Emission Tests on a Vespa 125 cc Primavera Scooter

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BACKGROUND

In the fall of 1975 EPA contacted a local Vespa motorcycle dealer with the intention of leasing a Vespa for testing purposes. The Vespa scooter models were of interest to EPA because of their unique body design (and thus possibly different road load characteristics), and because of recent advertised claims of 'exhaust pollutants almost entirely eliminated' (Ref. 1 and 2). As a result of our inquiry, the local dealer contacted the distributor and a 1974 Vespa 125 Primavera was made available to EPA for testing.

The Environmental Protection Agency receives information about many systems which appear to offer potential for emission reduction or fuel economy improvement compared to conventional engines and vehicles. EPA's Emission Control Technology Division is interested in evaluating all such systems, because of the obvious benefits to the nation from identification of systems that can reduce emissions, improve economy, on both. Tests are performed at the EPA Emissions Laboratory in Ann Arbor, Michigan, and the results of all such tests are set forth in a series of reports.

The conclusions from the EPA evaluation tests can be considered to be quantitatively valid only for the specific test vehicle used, however, it is reasonable to extrapolate the results from the EPA test to other types of vehicles in a directional or qualitative manner, i.e., to suggest that similar results are likely to be achieved on other types of vehicles.

VEHICLE DESCRIPTION

The motorcycle tested was a 1974 Vespa 125 Primavera scooter with 195 miles on the odometer. The engine is a single horizontal cylinder, two stroke, carbureted engine of 121.17cc displacement. A tag on the vehicle certifies the power does not exceed 5 brake horsepower (no specific power is specified.)

The motorcycle was inspected and tuned by a Vespa factory representative prior to delivery to EPA.

TEST PROCEDURE

The test procedure for this motorcycle consisted of coast down tests to determine road load horsepower, followed by emission tests.

The Vespa was taken to the Transportation Research Center of Ohio (TRC) for coast down tests. In a coast down test, the vehicle is accelerated to a constant speed, the clutch is disengaged, and the vehicle is allowed to coast with the road, vehicle, and aerodynamic forces slowing the vehicle. Ten coast downs, five in each direction, were performed. The velocity was measured by a radar unit and was recorded on magnetic tape along with the time and wind history. The data were processed using

a least squares curve fitting method which yielded a composite equation for the road load force.

The road load power determined from the coast down tests is shown in Figure 1. Also shown in this figure is the dynamometer power absorption curve which results from using the road load power value specified in the NPRM (Reference 3) for the Vespa's inertia category (2.53 kw at 65 kph for a 160 kg equivalent inertial mass). The curves show that the Vespa has a slightly lower road load power requirement in the 40-60 kph range than a 'standard' 160 kg equivalent inertial mass motorcycle.

For the Vespa emissions tests, a lower total absorbed power than specified in the NPRM was used. The lower absorbed power is based on the actual road power determined from the coast down tests. The normal procedure is to set the dynamometer power at 65 kph, however for the Vespa the power was set at 50 kph. The top speed of the Vespa, as determined at TRC, is 76 kph. Limited by the top speed, the coast downs occurred over a usable range of 65 to 25 kph. To avoid extrapolation of the coast down results, the road power at 50 kph was determined and this value, minus the dynamometer friction was set on the dynamometer power absorber. A summary of the road load powers is presented in Table I.

TABLE I

Road Load Power at 50 kph

As specified in NPRM	1.25 kw(1)
As determined from coast downs	1.15 kw
Power used for dyno tests	1.15 kw

Figure 2 presents a comparison of the road load power of the motorcycle and the power absorbed by the dynamometer. The absorbed power in both cases is 1.15 kw at 50 kph. The comparison shows that the dynamometer absorbed power is slightly less at most velocities than the road load power determined from the coast downs.

(1) Determined from Figure 1. The NPRM specified 2.53 kw at 65 kph.

