TASK NO. 4

EVALUATION OF EMISSIONS FROM MOTORIZED BICYCLES

CONTRACT NO. 68-03-2413

AESi
AUTOMOTIVE ENVIRONMENTAL SYSTEMS, INC.
A subsidiary of Clayton Manufacturing Company

EPA-420-R-78-105

TASK REPORT

TASK NO. 4
EVALUATION OF EMISSIONS FROM MOTORIZED BICYCLES

CONTRACT NO. 68-03-2413

for

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF MOBILE SOURCE AIR POLLUTION CONTROL
EMISSION CONTROL TECHNOLOGY DIVISION
ANN ARBOR, MICHIGAN 48105

PROJECT OFFICER - JOHN SHELTON

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SUBMITTED BY

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ABSTRACT

A study of exhaust emissions from ten motorized bicycles was conducted in the Los Angeles area during 1977 to determine the basic emission characteristics of this type of vehicle. This project was sponsored by the U.S. Environmental Protection Agency and performed by Automotive Environmental Systems, Incorporated (AESi).

The tests on these vehicles employed a dynamometer and analysis system developed for motorcycle testing.

Vehicles were tested over a range of steady state operating conditions as well as a modal emission driving sequence, developed specifically for this project.

The results from these tests are shown in Table A as a comparison with motorcycles and 1975 automobiles. The moped results indicate high HC, CO comparable with automobiles, low CO_2, very low (if any) NOx and very good fuel economy.

TABLE A

AVERAGE STEADY STATE EMISSION & FUEL ECONOMY RESULTS

		HC	CO	CO_2	NOx	Fuel Econ.
Idle	Mopeds (1)	1.11	1.52	2.6	0.00	1167.6
	Motorcycles (2)	1.91	6.62	-	0.01	-
	1975 Autos (3)	0.34	6.30	88.9	0.39	88.8
5 MPH Steady State	Mopeds	12.18	25.52	40.9	0.00	76.4
	Motorcycles	-	-	-	-	-
	1975 Autos	4.00	69.29	1069.1	0.76	7.5
10 MPH Steady State	Mopeds	6.18	14.46	27.6	0.00	130.3
	Motorcycles	-	-	-	-	-
	1975 Autos	1.84	30.36	653.4	0.48	12.6
15 MPH Steady State	Mopeds	4.93	13.83	25.7	0.00	146.6
	Motorcycles	-	-	-	-	-
	1975 Autos	1.16	19.44	464.5	0.46	17.8
20 MPH	Mopeds	4.67	15.54	28.49	0.00	138.2
	Motorcycles	8.99	60.61	-	.06	-
	1975 Autos	-	-	-	-	-
25 MPH Steady State	Mopeds	4.75	16.71	31.18	0.01	127.3
	Motorcycles	-	-	-	-	-
	1975 Autos	-	-	-	-	-
30 MPH Steady State	Mopeds	5.33	16.69	23.0	0.01	126.2
	Motorcycles	6.77	48.05	-	0.08	-
	1975 Autos	0.50	5.43	375.1	1.14	23.0

Emission results in grams per mile (per minute for idle)
Fuel economy results in miles per gallon (minutes per gallons for idle).

(1) Average of 10 mopeds tested at AESi (Contract No. 68-03-2413).
(2) These results are the average of seven 1971-72 motorcycles tested by SWRI in 1972 (Contract No. EHS-70-108). The engine displacements ranged from 125-1200cc. Four were 4-stroke cycle and three were 2-stroke cycle.
(3) These results are the average of 225 1975 model year non-California low-altitude vehicles tested in the FY-74 emission factor program (EPA Report No. 460/3-76-019).

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SECTION 1

1.0 INTRODUCTION

The testing project described in this report was performed as Task 4 of EPA Contract No. 68-03-2413. The purpose of this project was to provide emission data for motorized bicycles in order to assess the impact these vehicles have on air quality.

The vehicles tested in this program were in-use and rented motorized bicycles, commonly known as mopeds. The definition of a motorized bicycle is as follows:

> A motorized bicycle is a bicycle with a helper motor of between 1 and 2 brake horsepower, which when pedalled or operated with the motor, is capable of ordinary speeds up to 20 to 30 miles per hour. The maximum horsepower and speed are set by state law. The vehicle can be mounted, started, pedalled, controlled, and stopped like a bicycle.
>
> Both lighting and ignition are provided by a magneto flywheel turned by the engine. Most motorized bicycles have two stroke single cylinder engines which require a mixture of gasoline and oil as fuel.
>
> Motorized bicycles have a centrifugal clutch which acts as an automatic transmission and greatly simplifies the operation of the vehicle. They have hand brakes. Power from the motor is delivered either to the rear wheel by means of a pulley running from the crankshaft to the sprocket which then drives a chain to the wheel, or to the front wheel by a friction roller set on top of the wheel.

All vehicles were tested using a CVS (Constant Volume Sampler), a motorcycle dynamometer and sample analysis system previously qualified by the EPA for Contract 68-03-2413.

Specific tests performed on these warmed-up vehicles included a road load determination test which determined the load characteristics of each vehicle; a series of steady states at idle, 5, 10, 15, 20, 25 and 30 mph; and a modal emission test. These tests were developed specifically for the mopeds because they have less than a 50 cc displacement and due to the lack of power were not able to follow the motorcycle driving cycle.

Emission measurements were recorded continuously under the above operating conditions and the hydrocarbons (HC), carbon monoxide (CO), carbon dioxide (CO_2) and oxides of nitrogen (NOx) are reported in grams per mile. To convert these measurements to grams per kilometer simply multiply grams per mile by a factor of 0.6215.

SECTION 2

TECHNICAL DISCUSSION

2.1 PROGRAM OBJECTIVES

The primary objective of this study is to provide exhaust emission data of typical motorized bicycles. These vehicles are commonly known as "Mopeds" and will be referred to as such in this report. The data from this study may be used to analyze mobil source control strategies and to assess the impact of this type of vehicle on air quality.

