

Report No. DOT-TSC-OST-77-42

PERFORMANCE CHARACTERISTICS OF AUTOMOTIVE
ENGINES IN THE UNITED STATES

Report No. 7 -- Mercedes Benz Model OM617 Diesel Engine

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JULY 1977
INTERIM REPORT

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VIRGINIA 22161

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
OFFICE OF THE SECRETARY
Office of the Assistant Secretary for Systems
Development and Technology
Office of Systems Engineering
Washington DC 20590

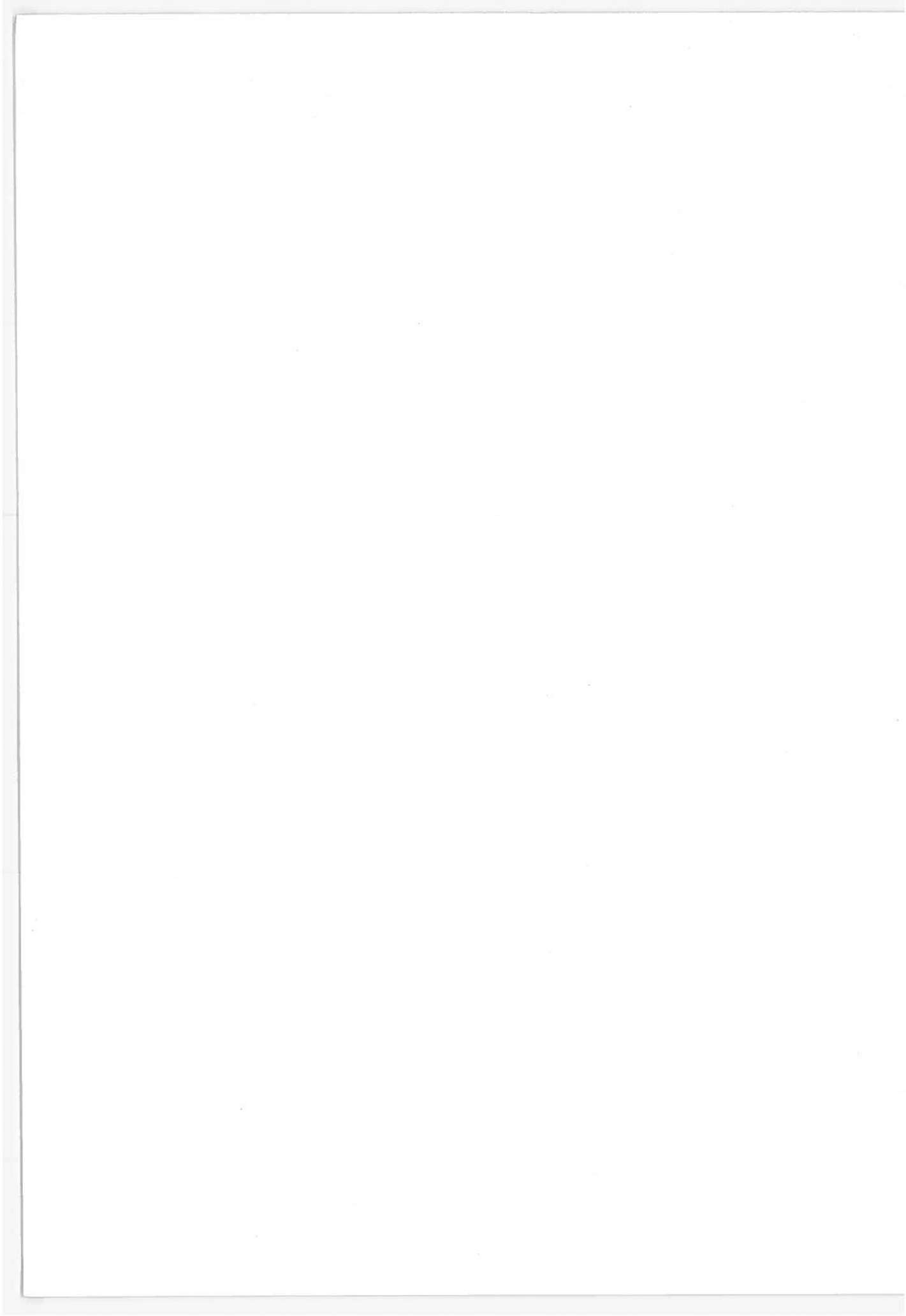
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1. Report No. DOT-TSC-OST-77-42		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle PERFORMANCE CHARACTERISTICS OF AUTOMOTIVE ENGINES IN THE UNITED STATES Report No. 7 -- Mercedes Benz Model OM617 Diesel Engine		5. Report Date July 1977		6. Performing Organization Code	
		8. Performing Organization Report No. DOT-TSC-OST-77-42 BERC/OP-76/31		10. Work Unit No. (TRAIS) OS714/R7508	
7. Author(s) W.F. Marshall and K.R. Stamper		9. Performing Organization Name and Address Energy Research and Development Administration* Bartlesville Energy Research Center P.O. Box 1398 Bartlesville OK 74003		11. Contract or Grant No. RA-75-10	
12. Sponsoring Agency Name and Address U.S. Department of Transportation Office of the Secretary Office of the Assistant Secretary for Systems Development and Technology Office of Systems Engineering Washington DC 20590		13. Type of Report and Period Covered Interim Report Sep. - Oct. 1975		14. Sponsoring Agency Code	
		15. Supplementary Notes U.S. Department of Transportation Transportation Systems Center Kendall Square Cambridge MA 02142 *Interagency agreement with:			
16. Abstract Experimental data were obtained in dynamometer tests of the Mercedes Benz Model OM617 diesel engine to determine fuel consumption and emissions (hydrocarbon, carbon monoxide, oxides of nitrogen, and smoke) at steady-state engine-operating modes. The objective of the program is to obtain engine-performance data for estimating emissions and fuel economy for varied engine service and duty. The intent of the work is to provide basic engine characteristic data required as input for engineering calculations involving ground transportation.					
17. Key Words IC Engines, Diesel Engines, Fuel Economy, Auto Emissions			18. Distribution Statement DOCUMENT IS AVAILABLE TO THE U.S. PUBLIC THROUGH THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VIRGINIA 22161		
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages 36	22. Price



PREFACE

This report, prepared by the Energy Research and Development Administration, Bartlesville Energy Research Center for the U.S. Department of Transportation, Transportation Systems Center, Energy Technology Branch, Cambridge, Massachusetts, presents results of experimental work to obtain information on performance characteristics of an engine used in automobiles sold in the United States. The engine used in this work is one of a series of 23 engines to be tested in the current program.

Mr. Ralph G. Colello is the technical monitor on this project.

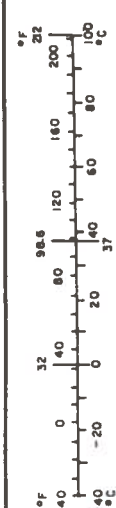
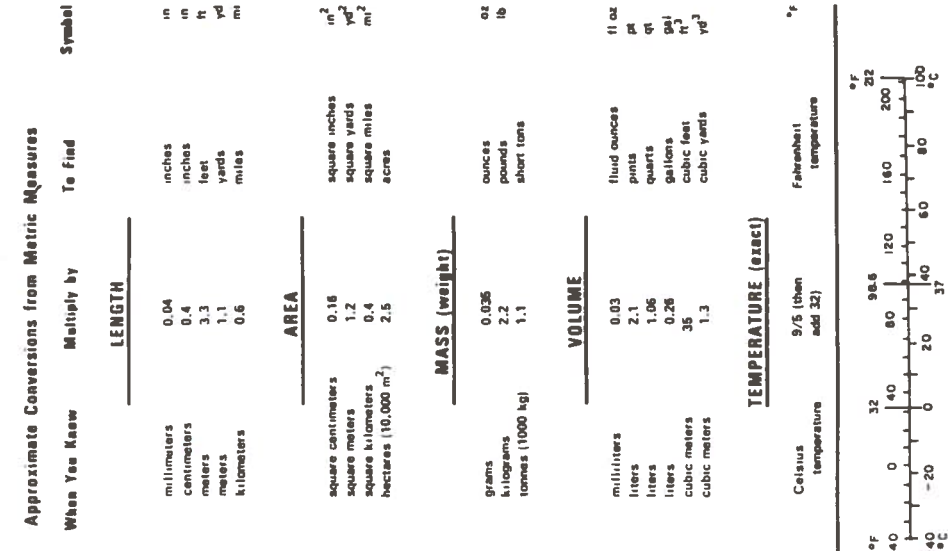
METRIC CONVERSION FACTORS

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				
m 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

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
km	kilometers	1.1	yards	yd
		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



1. INTRODUCTION

This report presents data acquired from tests of a Mercedes Benz model OM617 diesel engine. This engine is marketed in the United States in the 300 D vehicle. The test results are sufficient to establish steady-state maps for fuel consumption, emissions (carbon monoxide, unburned hydrocarbons, and oxides of nitrogen) and smoke opacity over the entire operating range of the engine.

