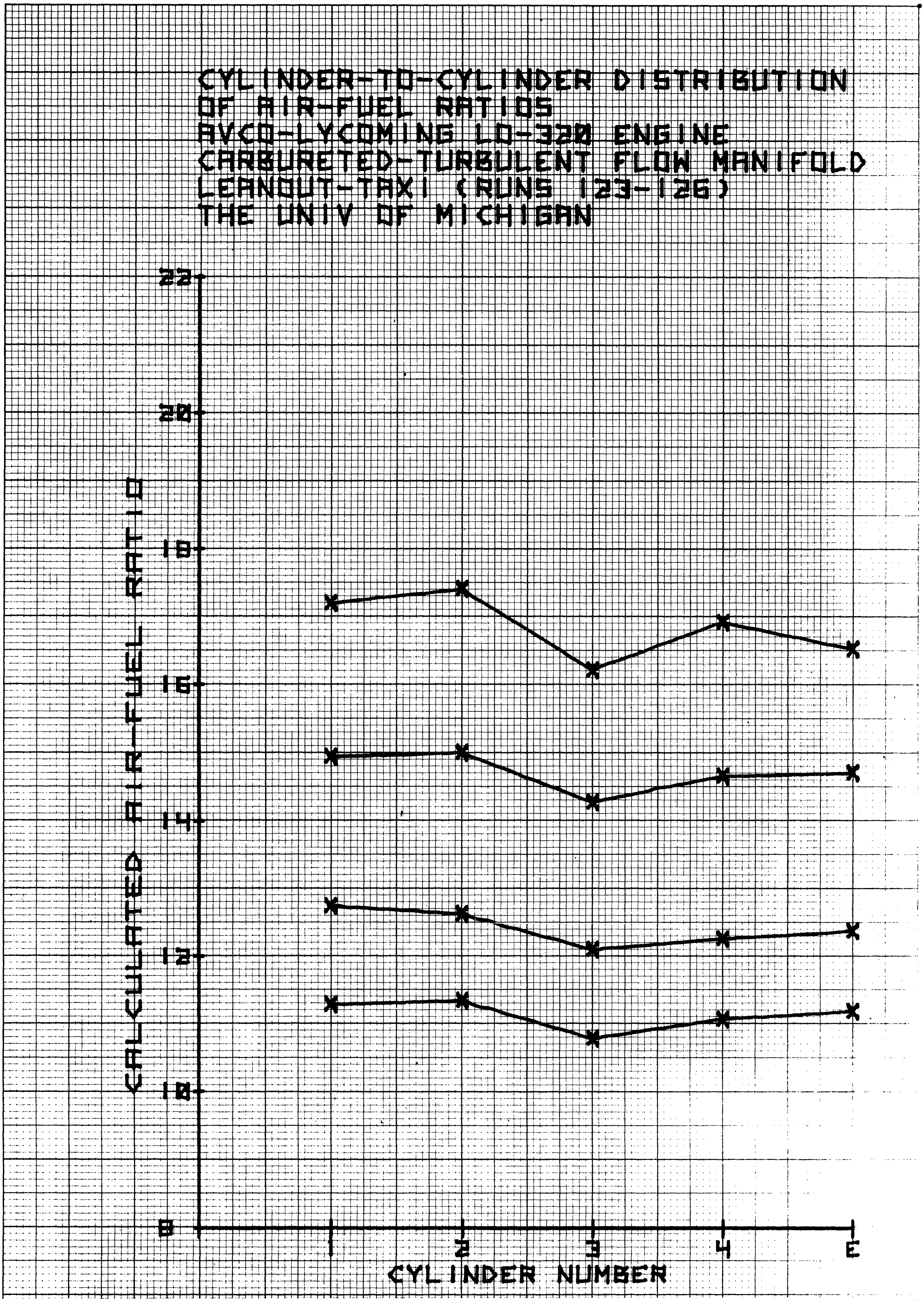

Figure A-13. Air-Fuel Variation, Turbulent Flow Manifold, Leanout, Taxi

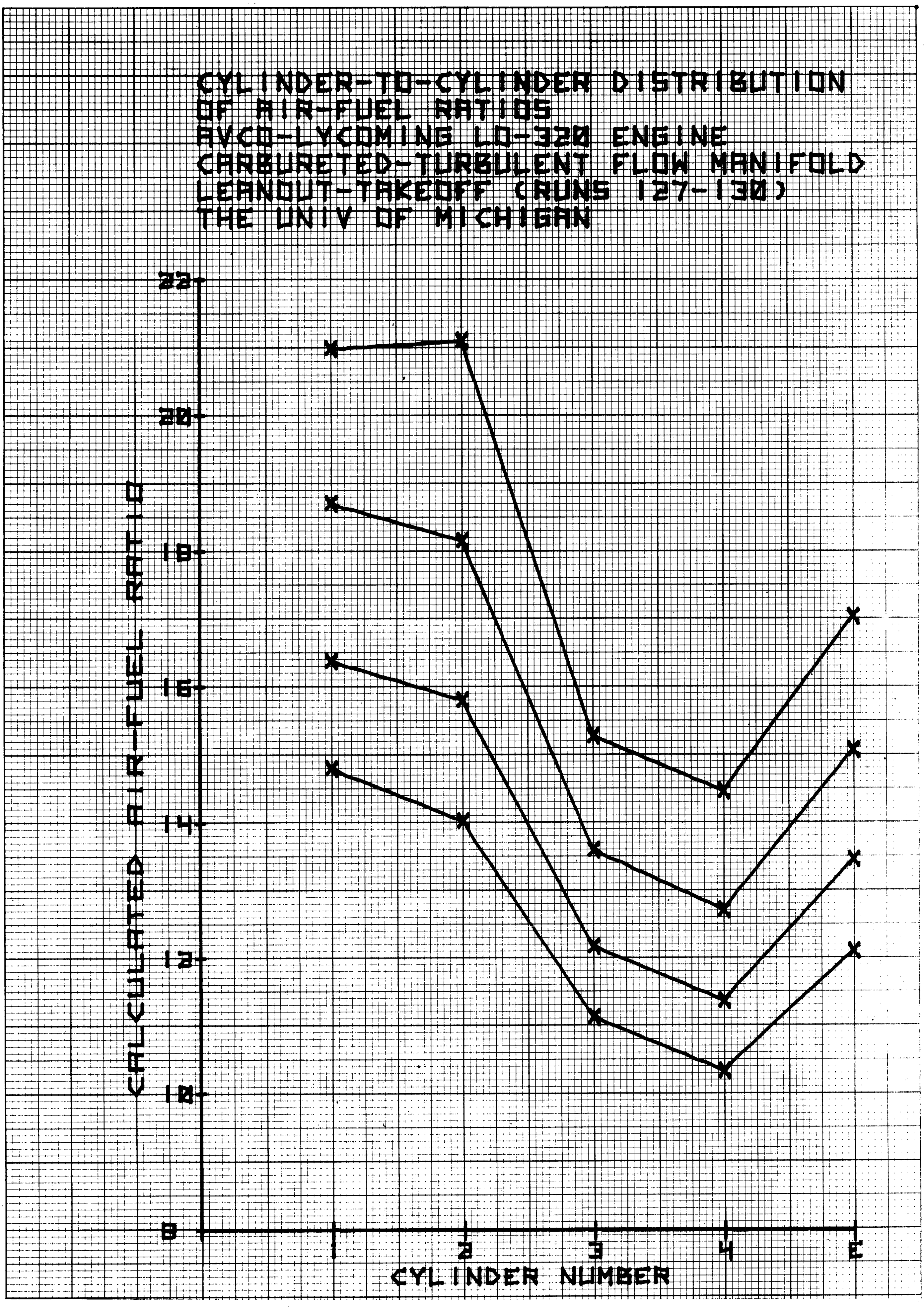

Figure A-14. Air-Fuel Variation, Turbulent Flow Manifold, Leanout, Takeoff

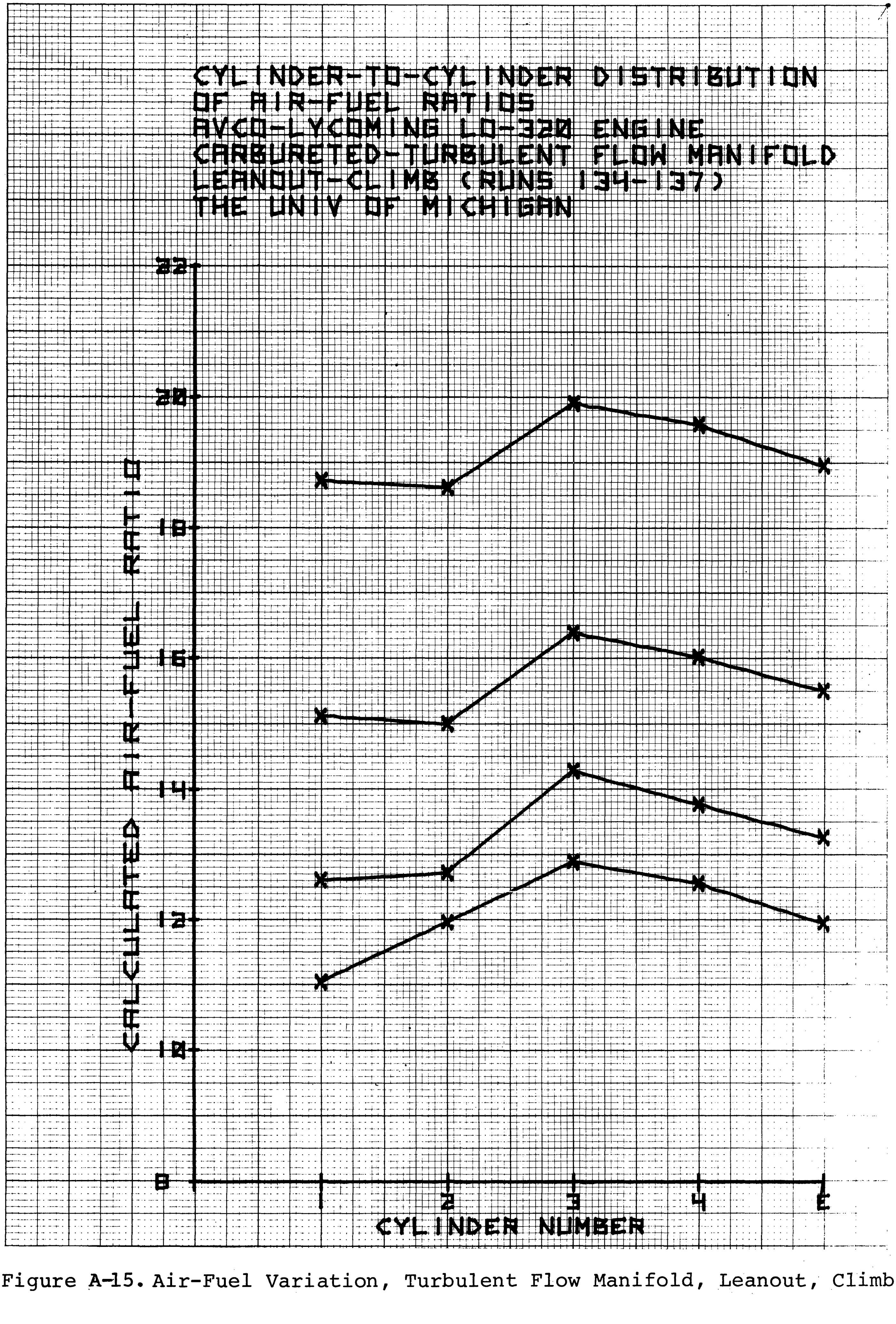

Figure A-15. Air-Fuel Variation, Turbulent Flow Manifold, Leanout, Climb

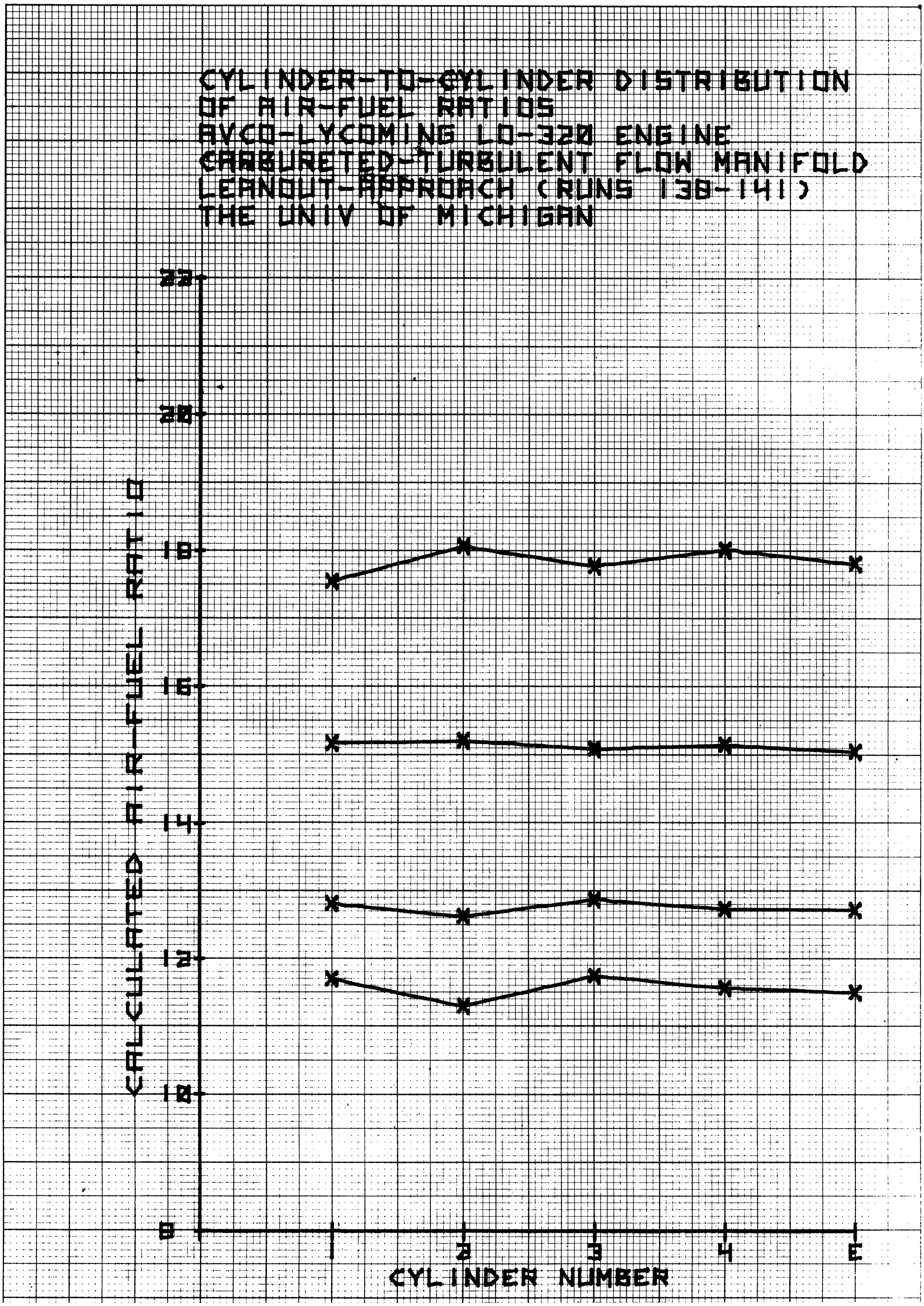

Figure A-16. Air-Fuel Variation, Turbulent Flow Manifold, Leanout, Approach

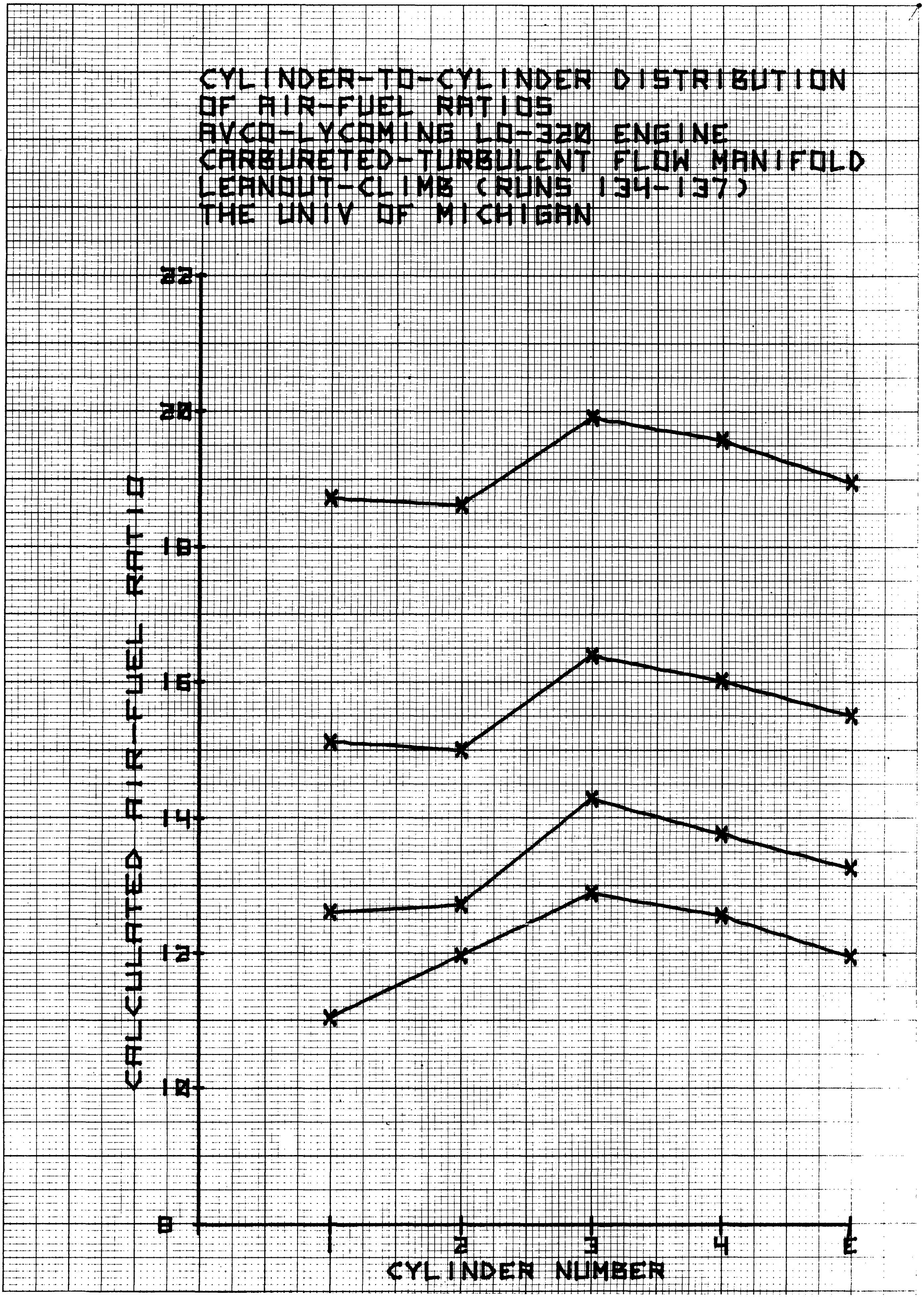

Figure A-15. Air-Fuel Variation, Turbulent Flow Manifold, Leanout, Climb

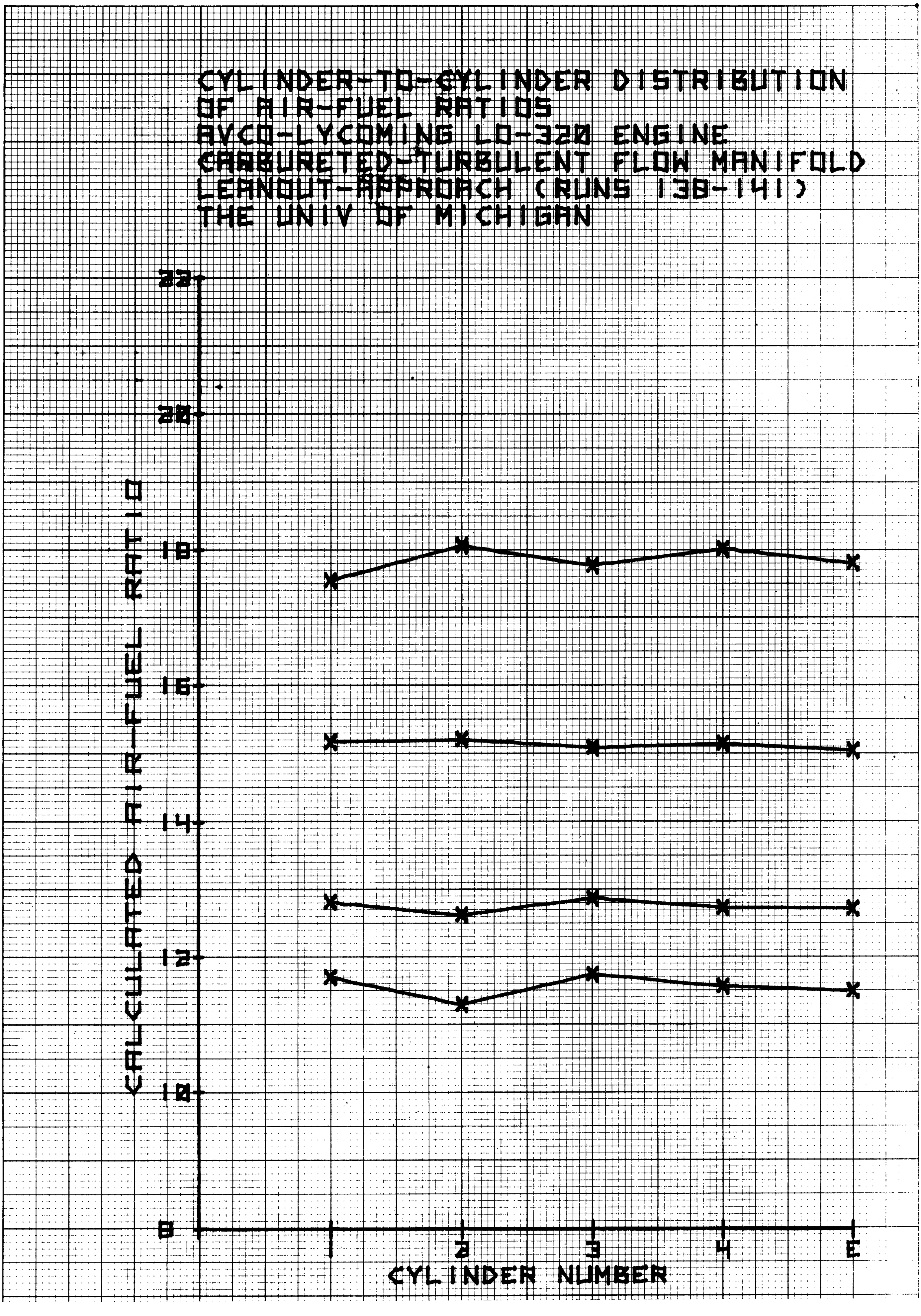