2.2 PROGRAM DESIGN

The program was designed to obtain two basic types of information from all vehicles. The first type was to determine the road load characteristics of each moped on an outdoor test surface. The second type was to obtain emission data using the modal cycle shown in Figure 2.1 and Table 2.1.

2.2.1 MODAL CYCLE DEVELOPMENT

Due to the lack of information concerning moped testing and the fact that moped emission testing is a relatively new state of the art, a meaningful modal test cycle was needed to quantify emission results.

Using guidelines supplied by the EPA Project Officer, AESi developed a cycle with the following acceleration and decelerations:

Accelerations (WOT)	Decelerations (Same average rate as WOT)
0-10 mph	10-0 mph
5-20 mph	20-5 mph
0-25 mph	25-0 mph
15-25 mph	25-15 mph

In order to develop the speed time listing for the cycle, 3 typical mopeds were run at WOT on the dynamometer. The distance traveled during the acceleration was measured and the same distance and rate of speed change was used for the corresponding deceleration rate between the two speeds. This speed/time listing as shown in Table 2.1 was used for all mopeds.

2.3 TEST VEHICLE PROCUREMENT

The EPA provided guidelines for selection of the test fleet. The guidelines stated that at least five (5) of the vehicles be in-use vehicles and the remainder may be rented vehicles. The EPA also requested that a variety of model year vehicles be tested, however as selection began AESi found that because of the recent emergence of mopeds, only late model mopeds could be found.

2.3.1 TEST VEHICLE SELECTION

The main body of the test fleet was procured by solicitation of prospective owners through local high schools and colleges. This solicitation was performed by means of a letter which explained the program and offered incentives for participation.

2.3.2 INCENTIVES

The normal incentives permitted by the basic Task Orders under which this study was performed were a $50 savings bond, a full tank of fuel when returned to the owner, and the use of a late model, fully-insured loan car.

Due to the age-group from which the test fleet was procured, the EPA allowed AESi to modify the incentive program. The fully-insured loan car was eliminated due to insurance regulations regarding minors operating loan cars. In most cases, the participants requested cash in lieu of the savings bond and were given a check instead.

TABLE 2.1

ACCELERATION/DECELERATION MODES OF MOPED MODAL SEQUENCE

MODE			TIME IN MODE (SEC)	AVERAGE SPEED (MPH)	AVERAGE ACCEL RATE (MPH/SEC)	DISTANCE (MILES)
NO.	TYPE	SPEED RANGE (MPH)				
1	Accel	0-10	6	5.62	1.67	0.00797
2	Decel	10-0	6	5.62	-1.67	0.00797
3	Accel	5-20	11	13.42	1.36	0.03753
4	Decel	20-5	11	13.42	-1.36	0.03753
5	Accel	0-25	19	12.96	1.32	0.06494
6	Decel	25-0	19	12.96	-1.32	0.06494
7	Accel	15-25	10	22.00	1.00	0.05556
8	Decel	25-15	10	22.00	-1.00	0.05556