The objective of the program is to obtain engine performance data for estimating emissions and fuel economy for varied engine service and duty. The intent of the work is to provide basic engine characteristic data required as input for engineering calculations involving ground transportation.

2. ENGINE TEST REPORT

The engine was mounted on a test stand and coupled to an eddy-current dynamometer. The engine was complete except for a fan (a cooling tower was used in place of a radiator). The alternator was used but was not wired into a charging system. General engine specifications for the Mercedes Benz diesel engine, model OM617, are listed in table 1. The engine break-in and tests were run using a single batch of No. 2 diesel fuel; an analysis of the fuel is given in table 2. The engine break-in consisted of 24 hours of operation at various speeds and loads; details of the break-in are given in table 3. The total engine operating time (break-in and testing) was approximately 120 hours. The period of testing ran from September 29 to October 15, 1975.

Test data were collected at the following steady-state modes:

Speeds: 1,100; 1,500; 2,000; 2,400; 3,000; 3,500; 4,000 rpm

Loads: 0, 5, 10, 25, 40, 60, 75, 90, 100 pct of full load
(repeated at 0, 10, 25, 40, 60, 100 pct of full load
at each speed except 4,000 rpm)

Idle: 0, 1.3, 2.7, 4 bhp (repeated at 0, 1.3 bhp)

Number of tests..... 67
Repeats..... 40
Total number of tests.....107.

The following data were recorded at each test point:

Test number
Date
Barometric pressure, mm Hg
Dew point, °F
Speed, rpm
Torque, lb-ft -- BLH strain gauge; Daytronics indicator
Fuel rate, lb/hr -- FLO-TRON linear mass flowmeter
Throttle angle, degrees
CO, pct -- Beckman NDIR
CO₂, pct -- Beckman NDIR
HC, ppmC -- Custom-built heated flame ionization detector
NO_x, ppm -- Thermo-Electron chemiluminescent detector
Oil temperature, °F
Oil pressure, psi
Coolant temperature, °F
Exhaust temperature, °F
Exhaust pressure, in. H₂O
Smoke, pct opacity -- Celesco in-line smokemeter
Air flow, lb/min -- Meriam laminar flow element.

The computed data include absolute humidity, power, exhaust flow rate, and emission rates of carbon monoxide (CO), unburned hydrocarbon (HC), and oxides of nitrogen (NO_x) in grams per hour. The following equations were applied in the computations:

$$H_2O \text{ (mm Hg)} = \exp \left[12.02 \left(\frac{\text{Dew pt. (}^\circ\text{F)} - 1.4}{\text{Dew pt.} + 212} \right) \right],$$

$$\text{Humidity (grains H}_2\text{O/lb dry air)} = \frac{4348 (H_2O)}{\text{Baro} - H_2O},$$

$$\text{Power (bhp)} = \left(\frac{\text{Speed} \times \text{Torque}}{5252} \right) \left(\frac{736.6}{\text{Baro} - H_2O} \right) \left(\frac{t_{\text{air}} + 460}{545} \right)^{0.7},$$

$$\text{Exhaust flow (lb/min)} = \text{Air flow (lb/min)} + \frac{\text{Fuel flow (lb/hr)}}{60},$$

$$\text{Mass CO} = (\text{exhaust flow rate}) \times (\text{concentration CO})$$

$$\times \left(\frac{\text{Mol. wt. CO}}{\text{Mol. wt. exhaust}} \right) \times (\text{correction for water removal}),$$

$$\text{Mass CO} = 0.0263 (\text{exhaust rate}) (\text{ppm CO}) \left[\frac{1}{1 + 0.03 \text{ CO}_2 \left(\frac{\text{CO} + \text{CO}_2}{\text{CO} + 3\text{CO}_2} \right)} \right],$$

$$\text{Mass HC} = 0.0132 (\text{exhaust rate}) (\text{ppmC HC}),$$

$$\text{Mass NO}_x = 0.0432 (\text{exhaust rate}) (\text{ppm NO}_x) \left[\frac{1}{1 + 0.03 \text{ CO}_2 \left(\frac{\text{CO} + \text{CO}_2}{\text{CO} + 3\text{CO}_2} \right)} \right]$$

$$\times (\text{humidity correction factor, } K_H),$$

$$K_H = \frac{400}{475 - H}.$$

TABLE 1. - GENERAL ENGINE SPECIFICATIONS

Model number.....	OM617
Displacement, cubic inches.....	183.4
Maximum power @ 4,000 rpm.....	77
Maximum torque, ft-lb @ 2,400 rpm.....	115
Configuration.....	in-line 5 cylinders, upright
Bore, inches.....	3.58
Stroke, inches.....	3.64
Combustion system.....	pre-chamber
Compression ratio.....	21.0
Firing order.....	1-2-4-5-3
Injection pressure, psi.....	1,700
Injection timing, °BTC.....	24
Rotational inertia, Kg m ²	0.372
Block material.....	cast iron
Head material.....	cast iron
Number of crankshaft main bearings.....	6
Number of compression rings/piston.....	2
Number of oil rings/piston.....	1
Cam drive.....	chain
Valve clearance (warm):	
Intake, inches.....	0.006
Exhaust, inches.....	0.014
Valve timing:	
Intake opens, °ATC.....	13.5
Intake closes, °ABC.....	15.5
Exhaust opens, °BBC.....	19
Exhaust closes, °BTC.....	17

TABLE 2. - FUEL ANALYSIS

Fuel No.....	7564
API gravity, degrees.....	36.8
Distillation, °F:	
10 pct evaporated.....	400
50 pct ".....	493
90 pct ".....	593
End point ".....	628
FIA analysis, pct:	
Aromatics.....	30
Olefins.....	3
Paraffins.....	67
Sulfur, pct.....	0.29

TABLE 3. - ENGINE BREAK-IN SCHEDULE

Engine speed, rpm	Torque, lb-ft	Time in mode, hr
1,800	9	1
2,200	9	1
2,200	19	2
2,600	19	2
2,600	30	2
3,100	30	2
3,100	37	2
3,500	37	2
3,500	46	2
3,700	46	2
3,700	55	2
4,000	55	1
4,000	64	1
4,200	64	1
4,400	74	1

3. DISCUSSION OF TEST RESULTS

The maximum measured torque (figure 1) was similar to the value quoted in table 1. The maximum horsepower produced by the test engine was about 10 percent lower than the quoted value. There was no apparent reason for the discrepancy. The emissions of CO (figure 2) show some variation at the 2,000; 2,400; and 3,000 rpm test points. Although the percent variation in concentration is large for replicate tests, the effect on total emissions is small since the level of concentration is low.

Emissions of HC, NO_x, and smoke were also plotted as a function of power at various engine speeds (figures 3 to 5). In each case, the dependence on power is clearly shown.

Fuel consumption at various engine speeds was found to be nearly linear with power output (figure 6).

4. CONCLUSIONS

The repeatability of fuel consumption and emission rate data is satisfactory for the purposes of the test.