Figure A-16. Air-Fuel Variation, Turbulent Flow Manifold, Leanout, Approach

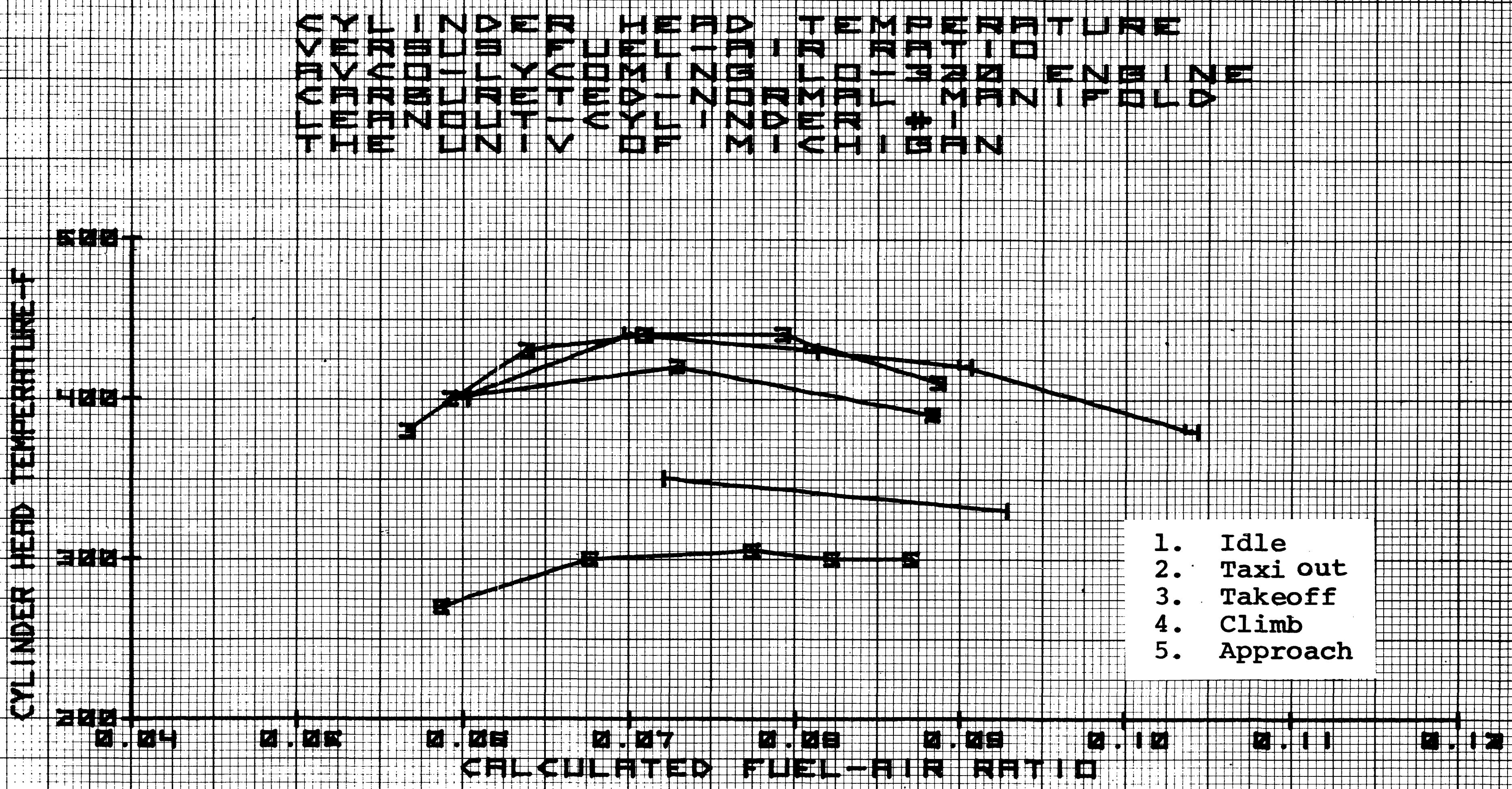

Figure A-17. Cylinder Head Temperature, Carbureted Engine, Cylinder 1

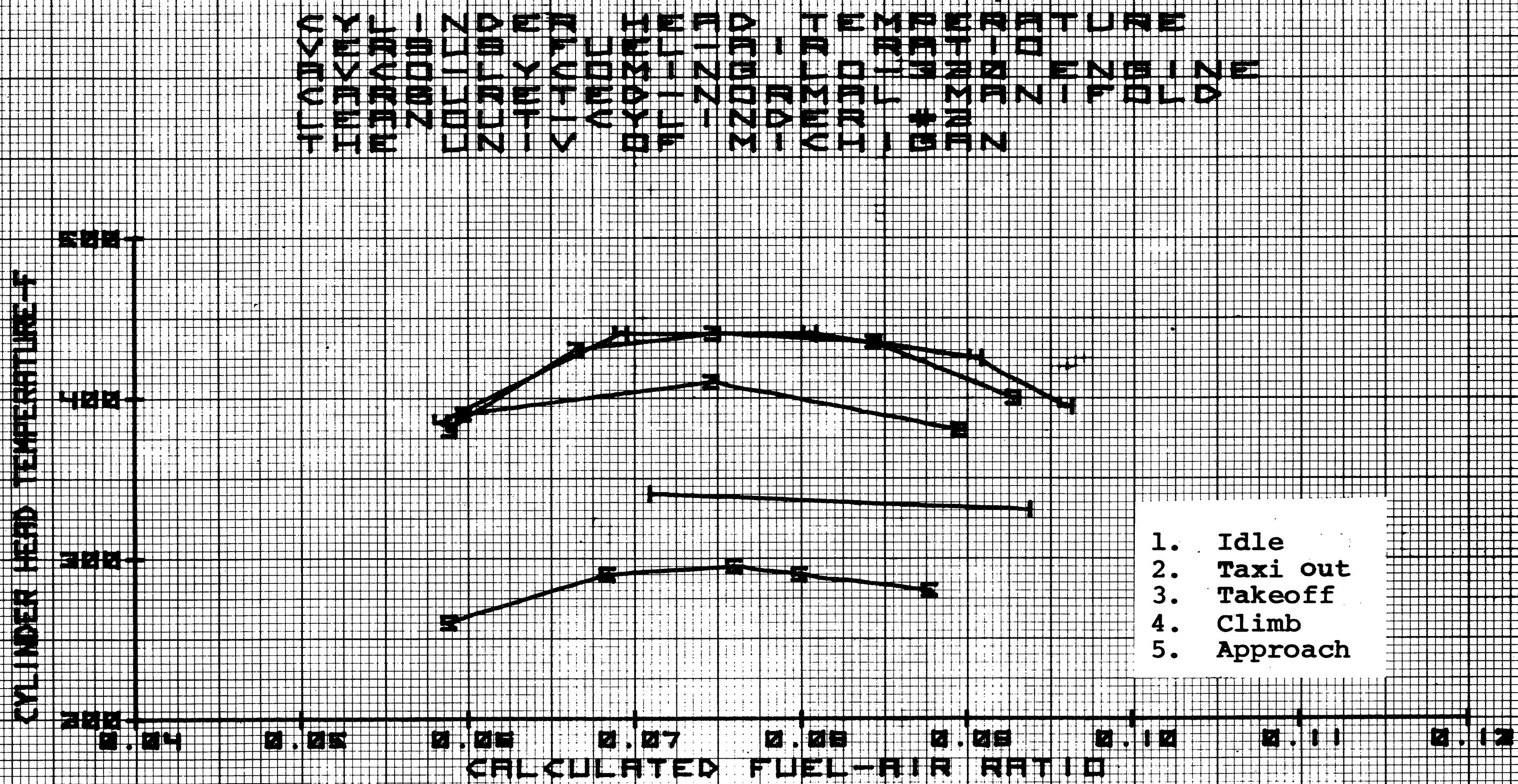

Figure A-18. Cylinder Head Temperature, Carbureted Engine, Cylinder 2

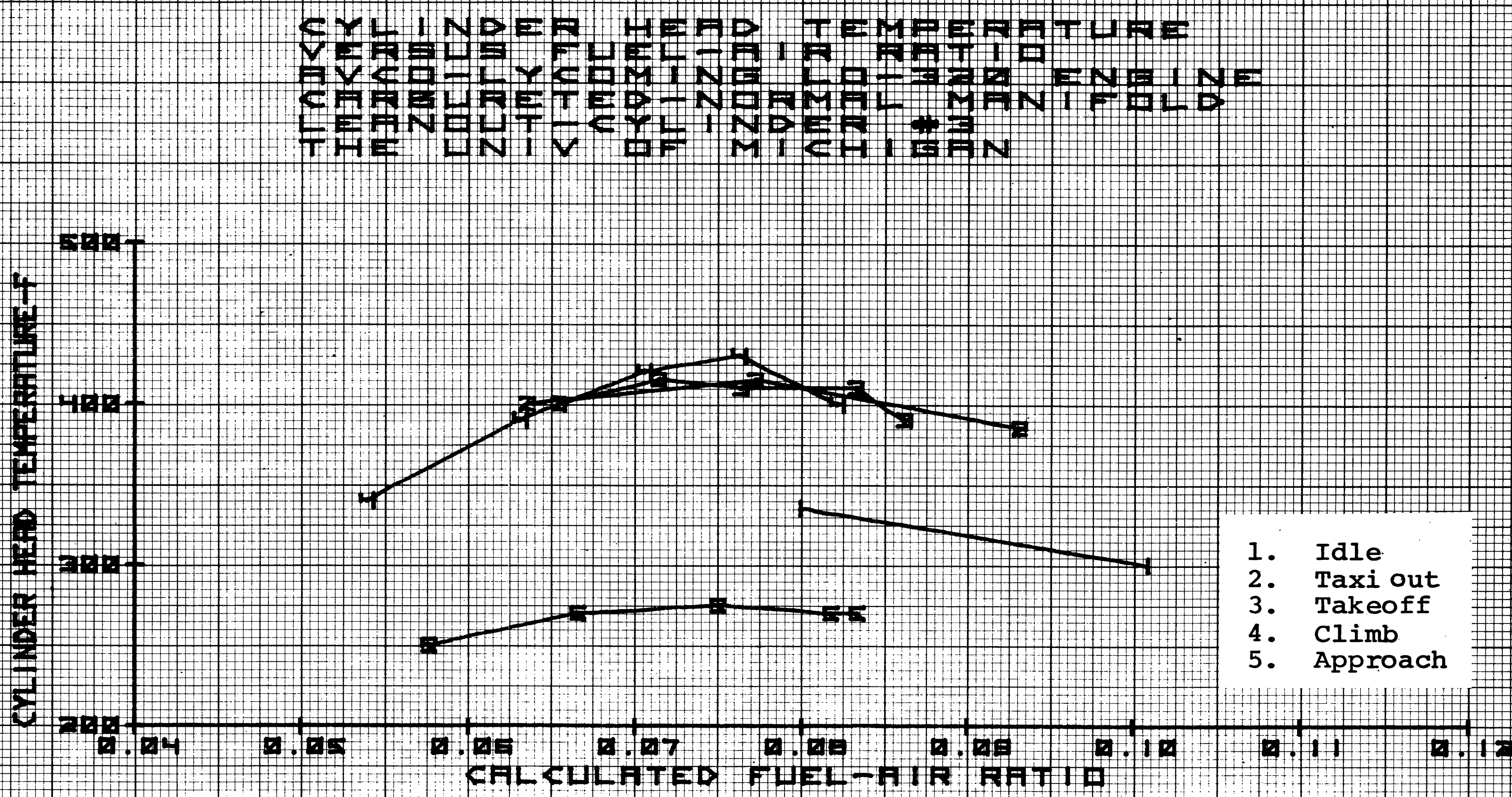

Figure A-19. Cylinder Head Temperature, Carbureted Engine, Cylinder 3

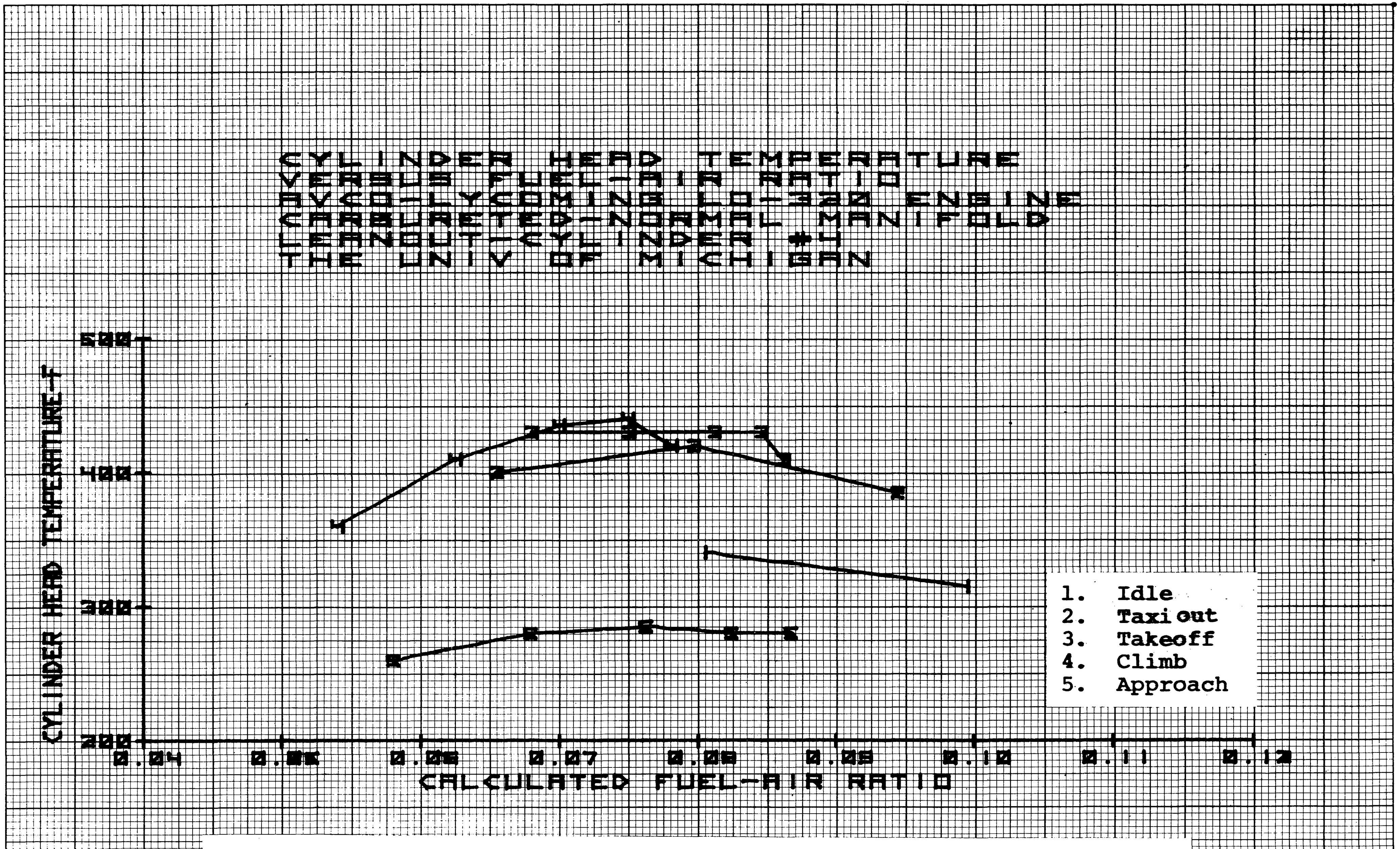

Figure A-20. Cylinder Head Temperature, Carbureted Engine, Cylinder 4

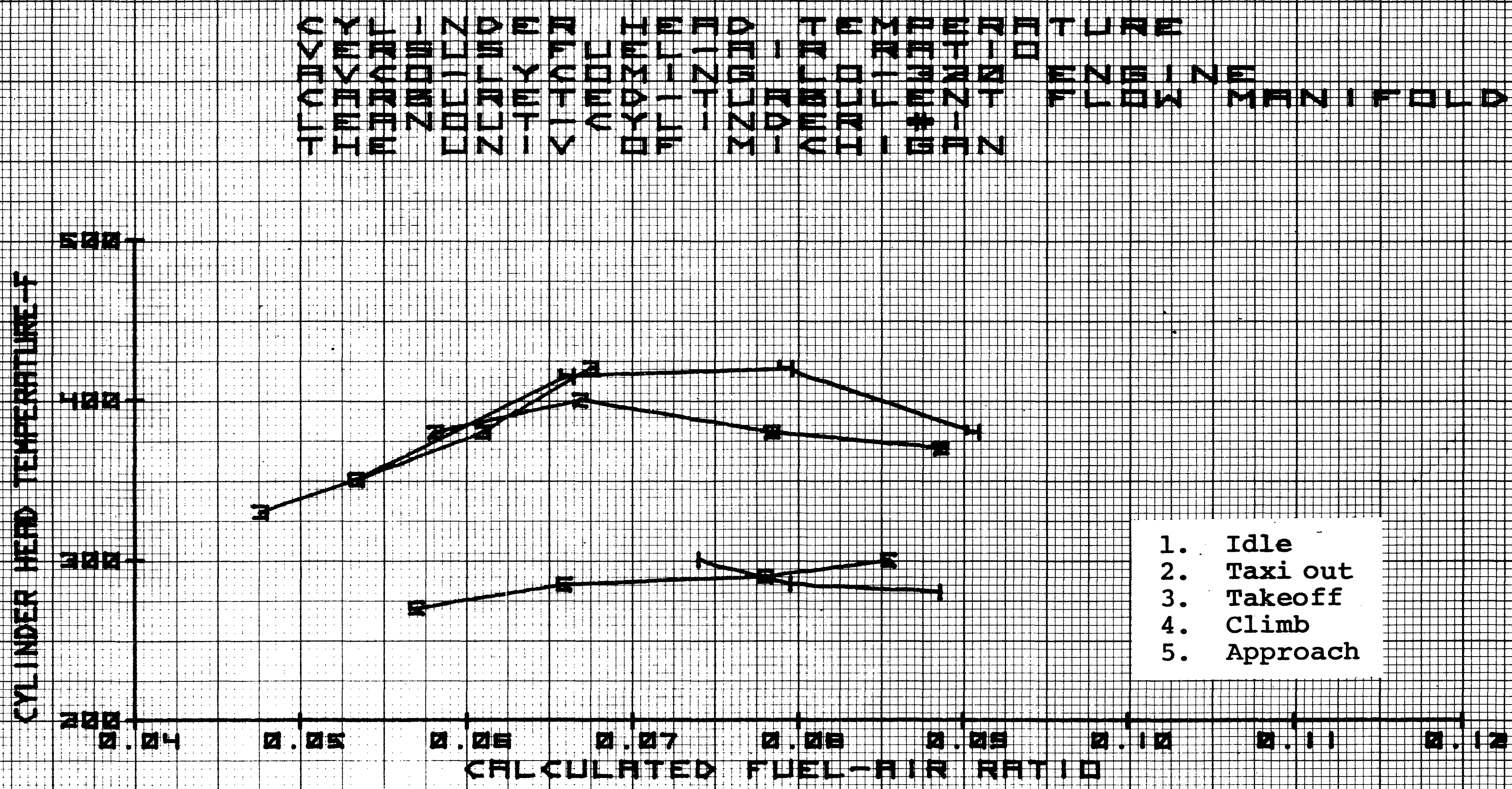

Figure A-21. Cylinder Head Temperature, Turbulent Flow Manifold, Cylinder 1