TEST RESULTS AND CONCLUSIONS

Two tests accomplished per the NPRM procedures were performed. Test conditions were 1.15 kw total absorbed power at 50 kph with 160 kg inertia. The modified driving cycle for motorcycles with displacements less than 170 cc was used. The motorcycle was capable of following all portions of the driving cycle. The average mass emissions are presented in Table II along with the proposed interim and final motorcycle emission standards.

FIGURE 1

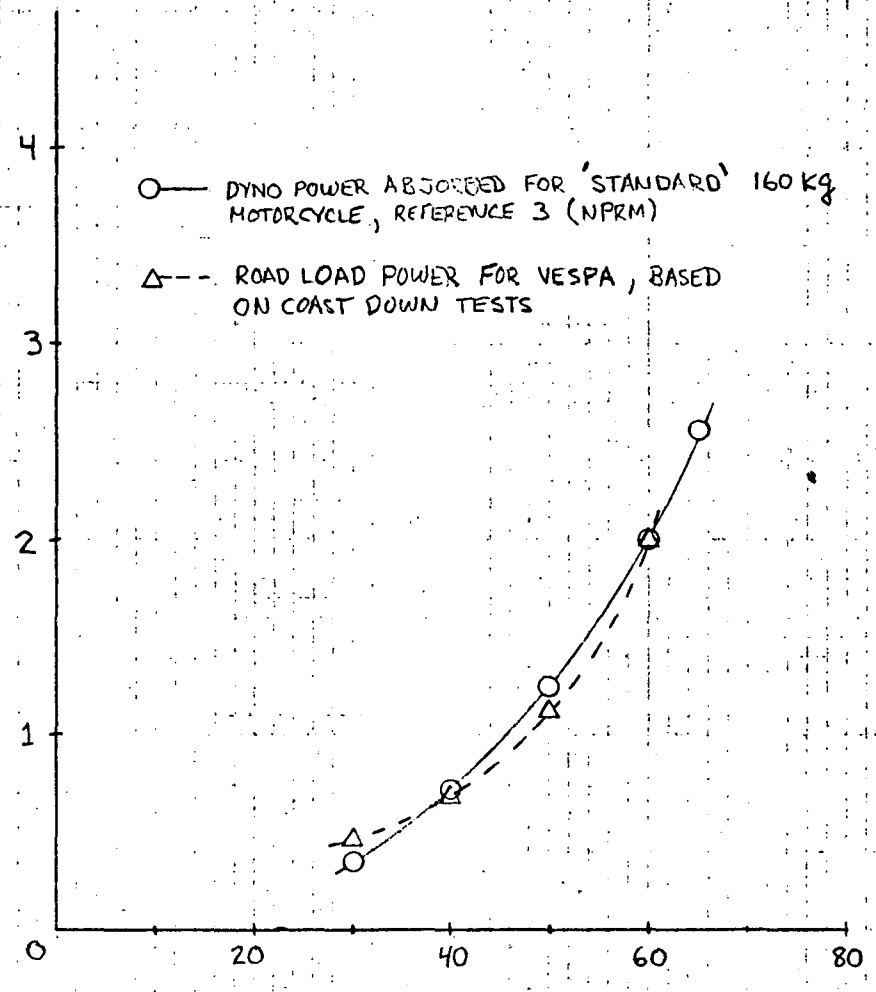
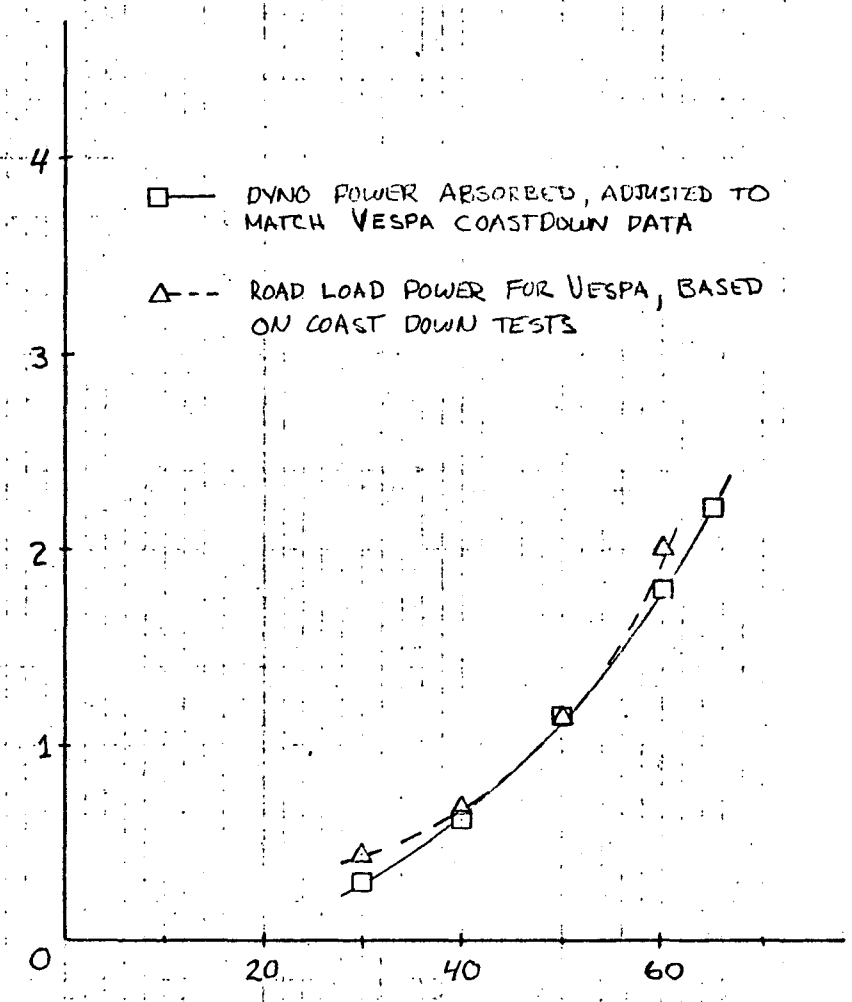