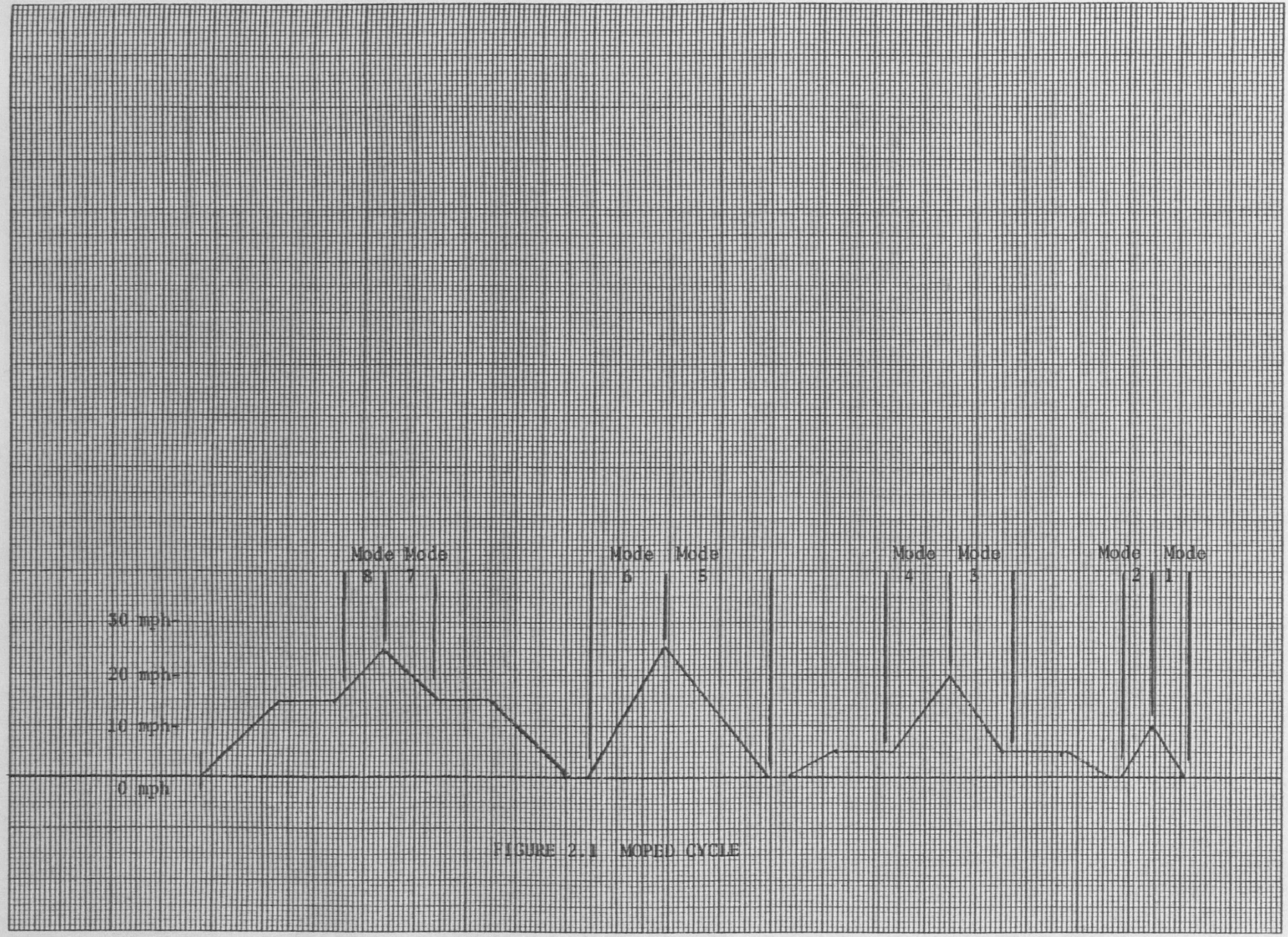


FIGURE 2.1 MOPED CYCLE

2.3.3 TEST VEHICLE HANDLING

Upon delivery at the test site, each vehicle was initially inspected for proper operation of basic safety features and was then scheduled for road load and emission testing.

2.4 TEST PROCEDURES

2.4.1 VEHICLE PREPARATION

All vehicles tested in this program were inspected upon receipt from the owner. The mopeds were inspected for the following safety items:

- Headlights and taillights - must be operational for bike to start.

- Braking - both front and rear operation.

- Tires - Must not have any cord showing.

Following the vehicle inspection, the owner completed a test agreement and filled out either a bond application or cash request.

Upon acceptance of the vehicle for testing, the fuel tank was drained and filled with the manufacturer's recommended fuel/oil mixtures.

2.4.2 ROAD LOAD CHARACTERISTIC DETERMINATION

After the mopeds were accepted for testing, the inertia weight for each vehicle was determined by adding 150 pounds (68 Kg) to the dry weight (supplied by manufacurer) of the vehicles.

The road load characteristics were determined by the following procedure:

> "The vehicles shall be operated on a smooth flat surface with little or no wind by a driver that weighs 150 ±10 lbs. The vehicle shall be operated at wide open throttle with the resulting stabilized velocity recorded. This measurement shall be repeated in the opposite direction to compensate for any wind that is present. This entire procedure shall be repeated three (3) times to obtain a total of six data points. The average velocity of the six runs shall be the average maximum velocity for future tests. The vehicle shall be operated from a standing start to maximum velocity at wide open throttle. The elapsed time for the acceleration shall also be recorded."

The information from this test was recorded on a form shown in Figure 2.2.

2.4.3 DYNAMOMETER TESTING

The AESi Motorcycle dynamometer, MCD 8400, was used for all moped tests. This particular dynamometer model has 140 Kg as its lowest inertia setting (the heaviest moped was 119 Kg) therefore the road load was set to zero and the following procedure was used to set the vehicle road load:

> "The vehicle was placed on the dynamometer at 140 Kg inertia with the road load equal to zero. The vehicle was then accelerated at wide open throttle. While at wide open throttle the road load control was adjusted to obtain the average maximum velocity obtained from the procedure stated in 2.4.2."

This adjusted road load setting was then used for all subsequent tests on that vehicle.

MOPED TASK ORDER

Veh. No. _____ Inertia (Kg) _____ Yr Mo Day _____ Driver _____

ROAD LOAD DETERMINATION

	1st Direction		2nd Direction	
(1)	Max Spd (Stabile) _____	Elapsed Time (Sec) _____	Max Spd _____	Elap. Time _____
(2)	Max Spd _____	Elap. Time _____	Max Spd _____	Elap. Time _____
(3)	Max Spd _____	Elap. Time _____	Max Spd _____	Elap. Time _____

AVERAGE

Max Spd _____ Elap. Time _____

Figure 2.2

Road Load Characteristics Form

2.4.4 STEADY STATE TESTS

Following preconditioning which consisted of the procedure in 2.4.3 and a 3 minute cruise at 19 mph the Steady State exhaust emissions were measured using the CVS dilute bag collection technique. Measurements were taken at each speed successively from idle (0 mph) through 5, 10, 15, 20, 25 and 30 (when vehicle was capable) mph. The exhaust emissions were continuously monitored and recorded on a strip chart recorder. For continuous sampling, the analytical system was equipped with a sample bypass to decrease delay time. Chart speed was 4 inches/min. At each speed, equilibrium of speed and all analyzer traces were maintained for at least 30 seconds before sampling started. A minimum sample volume of 2 cubic feet and a sample time of 5 minutes were required. Between each steady state, the moped was run at 10 mph to prevent engine load-up and to stabilize the vehicle.

2.4.5 MODAL TEST

Following the steady-state test each vehicle was sampled using the modal cycle shown in Figure 2.1. Because only the specific modes shown in paragraph 2.2.1 were sampled, emission measurements were sampled through the continuous dilute stream only. Bag collection was not performed during this cycle. All gram per mile results are computed values based on distance per mode.

SECTION 3
DISCUSSIONS

3.0 DISCUSSION OF TEST PROCEDURES

As shown in Table 3.1, which summarizes the ten (10) mopeds tested, all vehicles have engine displacements less than 50 cc. Due to engine size and lack of power it was impossible to use the existing motorcycle emission test procedures for moped testing. Therefore, EPA and AESi developed the procedures discussed in Section 2 to better quantify moped emissions.

One problem discovered during this program was that the motorcycle dynamometer utilized by AESi had 140 Kg as its lowest inertia setting. Since the heaviest moped (with rider) was 119 Kg it was necessary to manually set the road load to correspond with each moped's maximum wide open throttle speed. While this manual setting did not affect emission results, it was time consuming. Therefore it is recommended that in future studies a motorcycle dynamometer with a minimum of 100 Kg inertia capability be used. This would assure a more accurate road load setting and could be checked against the Federal Register specifications.

3.1 EMISSION RESULTS

The average exhaust emission results are presented in Tables 3.2 and 3.3. The HC, CO, CO_2 and NOx are shown as grams per mile except for '0' mph (idle) which are grams per minute. Fuel economies are represented as miles per gallon except for idle which are minutes per gallon.