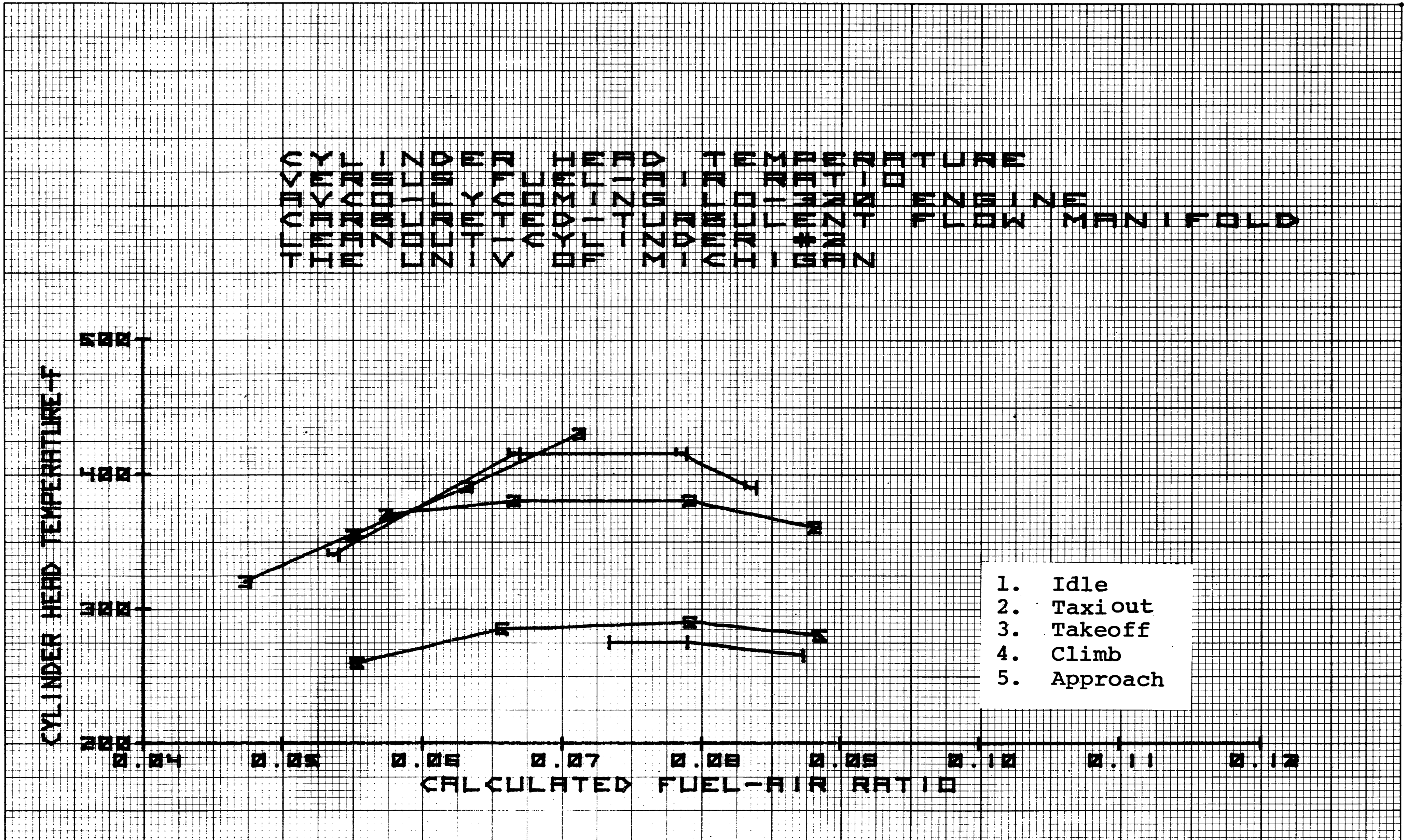

Figure A-22. Cylinder Head Temperature, Turbulent Flow Manifold, Cylinder 2

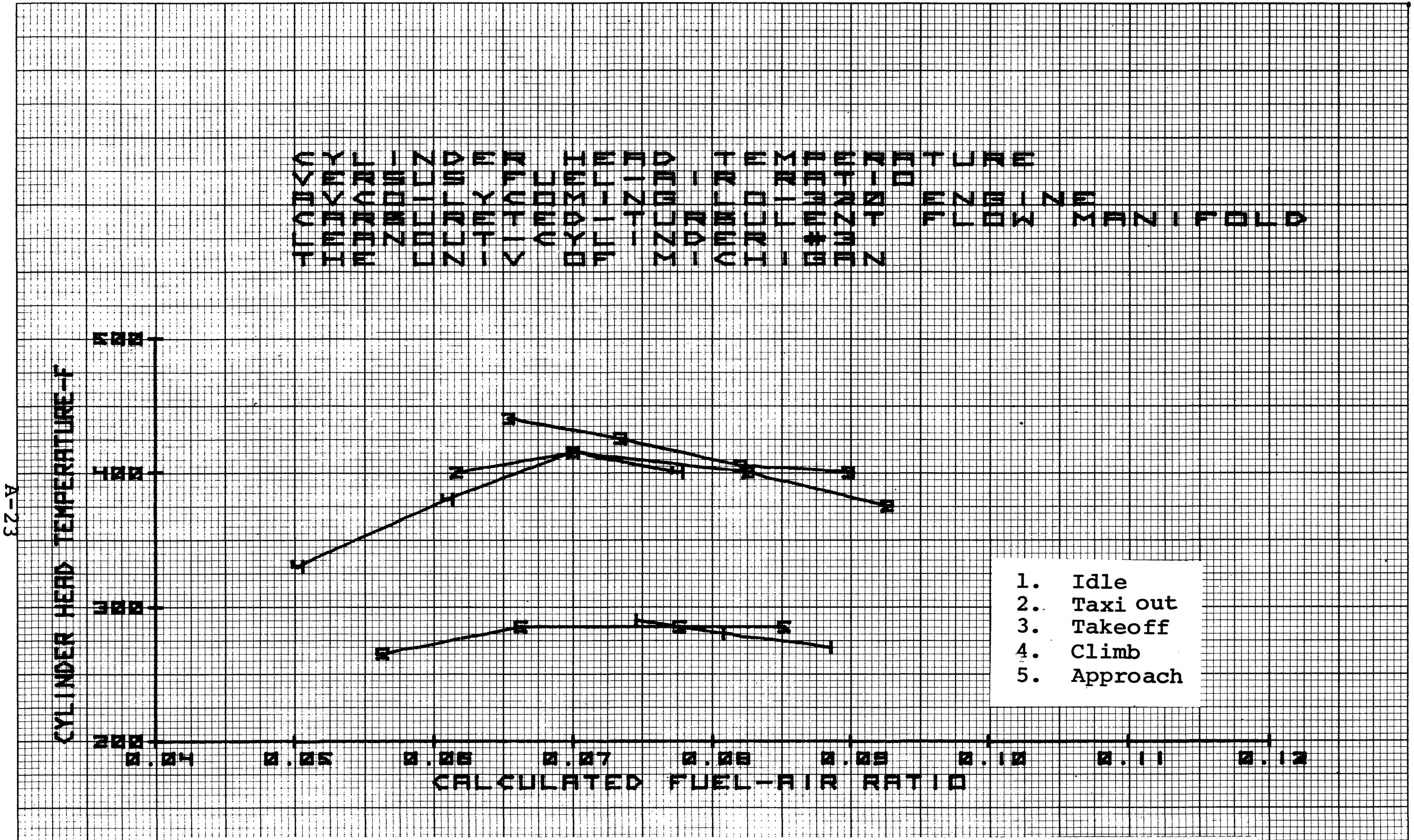

Figure A-23. Cylinder Head Temperature, Turbulent Flow Manifold, Cylinder 3

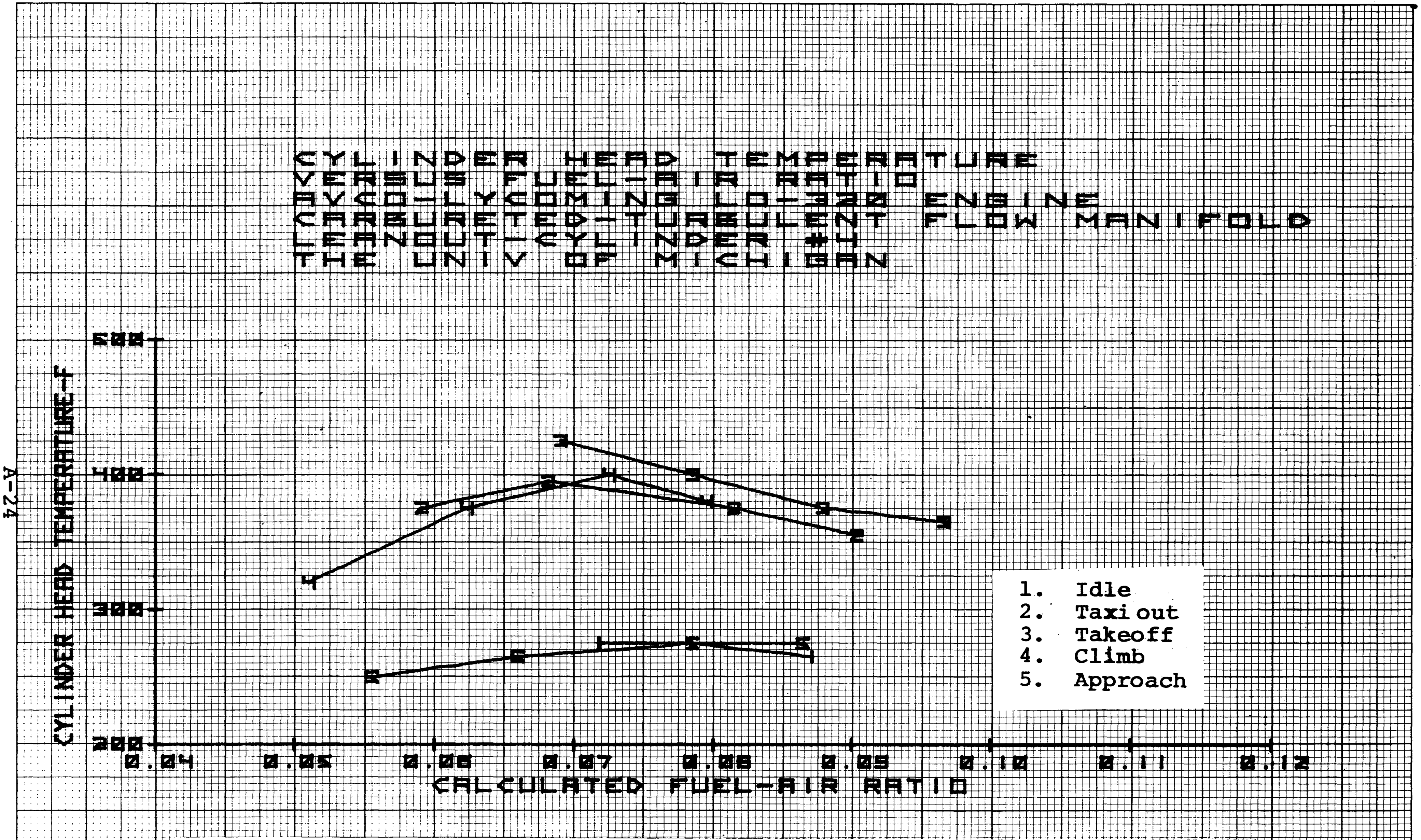

Figure A-24. Cylinder Head Temperature, Turbulent Flow Manifold, Cylinder 4

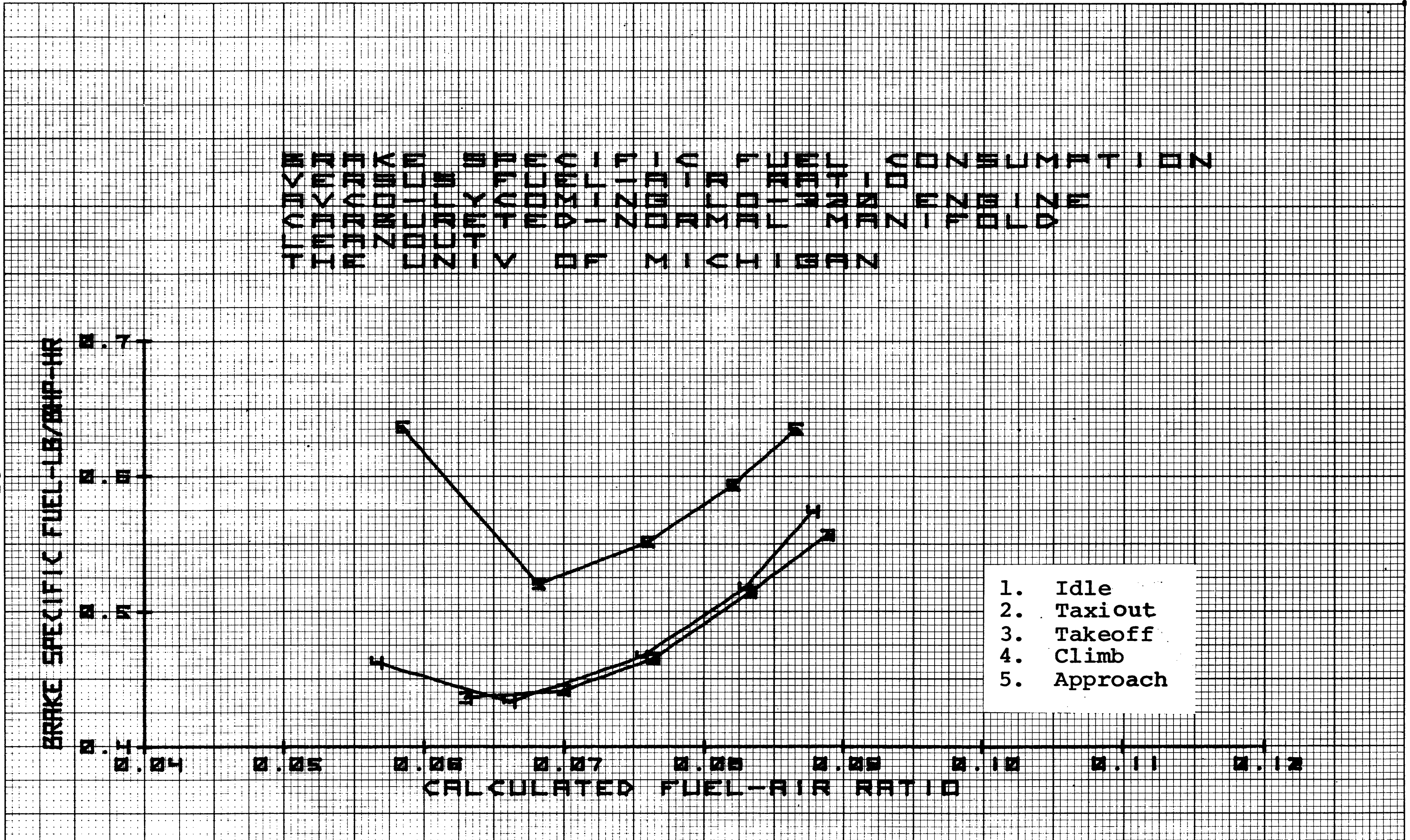

Figure A-25. Brake Specific Fuel Consumption, Carbureted Engine

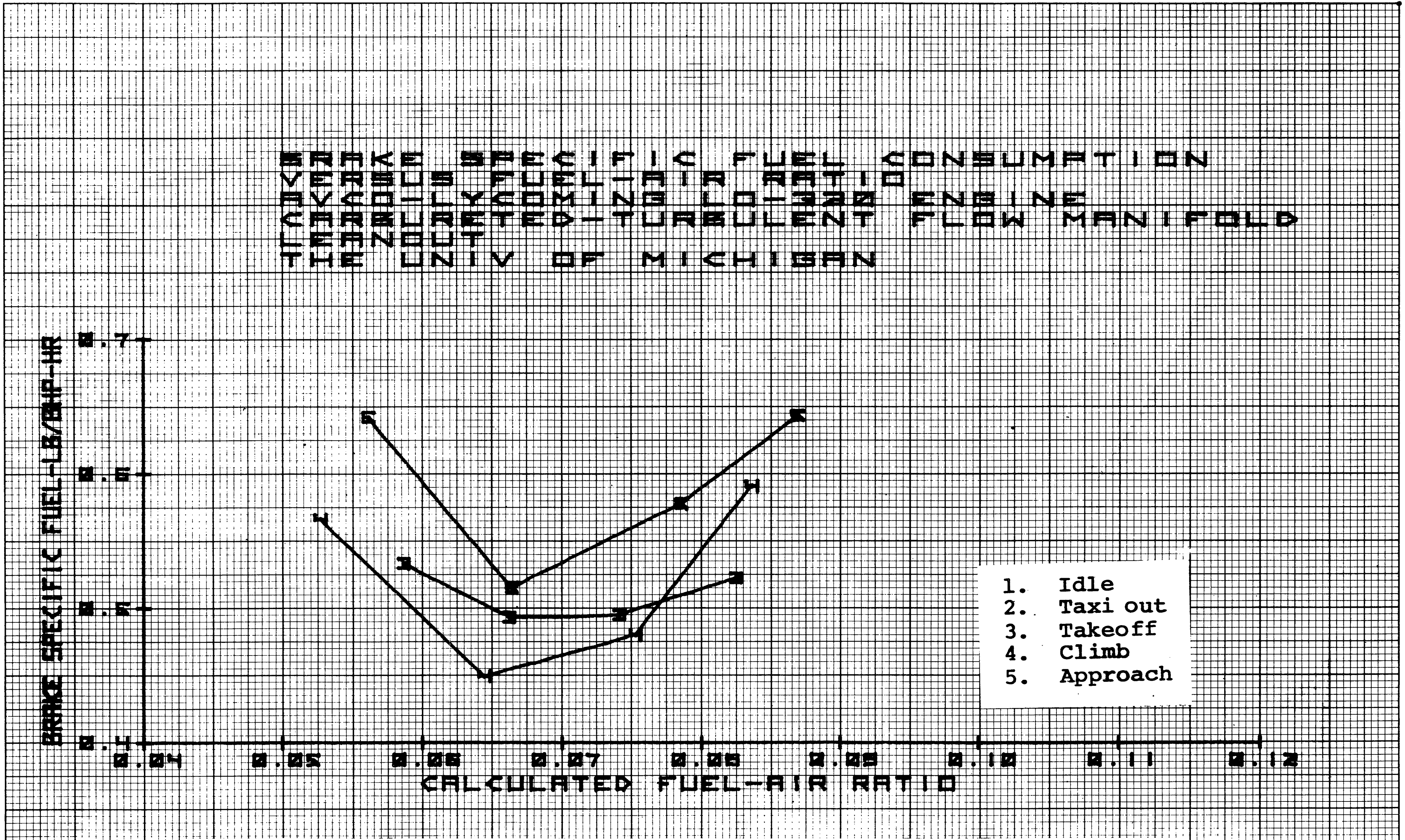

Figure A-26. Brake Specific Fuel Consumption, Turbulent Flow Manifold

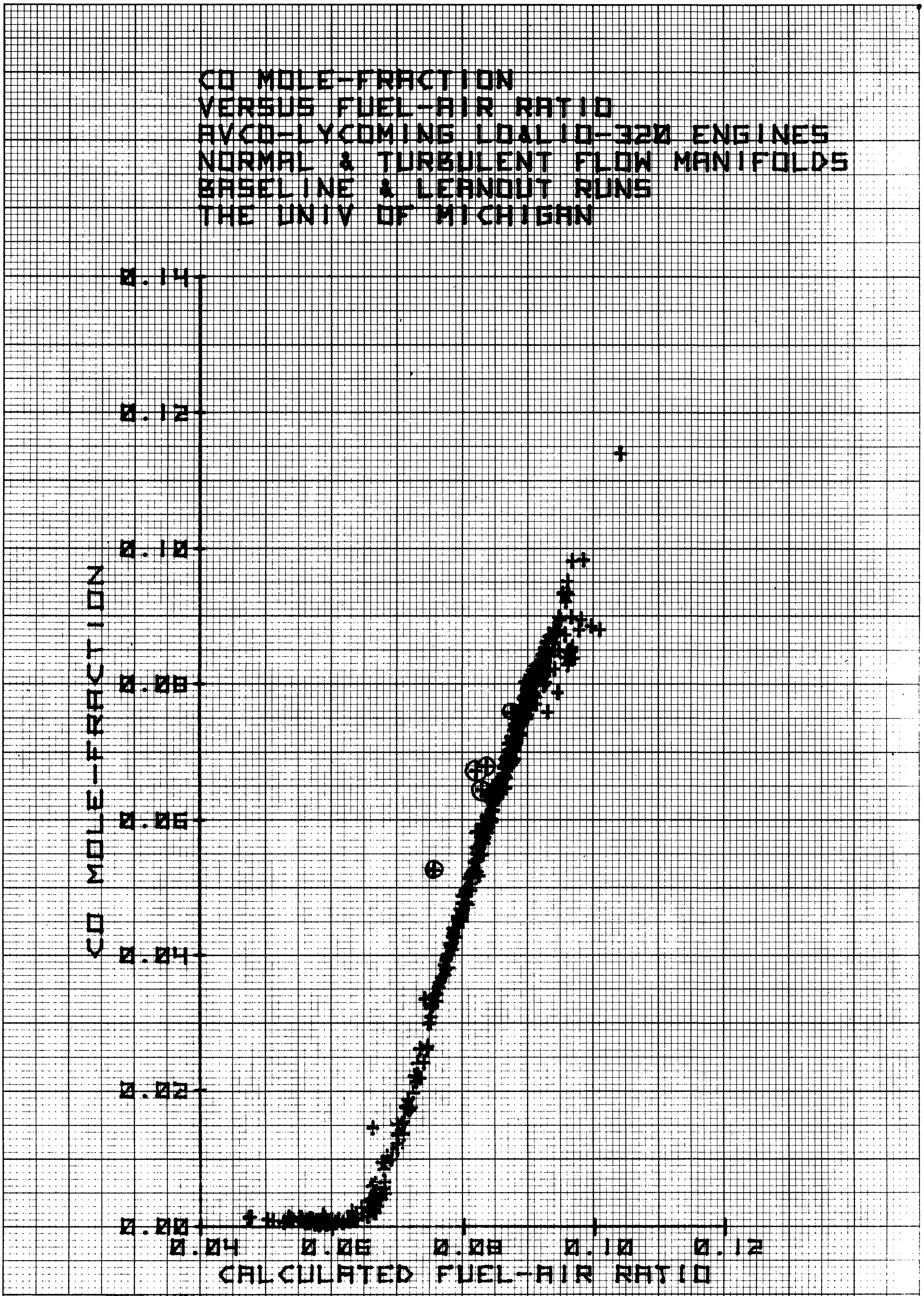