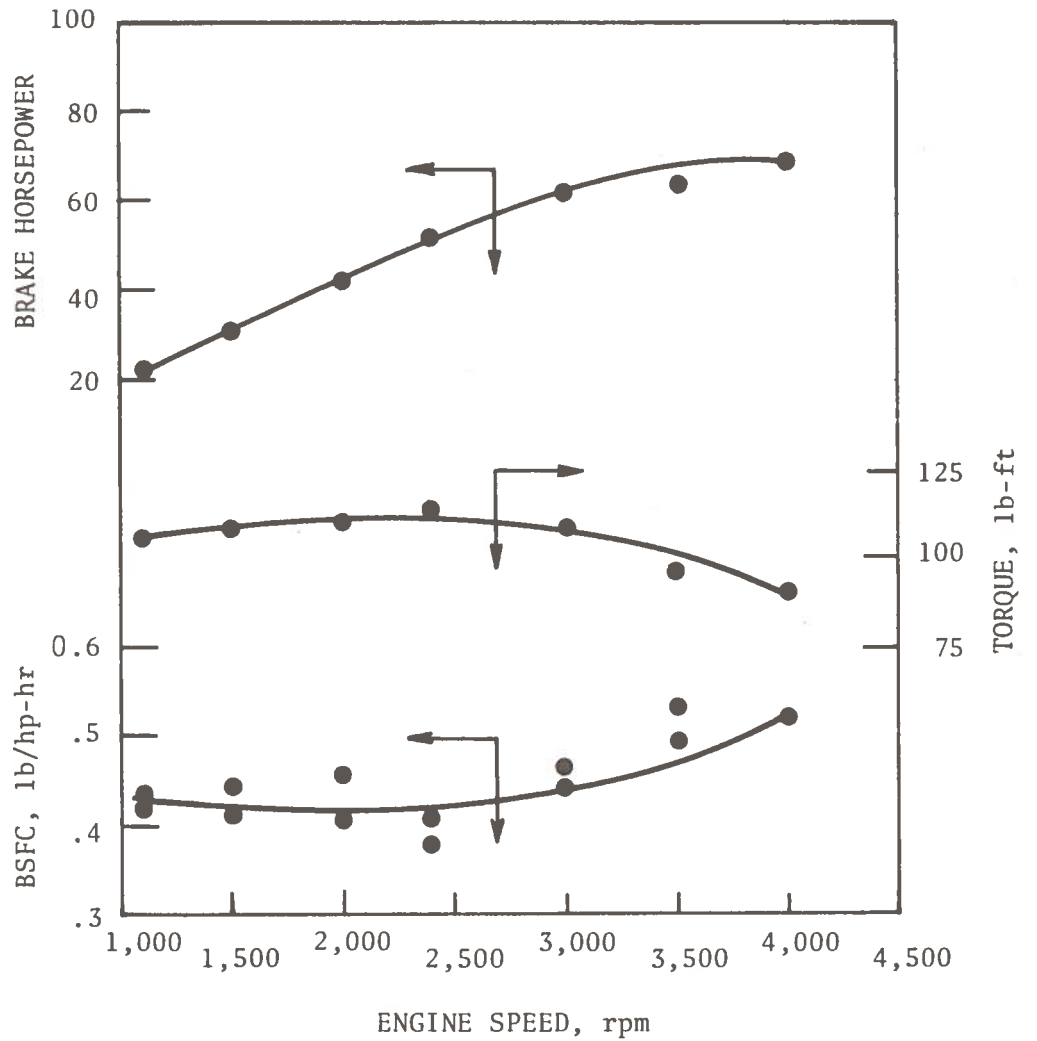


FIGURE 1. - BRAKE SPECIFIC FUEL CONSUMPTION, MAXIMUM TORQUE, AND BRAKE HORSEPOWER VERSUS ENGINE RPM AT FULL RACK-- MERCEDES BENZ DIESEL ENGINE.

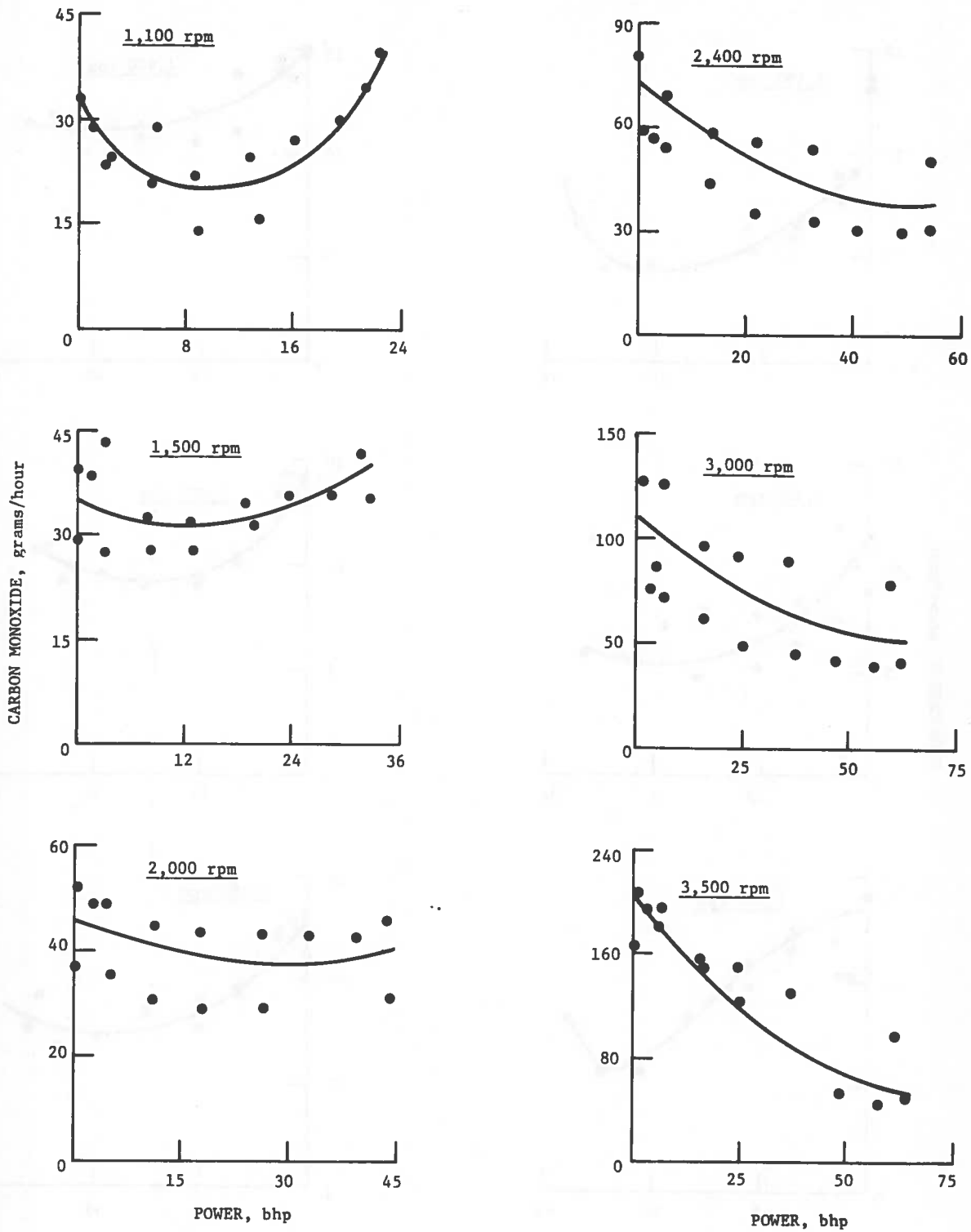


FIGURE 2. - CARBON MONOXIDE EMISSIONS AT VARIOUS SPEED AND LOAD CONDITIONS--MERCEDES BENZ DIESEL ENGINE.