- Table 3.2 - Average steady state emission results for Mopeds.
- Table 3.3 - Average modal emission for ten California mopeds.

TABLE 3.1

LISTING OF VEHICLES

VEHICLE #	YEAR	MAKE	MODEL	DISPLACEMENT, CC	INERTIA, KGS
M001	1976	Moto Milan	Smilly	49.0	119
M002	1976	Motobecane	"50"	49.9	113
M003	1976	Motobecane	"40"	49.9	109
M004	1977	Peugot	103	49.0	115
M005	1977	Honda	Express	49.0	111
M006	1971	Vespa	CIAO	49.0	111
M007	1976	Peugeot	103	49.0	115
M008	1976	Honda	Express	49.0	111
M009	1977	Puch	Maxi	48.8	112
M010	1975	Motobecane	"50"	49.9	113

TABLE 3.2

AVERAGE STEADY STATE EMISSION RESULTS

FOR MOPEDS

SPEED (MPH)	HC	CO	CO_2	NOxc	FUEL ECONOMY
'0' mph (idle)	1.11	1.52	2.61	0.00	1167.59
5 mph	12.18	25.52	40.87	0.00	76.40
10 mph	6.18	14.46	27.56	0.00	130.30
15 mph	4.93	13.83	25.70	0.00	146.60
20 mph	4.67	15.54	28.49	0.00	138.16
25 mph	4.75	16.71	31.18	0.01	127.32
30 mph	5.33	16.69	22.98	0.01	126.16

NOTE: Exhaust emission results are shown in gms/mile (gm/min for idle).

Fuel economies are shown miles/gallon (min/gal for idle).

TABLE 3.3

AVERAGE MODAL EMISSIONS FOR TEN CALIFORNIA MOPEDS

SPEED RANGE (MPH)	HC	CO	CO_2	NOxc	FUEL ECONOMY (MPG)
	gm/mi				
0-10	17.08	49.91	217.85	0.00	27.55
10-0	25.35	31.49	105.27	0.00	40.40
5-20	8.23	22.92	72.82	0.00	66.46
20-5	9.06	14.63	47.83	0.00	96.22
0-25	9.58	24.28	72.98	0.06	63.22
25-0	9.19	15.49	48.09	0.12	93.59
15-25	5.63	19.60	55.13	0.00	87.03
25-15	6.74	12.67	35.41	0.05	125.01

NOTE: The AESi Motorcycle dynamometer, MCD 8400, was used for all moped tests. This particular dynamometer model has 140 Kg as its lowest inertia setting (the heaviest moped was 119 Kg).

Appendices B and C show the emission results for each moped tested.

- Appendix B - Steady State Results by Vehicle

- Appendix C - Modal Emissions by Vehicle

APPENDIX A

Road Load Characteristics

Data Sheets

MOPED TASK ORDER

M 0 0 1 — Veh. No. | 1 1 9 — Inertia (Kg) | 7 7 0 8 1 8 — Yr Mo Day | Driver JE

ROAD LOAD DETERMINATION

	1st Direction		2nd Direction	
(1)	3 3 . 0 — Max Spd (Stabile)	1 1 . 9 — Elapsed Time (Sec)	3 5 . 0 — Max Spd	1 0 . 0 — Elap. Time
(2)	3 3 . 0 — Max Spd	1 1 . 5 — Elap. Time	3 5 . 0 — Max Spd	1 0 . 4 — Elap. Time
(3)	3 4 . 0 — Max Spd	1 2 . 1 — Elap. Time	3 . 5 — Max Spd	1 1 . 2 — Elap. Time

AVERAGE

3 4 . 16 — Max Spd | 1 1 . 18 — Elap. Time

MOPED TASK ORDER

M 0 0 2	1 1 3	7 7 0 8 2 5	Driver JE
Veh. No.	Inertia (Kg)	Yr Mo Day	

ROAD LOAD DETERMINATION

	1st Direction		2nd Direction	
(1)	3 0 . 0 Max Spd (Stabile)	2 6 . 7 Elapsed Time (Sec)	3 0 . 0 Max Spd	2 6 . 0 Elap. Time
(2)	3 0 . 0 Max Spd	2 6 . 1 Elap. Time	2 8 . 5 Max Spd	2 6 . 9 Elap. Time
(3)	3 0 . 0 Max Spd	2 4 . 0 Elap. Time	2 9 . 0 Max Spd	2 4 . 0 Elap. Time

AVERAGE

2 9 . 6	2 5 . 6
Max Spd	Elap. Time

MOPED TASK ORDER

M 0 0 3 (Veh. No.) 1 0 9 (Inertia (Kg)) 7 7 0 8 7 7 (Yr Mo Day) Driver JE

ROAD LOAD DETERMINATION

	1st Direction		2nd Direction	
(1)	29.0 Max Spd (Stabile)	20.2 Elapsed Time (Sec)	29.9 Max Spd	21.8 Elap. Time
(2)	28.9 Max Spd	22.0 Elap. Time	30.0 Max Spd	21.3 Elap. Time
(3)	29.9 Max Spd	23.4 Elap. Time	30.0 Max Spd	21.8 Elap. Time

AVERAGE

29.6 Max Spd 21.8 Elap. Time

MOPED TASK ORDER

M 0 0 4 (Veh. No.) 1 1 5 (Inertia (Kg)) 7 7 9 0 2 9 (Yr Mo Day) Driver JE

ROAD LOAD DETERMINATION

	1st Direction		2nd Direction	
(1)	32.0 Max Spd (Stabile)	201 Elapsed Time (Sec)	32.0 Max Spd	186 Elap. Time
(2)	32.0 Max Spd	198 Elap. Time	32.0 Max Spd	192 Elap. Time
(3)	32.0 Max Spd	197 Elap. Time	32.0 Max Spd	191 Elap. Time