Figure A-27. Exhaust Carbon Monoxide Versus Calculated Fuel-Air Ratio

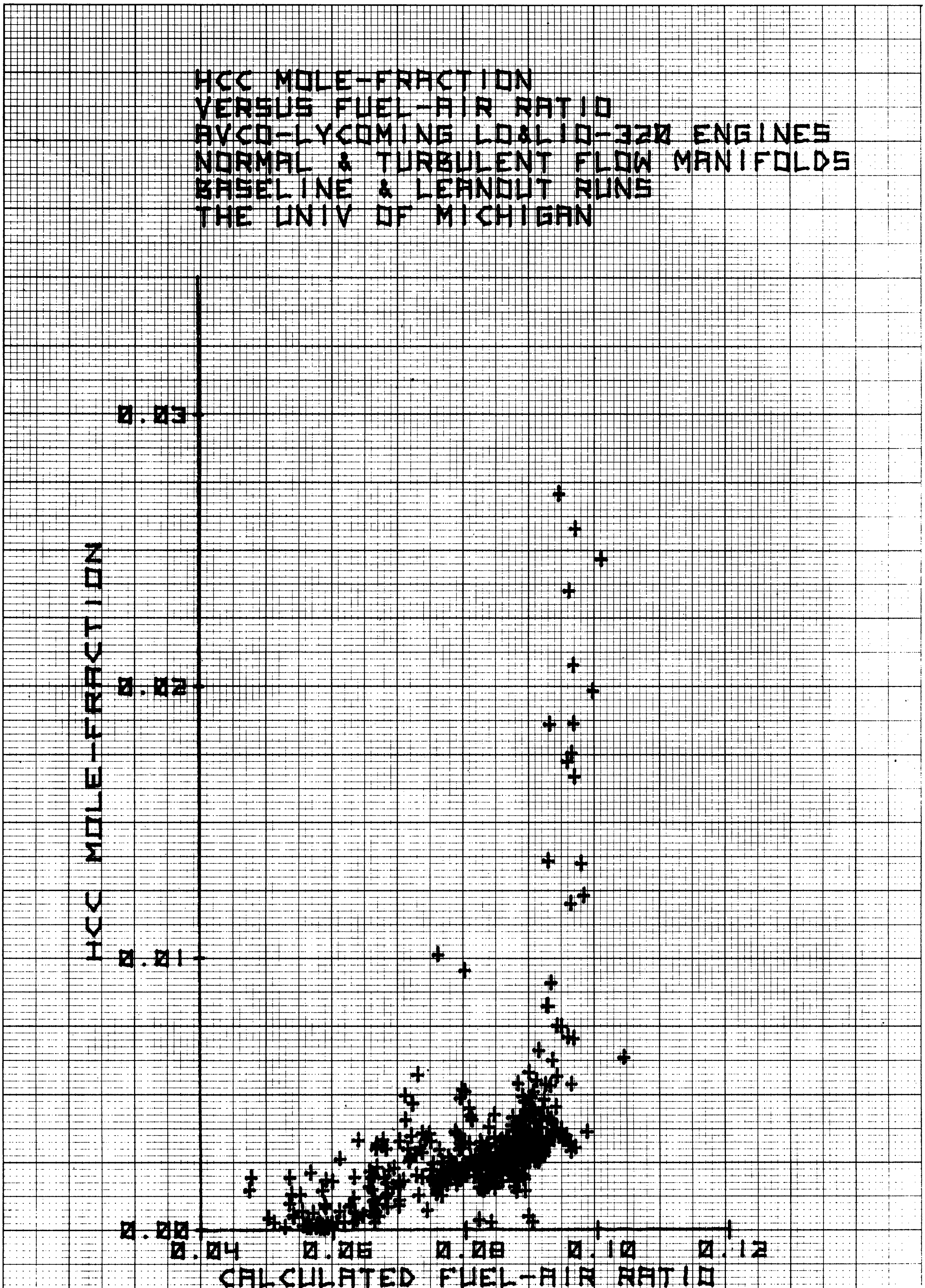

Figure A-28. Exhaust Hydrocarbons Versus Calculated Fuel-Air Ratio

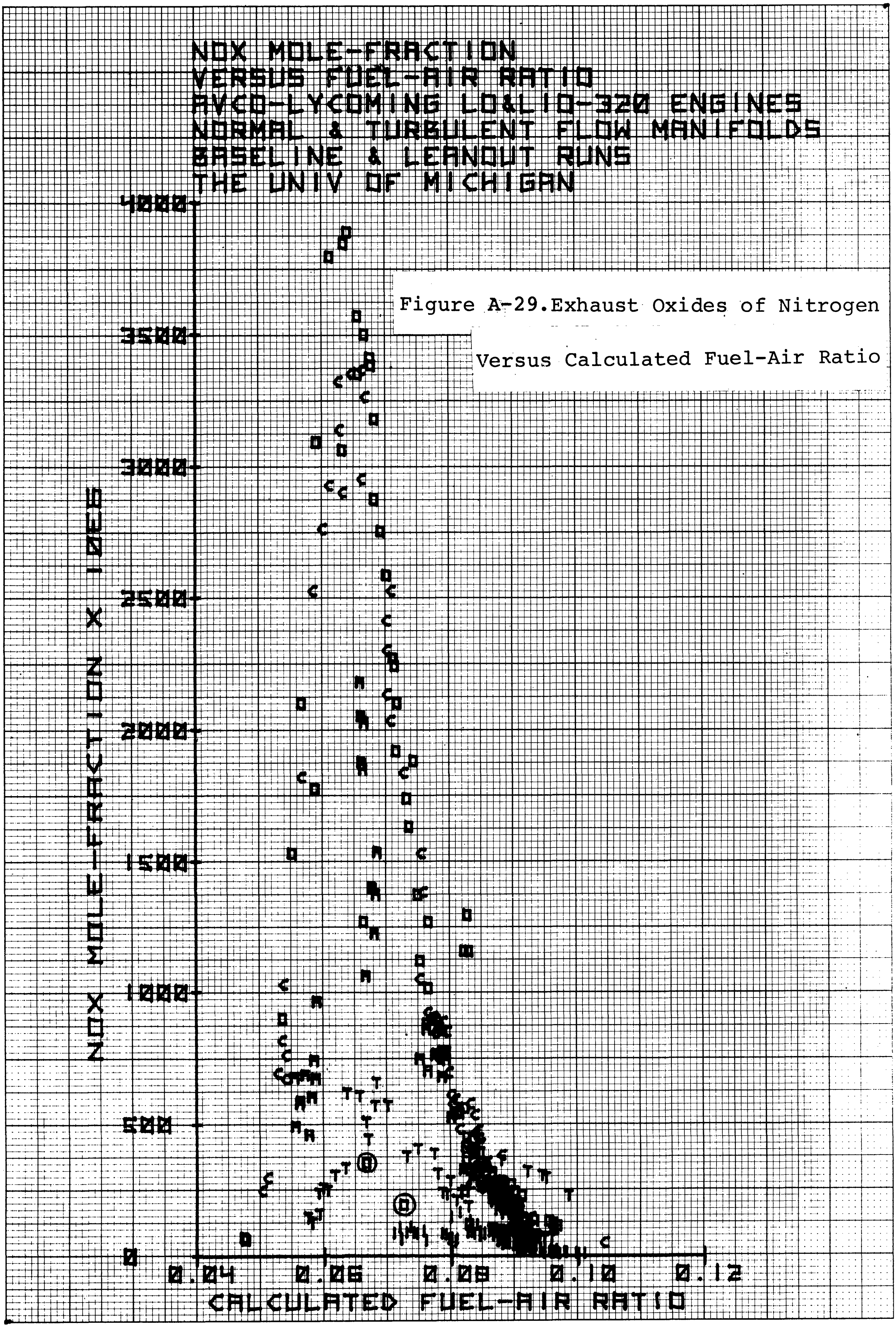

Figure A-29. Exhaust Oxides of Nitrogen Versus Calculated Fuel-Air Ratio

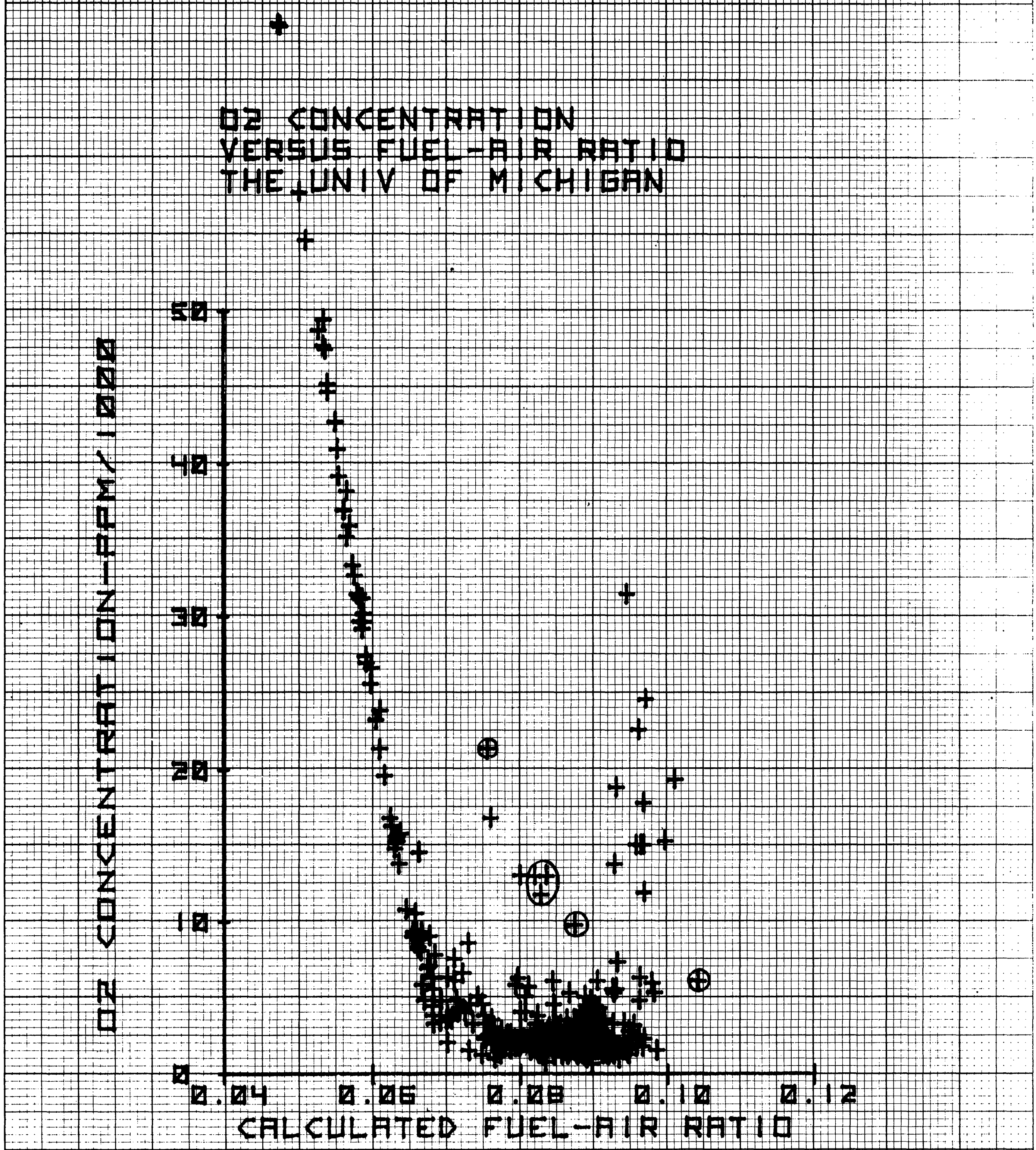

Figure A-30. Exhaust Oxygen Versus Calculated Fuel-Air Ratio

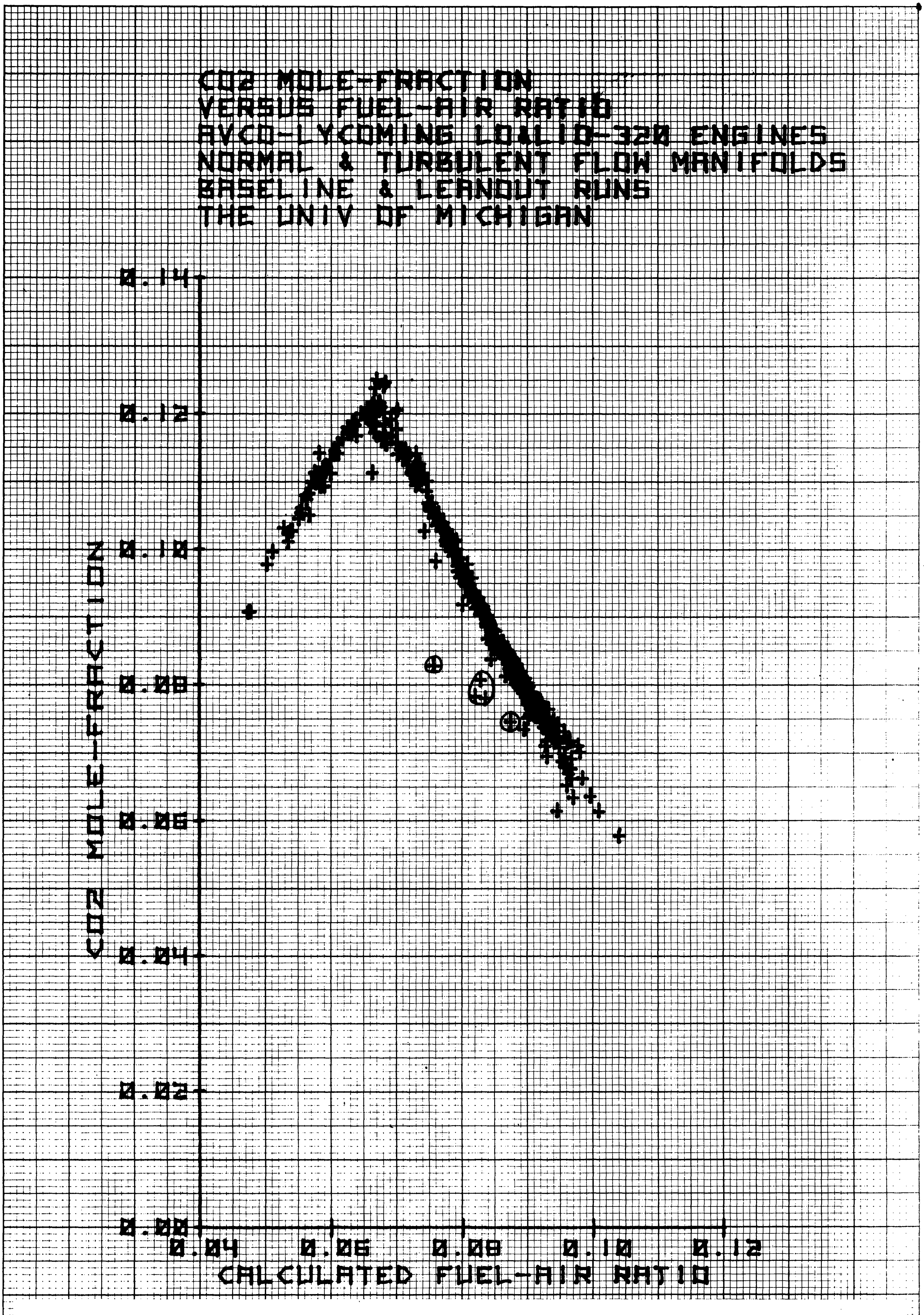

Figure A-31. Exhaust Carbon Dioxide Versus Calculated Fuel-Air Ratio

APPENDIX B

Development of Equation For Finding Mass of
Pollutant Per Rated Horsepower Per Cycle