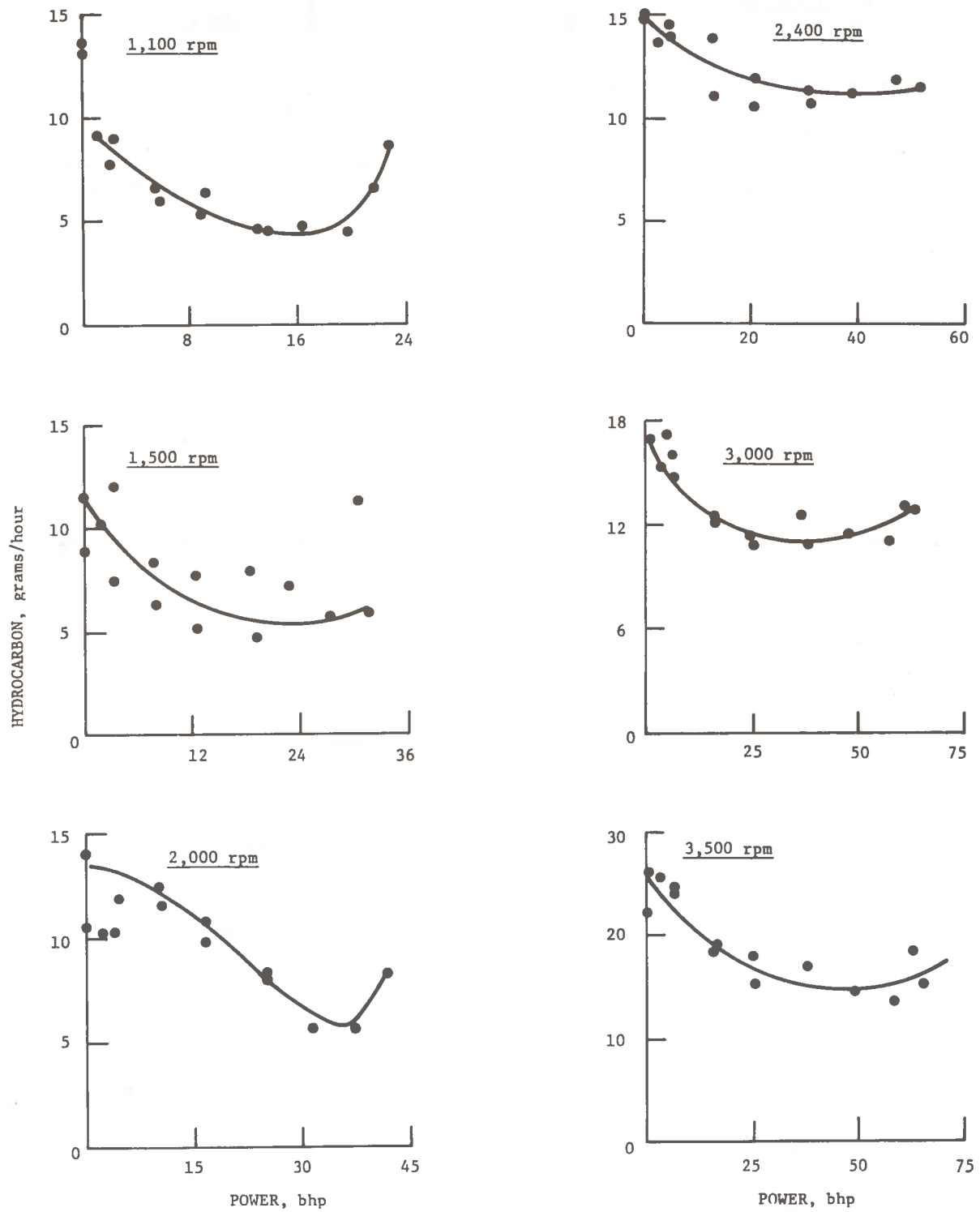


FIGURE 3. - HYDROCARBON EMISSIONS AT VARIOUS SPEED AND LOAD CONDITIONS--MERCEDES BENZ DIESEL ENGINE.

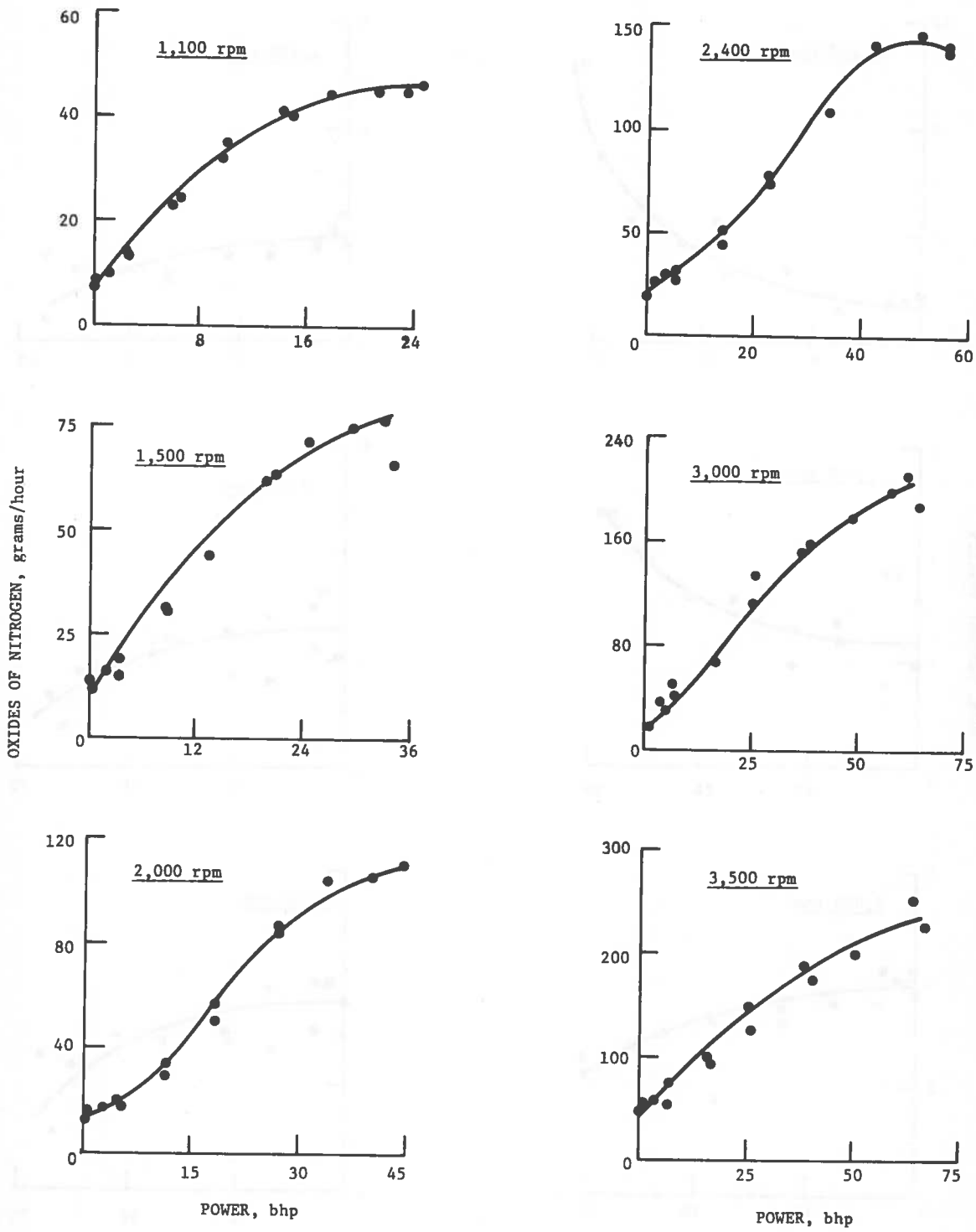


FIGURE 4. - OXIDES OF NITROGEN EMISSIONS AT VARIOUS SPEED AND LOAD CONDITIONS--MERCEDES BENZ DIESEL ENGINE.

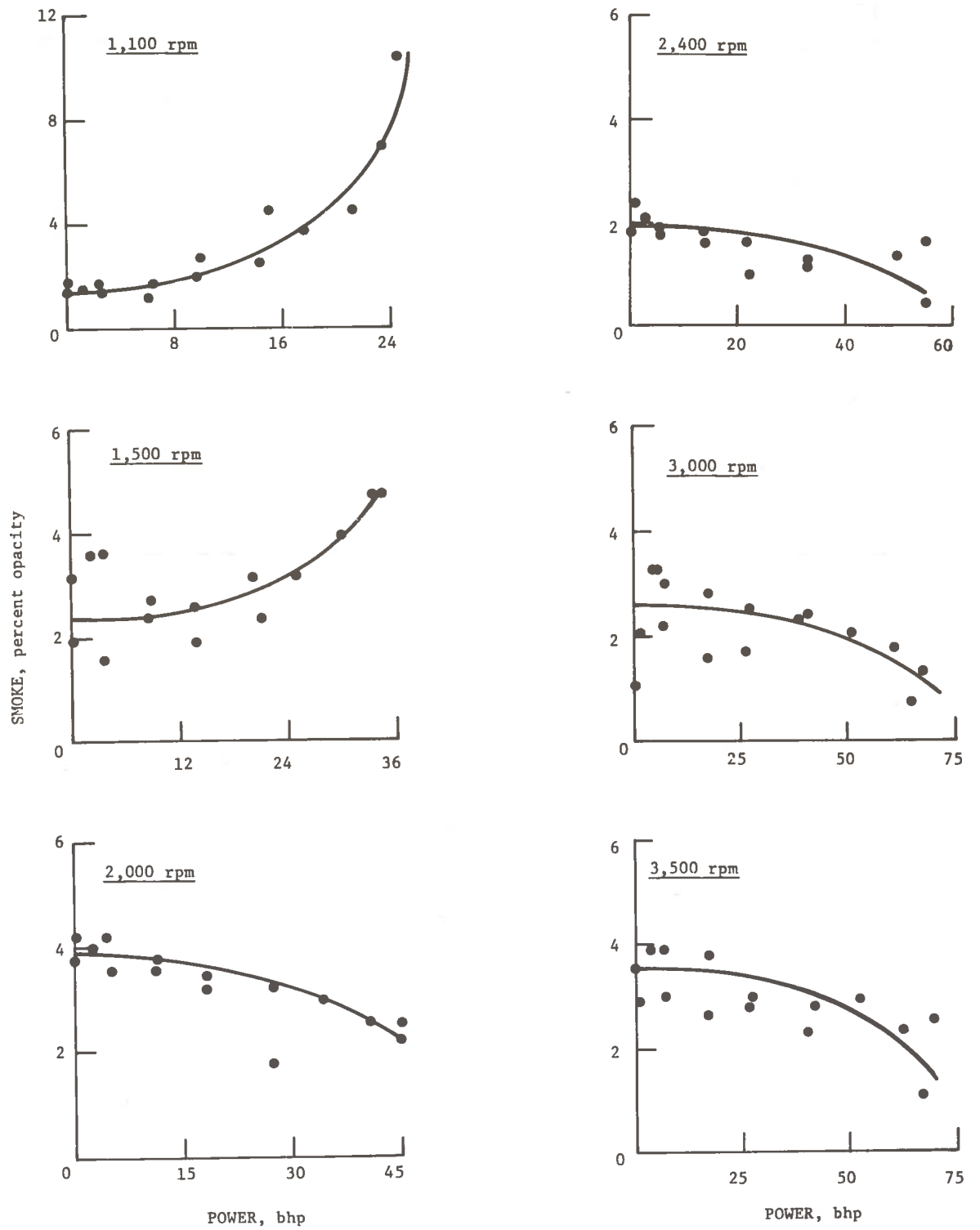


FIGURE 5. - EMISSIONS OF SMOKE AT VARIOUS SPEED AND LOAD CONDITIONS--MERCEDES BENZ DIESEL ENGINE.