AVERAGE

32.0 Max Spd 194 Elap. Time

MOPED TASK ORDER

M 0 0 5	1 1 1	7 7 0 8 2 5	Driver JE
Veh. No.	Inertia (Kg)	Yr Mo Day	

ROAD LOAD DETERMINATION

	1st Direction		2nd Direction	
(1)	3 0 0 Max Spd (Stabile)	1 1 6 Elapsed Time (Sec)	3 0 0 Max Spd	1 1 4 Elap. Time
(2)	3 0 0 Max Spd	1 1 1 Elap. Time	3 0 0 Max Spd	1 1 7 Elap. Time
(3)	3 0 0 Max Spd	1 1 8 Elap. Time	3 0 0 Max Spd	1 1 9 Elap. Time

AVERAGE

3 0 0	1 1 6
Max Spd	Elap. Time

MOPED TASK ORDER

M 0 0 6 (Veh. No.) 1 1 1 (Inertia (Kg)) 7 7 0 9 2 1 (Yr Mo Day) Driver JE

ROAD LOAD DETERMINATION

	1st Direction		2nd Direction	
(1)	30.0 Max Spd (Stabile)	18.81 Elapsed Time (Sec)	25.0 Max Spd	17.64 Elap. Time
(2)	28.6 Max Spd	15.07 Elap. Time	26.6 Max Spd	19.29 Elap. Time
(3)	29.0 Max Spd	16.28 Elap. Time	26.5 Max Spd	18.59 Elap. Time

AVERAGE

27.4 Max Spd | 17.6 Elap. Time

MOPED TASK ORDER

M 0 0 7 (Veh. No.) 1 1 5 (Inertia (Kg)) 7 7 0 9 2 0 (Yr Mo Day) Driver JE

ROAD LOAD DETERMINATION

	1st Direction		2nd Direction	
(1)	2 9 9 Max Spd (Stabile)	2 1 8 Elapsed Time (Sec)	2 8 0 Max Spd	2 4 9 Elap. Time
(2)	2 8 9 Max Spd	2 1 2 Elap. Time	2 8 4 Max Spd	2 1 4 Elap. Time
(3)	2 8 8 Max Spd	2 3 8 Elap. Time	2 7 9 Max Spd	2 4 3 Elap. Time

AVERAGE

2 8 7 Max Spd 2 3 6 Elap. Time

MOPED TASK ORDER

M 0 0 8 — Veh. No. 1 1 1 — Inertia (Kg) 0 9 2 2 7 7 — Yr Mo Day Driver Diana

ROAD LOAD DETERMINATION

	1st Direction		2nd Direction	
(1)	30.0 Max Spd (Stabile)	157 Elapsed Time (Sec)	30.2 Max Spd	141 Elap. Time
(2)	30.0 Max Spd	150 Elap. Time	29.9 Max Spd	170 Elap. Time
(3)	30.0 Max Spd	168 Elap. Time	29.9 Max Spd	168 Elap. Time

AVERAGE

30.0 Max Spd 159 Elap. Time

MOPED TASK ORDER

M 0 0 9 — Veh. No. | 1 1 2 — Inertia (Kg) | 7 7 0 9 2 2 — Yr Mo Day | Driver JE

ROAD LOAD DETERMINATION

	1st Direction		2nd Direction	
(1)	32.0 Max Spd (Stabile)	182 Elapsed Time (Sec)	30.0 Max Spd	192 Elap. Time
(2)	32.0 Max Spd	200 Elap. Time	30.0 Max Spd	220 Elap. Time
(3)	32.0 Max Spd	185 Elap. Time	30.0 Max Spd	208 Elap. Time

AVERAGE

31.0 Max Spd | 198 Elap. Time

MOPED TASK ORDER

M 0 1 0 — Veh. No. 1 1 3 — Inertia (Kg) 7 7 0 9 2 3 — Yr Mo Day Driver DW

ROAD LOAD DETERMINATION

	1st Direction		2nd Direction	
(1)	2 9 5 Max Spd (Stabile)	1 9 5 Elapsed Time (Sec)	3 1 0 Max Spd	1 7 5 Elap. Time
(2)	3 0 0 Max Spd	1 8 4 Elap. Time	3 1 0 Max Spd	1 7 9 Elap. Time
(3)	3 0 0 Max Spd	1 8 6 Elap. Time	3 1 0 Max Spd	1 7 5 Elap. Time

AVERAGE

3 0 4 Max Spd 1 8 2 Elap. Time

APPENDIX B

Steady State Results by Vehicle

Appendix B

Steady State Results by Vehicle

Vehicle No: M001 Make: Moto Milan
Model: Smilly Model Year: 1976

- - - - - - - - g/mi - - - - - - - -

	HC	CO	CO_2	NOx	FUEL ECONOMY*
0 mph**	1.04	0.90	1.76	0.00	1371.52
5 mph	14.41	26.24	32.32	0.00	74.36
10 mph	7.13	13.53	20.72	0.00	137.28
15 mph	5.09	11.52	19.66	0.00	164.50
20 mph	4.58	12.67	16.79	0.00	173.11
25 mph	6.13	15.16	15.80	0.00	150.13
30 mph	9.89	17.13	19.10	0.00	114.59

Vehicle No: M002 Make: Motobecane
Model: "50" Model Year: 1976

- - - - - - - - g/mi - - - - - - - -

	HC	CO	CO_2	NOx	FUEL ECONOMY*
0 mph	1.01	1.56	2.59	0.00	1075.05
5 mph	8.76	17.63	29.96	0.00	103.78
10 mph	6.11	16.93	27.63	0.00	120.46
15 mph	2.62	2.11	44.09	0.00	159.21
20 mph	8.00	24.40	33.12	0.03	91.57
25 mph	5.35	21.54	32.03	0.00	107.04
30 mph	6.28	22.76	28.91	0.00	104.83