Let,

KDW = water correction factor for converting "dry" pollutant concentration measurements to "wet" measurements

MPC(Z) = mass of pollutant "Z" per rated horsepower per test cycle

MPM(Z) = mass of pollutant "Z" per test mode

MW(Z) = molecular weight of pollutant "Z"

P = absolute pressure

$\bar{R}$ = universal gas constant

RHP = rated horsepower

T = absolute temperature

TIM = time in mode

$\dot{V}$ = exhaust volume flow rate at 14.696 psi and 60°F

X(Z) = exhaust mole fraction of pollutant "Z", measured "wet"

X(ZD) = exhaust mole fraction of pollutant "Z", measured "dry"

ρ(Z) = mass density of pollutant "Z" at 14.696 psi and 60°F

* = multiplication sign

The mass per operating mode of pollutant "Z" is given by:

$$MPM(Z) = \dot{V} * X(Z) * \rho(Z) * \frac{TIM}{60}$$

Summing over the 7-modes and dividing by the rated horsepower gives the mass per rated horsepower per test cycle, where i is the ith mode,

$$MPC(Z) = \sum_i [\dot{V} * X(Z) * \rho(Z) * TIM/60]/RHP$$

From the ideal gas relation,

$$\rho(Z) = \frac{P * MW(Z)}{\bar{R} * T}$$

Substituting and collecting terms gives:

$$MPC(Z) = \frac{P * MW(Z)}{\bar{R} * T * RHP * 60} \sum_i [\dot{V}_i * TIM_i * X(Z)_i]$$

where X(Z) is a "wet" mole-fraction. When pollutant measurements are made "dry", the above equation is converted to "dry" mole fraction, X(ZD), by use of the water correction factor KDW.

$$MPC(Z) = \frac{P * MW(Z)}{\bar{R} * T * RHP * 60} \sum_i [\dot{V}_i * TIM_i * X(ZD)_i * KDW_i] .$$

Substituting numerical values for the fixed quantities,

$$\frac{P}{\bar{R} * T * RHP * 60} = \frac{14.696(144)}{1544(528)(150)(60)} = 2.8842 * 10^{-7}$$

For CO (MW = 28.01), the constant term in the equation becomes:

$$2.8842 * 10^{-7} * 28.01 = 8.0786 * 10^{-6}$$

and for NO_x (MW - 46.01)

$$2.8842 * 10^{-7} * 46.01 = 1.3270 * 10^{-5}$$

The resulting equations for CO and NO_x are:

$$MPC(CO) = 8.0786 * 19^{-6} \sum [\dot{V}_i * TIM_i * X(CO)_i]$$

and

$$MPC(NO_x) = 1.3270 * 10^{-5} \sum [\dot{V}_i * TIM_i * X(NO_x)_i]$$

APPENDIX C

Computer Printout for Runs 69-75: Baseline
Runs of Normal Carbureted Engine

The following runs were made using the University of Michigan computer program FAA, which is described and listed in reference 2.

DATE: 9-14-76 ENGINE TYPE: LO-320-B1A FUEL H/C RATIO = 2.025
LOCATION: UNIV OF MICH SERIAL NUMBER: L-287-66A IGNITION TIMING= 25DEG
OPERATORS: IOTT, GRIFFIN, PONSONBY

RUN NO. 69.1
MODE: 1
COMMENTS: CARB. BASELINE, CYL. 1

MP(DB) = 89.50F	FUEL RATE= 5.4585#/HR	ENGINE RPM(NOM)= 700 RPM
TEMP(DP) = 52.00F	AIR RATE = 70.1649#/HR	ENGINE RPM(ACT)= 689. RPM
TEMP(BAR) = 78.00F	F/A RATIO= 0.0778#/#	BHP(OBS) = 4.8HP
BAR PRESS(OB)= 29.43"HG	PHIM = 1.1531	BHP(CORR) = 0.0HP
BAR PRESS(CR)= 29.30"HG	K = 3.5000	MAN VAC(OBS) =17.60"HG
SPEC HUMIDITY=0.0083#/#	C-BALANCE= 1	MAN PRESS(CORR)= 0.00"HG
CO2 AMBIENT = 0.045%	FUEL H/C = 2.0250	EXH H/C RATIO =1.850

	CYL1	CYL2	CYL3	CYL4	EXHAUST	
CHT	390.0	380.0	340.0	350.0		
EGT	840.0	770.0	840.0	790.0	420.0	
	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	101369.	1761.	2665.	73090.	84.	84.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1.2	0.86354	1.01018	27.39667	975.931	0.08513	0.07779	9.437
MASS/MODE(LBM)		0.16342	0.00206	0.00156	0.07464	0.00011	0.00016
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2.1	0.87392	1.00000	27.19733	964.454	0.08788	0.07779	12.969
MASS/MODE(LBM)		0.16344	0.00206	0.00154	0.07465	0.00010	0.00016
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.1	0.86789	0.99415	27.46346	1009.386	0.08300	0.07779	6.691
MASS/MODE(LBM)		0.16987	0.00215	0.00161	0.07759	0.00011	0.00017
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.2	0.86363	0.32623	27.46346	975.798	0.08613	0.07779	10.725
MASS/MODE(LBM)		0.16342	0.00000	0.00156	0.07464	0.00000	0.00000

RUN NO. 69.2
MODE: 1
COMMENTS: CARB. BASELINE, CYL. 2

TEMP(DB) = 89.50F	FUEL RATE= 5.4585#/HR	ENGINE RPM(NOM)= 700 RPM
TEMP(DP) = 52.00F	AIR RATE = 70.1649#/HR	ENGINE RPM(ACT)= 689. RPM
TEMP(BAR) = 78.00F	F/A RATIO= 0.0778#/#	BHP(OBS) = 4.8HP
BAR PRESS(OB)= 29.43"HG	PHIM = 1.1531	BHP(CORR) = 0.0HP
BAR PRESS(CR)= 29.30"HG	K = 3.5000	MAN VAC(OBS) =17.60"HG
SPEC HUMIDITY=0.0083#/#	C-BALANCE= 1	MAN PRESS(CORR)= 0.00"HG
CO2 AMBIENT = 0.045%	FUEL H/C = 2.0250	EXH H/C RATIO =1.850

	CYL1	CYL2	CYL3	CYL4	EXHAUST	
CHT	390.0	380.0	340.0	350.0		
EGT	840.0	770.0	840.0	790.0	420.0	
	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	99201.	1509.	2425.	75949.	97.	97.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1.2	0.86442	1.00684	27.33698	972.719	0.08595	0.07779	10.485
MASS/MODE(LBM)		0.15956	0.00176	0.00142	0.07738	0.00012	0.00019
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2.1	0.87139	1.00000	27.20248	965.012	0.08781	0.07779	12.875
MASS/MODE(LBM)		0.15957	0.00176	0.00140	0.07739	0.00012	0.00019
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.1	0.86733	0.99606	27.38197	994.900	0.08450	0.07779	8.626
MASS/MODE(LBM)		0.16375	0.00181	0.00145	0.07941	0.00013	0.00019
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.2	0.86449	0.32741	27.38197	972.630	0.08663	0.07779	11.361
SS/MODE(LBM)		0.15956	0.00000	0.00142	0.07738	0.00000	0.00000

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RUN NO.   69.3
MODE:      1
COMMENTS: CARB.  BASELINE,  CYL. 3
TEMP(DB)       = 89.50F        FUEL RATE=    5.4585#/HR      ENGINE RPM(NOM)= 700 RPM
  MP(DP)       = 52.00F        AIR RATE =   70.1649#/HR      ENGINE RPM(ACT)= 689.RPM
IEMP(BAR)      = 78.00F        F/A RATIO=    0.0778#/#       BHP(OBS)        =  4.8HP
BAR PRESS(OB)= 29.43"HG        PHIM      =   1.1531          BHP(CORR)       =  0.0HP
BAR PRESS(CR)= 29.30"HG        K         =   3.5000          MAN VAC(OBS)    =17.60"HG
SPEC HUMIDITY=0.0083#/#        C-BALANCE=    1               MAN PRESS(CORR)= 0.00"HG
CO2 AMBIENT   = 0.045%         FUEL H/C =    2.0250          EXH H/C RATIO   =1.850
                          CYL1        CYL2        CYL3       CYL4    EXHAUST
CHT                       390.0       380.0       340.0      350.0
EGT                       840.0       770.0       840.0      790.0      420.0
                          CO2         O2          UHCC       CO          NO         NOX
CONC(PPM)                89606.       2012.       3398.     89209.        63.        63.
                    KWD        XTC     MWEXH   EXH FLOW     FACAL        FAM   ERROR
METHOD 1.2      0.86843 1.00259 27.03149    943.121   0.09039   0.07779 16.199
MASS/MODE(LBM)          0.14039    0.00229    0.00192    0.08854    0.00007    0.00012
                    KWD        XTC     MWEXH   EXH FLOW     FACAL        FAM   ERROR
METHOD 2.1      0.87106 1.00000 26.97929    940.315   0.09113   0.07779 17.153
MASS/MODE(LBM)          0.14040    0.00229    0.00192    0.08854    0.00007    0.00012
                    KWD        XTC     MWEXH   EXH FLOW     FACAL        FAM   ERROR
METHOD 3.1      0.86949 0.99848 27.04884    951.080   0.08983   0.07779 15.469
MASS/MODE(LBM)          0.14175    0.00231    0.00194    0.08939    0.00007    0.00012
                    KWD        XTC     MWEXH   EXH FLOW     FACAL        FAM   ERROR
METHOD 3.2      0.86845 0.33592 27.04884    943.089   0.09067   0.07779 16.553
MASS/MODE(LBM)          0.14039    0.00000    0.00192    0.08854    0.00000    0.00000

RUN NO.   69.4
MODE:      1
COMMENTS: CARB.  BASELINE,   CYL. 4
TEMP(DB)       = 89.50F        FUEL RATE=    5.4585#/HR      ENGINE RPM(NOM)= 700 RPM
TEMP(DP)       = 52.00F        AIR RATE =   70.1649#/HR      ENGINE RPM(ACT)= 689.RPM
TEMP(BAR)      = 78.00F        F/A RATIO=    0.0778#/#       BHP(OBS)        =  4.8HP
BAR PRESS(OB)= 29.43"HG        PHIM      =   1.1531          BHP(CORR)       =  0.0HP
BAR PRESS(CR)= 29.30"HG        K         =   3.5000          MAN VAC(OBS)    =17.60"HG
SPEC HUMIDITY=0.0083#/#        C-BALANCE=    1               MAN PRESS(CORR)= 0.00"HG
CO2 AMBIENT   = 0.045%         FUEL H/C =    2.0250          EXH H/C RATIO   =1.850
                          CYL1        CYL2        CYL3       CYL4    EXHAUST
CHT                       390.0       380.0       340.0      350.0
EGT                       840.0       770.0       840.0      790.0      420.0
                          CO2         O2          UHCC       CO          NO         NOX
CONC(PPM)                86016.       1886.       3368.     95013.        53.        53.
                    KWD        XTC     MWEXH   EXH FLOW     FACAL        FAM   ERROR
METHOD 1.2      0.86993 1.00211 26.90331    930.499   0.09226   0.07779 18.593
MASS/MODE(LBM)          0.13319    0.00212    0.00188    0.09320    0.00006    0.00009
                    KWD        XTC     MWEXH   EXH FLOW     FACAL        FAM   ERROR
METHOD 2.1      0.87208 1.00000 26.86011    928.239   0.09288   0.07779 19.392
MASS/MODE(LBM)          0.13320    0.00212    0.00188    0.09320    0.00006    0.00009
                    KWD        XTC     MWEXH   EXH FLOW     FACAL        FAM   ERROR
METHOD 3.1      0.87079 0.99875 26.91763    936.888   0.09178   0.07779 17.986
MASS/MODE(LBM)          0.13424    0.00214    0.00189    0.09393    0.00006    0.00009
                    KWD        XTC     MWEXH   EXH FLOW     FACAL        FAM   ERROR
METHOD 3.2      0.86994 0.34015 26.91763    930.475   0.09249   0.07779 18.890
MASS/MODE(LBM)          0.13319    0.00000    0.00188    0.09320    0.00000    0.00000
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RUN NO. 69.5
MODE: 1
COMMENTS: CARB. BASELINE, STACK

TEMP(DB) = 89.50F	FUEL RATE= 5.4585#/HR	ENGINE RPM(NOM)= 700 RPM
MP(DP) = 52.00F	AIR RATE = 70.1649#/HR	ENGINE RPM(ACT)= 689. RPM
TEMP(BAR) = 78.00F	F/A RATIO= 0.0778#/#	BHP(OBS) = 4.8HP
BAR PRESS(OB)= 29.43"HG	PHIM = 1.1531	BHP(CORR) = 0.0HP
BAR PRESS(CR)= 29.30"HG	K = 3.5000	MAN VAC(OBS) =17.60"HG
SPEC HUMIDITY=0.0083#/#	C-BALANCE= 1	MAN PRESS(CORR)= 0.00"HG
CO2 AMBIENT = 0.045%	FUEL H/C = 2.0250	EXH H/C RATIO =1.850

	CYL1	CYL2	CYL3	CYL4	EXHAUST	
CHT	390.0	380.0	340.0	350.0		
EGT	840.0	770.0	840.0	790.0	420.0	
	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	93495.	1886.	3293.	84033.	75.	75.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1.2	0.86661	1.00580	27.15169	952.329	0.08870	0.07779	14.024
MASS/MODE(LBM)		0.14760	0.00217	0.00188	0.08404	0.00009	0.00014
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2.1	0.87252	1.00000	27.03566	945.974	0.09034	0.07779	16.125
MASS/MODE(LBM)		0.14762	0.00217	0.00187	0.08405	0.00009	0.00014
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.1	0.86903	0.99662	27.19023	970.553	0.08745	0.07779	12.413
MASS/MODE(LBM)		0.15085	0.00221	0.00192	0.08589	0.00009	0.00015
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.2	0.86666	0.33305	27.19023	952.258	0.08930	0.07779	14.798
MASS/MODE(LBM)		0.14760	0.00000	0.00188	0.08404	0.00000	0.00000

RUN NO. 70.1
MODE: 2
COMMENTS: CARB. BASELINE, CYL. 1

TEMP(DB) = 91.40F	FUEL RATE= 9.7403#/HR	ENGINE RPM(NOM)=1200 RPM
TEMP(DP) = 52.00F	AIR RATE = 106.7355#/HR	ENGINE RPM(ACT)=1174. RPM
TEMP(BAR) = 79.00F	F/A RATIO= 0.0912#/#	BHP(OBS) = 8.4HP
BAR PRESS(OB)= 29.40"HG	PHIM = 1.3527	BHP(CORR) = 0.0HP
BAR PRESS(CR)= 29.27"HG	K = 3.5000	MAN VAC(OBS) =19.20"HG
SPEC HUMIDITY=0.0084#/#	C-BALANCE= 1	MAN PRESS(CORR)= 0.00"HG
CO2 AMBIENT = 0.045%	FUEL H/C = 2.0250	EXH H/C RATIO =1.850

	CYL1	CYL2	CYL3	CYL4	EXHAUST	
CHT	390.0	385.0	380.0	380.0		
EGT	1030.0	940.0	1000.0	950.0	585.0	
	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	94954.	1383.	2275.	82369.	363.	363.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1.2	0.86593	1.00566	27.20383	1713.653	0.08773	0.09125	-3.862
MASS/MODE(LBM)		2.96491	0.03140	0.02575	1.62931	0.00888	0.01362
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2.1	0.87169	1.00000	27.09109	1702.412	0.08930	0.09125	-2.133
MASS/MODE(LBM)		2.96506	0.03141	0.02558	1.62940	0.00882	0.01353
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.1	0.86830	0.99671	27.24141	1745.799	0.08651	0.09125	-5.196
MASS/MODE(LBM)		3.02880	0.03208	0.02623	1.66442	0.00905	0.01388
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.2	0.86598	0.33142	27.24141	1713.528	0.08831	0.09125	-3.227
MASS/MODE(LBM)		2.96487	0.00000	0.02575	1.62929	0.00000	0.00000

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RUN NO.   70.2
MODE:     2
COMMENTS: CARB.  BASELINE,  CYL.2
TEMP(DB)        = 91.40F       FUEL RATE=    9.7403#/HR        ENGINE RPM(NOM)=1200 RPM
TEMP(DP)        = 52.00F       AIR RATE = 106.7355#/HR        ENGINE RPM(ACT)=1174.RPM
TEMP(BAR)       = 79.00F       F/A RATIO=    0.0912#/#         BHP(OBS)        =  8.4HP
BAR PRESS(OB)= 29.40"HG        PHIM      =   1.3527           BHP(CORR)       =  0.0HP
BAR PRESS(CR)= 29.27"HG        K         =   3.5000           MAN VAC(OBS)    =19.20"HG
SPEC HUMIDITY=0.0084#/#        C-BALANCE=    1                MAN PRESS(CORR)= 0.00"HG
CO2 AMBIENT   = 0.045%         FUEL H/C =    2.0250           EXH H/C RATIO   =1.850
                          CYL1       CYL2       CYL3       CYL4     EXHAUST
CHT                      390.0      385.0      380.0      380.0
EGT                     1030.0      940.0     1000.0      950.0      585.0
                          CO2        O2         UHCC        CO         NO         NOX
CONC(PPM)                86410.     1258.      2725.      94055.      322.       322.
                  KWD       XTC      MWEXH    EXH FLOW    FACAL      FAM    ERROR
METHOD 1.2      0.86991 0.99822 26.92690   1672.197   0.09185  0.09125  0.654
MASS/MODE(LBM)         2.64497   0.02799    0.03008    1.82379   0.00769   0.01179
                  KWD       XTC      MWEXH    EXH FLOW    FACAL      FAM    ERROR
METHOD 2.1      0.86810 1.00000 26.96304   1675.631   0.09133  0.09125  0.087
MASS/MODE(LBM)         2.64491   0.02799    0.03015    1.82375   0.00770   0.01181
                  KWD       XTC      MWEXH    EXH FLOW    FACAL      FAM    ERROR
METHOD 3.1      0.86918 1.00105 26.91489   1662.616   0.09224  0.09125  1.088
MASS/MODE(LBM)         2.62762   0.02780    0.02991    1.81184   0.00764   0.01172
                  KWD       XTC      MWEXH    EXH FLOW    FACAL      FAM    ERROR
METHOD 3.2      0.86989 0.33849 26.91489   1672.236   0.09166  0.09125  0.442
MASS/MODE(LBM)         2.64498   0.00000    0.03009    1.82380   0.00000   0.00000

RUN NO.   70.3
MODE:     2
COMMENTS: CARB.  BASELINE,  CYL.3
TEMP(DB)        = 91.40F       FUEL RATE=    9.7403#/HR        ENGINE RPM(NOM)=1200 RPM
TEMP(DP)        = 52.00F       AIR RATE = 106.7355#/HR        ENGINE RPM(ACT)=1174.RPM
TEMP(BAR)       = 79.00F       F/A RATIO=    0.0912#/#         BHP(OBS)        =  8.4HP
BAR PRESS(OB)= 29.40"HG        PHIM      =   1.3527           BHP(CORR)       =  0.0HP
BAR PRESS(CR)= 29.27"HG        K         =   3.5000           MAN VAC(OBS)    =19.20"HG
SPEC HUMIDITY=0.0084#/#        C-BALANCE=    1                MAN PRESS(CORR)= 0.00"HG
CO2 AMBIENT   = 0.045%         FUEL H/C =    2.0250           EXH H/C RATIO   =1.850
                          CYL1       CYL2       CYL3       CYL4     EXHAUST
CHT                      390.0      385.0      380.0      380.0
EGT                     1030.0      940.0     1000.0      950.0      585.0
                          CO2        O2         UHCC        CO         NO         NOX
CONC(PPM)                80800.     1761.      3308.     102546.      299.       299.
                  KWD       XTC      MWEXH    EXH FLOW    FACAL      FAM    ERROR
METHOD 1.2      0.87265 0.99867 26.72362   1635.576   0.09483  0.09125  3.924
MASS/MODE(LBM)         2.42671   0.03844    0.03573    1.95104   0.00699   0.01072
                  KWD       XTC      MWEXH    EXH FLOW    FACAL      FAM    ERROR
METHOD 2.1      0.87131 1.00000 26.75110   1638.068   0.09443  0.09125  3.484
MASS/MODE(LBM)         2.42666   0.03844    0.03579    1.95100   0.00700   0.01074
                  KWD       XTC      MWEXH    EXH FLOW    FACAL      FAM    ERROR
METHOD 3.1      0.87213 1.00080 26.71449   1628.611   0.09514  0.09125  4.257
MASS/MODE(LBM)         2.41492   0.03826    0.03558    1.94155   0.00696   0.01068
                  KWD       XTC      MWEXH    EXH FLOW    FACAL      FAM    ERROR
METHOD 3.2      0.87264 0.34495 26.71449   1635.603   0.09468  0.09125  3.760
MASS/MODE(LBM)         2.42672   0.00000    0.03573    1.95105   0.00000   0.00000
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RUN NO. 70. 4
MODE: 2
COMMENTS: CARB. BASELINE, CYL. 4