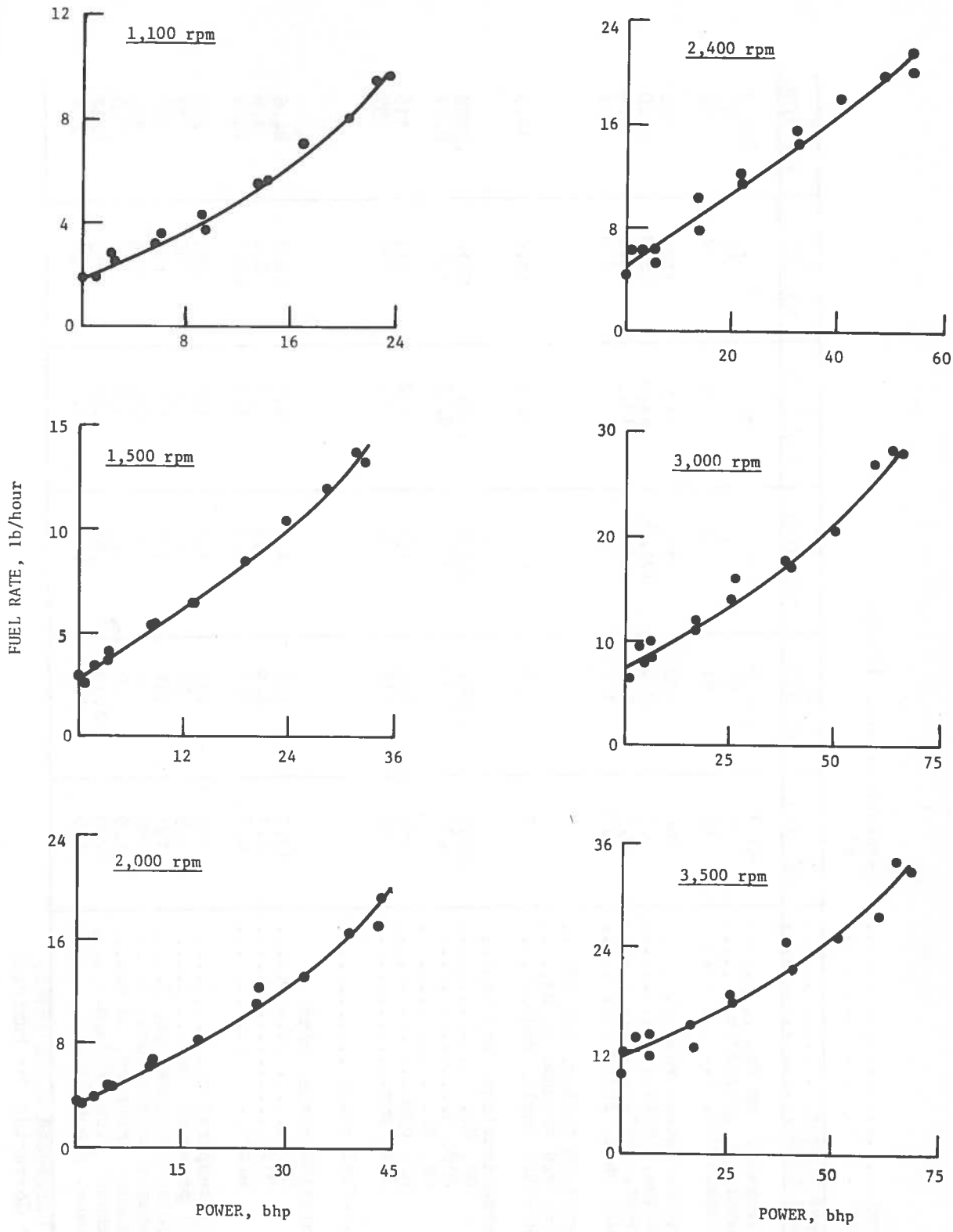


FIGURE 6. - FUEL RATE AT VARIOUS SPEED AND LOAD CONDITIONS--MERCEDES BENZ DIESEL ENGINE.

Mercedes diesel, 183-CID
7559

	1	2	3	4	5	6
Test Number	10/ 3/75	10/ 3/75	10/ 3/75	10/ 3/75	10/ 3/75	10/ 3/75
Test Date	751.3 57 84	751.3 57 84	751.3 57 82	751.3 57 85	751.3 57 84	751.3 57 84
Barometer, mm Hg	700	700	1100	1100	1100	1100
Humidity, grains/lb	0.0	10.0	104.0	94.0	78.0	62.0
Temperature, F	0.0	1.3	21.5	19.5	16.2	12.9
Engine speed, rpm	1.0	1.4	9.3	7.9	6.9	5.4
Torque, lb-ft						
Power, bhp*						
Fuel rate, lb/hr						
Ignition timing, deg BTC						
Manifold vacuum, in Hg	0.0	2.0	19.0	16.5	15.0	14.3
Throttle angle, deg						
Concentrations, dry basis:						
CO, %	.0255	.0260	.0398	.0347	.0310	.0282
CO2, %	2.17	2.85	10.25	9.02	7.73	6.27
O2, %						
HC, ppmC	159	157	157	112	114	113
NOx, ppm	80	110	330	330	320	295
Air-fuel ratio						
Emission rates, g/hr:						
CO	13.1	14.6	34.2	29.7	26.8	24.6
HC	4.1	4.4	6.8	4.8	5.0	4.9
NOx**	6.5	9.7	44.6	44.4	43.5	40.4
Oil temperature, F	186	185	188	198	201	200
Oil pressure, psi	25	25	40	36	36	37
Coolant temperature, F	190	181	175	178	171	187
Exhaust temperature, F	188	214	695	692	575	510
Exhaust pressure, in H2O	1.0	1.0	3.0	3.0	3.0	3.0
Exhaust flow, lb/min	2.00	2.19	5.61	5.55	5.55	3.52
Smoke, % opacity	1.5	1.7	6.4	4.2	3.5	2.4

* Corrected - SAE J876b.

** Corrected for humidity.

Engine..... Mercedes diesel, 183-CID
 Fuel..... 7559

	7 10/ 3/75	8 10/ 3/75	9 10/ 3/75	10 10/ 3/75	11 10/ 3/75	12 10/ 9/75
Test Number.....	751.3	751.3	751.3	751.3	751.3	751.3
Test Date.....	57 85	57 84	57 82	57 82	57 82	76 75
Barometer, mm Hg.....	1100	1100	1100	1100	1100	1500
Humidity, grains/lb.....	42.0	26.0	10.0	5.0	.4	107.0
Temperature, F.....	8.7 4.2	5.4 5.1	2.1 2.7	1.0 1.8	.1 1.7	30.3 13.4
Engine speed, rpm.....						
Torque, lb-ft.....						
Power, bhp*.....						
Fuel rate, lb/hr.....						
Ignition timing, deg BTC....						
Manifold vacuum, in Hg.....	13.8	12.5	10.0	9.1	8.8	19.0
Throttle angle, deg.....						
Concentrations, dry basis:						
CO, %.....	.0251	.0257	.0264	.0319	.0361	.0323
CO2, %.....	4.71	5.72	2.75	2.32	1.97	10.47
O2, %.....						
HC, ppmC.....	127	154	176	208	301	180
NOx, ppm.....	230	155	100	70	60	355
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	22.0	20.9	23.6	28.6	32.4	40.8
HC.....	5.6	6.8	7.9	9.5	13.6	11.4
NOx**.....	31.6	22.9	14.1	9.8	8.5	73.8
Oil temperature, F.....	201	198	198	196	196	192
Oil pressure, psi.....	36	36	36	36	37	50
Coolant temperature, F.....	185	188	185	191	189	174
Exhaust temperature, F.....	438	336	265	240	221	865
Exhaust pressure, in H2O....	3.0	2.0	2.0	2.0	2.0	6.0
Exhaust flow, lb/min.....	3.49	3.48	3.50	3.48	3.48	5.30
Smoke, % opacity.....	1.9	1.2	1.7	1.5	1.7	4.5

* Corrected - SAE J815b.
 ** Corrected for humidity.