Vehicle No: M003 Make: Motobecane
Model: "40" Model Year: 1976

- - - - - - - - g/mi - - - - - - - -

	HC	CO	CO_2	NOx	FUEL ECONOMY*
0 mph	1.33	1.80	0.51	0.00	1175.80
5 mph	9.75	35.49	55.45	0.00	62.38
10 mph	3.78	9.81	23.40	0.00	174.55
15 mph	3.78	16.06	28.24	0.00	135.46
20 mph	2.37	11.21	34.96	0.00	147.57
25 mph	3.42	15.27	32.93	0.02	130.85
30 mph	4.59	24.00	33.78	0.04	103.05

*Fuel economy in mi/gal except "0" in min/gal
**"0" mph emissions in grams per minute

Appendix B
Steady State Results by Vehicle
page 2

Vehicle No: M004 Make: Peugot
Model: 103 Model Year: 1976

g/mi

	HC	CO	CO_2	NOx	FUEL ECONOMY*
0 mph**	1.47	1.26	0.65	0.00	1217.22
5 mph	15.25	25.40	9.88	0.02	90.34
10 mph	9.38	20.23	23.96	0.00	103.73
15 mph	7.25	19.38	9.34	0.00	141.24
20 mph	6.70	20.51	24.36	0.00	113.79
25 mph	7.57	23.27	27.78	0.00	100.37
30 mph	5.39	20.59	24.33	0.00	120.21

Vehicle No: M005 Make: Honda
Model: Express Model Year: 1976

g/mi

	HC	CO	CO_2	NOx	FUEL ECONOMY*
0 mph	0.55	0.86	2.29	0.00	1646.94
5 mph	6.85	16.28	69.13	0.00	76.16
10 mph	4.21	9.57	43.88	0.00	122.71
15 mph	4.01	11.57	13.19	0.00	201.13
20 mph	2.96	8.97	28.80	0.00	169.61
25 mph	2.93	9.89	25.71	0.00	175.45
30 mph	2.96	8.92	29.84	0.00	166.55

Vehicle No: M006 Make: Vespa
Model: GA10 Model Year: 1971

g/mi

	HC	CO	CO_2	NOx	FUEL ECONOMY*
0 mph	0.62	2.76	8.66	0.00	592.03
5 mph	6.93	32.96	61.54	0.00	65.54
10 mph	3.46	14.16	39.77	0.00	121.49
15 mph	2.62	11.57	36.17	0.00	141.52
20 mph	2.71	9.82	28.52	0.00	168.76
25 mph	3.55	12.82	39.95	0.02	124.28
30 mph	None - wouldn't accel above 25 mph				

*Fuel economy in mi/gal except "0" mph in min/gal
** "0" mph emissions in grams per minute

Vehicle No: M007 Make: Peugot
Model: 103 Model Year: 1976

- - - - - - - - g/mi - - - - - - - -

	HC	CO	CO_2	NOx	FUEL ECONOMY*
0 mph**	1.63	1.79	1.98	0.00	889.65
5 mph	18.75	31.15	50.85	0.00	55.56
10 mph	6.91	20.50	22.40	0.00	115.87
15 mph	7.43	26.03	29.78	0.00	94.09
20 mph	6.33	26.10	32.93	0.00	94.32
25 mph	7.07	24.91	48.14	0.06	75.43
30 mph	None - wouldn't accel above 25 mph				

Vehicle No: M008 Make: Honda
Model: Express Model Year: 1976

- - - - - - - - g/mi - - - - - - - -

	HC	CO	CO_2	NOx	FUEL ECONOMY*
0 mph	0.80	0.75	2.20	0.00	1495.97
5 mph	15.07	29.65	32.45	0.00	69.92
10 mph	6.82	14.80	18.54	0.00	139.81
15 mph	5.76	14.21	27.21	0.00	130.78
20 mph	4.29	12.44	28.21	0.00	144.51
25 mph	3.01	10.39	25.96	0.00	171.08
30 mph	6.17	15.29	20.01	0.00	139.42

Vehicle No: M009 Make: Puch
Model: Maxi Model Year: 1977

- - - - - - - - g/mi - - - - - - - -

	HC	CO	CO_2	NOx	FUEL ECONOMY*
0 mph	1.60	2.41	4.90	0.00	644.34
5 mph	16.44	18.73	18.02	0.00	89.04
10 mph	9.54	15.43	30.12	0.00	104.79
15 mph	7.43	16.27	24.47	0.00	120.49
20 mph	6.17	16.09	25.84	0.00	125.44
25 mph	4.93	18.94	28.57	0.00	119.89
30 mph	3.97	14.26	32.22	0.02	131.92

*Fuel economy in mi/gal except "0" mph in min/gal
**"0" mph emissions in grams/min

Appendix B
Steady State Results by Vehicle
page 4

Vehicle No: M010 Make: Motobecane
Model: "40" Model Year: 1976

- - - - - - - - g/mi - - - - - - - -

	HC	CO	CO_2	NOx	FUEL ECONOMY*
0 mph**	1.06	1.13	0.52	0.00	1567.36
5 mph	9.63	22.69	49.11	0.00	76.91
10 mph	4.50	9.65	25.20	0.00	162.30
15 mph	3.16	9.60	24.84	0.00	177.54
20 mph	2.63	13.11	31.35	0.00	147.08
25 mph	3.51	14.90	34.97	0.00	127.56
30 mph	3.39	10.55	41.56	0.05	128.73

*Fuel economy in mi/gal except "0" mph in min/gal
**"0" mph emissions in grams/min

APPENDIX C

Modal Emissions By Vehicle for Low Altitude California Mopeds

APPENDIX C

MODAL EMISSIONS BY VEHICLE
FOR LOW ALTITUDE,
CALIFORNIA MOPEDS

VEHICLE #M001

SPEED/ RANGE (MPH)	HC	CO	CO_2	NOxc	FUEL ECONOMY (MPG)
		gm/mi			
0-10	20.33	42.91	195.73	0.00	27.07
10-0	31.37	51.44	99.12	0.00	31.73
5-20	7.99	24.78	68.48	0.00	66.80
20-5	10.13	19.72	48.23	0.00	79.64
0-25	10.32	27.41	69.30	0.00	61.11
25-0	10.47	20.17	41.12	0.00	83.64
15-25	5.40	18.72	47.34	0.00	94.46
25-15	6.84	16.74	29.88	0.00	113.86