TEMP(DB) = 91. 40F	FUEL RATE= 9. 7403#/HR	ENGINE RPM(NOM)=1200 RPM
TEMP(DP) = 52. 00F	AIR RATE = 106. 7355#/HR	ENGINE RPM(ACT)=1174. RPM
TEMP(BAR) = 79. 00F	F/A RATIO= 0. 0912#/#	BHP(OBS) = 8. 4HP
BAR PRESS(OB)= 29. 40"HG	PHIM = 1. 3527	BHP(CORR) = 0. 0HP
BAR PRESS(CR)= 29. 27"HG	K = 3. 5000	MAN VAC(OBS) =19. 20"HG
SPEC HUMIDITY=0. 0084#/#	C-BALANCE= 1	MAN PRESS(CORR)= 0. 00"HG
CO2 AMBIENT = 0. 045%	FUEL H/C = 2. 0250	EXH H/C RATIO =1. 850

	CYL1	CYL2	CYL3	CYL4	EXHAUST	
CHT	390. 0	385. 0	380. 0	380. 0		
EGT	1030. 0	940. 0	1000. 0	950. 0	585. 0	
	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	75417.	1509.	3593.	112430.	230.	230.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1. 2	0. 87524	1. 00161	26. 49438	1589. 989	0. 09843	0. 09125	7. 864
MASS/MODE(LBM)		2. 20844	0. 03213	0. 03772	2. 08564	0. 00522	0. 00799
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2. 1	0. 87688	1. 00000	26. 46019	1587. 058	0. 09894	0. 09125	8. 427
MASS/MODE(LBM)		2. 20851	0. 03213	0. 03765	2. 08570	0. 00521	0. 00798
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3. 1	0. 87587	0. 99902	26. 50575	1598. 225	0. 09805	0. 09125	7. 445
MASS/MODE(LBM)		2. 22147	0. 03232	0. 03792	2. 09794	0. 00524	0. 00803
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3. 2	0. 87525	0. 35388	26. 50575	1589. 961	0. 09862	0. 09125	8. 072
MASS/MODE(LBM)		2. 20844	0. 00000	0. 03772	2. 08563	0. 00000	0. 00000

RUN NO. 70. 5
MODE: 2
COMMENTS: CARB. BASELINE, STACK

TEMP(DB) = 91. 40F	FUEL RATE= 9. 7403#/HR	ENGINE RPM(NOM)=1200 RPM
TEMP(DP) = 52. 00F	AIR RATE = 106. 7355#/HR	ENGINE RPM(ACT)=1174. RPM
TEMP(BAR) = 79. 00F	F/A RATIO= 0. 0912#/#	BHP(OBS) = 8. 4HP
BAR PRESS(OB)= 29. 40"HG	PHIM = 1. 3527	BHP(CORR) = 0. 0HP
BAR PRESS(CR)= 29. 27"HG	K = 3. 5000	MAN VAC(OBS) =19. 20"HG
SPEC HUMIDITY=0. 0084#/#	C-BALANCE= 1	MAN PRESS(CORR)= 0. 00"HG
CO2 AMBIENT = 0. 045%	FUEL H/C = 2. 0250	EXH H/C RATIO =1. 850

	CYL1	CYL2	CYL3	CYL4	EXHAUST	
CHT	390. 0	385. 0	380. 0	380. 0		
EGT	1030. 0	940. 0	1000. 0	950. 0	585. 0	
	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	82708.	1509.	3443.	100445.	308.	308.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1. 2	0. 87142	1. 00150	26. 77820	1638. 132	0. 09417	0. 09125	3. 196
MASS/MODE(LBM)		2. 48438	0. 03296	0. 03724	1. 91134	0. 00719	0. 01104
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2. 1	0. 87295	1. 00000	26. 74712	1635. 302	0. 09462	0. 09125	3. 693
MASS/MODE(LBM)		2. 48444	0. 03296	0. 03718	1. 91139	0. 00718	0. 01102
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3. 1	0. 87202	0. 99910	26. 78851	1646. 101	0. 09383	0. 09125	2. 821
MASS/MODE(LBM)		2. 49820	0. 03314	0. 03743	1. 92197	0. 00723	0. 01109
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3. 2	0. 87143	0. 34436	26. 78851	1638. 102	0. 09434	0. 09125	3. 380
MASS/MODE(LBM)		2. 48437	0. 00000	0. 03724	1. 91133	0. 00000	0. 00000

RUN NO. 71.1
MODE: 3
COMMENTS: CARB. BASELINE, CYL. 1

TEMP(DB) = 84.50F	FUEL RATE= 78.6370#/HR	ENGINE RPM(NOM)=2700 RPM
MP(DP) = 52.00F	AIR RATE = 928.9316#/HR	ENGINE RPM(ACT)=2706. RPM
TEMP(BAR) = 80.00F	F/A RATIO= 0.0846#/#	BHP(OBS) =127.6HP
BAR PRESS(OB)= 29.40"HG	PHIM = 1.2548	BHP(CORR) =144.1HP
BAR PRESS(CR)= 29.26"HG	K = 3.5000	MAN VAC(OBS) = 1.30"HG
SPEC HUMIDITY=0.0084#/#	C-BALANCE= 1	MAN PRESS(CORR)=29.47"HG
CO2 AMBIENT = 0.045%	FUEL H/C = 2.0250	EXH H/C RATIO =1.850

	CYL1	CYL2	CYL3	CYL4	EXHAUST	
CHT	405.0	415.0	380.0	405.0		
EGT	1220.0	1290.0	1270.0	1235.0	1230.0	
	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	88199.	4276.	4360.	88805.	205.	205.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1.2	0.86973	1.00359	27.02116	13619.980	0.09009	0.08465	6.433
MASS/MODE(LBM)		0.59958	0.02113	0.01069	0.38244	0.00109	0.00167
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2.1	0.87339	1.00000	26.94875	13564.210	0.09112	0.08465	7.643
MASS/MODE(LBM)		0.59964	0.02113	0.01065	0.38247	0.00108	0.00166
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.1	0.87121	0.99789	27.04530	13780.860	0.08930	0.08465	5.497
MASS/MODE(LBM)		0.60770	0.02142	0.01082	0.38762	0.00110	0.00169
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.2	0.86977	0.33426	27.04530	13619.370	0.09047	0.08465	6.882
MASS/MODE(LBM)		0.59958	0.00000	0.01069	0.38244	0.00000	0.00000

RUN NO. 71.2
ODE: 3
MMENTS: CARB. BASELINE, CYL. 2

TEMP(DB) = 84.50F	FUEL RATE= 78.6370#/HR	ENGINE RPM(NOM)=2700 RPM
TEMP(DP) = 52.00F	AIR RATE = 928.9316#/HR	ENGINE RPM(ACT)=2706. RPM
TEMP(BAR) = 80.00F	F/A RATIO= 0.0846#/#	BHP(OBS) =127.6HP
BAR PRESS(OB)= 29.40"HG	PHIM = 1.2548	BHP(CORR) =144.1HP
BAR PRESS(CR)= 29.26"HG	K = 3.5000	MAN VAC(OBS) = 1.30"HG
SPEC HUMIDITY=0.0084#/#	C-BALANCE= 1	MAN PRESS(CORR)=29.47"HG
CO2 AMBIENT = 0.045%	FUEL H/C = 2.0250	EXH H/C RATIO =1.850

	CYL1	CYL2	CYL3	CYL4	EXHAUST	
CHT	405.0	415.0	380.0	405.0		
EGT	1220.0	1290.0	1270.0	1235.0	1230.0	
	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	94536.	3521.	3400.	80233.	282.	282.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1.2	0.86692	1.00524	27.22540	13916.700	0.08713	0.08465	2.934
MASS/MODE(LBM)		0.65454	0.01773	0.00852	0.35191	0.00153	0.00234
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2.1	0.87225	1.00000	27.12169	13832.980	0.08857	0.08465	4.635
MASS/MODE(LBM)		0.65460	0.01773	0.00847	0.35194	0.00152	0.00233
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.1	0.86912	0.99696	27.26012	14158.970	0.08601	0.08465	1.605
MASS/MODE(LBM)		0.66762	0.01808	0.00867	0.35895	0.00155	0.00238
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.2	0.86697	0.32856	27.26012	13915.750	0.08766	0.08465	3.562
MASS/MODE(LBM)		0.65453	0.00000	0.00852	0.35191	0.00000	0.00000

RUN NO. 71.3
MODE: 3
COMMENTS: CARB. BASELINE, CYL. 3

TEMP(DB) = 84.50F	FUEL RATE= 78.6370#/HR	ENGINE RPM(NOM)=2700 RPM
TEMP(DP) = 52.00F	AIR RATE = 928.9316#/HR	ENGINE RPM(ACT)=2706. RPM
TEMP(BAR) = 80.00F	F/A RATIO= 0.0846#/#	BHP(OBS) =127.6HP
BAR PRESS(OB)= 29.40"HG	PHIM = 1.2548	BHP(CORR) =144.1HP
BAR PRESS(CR)= 29.26"HG	K = 3.5000	MAN VAC(OBS) = 1.30"HG
SPEC HUMIDITY=0.0084#/#	C-BALANCE= 1	MAN PRESS(CORR)=29.47"HG
CO2 AMBIENT = 0.045%	FUEL H/C = 2.0250	EXH H/C RATIO =1.850

	CYL1	CYL2	CYL3	CYL4	EXHAUST
CHT	405.0	415.0	380.0	405.0	
EGT	1220.0	1290.0	1270.0	1235.0	1230.0

	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	89404.	2515.	2906.	89182.	195.	195.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1.2	0.86863	1.00313	27.04008	13643.300	0.08990	0.08465	6.207

MASS/MODE(LBM)	0.60804	0.01244	0.00714	0.38423	0.00104	0.00159

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2.1	0.87181	1.00000	26.97700	13594.120	0.09080	0.08465	7.262

MASS/MODE(LBM)	0.60807	0.01244	0.00711	0.38425	0.00103	0.00158

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.1	0.86991	0.99816	27.06110	13783.380	0.08922	0.08465	5.395

MASS/MODE(LBM)	0.61519	0.01258	0.00721	0.38875	0.00105	0.00161

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.2	0.86865	0.33508	27.06110	13642.770	0.09023	0.08465	6.597

MASS/MODE(LBM)	0.60804	0.00000	0.00714	0.38423	0.00000	0.00000

RUN NO. 71.4
MODE: 3
COMMENTS: CARB. BASELINE, CYL. 4

TEMP(DB) = 84.50F	FUEL RATE= 78.6370#/HR	ENGINE RPM(NOM)=2700 RPM
TEMP(DP) = 52.00F	AIR RATE = 928.9316#/HR	ENGINE RPM(ACT)=2706. RPM
TEMP(BAR) = 80.00F	F/A RATIO= 0.0846#/#	BHP(OBS) =127.6HP
BAR PRESS(OB)= 29.40"HG	PHIM = 1.2548	BHP(CORR) =144.1HP
BAR PRESS(CR)= 29.26"HG	K = 3.5000	MAN VAC(OBS) = 1.30"HG
SPEC HUMIDITY=0.0084#/#	C-BALANCE= 1	MAN PRESS(CORR)=29.47"HG
CO2 AMBIENT = 0.045%	FUEL H/C = 2.0250	EXH H/C RATIO =1.850

	CYL1	CYL2	CYL3	CYL4	EXHAUST
CHT	405.0	415.0	380.0	405.0	
EGT	1220.0	1290.0	1270.0	1235.0	1230.0

	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	102464.	2389.	2470.	68140.	388.	388.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1.2	0.86444	1.00125	27.48317	14374.720	0.08363	0.08465	-1.204

MASS/MODE(LBM)	0.73069	0.01239	0.00639	0.30782	0.00217	0.00333

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2.1	0.86571	1.00000	27.45912	14353.890	0.08395	0.08465	-0.820

MASS/MODE(LBM)	0.73070	0.01239	0.00638	0.30783	0.00217	0.00333

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.1	0.86498	0.99929	27.49133	14434.400	0.08337	0.08465	-1.511

MASS/MODE(LBM)	0.73418	0.01245	0.00642	0.30929	0.00218	0.00334

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.2	0.86446	0.31974	27.49133	14374.480	0.08375	0.08465	-1.062

MASS/MODE(LBM)	0.73068	0.00000	0.00639	0.30782	0.00000	0.00000

RUN NO. 71.5
MODE: 3
COMMENTS: CARB. BASELINE, STACK

TEMP(DB) = 84.50F	FUEL RATE= 78.6370#/HR	ENGINE RPM(NOM)=2700 RPM
TEMP(DP) = 52.00F	AIR RATE = 928.9316#/HR	ENGINE RPM(ACT)=2706. RPM
TEMP(BAR) = 80.00F	F/A RATIO= 0.0846#/#	BHP(OBS) =127.6HP
BAR PRESS(OB)= 29.40"HG	PHIM = 1.2548	BHP(CORR) =144.1HP
BAR PRESS(CR)= 29.26"HG	K = 3.5000	MAN VAC(OBS) = 1.30"HG
SPEC HUMIDITY=0.0084#/#	C-BALANCE= 1	MAN PRESS(CORR)=29.47"HG
CO2 AMBIENT = 0.045%	FUEL H/C = 2.0250	EXH H/C RATIO =1.850

	CYL1	CYL2	CYL3	CYL4	EXHAUST
CHT	405.0	415.0	380.0	405.0	
EGT	1220.0	1290.0	1270.0	1235.0	1230.0

	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	93910.	2389.	1569.	83451.	265.	265.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1.2	0.86651	1.00664	27.19298	13886.210	0.08732	0.08465	3.157
MASS/MODE(LBM)		0.64847	0.01200	0.00392	0.36505	0.00143	0.00220
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2.1	0.87329	1.00000	27.06018	13778.770	0.08917	0.08465	5.343
MASS/MODE(LBM)		0.64849	0.01200	0.00389	0.36506	0.00142	0.00218
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.1	0.86928	0.99613	27.23732	14195.050	0.08588	0.08465	1.458
MASS/MODE(LBM)		0.66502	0.01230	0.00401	0.37436	0.00147	0.00225
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.2	0.86657	0.33092	27.23732	13885.020	0.08800	0.08465	3.956
MASS/MODE(LBM)		0.64846	0.00000	0.00392	0.36504	0.00000	0.00000

RUN NO. 72.1
MODE: 4
COMMENTS: CARB. BASELINE, CYL. 1

TEMP(DB) = 87.70F	FUEL RATE= 55.9701#/HR	ENGINE RPM(NOM)=2430 RPM
TEMP(DP) = 52.00F	AIR RATE = 683.3022#/HR	ENGINE RPM(ACT)=2433. RPM
TEMP(BAR) = 80.00F	F/A RATIO= 0.0819#/#	BHP(OBS) = 94.1HP
BAR PRESS(OB)= 29.40"HG	PHIM = 1.2141	BHP(CORR) = 0.0HP
BAR PRESS(CR)= 29.26"HG	K = 3.5000	MAN VAC(OBS) = 3.50"HG
SPEC HUMIDITY=0.0084#/#	C-BALANCE= 1	MAN PRESS(CORR)= 0.00"HG
CO2 AMBIENT = 0.045%	FUEL H/C = 2.0250	EXH H/C RATIO =1.850

	CYL1	CYL2	CYL3	CYL4	EXHAUST
CHT	405.0	400.0	380.0	390.0	
EGT	1230.0	1245.0	1280.0	1190.0	1155.0

	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	100081.	2767.	3233.	73364.	339.	339.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1.2	0.86449	1.00909	27.37810	10016.440	0.08521	0.08191	4.030
MASS/MODE(LBM)		8.28889	0.16659	0.09721	3.84918	0.02205	0.03380
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2.1	0.87375	1.00000	27.20030	9911.801	0.08765	0.08191	7.016
MASS/MODE(LBM)		8.29015	0.16662	0.09620	3.84976	0.02182	0.03345
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.1	0.86836	0.99478	27.43771	10322.530	0.08330	0.08191	1.696
MASS/MODE(LBM)		8.58047	0.17245	0.10019	3.98458	0.02272	0.03484
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.2	0.86457	0.32541	27.43771	10015.210	0.08610	0.08191	5.124
MASS/MODE(LBM)		8.28869	0.00000	0.09720	3.84908	0.00000	0.00000

RUN NO. 72. 2
MODE: 4
COMMENTS: CARB. BASELINE, CYL. 2

TEMP(DB) = 87. 70F	FUEL RATE= 55. 9701#/HR	ENGINE RPM(NOM)=2430 RPM
TEMP(DP) = 52. 00F	AIR RATE = 683. 3022#/HR	ENGINE RPM(ACT)=2433. RPM
TEMP(BAR) = 80. 00F	F/A RATIO= 0. 0819#/#	BHP(OBS) = 94. 1HP
BAR PRESS(OB)= 29. 40"HG	PHIM = 1. 2141	BHP(CORR) = 0. 0HP
BAR PRESS(CR)= 29. 26"HG	K = 3. 5000	MAN VAC(OBS) = 3. 50"HG
SPEC HUMIDITY=0. 0084#/#	C-BALANCE= 1	MAN PRESS(CORR)= 0. 00"HG
CO2 AMBIENT = 0. 045%	FUEL H/C = 2. 0250	EXH H/C RATIO =1. 850

	CYL1	CYL2	CYL3	CYL4	EXHAUST	
CHT	405. 0	400. 0	380. 0	390. 0		
EGT	1230. 0	1245. 0	1280. 0	1190. 0	1155. 0	
	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	97708.	3018.	3293.	76751.	304.	304.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1. 2	0. 86534	1. 00880	27. 30713	9946. 527	0. 08613	0. 08191	5. 153
MASS/MODE(LBM)		8. 04377	0. 18065	0. 09832	4. 00269	0. 01962	0. 03009
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2. 1	0. 87430	1. 00000	27. 13379	9846. 000	0. 08853	0. 08191	8. 082
MASS/MODE(LBM)		8. 04497	0. 18068	0. 09733	4. 00329	0. 01943	0. 02978
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3. 1	0. 86906	0. 99492	27. 36513	10240. 130	0. 08426	0. 08191	2. 871
MASS/MODE(LBM)		8. 31686	0. 18678	0. 10123	4. 13858	0. 02020	0. 03098
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3. 2	0. 86542	0. 32745	27. 36513	9945. 371	0. 08701	0. 08191	6. 226
MASS/MODE(LBM)		8. 04358	0. 00000	0. 09831	4. 00259	0. 00000	0. 00000

RUN NO. 72. 3
MODE: 4
COMMENTS: CARB. BASELINE, CYL. 3

TEMP(DB) = 87. 70F	FUEL RATE= 55. 9701#/HR	ENGINE RPM(NOM)=2430 RPM
TEMP(DP) = 52. 00F	AIR RATE = 683. 3022#/HR	ENGINE RPM(ACT)=2433. RPM
TEMP(BAR) = 80. 00F	F/A RATIO= 0. 0819#/#	BHP(OBS) = 94. 1HP
BAR PRESS(OB)= 29. 40"HG	PHIM = 1. 2141	BHP(CORR) = 0. 0HP
BAR PRESS(CR)= 29. 26"HG	K = 3. 5000	MAN VAC(OBS) = 3. 50"HG
SPEC HUMIDITY=0. 0084#/#	C-BALANCE= 1	MAN PRESS(CORR)= 0. 00"HG
CO2 AMBIENT = 0. 045%	FUEL H/C = 2. 0250	EXH H/C RATIO =1. 850