Mercedes diesel, 183-CID
7559

	15 10/ 9/75	14 10/ 9/75	15 10/ 9/75	16 10/ 9/75	17 10/ 9/75	18 10/ 9/75
Engine.....						
Fuel.....						
Test Number.....						
Test Date.....						
Barometer, mm Hg.....	746.0	746.0	746.0	746.0	746.0	746.0
Humidity, grains/lb.....	76	76	76	76	76	76
Temperature, F.....	75	75	75	75	75	75
Engine speed, rpm.....	1500	1500	1500	1500	1500	1500
Torque, lb-ft.....	26.0	80.0	64.0	43.0	27.0	11.0
Power, bhp*.....	27.1	22.6	18.1	12.2	7.6	3.1
Fuel rate, lb/hr.....	11.7	10.1	8.3	6.3	5.3	3.9
Ignition timing, deg BTC.....						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	18.0	17.5	17.0	16.5	15.0	14.5
Concentrations, dry basis:						
CO, %.....	.0282	.0273	.0264	.0246	.0246	.0273
CO2, %.....	9.02	7.75	6.34	4.71	3.72	2.62
O2, %.....						
HC, ppmC.....	96	115	124	123	129	154
NOx, ppm.....	350	325	280	200	140	55
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	35.2	35.0	34.1	31.5	32.2	42.4
HC.....	6.0	7.4	8.1	7.9	8.5	12.0
NOx**.....	72.1	68.6	59.5	42.1	30.2	14.1
Oil temperature, F.....	204	205	203	201	201	200
Oil pressure, psi.....	50	50	49	48	50	55
Coolant temperature, F.....	162	191	185	186	191	186
Exhaust temperature, F.....	735	640	548	442	357	280
Exhaust pressure, in H2O.....	5.0	5.0	5.0	4.0	4.0	3.5
Exhaust flow, lb/min.....	5.18	5.25	5.22	5.09	5.17	6.07
Smoke, % opacity.....	3.8	3.1	3.1	2.6	2.4	3.5

* Corrected - SAE J816b.
** Corrected for humidity.

Engine..... Mercedes diesel, 183-CID
 Fuel..... 7559

Test Number.....	19	20	21	22	23	24
Test Date.....	10/ 9/75	10/ 9/75	10/ 9/75	10/ 9/75	10/ 9/75	10/ 9/75
Barometer, mm Hg.....	746.0	746.0	746.0	746.0	746.0	746.0
Humidity, grains/lb.....	76	76	76	76	76	76
Temperature, F.....	75	75	75	75	75	75
Engine speed, rpm.....	1500	1500	2000	2000	2000	2000
Torque, lb-ft.....	6.0	0.0	110.0	99.0	83.0	66.0
Power, bhp*.....	1.7	0.0	41.4	37.3	31.3	24.9
Fuel rate, lb/hr.....	3.3	2.9	16.8	16.4	13.0	11.0
Ignition timing, deg BTC.....			19.0	18.0	17.0	16.5
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	14.0	14.0	19.0	18.0	17.0	16.5
Concentrations, dry basis:						
CO, %.....	.0264	.0269	.0273	.0255	.0255	.0255
CO2, %.....	2.42	2.02	10.68	9.42	7.65	6.27
O2, %.....						
HC, ppmC.....	143	159	101	71	70	97
NOx, ppm.....	55	55	375	380	370	300
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	37.9	38.7	45.5	42.4	42.7	43.1
HC.....	10.3	11.5	8.4	5.9	5.9	8.2
NOx**.....	15.4	13.1	103.0	104.1	102.2	83.5
Oil temperature, F.....	199	199	198	214	215	218
Oil pressure, psi.....	55	50	60	60	60	60
Coolant temperature, F.....	191	191	184	184	186	185
Exhaust temperature, F.....	267	245	975	869	747	601
Exhaust pressure, in H2O.....	3.0	3.0	10.0	10.0	9.0	8.0
Exhaust flow, lb/min.....	5.59	5.59	7.02	6.92	6.86	6.83
Smoke, % opacity.....	3.5	3.1	2.7	2.7	3.1	3.3

* Corrected - SAE J816b.
 ** Corrected for humidity.

Mercedes diesel, 183-CID
7559

	25 10/ 9/75	26 10/ 9/75	27 10/ 9/75	28 10/ 9/75	29 10/ 9/75	30 9/29/75
Engine.....						
Fuel.....						
Test Number.....						
Test Date.....						
Barometer, mm Hg.....	746.0	746.0	746.0	746.0	746.0	743.1
Humidity, grains/lb.....	76	76	76	76	76	75
Temperature, F.....	75	75	75	75	75	81
Engine speed, rpm.....	2000	2000.	2000	2000	2000	2400
Torque, lb-ft.....	44.0	23.0	11.0	6.0	1.0	113.0
Power, bhp*.....	16.6	10.5	4.1	2.3	.4	51.6
Fuel rate, lb/hr.....	8.5	6.7	4.5	4.0	3.6	19.5
Ignition timing, deg BTC.....						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	15.5	14.8	14.0	15.7	13.6	19.0
Concentrations, dry basis:						
CO, %.....	.0255	.0260	.0232	.0232	.0300	.0176
CO2, %.....	4.72	5.72	2.78	2.42	2.22	11.13
O2, %.....						
HC, ppmC.....	116	135	120	120	123	108
NOx, ppm.....	200	120	70	60	55	400
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	43.4	44.5	48.5	48.6	51.7	36.6
HC.....	9.9	11.6	10.4	10.4	10.6	11.3
NOx**.....	56.1	33.9	19.9	17.0	15.6	136.8
Oil temperature, F.....	214	212	211	211	209	219
Oil pressure, psi.....	60	60	60	60	60	74
Coolant temperature, F.....	189	183	192	188	190	182
Exhaust temperature, F.....	492	423	333	298	284	1034
Exhaust pressure, in H2O.....	7.0	6.0	6.0	5.0	5.0	12.0
Exhaust flow, lb/min.....	6.78	6.76	6.73	6.71	6.71	8.79
Smoke, % opacity.....	3.5	3.8	4.2	4.0	4.2	2.4

* Corrected - SAE J816b.
** Corrected for humidity.

Mercedes diesel, 183-CID
7559

	31 9/29/75	32 9/29/75	33 9/29/75	34 9/29/75	35 9/29/75	36 9/29/75
Engine.....	743.1	743.1	743.1	743.1	743.1	743.1
Fuel.....	75	75	75	75	75	75
Test Number.....	81	81	82	81	81	82
Test Date.....	2400	2400	2400	2400	2400	2400
Barometer, mm Hg.....	102.0	85.0	68.0	45.0	28.0	11.0
Humidity, grains/lb.....	46.6	38.8	31.1	20.6	12.8	5.0
Temperature, F.....	19.2	17.5	14.0	11.8	10.0	6.0
Engine speed, rpm.....	19.0	17.0	16.5	16.0	15.0	14.6
Torque, lb-ft.....	.0167	.0167	.0176	.0185	.0211	.0255
Power, bhp*.....	9.42	8.64	6.57	5.32	4.33	3.27
Fuel rate, lb/hr.....	109	102	97	96	118	123
Ignition timing, deg BTC.....	410	390	300	215	135	85
Manifold vacuum, in Hg.....						
Throttle angle, deg.....						
Concentrations, dry basis:						
CO, %.....	55.6	36.1	38.4	40.4	48.8	58.9
CO2, %.....	11.7	11.1	10.6	10.5	13.7	14.3
HC, %.....	143.7	138.7	107.7	77.2	51.3	32.3
O2, %.....	227	230	227	226	226	225
NOx, ppm.....	66	72	72	69	65	75
Air-fuel ratio.....	165	180	175	181	192	188
Emission rates, g/hr:	907	848	664	560	490	411
CO.....	12.0	13.0	11.0	10.0	10.0	10.0
HC.....	8.88	8.94	8.85	8.75	9.17	9.07
NOx**.....	2.0	1.7	1.9	2.4	2.7	2.7
Oil temperature, F.....						
Oil pressure, psi.....						
Coolant temperature, F.....						
Exhaust temperature, F.....						
Exhaust pressure, in H2O.....						
Exhaust flow, lb/min.....						
Smoke, % opacity.....						