FIGURE 2



POWER ~ kW

VELOCITY ~ kph

TABLE II

Mass Emissions - Vespa 125

(Grams per kilometer)

	HC	CO	NO_x	Economy, Km/1
Test # 2605	4.71	13.3	.04	33
Test # 2619	4.82	12.3	.03	34
Average	4.77	12.8	.03	34
1978 Standard	5.0	17	1.2	-
1980 Standard	0.25	2.1	0.25	-

The motorcycle tested meets the 1978 interim standards but exceeds the 1980 standards by factors of 19 for HC and 6 for CO.

Table III compares the Vespa test data with similar motorcycles and with light duty vehicles.

TABLE III

Comparisons with Other Vehicles

(Grams per Kilometer)

	HC	CO	NO_x
Vespa 125	4.8	12.8	.03
Range for similar motorcycles (1)	4.6-8.5	5-15	.02-.10
1972 LDV Standard	2.1	24	1.9
1975 LDV Standard	.93	9.3	1.9

(1) Range is for other single cylinder 2 stroke motorcycles of approximately 125 cc displacement, based on EPA and industry test results.

Table III indicates that the Vespa's emissions are typical of other single cylinder two stroke engines of similar displacement. When compared to controlled light duty vehicle standards, the Vespa emits 5 times more HC and 1.4 times more CO than the 1975 Light Duty Standard. NO_x emissions are only one sixth the standard, and fuel economy is much better than most light duty vehicles. The claim, however, that Vespa emissions are almost entirely eliminated is not justified when compared to other similar motorcycles or controlled light duty vehicles.