	CYL1	CYL2	CYL3	CYL4	EXHAUST	
CHT	405. 0	400. 0	380. 0	390. 0		
EGT	1230. 0	1245. 0	1280. 0	1190. 0	1155. 0	
	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	104712.	2515.	2560.	65928.	400.	400.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1. 2	0. 86333	1. 00677	27. 53433	10235. 660	0. 08293	0. 08191	1. 247
MASS/MODE(LBM)		8. 85034	0. 15456	0. 07864	3. 52997	0. 02654	0. 04069
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2. 1	0. 87020	1. 00000	27. 40446	10155. 660	0. 08468	0. 08191	3. 387
MASS/MODE(LBM)		8. 85105	0. 15457	0. 07803	3. 53025	0. 02633	0. 04038
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3. 1	0. 86625	0. 99616	27. 57837	10468. 870	0. 08153	0. 08191	-0. 459
MASS/MODE(LBM)		9. 08262	0. 15861	0. 08043	3. 62261	0. 02715	0. 04162
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3. 2	0. 86339	0. 31959	27. 57837	10234. 710	0. 08357	0. 08191	2. 033
MASS/MODE(LBM)		8. 85018	0. 00000	0. 07863	3. 52990	0. 00000	0. 00000

RUN NO. 72.4
MODE: 4
COMMENTS: CARB. BASELINE, CYL. 4

TEMP(DB)	= 87.70F	FUEL RATE=	55.9701#/HR	ENGINE RPM(NOM)	=2430 RPM
MP(DP)	= 52.00F	AIR RATE =	683.3022#/HR	ENGINE RPM(ACT)	=2433. RPM
TEMP(BAR)	= 80.00F	F/A RATIO=	0.0819#/#	BHP(OBS)	= 94.1HP
BAR PRESS(OB)	= 29.40"HG	PHIM =	1.2141	BHP(CORR)	= 0.0HP
BAR PRESS(CR)	= 29.26"HG	K =	3.5000	MAN VAC(OBS)	= 3.50"HG
SPEC HUMIDITY	=0.0084#/#	C-BALANCE=	1	MAN PRESS(CORR)	= 0.00"HG
CO2 AMBIENT	= 0.045%	FUEL H/C =	2.0250	EXH H/C RATIO	=1.850

	CYL1	CYL2	CYL3	CYL4	EXHAUST
CHT	405.0	400.0	380.0	390.0	
EGT	1230.0	1245.0	1280.0	1190.0	1155.0

	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	98782.	1761.	2245.	68941.	355.	355.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1.2	0.86744	0.97972	27.43539	10384.790	0.08441	0.08191	3.057
MASS/MODE(LBM)		8.51112	0.11029	0.06999	3.76290	0.02393	0.03668
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2.1	0.84738	1.00000	27.81717	10628.570	0.07932	0.08191	-3.156
MASS/MODE(LBM)		8.50948	0.11027	0.07163	3.76218	0.02449	0.03754
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.1	0.85884	1.01144	27.30449	9727.027	0.08861	0.08191	8.183
MASS/MODE(LBM)		7.89302	0.10228	0.06556	3.48963	0.02241	0.03436
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.2	0.86725	0.31541	27.30449	10387.690	0.08244	0.08191	0.655
MASS/MODE(LBM)		8.51163	0.00000	0.07001	3.76313	0.00000	0.00000

RUN NO. 72.5
MODE: 4
COMMENTS: CARB. BASELINE, STACK

TEMP(DB)	= 87.70F	FUEL RATE=	55.9701#/HR	ENGINE RPM(NOM)	=2430 RPM
TEMP(DP)	= 52.00F	AIR RATE =	683.3022#/HR	ENGINE RPM(ACT)	=2433. RPM
TEMP(BAR)	= 80.00F	F/A RATIO=	0.0819#/#	BHP(OBS)	= 94.1HP
BAR PRESS(OB)	= 29.40"HG	PHIM =	1.2141	BHP(CORR)	= 0.0HP
BAR PRESS(CR)	= 29.26"HG	K =	3.5000	MAN VAC(OBS)	= 3.50"HG
SPEC HUMIDITY	=0.0084#/#	C-BALANCE=	1	MAN PRESS(CORR)	= 0.00"HG
CO2 AMBIENT	= 0.045%	FUEL H/C =	2.0250	EXH H/C RATIO	=1.850

	CYL1	CYL2	CYL3	CYL4	EXHAUST
CHT	405.0	400.0	380.0	390.0	
EGT	1230.0	1245.0	1280.0	1190.0	1155.0

	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	97494.	1258.	1796.	73866.	356.	356.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1.2	0.86676	0.98794	27.35583	10206.350	0.08550	0.08191	4.393
MASS/MODE(LBM)		8.24939	0.07736	0.05503	3.95938	0.02361	0.03620
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2.1	0.85473	1.00000	27.58723	10349.340	0.08237	0.08191	0.567
MASS/MODE(LBM)		8.24881	0.07735	0.05580	3.95910	0.02394	0.03671
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.1	0.86168	1.00688	27.27722	9814.848	0.08803	0.08191	7.481
MASS/MODE(LBM)		7.88640	0.07395	0.05292	3.78516	0.02271	0.03481
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.2	0.86665	0.32096	27.27722	10208.020	0.08431	0.08191	2.940
MASS/MODE(LBM)		8.24967	0.00000	0.05504	3.95952	0.00000	0.00000

RUN NO. 73. 1
MODE: 5
COMMENTS: CARB. BASELINE, CYL. 1

TEMP(DB) = 92. 40F	FUEL RATE= 35. 8209#/HR	ENGINE RPM(NOM)=2349 RPM
:MP(DP) = 49. 00F	AIR RATE = 422. 2913#/HR	ENGINE RPM(ACT)=2352. RPM
ıEMP(BAR) = 81. 00F	F/A RATIO= 0. 0848#/#	BHP(OBS) = 49. 0HP
BAR PRESS(OB)= 29. 37"HG	PHIM = 1. 2573	BHP(CORR) = 0. 0HP
BAR PRESS(CR)= 29. 23"HG	K = 3. 5000	MAN VAC(OBS) =11. 60"HG
SPEC HUMIDITY=0. 0075#/#	C-BALANCE= 1	MAN PRESS(CORR)= 0. 00"HG
CO2 AMBIENT = 0. 045%	FUEL H/C = 2. 0250	EXH H/C RATIO =1. 850

	CYL1	CYL2	CYL3	CYL4	EXHAUST	
CHT	400. 0	385. 0	360. 0	375. 0		
EGT	1240. 0	1230. 0	1280. 0	1160. 0	1035. 0	
	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	96826.	3018.	3293.	77146.	318.	318.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1. 2	0. 86685	1. 00532	27. 30731	6372. 422	0. 08628	0. 08482	1. 716
MASS/MODE(LBM)		6. 13891	0. 13912	0. 07559	3. 09851	0. 01578	0. 02420
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2. 1	0. 87224	1. 00000	27. 20259	6333. 566	0. 08772	0. 08482	3. 417
MASS/MODE(LBM)		6. 13946	0. 13914	0. 07513	3. 09879	0. 01569	0. 02405
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3. 1	0. 86909	0. 99693	27. 34238	6485. 109	0. 08515	0. 08482	0. 384
MASS/MODE(LBM)		6. 26365	0. 14195	0. 07692	3. 16147	0. 01606	0. 02463
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3. 2	0. 86689	0. 32592	27. 34238	6372. 008	0. 08681	0. 08482	2. 345
MASS/MODE(LBM)		6. 13882	0. 00000	0. 07558	3. 09846	0. 00000	0. 00000

RUN NO. 73. 2
MODE: 5
COMMENTS: CARB. BASELINE, CYL. 2

TEMP(DB) = 92. 40F	FUEL RATE= 35. 8209#/HR	ENGINE RPM(NOM)=2349 RPM
TEMP(DP) = 49. 00F	AIR RATE = 422. 2913#/HR	ENGINE RPM(ACT)=2352. RPM
TEMP(BAR) = 81. 00F	F/A RATIO= 0. 0848#/#	BHP(OBS) = 49. 0HP
BAR PRESS(OB)= 29. 37"HG	PHIM = 1. 2573	BHP(CORR) = 0. 0HP
BAR PRESS(CR)= 29. 23"HG	K = 3. 5000	MAN VAC(OBS) =11. 60"HG
SPEC HUMIDITY=0. 0075#/#	C-BALANCE= 1	MAN PRESS(CORR)= 0. 00"HG
CO2 AMBIENT = 0. 045%	FUEL H/C = 2. 0250	EXH H/C RATIO =1. 850

	CYL1	CYL2	CYL3	CYL4	EXHAUST	
CHT	400. 0	385. 0	360. 0	375. 0		
EGT	1240. 0	1230. 0	1280. 0	1160. 0	1035. 0	
	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	88788.	3018.	3233.	89398.	209.	209.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1. 2	0. 86990	1. 00300	27. 04359	6206. 809	0. 08995	0. 08482	6. 048
MASS/MODE(LBM)		5. 50234	0. 13599	0. 07228	3. 50959	0. 01009	0. 01547
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2. 1	0. 87295	1. 00000	26. 98297	6185. 434	0. 09081	0. 08482	7. 057
MASS/MODE(LBM)		5. 50261	0. 13599	0. 07204	3. 50976	0. 01005	0. 01542
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3. 1	0. 87114	0. 99823	27. 06380	6267. 988	0. 08929	0. 08482	5. 269
MASS/MODE(LBM)		5. 56446	0. 13752	0. 07300	3. 54921	0. 01019	0. 01562
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3. 2	0. 86993	0. 33400	27. 06380	6206. 590	0. 09027	0. 08482	6. 422
MASS/MODE(LBM)		5. 50229	0. 00000	0. 07228	3. 50957	0. 00000	0. 00000

RUN NO. 73.3
MODE: 5
COMMENTS: CARB. BASELINE, CYL. 3

TEMP(DB)	= 92.40F	FUEL RATE=	35.8209#/HR	ENGINE RPM(NOM)	=2349 RPM
TEMP(DP)	= 49.00F	AIR RATE =	422.2913#/HR	ENGINE RPM(ACT)	=2352. RPM
TEMP(BAR)	= 81.00F	F/A RATIO=	0.0848#/#	BHP(OBS)	= 49.0HP
BAR PRESS(OB)	= 29.37"HG	PHIM =	1.2573	BHP(CORR)	= 0.0HP
BAR PRESS(CR)	= 29.23"HG	K =	3.5000	MAN VAC(OBS)	=11.60"HG
SPEC HUMIDITY	=0.0075#/#	C-BALANCE=	1	MAN PRESS(CORR)	= 0.00"HG
CO2 AMBIENT	= 0.045%	FUEL H/C =	2.0250	EXH H/C RATIO	=1.850

	CYL1	CYL2	CYL3	CYL4	EXHAUST
CHT	400.0	385.0	360.0	375.0	
EGT	1240.0	1230.0	1280.0	1160.0	1035.0

	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	96403.	1886.	2470.	78182.	234.	234.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1.2	0.86694	1.00086	27.29285	6383.844	0.08658	0.08482	2.069
MASS/MODE(LBM)		6.12371	0.08711	0.05680	3.14607	0.01161	0.01780
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2.1	0.86781	1.00000	27.27603	6377.531	0.08681	0.08482	2.343
MASS/MODE(LBM)		6.12377	0.08711	0.05674	3.14610	0.01160	0.01779
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.1	0.86730	0.99951	27.29851	6401.793	0.08639	0.08482	1.855
MASS/MODE(LBM)		6.14348	0.08739	0.05696	3.15622	0.01165	0.01785
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.2	0.86695	0.32611	27.29851	6383.777	0.08666	0.08482	2.171
MASS/MODE(LBM)		6.12369	0.00000	0.05680	3.14606	0.00000	0.00000

RUN NO. 73.4
MODE: 5
COMMENTS: CARB. BASELINE, CYL. 4

TEMP(DB)	= 92.40F	FUEL RATE=	35.8209#/HR	ENGINE RPM(NOM)	=2349 RPM
TEMP(DP)	= 49.00F	AIR RATE =	422.2913#/HR	ENGINE RPM(ACT)	=2352. RPM
TEMP(BAR)	= 81.00F	F/A RATIO=	0.0848#/#	BHP(OBS)	= 49.0HP
BAR PRESS(OB)	= 29.37"HG	PHIM =	1.2573	BHP(CORR)	= 0.0HP
BAR PRESS(CR)	= 29.23"HG	K =	3.5000	MAN VAC(OBS)	=11.60"HG
SPEC HUMIDITY	=0.0075#/#	C-BALANCE=	1	MAN PRESS(CORR)	= 0.00"HG
CO2 AMBIENT	= 0.045%	FUEL H/C =	2.0250	EXH H/C RATIO	=1.850

	CYL1	CYL2	CYL3	CYL4	EXHAUST
CHT	400.0	385.0	360.0	375.0	
EGT	1240.0	1230.0	1280.0	1160.0	1035.0

	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	94515.	1886.	2575.	82053.	227.	227.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1.2	0.86724	1.00422	27.21675	6307.160	0.08767	0.08482	3.355
MASS/MODE(LBM)		5.93372	0.08610	0.05849	3.26333	0.01116	0.01710
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2.1	0.87153	1.00000	27.13281	6276.473	0.08884	0.08482	4.733
MASS/MODE(LBM)		5.93401	0.08610	0.05821	3.26349	0.01110	0.01702
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.1	0.86901	0.99755	27.24475	6395.027	0.08676	0.08482	2.286
MASS/MODE(LBM)		6.02863	0.08747	0.05931	3.31553	0.01131	0.01734
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.2	0.86728	0.32971	27.24475	6306.836	0.08810	0.08482	3.864
MASS/MODE(LBM)		5.93365	0.00000	0.05849	3.26330	0.00000	0.00000

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RUN NO.   73.5
MODE:     5
COMMENTS: CARB.  BASELINE,  STACK
TEMP(DB)       = 92.40F      FUEL RATE=   35.8209#/HR      ENGINE RPM(NOM)=2349 RPM
  MP(DP)       = 49.00F      AIR RATE  = 422.2913#/HR      ENGINE RPM(ACT)=2352. RPM
 EMP(BAR)      = 81.00F      F/A RATIO=    0.0848#/#       BHP(OBS)        = 49.0HP
BAR PRESS(OB)= 29.37"HG      PHIM      =   1.2573          BHP(CORR)       =  0.0HP
BAR PRESS(CR)= 29.23"HG      K         =   3.5000          MAN VAC(OBS)    =11.60"HG
SPEC HUMIDITY=0.0075#/#      C-BALANCE=    1               MAN PRESS(CORR)= 0.00"HG
CO2 AMBIENT   = 0.045%       FUEL H/C =    2.0250          EXH H/C RATIO   =1.850
                          CYL1        CYL2        CYL3        CYL4    EXHAUST
CHT                      400.0       385.0       360.0       375.0
EGT                     1240.0      1230.0      1280.0      1160.0     1035.0
                          CO2         O2         UHCC         CO         NO         NOX
CONC(PPM)               94306.       1761.       1826.      82949.      275.       275.
                 KWD        XTC      MWEXH    EXH FLOW     FACAL        FAM   ERROR
METHOD 1.2     0.86717 1.00505 27.21214   6313.937   0.08750  0.08482  3.161
MASS/MODE(LBM)         5.92646    0.08044    0.04153    3.30222    0.01351    0.02072
                 KWD        XTC      MWEXH    EXH FLOW     FACAL        FAM   ERROR
METHOD 2.1     0.87230 1.00000 27.11150   6276.992   0.08890  0.08482  4.814
MASS/MODE(LBM)         5.92664    0.08044    0.04129    3.30232    0.01343    0.02060
                 KWD        XTC      MWEXH    EXH FLOW     FACAL        FAM   ERROR
METHOD 3.1     0.86927 0.99706 27.24576   6419.699   0.08641  0.08482  1.879
MASS/MODE(LBM)         6.04038    0.08198    0.04223    3.36570    0.01374    0.02107
                 KWD        XTC      MWEXH    EXH FLOW     FACAL        FAM   ERROR
METHOD 3.2     0.86721 0.33006 27.24576   6313.551   0.08802  0.08482  3.768
MASS/MODE(LBM)         5.92638    0.00000    0.04153    3.30217    0.00000    0.00000

RUN NO.   74.1
 ODE:     6
 MMENTS: CARB.  BASELINE,  CYL.1
TEMP(DB)       = 95.90F      FUEL RATE=    9.6837#/HR      ENGINE RPM(NOM)=1200 RPM
TEMP(DP)       = 49.00F      AIR RATE  = 109.6347#/HR      ENGINE RPM(ACT)=1199. RPM
TEMP(BAR)      = 81.00F      F/A RATIO=    0.0883#/#       BHP(OBS)        =  8.6HP
BAR PRESS(OB)= 29.37"HG      PHIM      =   1.3092          BHP(CORR)       =  0.0HP
BAR PRESS(CR)= 29.23"HG      K         =   3.5000          MAN VAC(OBS)    =19.00"HG
SPEC HUMIDITY=0.0075#/#      C-BALANCE=    1               MAN PRESS(CORR)= 0.00"HG
CO2 AMBIENT   = 0.045%       FUEL H/C =    2.0250          EXH H/C RATIO   =1.850
                          CYL1        CYL2        CYL3        CYL4    EXHAUST
CHT                      405.0       405.0       405.0       405.0
EGT                     1060.0       985.0      1040.0       990.0      630.0
                          CO2         O2         UHCC         CO         NO         NOX
CONC(PPM)               91231.       1509.       2515.      88645.       92.        92.
                 KWD        XTC      MWEXH    EXH FLOW     FACAL        FAM   ERROR
METHOD 1.2     0.86798 1.00731 27.08501   1673.555   0.08964  0.08832  1.489
MASS/MODE(LBM)         0.76053    0.00914    0.00758    0.46813    0.00060    0.00092
                 KWD        XTC      MWEXH    EXH FLOW     FACAL        FAM   ERROR
METHOD 2.1     0.87543 1.00000 26.93712   1659.453   0.09173  0.08832  3.863
MASS/MODE(LBM)         0.76059    0.00914    0.00751    0.46817    0.00060    0.00091
                 KWD        XTC      MWEXH    EXH FLOW     FACAL        FAM   ERROR
METHOD 3.1     0.87100 0.99571 27.13402   1714.032   0.08804  0.08832 -0.320
MASS/MODE(LBM)         0.78163    0.00940    0.00776    0.48112    0.00061    0.00094
                 KWD        XTC      MWEXH    EXH FLOW     FACAL        FAM   ERROR
METHOD 3.2     0.86804 0.33554 27.13402   1673.411   0.09041  0.08832  2.359
MASS/MODE(LBM)         0.76051    0.00000    0.00757    0.46812    0.00000    0.00000
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RUN NO. 74.2
MODE: 6
COMMENTS: CARB. BASELINE, CYL. 2

TEMP(DB) = 95.90F	FUEL RATE= 9.6837#/HR	ENGINE RPM(NOM)=1200 RPM
TEMP(DP) = 49.00F	AIR RATE = 109.6347#/HR	ENGINE RPM(ACT)=1199. RPM
TEMP(BAR) = 81.00F	F/A RATIO= 0.0883#/#	BHP(OBS) = 8.6HP
BAR PRESS(OB)= 29.37"HG	PHIM = 1.3092	BHP(CORR) = 0.0HP
BAR PRESS(CR)= 29.23"HG	K = 3.5000	MAN VAC(OBS) =19.00"HG
SPEC HUMIDITY=0.0075#/#	C-BALANCE= 1	MAN PRESS(CORR)= 0.00"HG
CO2 AMBIENT = 0.045%	FUEL H/C = 2.0250	EXH H/C RATIO =1.850