VEHICLE #M002

0-10	18.32	45.55	189.46	0.00	27.79
10-0	25.09	27.60	84.07	0.00	42.83
5-20	6.93	21.85	62.35	0.00	74.73
20-5	8.53	18.39	42.10	0.00	90.44
0-25	9.70	27.72	58.21	0.00	66.91
25-0	8.31	16.01	44.66	0.15	92.20
15-25	5.58	20.15	59.22	0.00	81.67
25-15	6.29	13.68	32.39	0.00	120.10

VEHICLE #M003

0-10	31.37	40.40	160.61	0.00	27.40
10-0	35.13	32.62	90.34	0.00	35.05
5-20	7.19	22.65	62.35	0.00	73.44
20-5	7.73	10.39	49.29	0.00	98.38
0-25	9.55	21.25	64.98	0.15	68.92
25-0	8.01	8.32	50.20	0.15	100.00
15-25	4.68	16.56	51.30	0.00	96.22
25-15	5.58	7.38	37.08	0.18	133.60

Appendix C
Modal Emissions by Vehicle for Low Altitude, California Mopeds
page 2

VEHICLE #M004

SPEED/ RANGE (MPH)	HC	CO	CO_2	NOxc	FUEL ECONOMY (MPG)
		gm/mi			
0-10	6.27	99.75	203.26	0.0	23.34
10-0	22.59	22.59	82.82	0.0	46.68
5-20	8.26	26.11	66.88	0.0	66.12
20-5	10.39	24.51	48.23	0.0	74.08
0-25	9.09	28.18	59.13	0.0	67.06
25-0	11.55	34.80	50.97	0.0	62.32
15-25	6.66	28.44	46.44	0.0	79.00
25-15	7.74	20.16	33.30	0.0	99.05

VEHICLE #M005

0-10	15.06	86.57	224.59	0.00	21.71
10-0	30.11	25.09	48.93	0.00	48.23
5-20	7.46	21.58	61.28	0.00	74.61
20-5	6.66	6.39	16.52	0.00	185.96
0-25	8.47	20.17	68.37	0.15	69.86
25-0	6.62	7.70	18.32	0.15	172.47
15-25	4.68	14.22	46.62	0.00	105.81
25-15	5.22	5.04	11.16	0.00	248.83

VEHICLE #M006

0-10	8.41	15.81	274.78	0.00	27.18
10-0	12.55	52.70	208.28	0.00	26.80
5-20	4.53	21.58	100.19	0.00	59.73
20-5	6.66	11.46	57.02	0.00	92.23
0-25	6.16	23.41	102.40	0.15	55.87
25-0	8.62	14.94	63.29	0.15	77.71
15-25	3.60	16.20	69.83	0.00	83.11
25-15	6.30	10.98	48.78	0.18	103.10

Appendix C
Modal Emissions by Vehicle for Low Altitude, California Mopeds
page 3

VEHICLE #M007

SPEED/ RANGE (MPH)	HC	CO	CO_2	NOxc	FUEL ECONOMY (MPG)
		gm/mi			
0-10	13.17	1.26	111.98	0.00	56.94
10-0	6.27	26.35	65.24	0.00	70.08
5-20	15.45	34.11	65.55	0.00	52.74
20-5	15.19	26.91	51.96	0.00	62.26
0-25	14.63	34.49	67.60	0.00	52.72
25-0	12.78	21.56	57.90	0.15	67.02
15-25	9.72	33.48	59.04	0.00	62.24
25-15	10.44	19.80	44.28	0.00	81.73

VEHICLE #M008

0-10	13.93	65.24	338.77	0.00	18.27
10-0	38.90	23.84	82.81	0.00	36.39
5-20	10.39	30.38	66.61	0.00	60.20
20-5	9.86	12.26	35.70	0.00	102.83
0-25	12.32	32.49	64.06	0.00	57.51
25-0	10.16	17.25	37.88	0.00	91.22
15-25	5.94	18.54	51.66	0.00	89.00
25-15	7.92	16.20	31.32	0.00	108.28

VEHICLE #M009

0-10	13.80	33.88	264.74	0.00	24.51
10-0	23.84	30.11	158.09	0.00	31.56
5-20	8.26	13.32	82.07	0.00	68.64
20-5	9.06	12.26	65.55	0.00	78.10
0-25	8.01	14.01	81.77	0.00	68.64
25-0	8.62	12.47	50.51	0.00	91.00
15-25	5.94	15.30	59.22	0.00	86.85
25-15	6.12	12.42	39.96	0.00	112.41