* Corrected - SAE J816b.
** Corrected for humidity.

Mercedes diesel, 183-CID
7559

Engine.....
Fuel.....

	37 9/29/75	38 9/29/75	39 9/29/75	40 9/29/75	41 9/29/75	42 9/29/75
Test Number.....						
Test Date.....						
Barometer, mm Hg.....	743.1	743.1	743.1	743.1	743.1	743.1
Humidity, grains/lb.....	75	75	75	75	75	75
Temperature, F.....	81	81	82	82	81	81
Engine speed, rpm.....	2400	2400	3000	3000	3000	3000
Torque, lb-ft.....	6.0	2.0	110.0	99.0	83.0	66.0
Power, bhp*.....	2.7	2.9	62.8	56.5	47.3	37.6
Fuel rate, lb/hr.....	6.0	6.0	27.3	26.8	20.4	17.1
Ignition timing, deg BTC.....						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	14.5	14.2	19.0	17.8	18.1	16.8
Concentrations, dry basis:						
CO, %.....	.0264	.0273	.0176	.0167	.0176	.0185
CO2, %.....	2.93	2.73	11.25	10.47	8.45	6.72
O2, %.....						
HC, ppmC.....	115	129	105	89	91	86
NOx, ppm.....	80	70	445	465	415	370
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	61.4	63.6	45.7	42.1	44.5	47.3
HC.....	17.5	15.0	13.0	11.3	11.6	11.1
NOx**.....	30.6	26.8	181.7	192.6	172.4	155.4
Oil temperature, F.....	224	224	240	242	240	241
Oil pressure, psi.....	75	75	75	74	73	73
Coolant temperature, F.....	191	191	182	186	181	181
Exhaust temperature, F.....	371	348	1110	1040	835	765
Exhaust pressure, in H2O.....	10.0	8.0	20.0	20.0	17.0	15.0
Exhaust flow, lb/min.....	9.10	9.10	10.51	10.58	10.42	10.37
Smoke, % opacity.....	3.1	3.5	2.0	2.7	3.1	3.6

* Corrected - SAE J816b.
** Corrected for humidity.

Mercedes diesel, 183-CID
7559

	43 9/29/75	44 9/29/75	45 9/29/75	46 9/29/75	47 9/29/75	48 9/29/75
Engine.....						
Fuel.....						
Test Number.....	743.1	743.1	743.1	743.1	743.1	743.1
Test Date.....	75 81	75 81	75 82	75 82	75 82	75 80
Barometer, mm Hg.....	3000	3000	3000	3000	3000	3500
Humidity, grains/lb.....	44.0	28.0	11.0	6.0	2.8	98.0
Temperature, F.....	25.1	16.0	6.3	3.4	1.6	65.0
Engine speed, rpm.....	16.0	12.0	10.0	9.5	8.0	32.0
Torque, lb-ft.....						
Power, bhp*.....						
Fuel rate, lb/hr.....						
Ignition timing, deg BTC....						
Manifold vacuum, in Hg.....	15.0	15.4	14.5	14.3	14.2	19.0
Throttle angle, deg.....						
Concentrations, dry basis:						
CO, %.....	.0202	.0255	.0291	.0310	.0347	.0185
CO2, %.....	6.42	4.33	5.38	5.16	2.83	10.80
O2, %.....						
HC, ppmC.....	86	98	117	122	135	104
NOx, ppm.....	310	160	100	85	75	450
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	51.7	63.8	73.0	77.8	87.2	55.5
HC.....	11.1	12.3	14.7	15.3	17.0	15.7
NOx**.....	130.3	65.8	41.2	35.1	31.0	221.7
Oil temperature, F.....	237	235	232	230	229	242
Oil pressure, psi.....	74	75	75	75	76	75
Coolant temperature, F.....	179	192	192	192	190	188
Exhaust temperature, F.....	655	525	420	410	400	1116
Exhaust pressure, in H2O....	14.0	12.0	11.0	11.0	11.0	26.0
Exhaust flow, lb/min.....	10.35	9.92	9.86	9.85	9.82	12.63
Smoke, % opacity.....	3.8	4.2	4.5	4.9	4.9	3.8

* Corrected - SAE J815b.
** Corrected for humidity.

Mercedes diesel, 135-CID
7559

Engine.....
Fuel.....

	49 9/29/75	50 9/29/75	51 9/29/75	52 10/1/75	53 10/1/75	54 10/1/75
Test Number.....						
Test Date.....						
Barometer, mm Hg.....	743.1	743.1	743.1	752.1	752.1	752.1
Humidity, grains/lb.....	75	75	75	76	76	76
Temperature, F.....	80	80	78	78	78	78
Engine speed, rpm.....	3500	3500	3500	3500	3500	3500
Torque, lb-ft.....	98.0	74.0	59.0	59.0	25.0	10.0
Power, bhp*.....	53.4	49.1	39.1	25.5	16.4	6.5
Fuel rate, lb/hr.....	27.0	24.5	21.0	17.0	12.0	11.0
Ignition timing, deg BTC.....						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	18.3	17.3	16.2	16.0	15.3	14.5
Concentrations, dry basis:						
CO, %.....	.0176	.0202	.0100	.0403	.0491	.0615
CO ₂ , %.....	9.83	8.64	4.00	5.67	4.85	4.08
O ₂ , %.....						
HC, ppmC.....	97	102	156	100	126	165
NOx, ppm.....	445	405	150	240	185	110
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	51.4	59.4	30.8	126.4	149.7	181.5
HC.....	14.2	15.1	24.1	15.8	19.3	24.4
NOx**.....	213.4	195.7	75.8	123.9	92.8	53.4
Oil temperature, F.....	248	250	250	232	239	238
Oil pressure, psi.....	73	72	75	75	75	75
Coolant temperature, F.....	190	186	176	194	191	192
Exhaust temperature, F.....	1025	925	790	657	575	525
Exhaust pressure, in H ₂ O.....	25.0	23.0	21.0	20.0	18.0	18.0
Exhaust flow, lb/min.....	12.19	12.14	12.16	12.61	12.16	11.68
Smoke, % opacity.....	3.5	4.4	4.2	4.5	5.6	5.8

* Corrected - SAE J816b.

** Corrected for humidity.

Mercedes diesel, 183-CID
7559

	55	56	57	58	59	60
Test Date	10/ 1/75	10/ 1/75	10/ 1/75	10/ 1/75	10/ 1/75	10/ 1/75
Engine	752.1	752.1	752.1	752.1	752.1	752.1
Fuel	76	76	76	76	76	76
Temperature, F	78	78	78	78	78	78
Barometer, mm Hg	3500	3500	4000	4000	4000	4000
Humidity, grains/lb	5.0	0.0	92.0	83.0	69.0	55.0
Engine speed, rpm	3.3	0.0	68.7	62.0	51.5	41.1
Torque, lb-ft	13.0	9.0	35.6	32.5	28.9	22.0
Power, bhp*	14.3	14.2	19.0	18.0	17.1	16.8
Fuel rate, lb/hr						
Ignition timing, deg BTC						
Manifold vacuum, in Hg						
Throttle angle, deg						
Concentrations, dry basis:						
CO, %	.0626	.0542	.0347	.0323	.0365	.0422
CO2, %	3.67	3.27	10.91	9.83	8.83	7.56
O2, %						
HC, ppmC	164	144	105	98	107	116
NOx, ppm	110	90	485	480	450	410
Air-fuel ratio						
Emission rates, g/hr:						
CO	194.2	167.1	114.6	107.3	119.4	136.6
HC	25.5	22.2	17.5	16.3	17.5	18.9
NOx**	56.1	45.6	263.5	262.3	242.2	218.4
Oil temperature, F	235	238	261	262	260	259
Oil pressure, psi	75	75	70	71	71	71
Coolant temperature, F	186	189	190	187	190	184
Exhaust temperature, F	478	465	1190	1098	964	855
Exhaust pressure, in H2O	18.0	18.0	37.0	35.0	32.0	30.0
Exhaust flow, lb/min	12.23	12.11	13.93	13.87	13.54	13.24
Smoke, % opacity	5.8	5.3	4.5	4.4	4.5	5.1

* Corrected - SAE J816b.
** Corrected for humidity.