	CYL1	CYL2	CYL3	CYL4	EXHAUST
CHT	405.0	405.0	405.0	405.0	
EGT	1060.0	985.0	1040.0	990.0	630.0

	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	92050.	1509.	2725.	87338.	101.	101.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1.2	0.86766	1.00757	27.11009	1676.401	0.08936	0.08832	1.170
MASS/MODE(LBM)		0.76838	0.00915	0.00822	0.46184	0.00065	0.00101
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2.1	0.87537	1.00000	26.95728	1661.784	0.09152	0.08832	3.620
MASS/MODE(LBM)		0.76845	0.00915	0.00815	0.46188	0.00065	0.00100
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.1	0.87079	0.99556	27.16077	1718.425	0.08771	0.08832	-0.696
MASS/MODE(LBM)		0.79048	0.00942	0.00843	0.47513	0.00067	0.00103
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.2	0.86772	0.33482	27.16077	1676.251	0.09015	0.08832	2.068
MASS/MODE(LBM)		0.76836	0.00000	0.00822	0.46183	0.00000	0.00000

RUN NO. 74.3
MODE: 6
COMMENTS: CARB. BASELINE, CYL. 3

TEMP(DB) = 95.90F	FUEL RATE= 9.6837#/HR	ENGINE RPM(NOM)=1200 RPM
TEMP(DP) = 49.00F	AIR RATE = 109.6347#/HR	ENGINE RPM(ACT)=1199. RPM
TEMP(BAR) = 81.00F	F/A RATIO= 0.0883#/#	BHP(OBS) = 8.6HP
BAR PRESS(OB)= 29.37"HG	PHIM = 1.3092	BHP(CORR) = 0.0HP
BAR PRESS(CR)= 29.23"HG	K = 3.5000	MAN VAC(OBS) =19.00"HG
SPEC HUMIDITY=0.0075#/#	C-BALANCE= 1	MAN PRESS(CORR)= 0.00"HG
CO2 AMBIENT = 0.045%	FUEL H/C = 2.0250	EXH H/C RATIO =1.850

	CYL1	CYL2	CYL3	CYL4	EXHAUST
CHT	405.0	405.0	405.0	405.0	
EGT	1060.0	985.0	1040.0	990.0	630.0

	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	87004.	2012.	3039.	93337.	87.	87.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1.2	0.87032	1.00228	26.96111	1659.551	0.09141	0.08832	3.498
MASS/MODE(LBM)		0.72116	0.01213	0.00908	0.49011	0.00056	0.00086
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2.1	0.87264	1.00000	26.91469	1655.206	0.09208	0.08832	4.249
MASS/MODE(LBM)		0.72119	0.01213	0.00905	0.49012	0.00056	0.00086
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.1	0.87125	0.99865	26.97652	1671.881	0.09091	0.08832	2.925
MASS/MODE(LBM)		0.72730	0.01223	0.00915	0.49427	0.00057	0.00087
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.2	0.87034	0.33763	26.97652	1659.507	0.09166	0.08832	3.777
MASS/MODE(LBM)		0.72116	0.00000	0.00908	0.49010	0.00000	0.00000

RUN NO. 74. 4
MODE: 6
COMMENTS: CARB. BASELINE, CYL. 4

TEMP(DB)	= 95. 90F	FUEL RATE=	9. 6837#/HR	ENGINE RPM(NOM)=	1200 RPM
TEMP(DP)	= 49. 00F	AIR RATE =	109. 6347#/HR	ENGINE RPM(ACT)=	1199. RPM
TEMP(BAR)	= 81. 00F	F/A RATIO=	0. 0883#/#	BHP(OBS) =	8. 6HP
BAR PRESS(OB)=	29. 37"HG	PHIM =	1. 3092	BHP(CORR) =	0. 0HP
BAR PRESS(CR)=	29. 23"HG	K =	3. 5000	MAN VAC(OBS) =	19. 00"HG
SPEC HUMIDITY=	0. 0075#/#	C-BALANCE=	1	MAN PRESS(CORR)=	0. 00"HG
CO2 AMBIENT	= 0. 045%	FUEL H/C =	2. 0250	EXH H/C RATIO =	1. 850

	CYL1	CYL2	CYL3	CYL4	EXHAUST	
CHT	405. 0	405. 0	405. 0	405. 0		
EGT	1060. 0	985. 0	1040. 0	990. 0	630. 0	
	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	79105.	1886.	3219.	105516.	71.	71.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1. 2	0. 87420	0. 99956	26. 67374	1613. 193	0. 09568	0. 08832	8. 331
MASS/MODE(LBM)		0. 64022	0. 01110	0. 00935	0. 54098	0. 00045	0. 00068
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2. 1	0. 87376	1. 00000	26. 68285	1613. 999	0. 09555	0. 08832	8. 180
MASS/MODE(LBM)		0. 64021	0. 01110	0. 00935	0. 54098	0. 00045	0. 00068
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3. 1	0. 87403	1. 00026	26. 67072	1610. 932	0. 09578	0. 08832	8. 445
MASS/MODE(LBM)		0. 63919	0. 01108	0. 00933	0. 54011	0. 00045	0. 00068
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3. 2	0. 87420	0. 34644	26. 67072	1613. 201	0. 09563	0. 08832	8. 275
MASS/MODE(LBM)		0. 64022	0. 00000	0. 00935	0. 54098	0. 00000	0. 00000

RUN NO. 74. 5
MODE: 6
COMMENTS: CARB. BASELINE, STACK

TEMP(DB)	= 95. 90F	FUEL RATE=	9. 6837#/HR	ENGINE RPM(NOM)=	1200 RPM
TEMP(DP)	= 49. 00F	AIR RATE =	109. 6347#/HR	ENGINE RPM(ACT)=	1199. RPM
TEMP(BAR)	= 81. 00F	F/A RATIO=	0. 0883#/#	BHP(OBS) =	8. 6HP
BAR PRESS(OB)=	29. 37"HG	PHIM =	1. 3092	BHP(CORR) =	0. 0HP
BAR PRESS(CR)=	29. 23"HG	K =	3. 5000	MAN VAC(OBS) =	19. 00"HG
SPEC HUMIDITY=	0. 0075#/#	C-BALANCE=	1	MAN PRESS(CORR)=	0. 00"HG
CO2 AMBIENT	= 0. 045%	FUEL H/C =	2. 0250	EXH H/C RATIO =	1. 850

	CYL1	CYL2	CYL3	CYL4	EXHAUST	
CHT	405. 0	405. 0	405. 0	405. 0		
EGT	1060. 0	985. 0	1040. 0	990. 0	630. 0	
	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	86806.	3270.	3263.	94069.	89.	89.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1. 2	0. 87022	1. 00928	26. 95511	1652. 663	0. 09116	0. 08832	3. 207
MASS/MODE(LBM)		0. 71645	0. 01962	0. 00971	0. 49184	0. 00057	0. 00087
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2. 1	0. 87972	1. 00000	26. 76445	1635. 066	0. 09389	0. 08832	6. 300
MASS/MODE(LBM)		0. 71656	0. 01962	0. 00961	0. 49191	0. 00056	0. 00086
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3. 1	0. 87401	0. 99449	27. 01826	1703. 812	0. 08908	0. 08832	0. 859
MASS/MODE(LBM)		0. 74184	0. 02032	0. 01001	0. 50927	0. 00059	0. 00090
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3. 2	0. 87029	0. 33877	27. 01826	1652. 487	0. 09215	0. 08832	4. 338
MASS/MODE(LBM)		0. 71643	0. 00000	0. 00971	0. 49183	0. 00000	0. 00000

RUN NO. 75.1
MODE: 7
COMMENTS: CARB. BASELINE, CYL. 1

TEMP(DB) = 95.20F	FUEL RATE= 5.3918#/HR	ENGINE RPM(NOM)= 700 RPM
TEMP(DP) = 57.00F	AIR RATE = 66.9652#/HR	ENGINE RPM(ACT)= 718. RPM
TEMP(BAR) = 82.00F	F/A RATIO= 0.0805#/#	BHP(OBS) = 5.1HP
BAR PRESS(OB)= 29.36"HG	PHIM = 1.1935	BHP(CORR) = 0.0HP
BAR PRESS(CR)= 29.22"HG	K = 3.5000	MAN VAC(OBS) =17.40"HG
SPEC HUMIDITY=0.0101#/#	C-BALANCE= 1	MAN PRESS(CORR)= 0.00"HG
CO2 AMBIENT = 0.045%	FUEL H/C = 2.0250	EXH H/C RATIO =1.850

	CYL1	CYL2	CYL3	CYL4	EXHAUST	
CHT	390.0	380.0	385.0	380.0		
EGT	780.0	785.0	850.0	790.0	430.0	
	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	105914.	1886.	2708.	65843.	107.	107.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1.2	0.86058	1.01000	27.51114	981.821	0.08324	0.08051	3.390
MASS/MODE(LBM)		0.17119	0.00222	0.00160	0.06741	0.00014	0.00021
MASS/HP/CYC(#/HP/C)		0.12725	0.00248	0.00147	0.06379	0.00032	0.00050
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2.1	0.87080	1.00000	27.31865	970.417	0.08587	0.08051	6.651
MASS/MODE(LBM)		0.17121	0.00222	0.00158	0.06742	0.00014	0.00021
MASS/HP/CYC(#/HP/C)		0.12726	0.00248	0.00145	0.06380	0.00032	0.00049
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.1	0.86492	0.99432	27.57617	1015.084	0.08117	0.08051	0.823
MASS/MODE(LBM)		0.17788	0.00230	0.00165	0.07005	0.00014	0.00022
MASS/HP/CYC(#/HP/C)		0.13073	0.00255	0.00150	0.06551	0.00033	0.00051
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.2	0.86069	0.32309	27.57617	981.664	0.08420	0.08051	4.580
MASS/MODE(LBM)		0.17118	0.00000	0.00160	0.06741	0.00000	0.00000
MASS/HP/CYC(#/HP/C)		0.12725	0.00000	0.00147	0.06379	0.00000	0.00000

RUN NO. 75.2
MODE: 7
COMMENTS: CARB. BASELINE, CYL. 2

TEMP(DB) = 95.20F	FUEL RATE= 5.3918#/HR	ENGINE RPM(NOM)= 700 RPM
TEMP(DP) = 57.00F	AIR RATE = 66.9652#/HR	ENGINE RPM(ACT)= 718. RPM
TEMP(BAR) = 82.00F	F/A RATIO= 0.0805#/#	BHP(OBS) = 5.1HP
BAR PRESS(OB)= 29.36"HG	PHIM = 1.1935	BHP(CORR) = 0.0HP
BAR PRESS(CR)= 29.22"HG	K = 3.5000	MAN VAC(OBS) =17.40"HG
SPEC HUMIDITY=0.0101#/#	C-BALANCE= 1	MAN PRESS(CORR)= 0.00"HG
CO2 AMBIENT = 0.045%	FUEL H/C = 2.0250	EXH H/C RATIO =1.850

	CYL1	CYL2	CYL3	CYL4	EXHAUST	
CHT	390.0	380.0	385.0	380.0		
EGT	780.0	785.0	850.0	790.0	430.0	
	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	104343.	1761.	2528.	68686.	118.	118.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1.2	0.86087	1.01073	27.45920	975.604	0.08392	0.08051	4.235
MASS/MODE(LBM)		0.16764	0.00206	0.00148	0.06990	0.00015	0.00023
MASS/HP/CYC(#/HP/C)		0.11961	0.00250	0.00147	0.06864	0.00027	0.00041
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2.1	0.87186	1.00000	27.25116	963.426	0.08678	0.08051	7.780
MASS/MODE(LBM)		0.16766	0.00206	0.00146	0.06991	0.00015	0.00023
MASS/HP/CYC(#/HP/C)		0.11962	0.00250	0.00146	0.06865	0.00026	0.00041
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.1	0.86550	0.99388	27.52924	1011.089	0.08169	0.08051	1.461
MASS/MODE(LBM)		0.17467	0.00214	0.00153	0.07284	0.00016	0.00024
MASS/HP/CYC(#/HP/C)		0.12204	0.00256	0.00149	0.06990	0.00027	0.00041
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.2	0.86099	0.32513	27.52924	975.437	0.08496	0.08051	5.526
MASS/MODE(LBM)		0.16763	0.00000	0.00148	0.06990	0.00000	0.00000
MASS/HP/CYC(#/HP/C)		0.11961	0.00000	0.00147	0.06864	0.00000	0.00000

?

MODE: 7

COMMENTS: CARB. BASELINE, CYL. 3

TEMP(DB) = 95. 20F	FUEL RATE= 5. 3918#/HR	ENGINE RPM(NOM)= 700 RPM
TEMP(DP) = 57. 00F	AIR RATE = 66. 9652#/HR	ENGINE RPM(ACT)= 718. RPM
TEMP(BAR) = 82. 00F	F/A RATIO= 0. 0805#/#	BHP(OBS) = 5. 1HP
BAR PRESS(OB)= 29. 36"HG	PHIM = 1. 1935	BHP(CORR) = 0. 0HP
BAR PRESS(CR)= 29. 22"HG	K = 3. 5000	MAN VAC(OBS) =17. 40"HG
SPEC HUMIDITY=0. 0101#/#	C-BALANCE= 1	MAN PRESS(CORR)= 0. 00"HG
CO2 AMBIENT = 0. 045%	FUEL H/C = 2. 0250	EXH H/C RATIO =1. 850

	CYL1	CYL2	CYL3	CYL4	EXHAUST	
CHT	390. 0	380. 0	385. 0	380. 0		
EGT	780. 0	785. 0	850. 0	790. 0	430. 0	
	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	93553.	2515.	3460.	84033.	74.	74.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1. 2	0. 86489	1. 00850	27. 12425	941. 214	0. 08864	0. 08051	10. 092
MASS/MODE(LBM)		0. 14568	0. 00285	0. 00196	0. 08289	0. 00009	0. 00014
MASS/HP/CYC(#/HP/C)		0. 12677	0. 00207	0. 00128	0. 06448	0. 00031	0. 00048
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2. 1	0. 87361	1. 00000	26. 95390	931. 965	0. 09105	0. 08051	13. 086
MASS/MODE(LBM)		0. 14571	0. 00285	0. 00194	0. 08291	0. 00008	0. 00014
MASS/HP/CYC(#/HP/C)		0. 12678	0. 00207	0. 00127	0. 06448	0. 00031	0. 00048
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3. 1	0. 86846	0. 99504	27. 18083	967. 883	0. 08679	0. 08051	7. 799
MASS/MODE(LBM)		0. 15043	0. 00294	0. 00201	0. 08559	0. 00009	0. 00014
MASS/HP/CYC(#/HP/C)		0. 12850	0. 00210	0. 00129	0. 06518	0. 00032	0. 00049
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3. 2	0. 86499	0. 33503	27. 18083	941. 093	0. 08952	0. 08051	11. 188
MASS/MODE(LBM)		0. 14568	0. 00000	0. 00195	0. 08289	0. 00000	0. 00000
MASS/HP/CYC(#/HP/C)		0. 12677	0. 00000	0. 00128	0. 06448	0. 00000	0. 00000

RUN NO. 75. 4

MODE: 7

COMMENTS: CARB. BASELINE, CYL. 4

TEMP(DB) = 95. 20F	FUEL RATE= 5. 3918#/HR	ENGINE RPM(NOM)= 700 RPM
TEMP(DP) = 57. 00F	AIR RATE = 66. 9652#/HR	ENGINE RPM(ACT)= 718. RPM
TEMP(BAR) = 82. 00F	F/A RATIO= 0. 0805#/#	BHP(OBS) = 5. 1HP
BAR PRESS(OB)= 29. 36"HG	PHIM = 1. 1935	BHP(CORR) = 0. 0HP
BAR PRESS(CR)= 29. 22"HG	K = 3. 5000	MAN VAC(OBS) =17. 40"HG
SPEC HUMIDITY=0. 0101#/#	C-BALANCE= 1	MAN PRESS(CORR)= 0. 00"HG
CO2 AMBIENT = 0. 045%	FUEL H/C = 2. 0250	EXH H/C RATIO =1. 850

	CYL1	CYL2	CYL3	CYL4	EXHAUST	
CHT	390. 0	380. 0	385. 0	380. 0		
EGT	780. 0	785. 0	850. 0	790. 0	430. 0	
	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	89241.	2465.	3536.	90769.	65.	65.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1. 2	0. 86665	1. 00774	26. 97679	926. 619	0. 09077	0. 08051	12. 740
MASS/MODE(LBM)		0. 13709	0. 00275	0. 00197	0. 08833	0. 00007	0. 00012
MASS/HP/CYC(#/HP/C)		0. 12196	0. 00171	0. 00124	0. 06761	0. 00029	0. 00044
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2. 1	0. 87460	1. 00000	26. 81931	918. 329	0. 09303	0. 08051	15. 549
MASS/MODE(LBM)		0. 13711	0. 00275	0. 00195	0. 08834	0. 00007	0. 00012
MASS/HP/CYC(#/HP/C)		0. 12195	0. 00171	0. 00125	0. 06761	0. 00029	0. 00045
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3. 1	0. 86985	0. 99543	27. 02893	950. 396	0. 08905	0. 08051	10. 609
MASS/MODE(LBM)		0. 14113	0. 00283	0. 00202	0. 09093	0. 00008	0. 00012
MASS/HP/CYC(#/HP/C)		0. 11861	0. 00167	0. 00122	0. 06624	0. 00028	0. 00043
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3. 2	0. 86673	0. 33977	27. 02893	926. 513	0. 09160	0. 08051	13. 770
MASS/MODE(LBM)		0. 13709	0. 00000	0. 00197	0. 08833	0. 00000	0. 00000
MASS/HP/CYC(#/HP/C)		0. 12197	0. 00000	0. 00124	0. 06761	0. 00000	0. 00000

RUN NO. 75.5
MODE: 7
COMMENTS: CARB. BASELINE, STACK

TEMP(DB)	= 95.20F	FUEL RATE=	5.3918#/HR	ENGINE RPM(NOM)=	700 RPM
TEMP(DP)	= 57.00F	AIR RATE =	66.9652#/HR	ENGINE RPM(ACT)=	718. RPM
TEMP(BAR)	= 82.00F	F/A RATIO=	0.0805#/#	BHP(OBS) =	5.1HP
BAR PRESS(OB)=	29.36"HG	PHIM =	1.1935	BHP(CORR) =	0.0HP
BAR PRESS(CR)=	29.22"HG	K =	3.5000	MAN VAC(OBS) =	17.40"HG
SPEC HUMIDITY=	0.0101#/#	C-BALANCE=	1	MAN PRESS(CORR)=	0.00"HG
CO2 AMBIENT	= 0.045%	FUEL H/C =	2.0250	EXH H/C RATIO =	1.850

	CYL1	CYL2	CYL3	CYL4	EXHAUST	
CHT	390.0	380.0	385.0	380.0		
EGT	780.0	785.0	850.0	790.0	430.0	
	CO2	O2	UHCC	CO	NO	NOX
CONC(PPM)	95441.	2515.	3265.	81518.	87.	87.

	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 1.2	0.86405	1.01011	27.18367	946.534	0.08773	0.08051	8.970
MASS/MODE(LBM)		0.14932	0.00286	0.00186	0.08079	0.00011	0.00016
MASS/HP/CYC(#/HP/C)		0.12215	0.00152	0.00101	0.06796	0.00031	0.00048 (OK)
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 2.1	0.87443	1.00000	26.98190	935.456	0.09058	0.08051	12.499
MASS/MODE(LBM)		0.14934	0.00286	0.00183	0.08080	0.00011	0.00016
MASS/HP/CYC(#/HP/C)		0.12215	0.00152	0.00101	0.06796	0.00031	0.00048
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.1	0.86831	0.99412	27.25076	978.652	0.08555	0.08051	6.262
MASS/MODE(LBM)		0.15515	0.00297	0.00192	0.08394	0.00011	0.00017
MASS/HP/CYC(#/HP/C)		0.12092	0.00151	0.00100	0.06750	0.00031	0.00047
	KWD	XTC	MWEXH	EXH FLOW	FACAL	FAM	ERROR
METHOD 3.2	0.86416	0.33350	27.25076	946.388	0.08877	0.08051	10.258
MASS/MODE(LBM)		0.14931	0.00000	0.00185	0.08079	0.00000	0.00000
MASS/HP/CYC(#/HP/C)		0.12215	0.00000	0.00101	0.06796	0.00000	0.00000