Appendix C
Modal Emissions by Vehicle for Low Altitude, California Mopeds
page 4

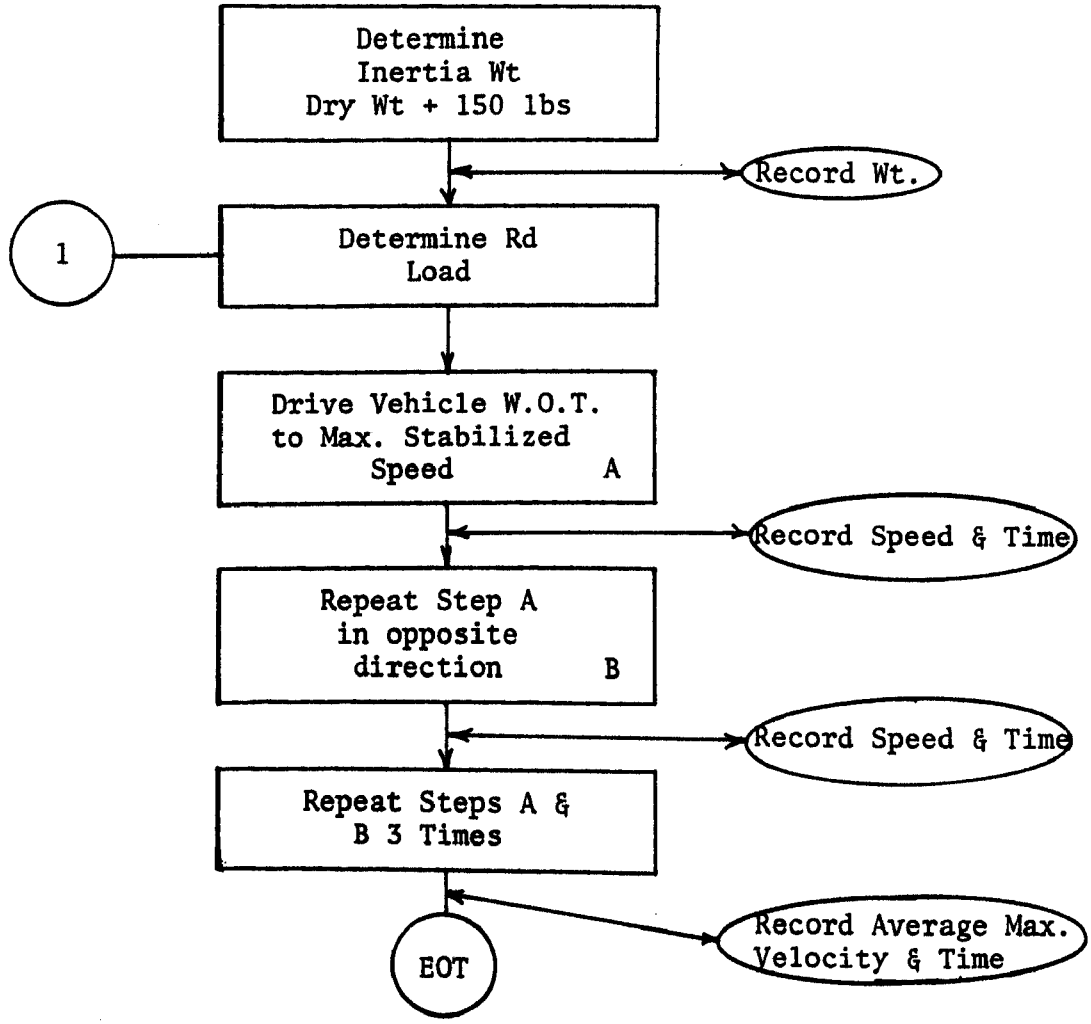
VEHICLE #M010

SPEED/ RANGE (MPH)	HC	CO	CO_2	NOxc	FUEL ECONOMY (MPG)
	----------	----------	gm/mi	----------	
0-10	30.11	67.75	214.55	0.00	21.29
10-0	27.60	22.58	133.00	0.00	34.64
5-20	5.86	12.79	92.46	0.00	67.62
20-5	6.39	4.00	63.68	0.27	98.28
0-25	7.55	13.70	93.93	0.15	63.61
25-0	6.78	1.69	66.06	0.46	98.29
15-25	4.14	14.40	60.66	0.00	91.97
25-15	5.04	4.32	45.90	0.18	129.13

APPENDIX D

MOPED TESTING PROCEDURES

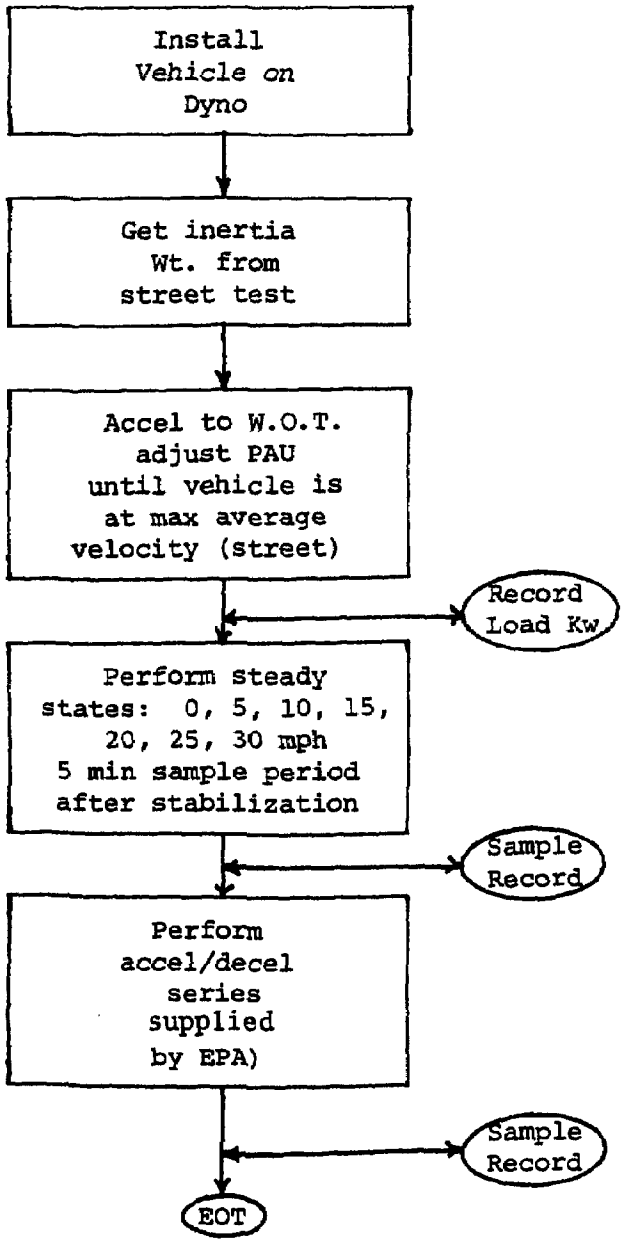
FLOW CHART



MO-PED TASK ORDER

ROAD LOAD CHARACTERISTICS
TESTS

1 Smooth flat surface
little or no wind
driver must weigh
150 ±10 lbs



MO-PED TASK ORDER

- *DYNO TESTING* -

SEQUENCE

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