REFERENCES:

1. Wall Street Journal - Eastern Edition, Friday, August 15, 1975, Page 3.

2. T.V. Guide - Southeast Michigan Edition, September 6-12, 1975, Page A-49.

3. Federal Register, Vol. 40, No. 205, October 22, 1975, pages 49496-49530.

APPENDIX I

TEST VEHICLE DESCRIPTION

1974 VESPA 125 PRIMAVERA SCOOTER

ENGINE

Type	2 cycle, horizonal single cylinder
Bore X Stroke	55 mm x 51 mm
Displacement	121.17 cc
Compression Ratio	8.2:1
Maximum Power	Specified as less than 5 hp (3.7 KW)
Fuel Metering	1 barrel carburetor
Fuel Requirement	Petrol with a 2 percent mixture of 2 stroke motor oil (RON not specified)
Cooling	Air cooled by centrifugal fan

DRIVE TRAIN

Transmission Type	4 speed manual
Final Drive Ratio	5.31:1

CHASSIS

Type	Monocoque type of pressed steel sheet
Tire Size	3.10-10"
Tire Pressure	Front 123 kPa (17 PSIG) Rear 157 kPa (22.7 PSIG)
Weight As Tested	162 Kg
Inertia Weight	160 Kg

1976 MSPCP CONSTANT-VOLUME SAMPLER RESULTS MOTORCYCLE

TEST # 18-2605 PROCESSED: 15:50:59 OCT 15, 1975

MFG. CODE	MODEL	VEHICLE I.D.	MOD. YR	DISPL. CC	INERTIA MASS-KG	CURB MASS-KG	NO. CYL.	ACT. DYNO H.P.	HP @ 65 KPH	A/C	UTL	TRANS	S.PAT.	TEST YEAR	TEST TYPE
415	125 SCOOTER	VESPA 74 SCO	74	125.0	160	0	1	0	3.0	0	0	0	0	76	5

AXLE RATIO	N/V RATIO	MANUFACTURE SPECS. BORE	STROKE	C.R.	TIMING	RPM	% CO	GEAR	IDLE/-----MANUFACTURE DATA---------/ RPM	HC	CO	NOX	EVAP	TIRES SIZE	RIM	DRIVE CYCLE	SOURCE CODE
0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0		0.	0.0	0.0	0.0	0.0			2	1

REQUESTOR INIT.	BRANCH	DATE	FUEL INJ.	SHUT.	#CARB	#BBLS CARB	MODEL	EXHAUST SYSTEM TYPES	NAME	EVAP SYS.	EGN TYPE	CRANK CASE	FUEL TYPE	FUEL TANK	MAINT	ODOM	GVW
T C	ECT	10-15-75	0	0				0 0 0 0 0		0	1	0	1	0	0	0	0

REQUESTOR COMMENTS : HP SET AT 50 KPH BASED ON COAST DOWNS,=1.53VESPA 74 SCOOTER
LABORATORY COMMENTS : HP B1=1661283 B2=2224551 B3=1680900

ENGINE FAMILY :
CVS HOURS :

TEST DATE	ODOMETER	IND. H.P.	BARO "HG	/----TEMP.,DF--------/ DRY	WET	CVS	/----MANOMETER---/ SPEC.GR.	UNITS	/-----CVS PRES.----/ IN	OUT	/---INITIALS---/ OPER.	DRIVER	DYNO. NO.	CVS UNIT
10-15-75	0.	2.4	29.90	74.0	59.0	101.0	1.75	IN	22.20	20.60	TJC	DCS	MC	11C
		DILUTION AIR		0.0	0.0									

CUBIC FT PER REV.	CALCULATED RPM	NOX FACTOR	IGN TIMING	RPM	% CO	GEAR	IDLE RPM	EVAP. LOSS GRAMS	TIRE PRES.
0.27697	1443.	0.8927	00	0.	0.0		0.		23.0

BAG 1 4.612 KM 12174. COUNTS 2867.7 CU. FT. D/FACTOR=46.183

	EXHAUST SAMPLE RANGE	METER	CONC.	BACKGROUND SAMPLE RANGE	METER	CONC.	CORRECTED CONCENTRATIONS	MASS EMISSIONS GMS	GMS/KM	KM/L
HC-FID	7	18.4	579.08	7	0.1	3.43	575.73 PPM	26.96	5.85	
CO	8	34.7	730.60	8	0.4	8.13	722.64 PPM	68.32	14.81	
CO2	1	18.4	0.159	1	4.9	0.042	0.118 %	175.08	37.96	29.4
NOX CHEM	4	1.7	1.70	4	0.2	0.20	1.50 PPM	0.21	0.05	

BAG 2 6.176 KM 20797. COUNTS 4899.0 CU. FT. 1377.5 SECONDS D/FACTOR=65.054 ACT RPM= 1436.1 RPM RATIO(C/A)=0.9954

	EXHAUST SAMPLE RANGE	METER	CONC.	BACKGROUND SAMPLE RANGE	METER	CONC.	CORRECTED CONCENTRATIONS	MASS EMISSIONS GMS	GMS/KM	KM/L
HC-FID	7	10.6	342.93	7	0.2	6.85	336.17 PPM	26.89	4.35	
CO	8	23.3	481.53	8	0.4	8.13	473.52 PPM	76.48	12.38	
CO2	1	14.3	0.124	1	5.0	0.043	0.081 %	205.72	33.31	35.2
NOX CHEM	4	1.0	1.00	4	0.2	0.20	0.80 PPM	0.19	0.03	

BAG 3 4.667 KM 12119. COUNTS 2854.8 CU. FT. 507.4 SECONDS D/FACTOR=48.839 ACT RPM= 1433.1 RPM RATIO(C/A)=0.9933

	EXHAUST SAMPLE RANGE	METER	CONC.	BACKGROUND SAMPLE RANGE	METER	CONC.	CORRECTED CONCENTRATIONS	MASS EMISSIONS GMS	GMS/KM	KM/L
HC-FID	7	14.9	474.10	7	0.1	3.43	470.74 PPM	21.95	4.70	
CO	8	33.9	712.68	8	0.0	0.0	712.68 PPM	67.08	14.37	
CO2	1	18.0	0.156	1	4.9	0.042	0.114 %	169.05	36.22	31.8
NOX CHEM	4	1.8	1.80	4	0.4	0.40	1.41 PPM	0.19	0.04	

WEIGHTED VALUES(1)	HC	CO	CO2	NOX
GRAMS/KM	4.71	13.3	34.9	0.04
BEFORE ROUNDING	4.7140	13.3187	34.8793	0.03611

75 WEIGHTED: KM/L	FUEL-WEIGHT: KM/L
33.	0.0
33.1247	

APPENDIX II

1976 MSPCP CONSTANT-VOLUME SAMPLER RESULTS MOTORCYCLE

TEST # 18-2619 PROCESSED: 15:03:10 OCT 20, 1975

MFG. CODE	MODEL	VEHICLE I.D.	MOD. YR	DISPL. CC	INERTIA MASS-KG	CURB MASS-KG	NO. CYL.	ACT. DYNO H.P. @ 65 KPH	A/C	UTL	TRANS	S.PAT.	TEST YEAR	TEST TYPE
415	125 SCOOTER	VESPA 74 SCO	74	125.0	160	0	1	3.0	0	0	0	0	76	5

AXLE RATIO	N/V RATIO	MANUFACTURE SPECS. BORE	STROKE	C.R.	TIMING	PPM	% CO	GEAR	IDLE/-----MANUFACTURE DATA---------/ RPM	HC	CO	NOX	EVAP	TIRES SIZE	RIM	DRIVE CYCLE	SOURCE CODE
0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0		0.	0.0	0.0	0.0	0.0			2	1

REQUESTOR INIT.	BRANCH	DATE	FUEL INJ.	SHUT.	#CARB	#BBLS CARB MODEL	EXHAUST SYSTEM TYPES	NAME	EVAP SYS.	EGN TYPE	CRANK CASE	FUEL TYPE	FUEL TANK	MAINT	ODOM	GVW
TC	ECT	10-15-75	0	0			0 0 0 0 0		0	1	0	1	0	0	0	0

REQUESTOR COMMENTS : HP SET @ 50KPH BASED ON COAST DOWNS,=1.53HPVESPA 74 SCOOTER ENGINE FAMILY :

LABORATORY COMMENTS : B1=1660615 B2=2206972 B3=1659268 CVS HOURS :

TEST DATE	ODOMETER	IND. H.P.	BARO "HG	/----TEMP.,OF--------/ DRY	WET	CVS	MANOMETER---/ SPEC.GR.	UNITS	CVS PRES.-----/ IN	OUT	INITIALS---/ OPER.	DRIVER	DYNO. NO.	CVS UNIT
10-16-75	196.	2.4	29.07	76.0	57.0	101.0	1.75	IN	22.11	20.75	VDC	JSH	MC	11C
			DILUTION AIR	0.0	0.0									

CUBIC FT PER REV.	CALCULATED RPM	NOX FACTOR	IGN TIMING	RPM	% CO	GEAR	IDLE RPM	EVAP. LOSS GRAMS	TIRE PRES.
0.27631	1443.	0.8575	00	0.	0.0		0.		0.0

BAG 1 4.610 KM 12231. COUNTS 2787.2 CU. FT. D/FACTOR=49.534

	EXHAUST SAMPLE RANGE	METER	CONC.	BACKGROUND SAMPLE RANGE	METER	CONC.	CORRECTED CONCENTRATIONS	MASS EMISSIONS GMS	GMS/KM	KM/L
HC-FID	7	16.9	534.24	7	0.3	10.27	524.18 PPM	23.86	5.18	
CO	8	32.6	683.73	8	0.1	2.03	681.73 PPM	62.65	13.59	
CO2	1	17.2	0.149	1	4.9	0.042	0.107 %	154.96	33.61	32.8
NOX CHEM	2	5.9	1.47	2	0.3	0.07	1.40 PPM	0.18	0.04	

BAG 2 6.127 KM 20796. COUNTS 4739.0 CU. FT. 1379.0 SECONDS D/FACTOR=65.584 ACT RPM= 1437.0 RPM RATIO(C/A)=0.9961

	EXHAUST SAMPLE RANGE	METER	CONC.	BACKGROUND SAMPLE RANGE	METER	CONC.	CORRECTED CONCENTRATIONS	MASS EMISSIONS GMS	GMS/KM	KM/L
HC-FID	7	11.6	373.70	7	0.2	6.85	366.95 PPM	28.40	4.63	
CO	8	22.7	468.75	8	0.4	8.13	460.75 PPM	71.99	11.75	
CO2	1	13.9	0.120	1	4.2	0.036	0.084 %	207.18	33.81	35.0
NOX CHEM	2	3.3	0.83	2	0.1	0.03	0.80 PPM	0.18	0.03	

BAG 3 4.607 KM 12341. COUNTS 2812.3 CU. FT. 517.2 SECONDS D/FACTOR=52.209 ACT RPM= 1431.7 RPM RATIO(C/A)=0.9924

	EXHAUST SAMPLE RANGE	METER	CONC.	BACKGROUND SAMPLE RANGE	METER	CONC.	CORRECTED CONCENTRATIONS	MASS EMISSIONS GMS	GMS/KM	KM/L
HC-FID	7	16.0	507.23	7	0.2	6.85	500.51 PPM	22.99	4.99	
CO	8	30.7	641.73	8	0.4	8.13	633.75 PPM	58.76	12.76	
CO2	1	16.4	0.142	1	3.7	0.032	0.110 %	160.96	34.94	33.1
NOX CHEM	2	5.7	1.42	2	0.2	0.05	1.38 PPM	0.18	0.04	

WEIGHTED VALUES(1)	HC	CO	CO2	NOX
GRAMS/KM	4.82	12.3	34.1	0.03
BEFORE ROUNDING	4.8213	12.3352	34.0519	0.03321

75 WEIGHTED1 KM/L	FUEL-WEIGHT1 KM/L
34.	0.0
34.1042	