Mercedes diesel, 183-CID
7559

	61		62		63		64		65		66	
	10/	1/75	10/	1/75	10/	1/75	10/	1/75	10/	1/75	10/	1/75
Engine.....	751.6		751.6		751.6		751.6		751.6		751.6	
Fuel.....	76		76		76		76		76		76	
Test Number.....	73		73		73		73		73		73	
Test Date.....												
Barometer, mm Hg.....	4000		4000		4000		4000		4000		4000	
Humidity, grains/lb.....	37.0		23.0		9.0		5.0		1.0		.4	
Temperature, F.....	27.5		17.1		6.7		3.7		.7		.1	
Engine speed, rpm.....	19.0		17.0		15.0		15.0		11.0		.7	
Torque, lb-ft.....												
Power, bhp*.....												
Fuel rate, lb/hr.....												
Ignition timing, deg BTC.....												
Manifold vacuum, in Hg.....	15.0		15.4		14.5		14.3		14.2		0.0	
Throttle angle, deg.....												
Concentrations, dry basis:												
CO, %.....	.0516		.0573		.0674		.0647		.0636		.0300	
CO2, %.....	5.67		5.11		4.33		3.84		3.61		2.52	
O2, %.....												
HC, ppmC.....	121		134		178		164		145		247	
NOx, ppm.....	275		220		150		130		115		98	
Air-fuel ratio.....												
Emission rates, g/hr:												
CO.....	178.0		192.9		234.4		226.0		221.6		14.5	
HC.....	20.9		22.6		51.1		28.8		25.4		6.0	
NOx**.....	156.1		121.9		85.8		74.7		65.9		7.8	
Oil temperature, F.....	234		250		239		242		245		216	
Oil pressure, psi.....	75		72		75		74		75		16	
Coolant temperature, F.....	190		190		192		191		190		188	
Exhaust temperature, F.....	740		670		575		530		525		244	
Exhaust pressure, in H2O.....	27.0		26.0		24.0		23.0		23.0		0.0	
Exhaust flow, lb/min.....	13.87		13.46		15.80		15.80		13.73		1.89	
Smoke, % opacity.....	5.8		5.8		5.3		4.9		4.9		2.4	

* Corrected - SAE J816b.

** Corrected for humidity.

Mercedes diesel, 183-CID
7559

	67	68	69	70	71	72
Test Number.....	10/ 1/75	10/ 1/75	10/ 1/75	10/ 1/75	10/ 3/75	10/ 3/75
Test Date.....						
Barometer, mm Hg.....	751.6	751.6	751.6	751.6	751.3	751.3
Humidity, grains/lb.....	76	76	76	76	58	58
Temperature, F.....	73	73	73	73	78	77
Engine speed, rpm.....	700	1100	1100	1100	1100	1100
Torque, lb-ft.....	10.0	110.0	66.0	44.0	28.0	11.0
Power, bhp*.....	1.3	22.6	13.6	9.0	5.8	2.3
Fuel rate, lb/hr.....	1.0	9.5	5.5	3.6	3.5	2.5
Ignition timing, deg BTC.....						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	2.0	19.0	14.3	13.8	12.5	10.0
Concentrations, dry basis:						
CO, %.....	.0255	.0422	.0193	.0159	.0328	.0273
CO2, %.....	3.05	10.91	6.73	4.78	4.08	2.73
O2, %.....						
HC, ppmC.....	117	190	115	146	141	205
NOx, ppm.....	130	300	292	230	175	95
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	13.5	39.1	16.0	14.4	28.7	24.2
HC.....	3.1	8.8	4.8	6.6	6.2	9.1
NOx**.....	11.3	45.7	39.9	34.4	24.1	13.2
Oil temperature, F.....	190	190	197	198	185	190
Oil pressure, psi.....	22	40	36	36	41	40
Coolant temperature, F.....	188	185	178	178	184	192
Exhaust temperature, F.....	220	780	595	425	308	260
Exhaust pressure, in H2O.....	0.0	3.0	3.0	2.0	2.0	2.0
Exhaust flow, lb/min.....	2.08	3.91	3.37	3.62	3.47	3.46
Smoke, % opacity.....	2.0	9.5	4.2	2.6	1.7	1.4

* Corrected - SAE J816b.

** Corrected for humidity.

Mercedes diesel, 183-CID
7559

	73		74		75		76		77		78	
	10/	3/75	10/	3/75	10/	3/75	10/	3/75	10/	3/75	10/	3/75
Engine.....	751.3		751.3		751.3		751.3		751.3		751.3	
Fuel.....	58	78	58	81	58	81	58	82	58	84	58	82
Test Number.....	1100		1500		1500		1500		1500		1500	
Test Date.....	.4		111.0		67.0		44.0		28.0		11.0	
Barometer, mm Hg.....	.1		31.3		18.9		12.4		7.9		3.1	
Humidity, grains/lb.....	1.8		12.9		8.4		6.2		5.3		3.7	
Temperature, F.....												
Engine speed, rpm.....												
Torque, lb-ft.....												
Power, bhp*.....												
Fuel rate, lb/hr.....												
Ignition timing, deg BTC....												
Manifold vacuum, in Hg.....	3.8		19.0		16.8		16.0		15.3		14.4	
Throttle angle, deg.....												
Concentrations, dry basis:												
CO, %.....	.0370		.0319		.0246		.0220		.0220		.0220	
CO2, %.....	2.02		10.91		6.42		4.85		5.96		2.83	
O2, %.....												
HC, ppmC.....	295		114		82		87		104		121	
NOx, ppm.....	55		370		310		215		150		93	
Air-fuel ratio.....												
Emission rates, g/hr:												
CO.....	32.8		34.7		50.8		27.6		27.6		27.4	
HC.....	13.1		6.2		5.1		5.5		6.5		7.6	
NOx**.....	7.7		63.4		61.0		42.5		29.6		18.3	
Oil temperature, F.....	194		204		207		207		206		204	
Oil pressure, psi.....	40		46		50		50		51		41	
Coolant temperature, F.....	192		183		188		188		182		190	
Exhaust temperature, F.....	218		866		556		435		346		285	
Exhaust pressure, in H2O....	2.0		4.0		3.0		3.0		3.0		3.0	
Exhaust flow, lb/min.....	3.44		4.59		5.06		5.01		4.96		4.88	
Smoke, % opacity.....	1.4		4.5		2.4		2.0		2.7		1.7	

* Corrected - SAE J316b.
** Corrected for humidity.

Mercedes diesel, 183-CID
7559

	79	80	81	82	83	84
Test Number	10/5/75	10/16/75	10/16/75	10/16/75	10/16/75	10/16/75
Test Date						
Barometer, mm Hg	751.3	744.7	744.7	744.7	744.7	744.7
Humidity, grains/lb	58	65	65	65	65	65
Temperature, F	84	82	82	82	82	82
Engine speed, rpm	1500	2000	2000	2000	2000	2000
Torque, lb-ft	.6	110.0	66.0	44.0	27.0	12.0
Power, bhp*	.2	41.8	25.1	16.7	10.3	4.6
Fuel rate, lb/hr	2.6	19.1	12.2	8.2	6.4	4.8
Ignition timing, deg BTC						
Manifold vacuum, in Hg						
Throttle angle, deg	14.1	22.0	16.5	15.6	14.8	14.0
Concentrations, dry basis:						
CO, %	.0250	.0176	.0167	.0167	.0176	.0202
CO2, %	2.07	13.04	6.04	4.58	3.49	2.73
O2, %						
HC, ppmC	145	96	95	126	143	136
NOx, ppm	60	395	300	130	105	65
Air-fuel ratio						
Emission rates, g/hr:						
CO	29.0	30.9	29.5	28.9	30.7	35.3
HC	9.0	8.4	8.5	10.9	12.5	11.9
NOx**	11.7	108.2	85.0	49.9	29.3	18.2
Oil temperature, F	202	113	214	212	211	210
Oil pressure, psi	46	72	60	59	60	60
Coolant temperature, F	192	181	181	184	192	194
Exhaust temperature, F	255	975	597	494	386	327
Exhaust pressure, in H2O	3.0	9.0	8.0	7.0	6.0	5.0
Exhaust flow, lb/min	4.83	7.34	7.15	6.89	6.86	6.83
Smoke, % opacity	2.0	2.4	2.0	3.3	3.6	3.6

* Corrected - SAE J816b.
** Corrected for humidity.

Mercedes diesel, 183-CID
7559

	85 10/16/75	86 10/ 1/75	87 10/ 1/75	88 10/ 1/75	89 10/ 1/75	90 10/ 1/75
Engine.....						
Fuel.....						
Test Number.....						
Test Date.....						
Barometer, mm Hg.....	744.7	752.1	752.1	752.1	752.1	752.1
Humidity, grains/lb.....	65	76	76	76	76	76
Temperature, F.....	82	82	83	83	83	83
Engine speed, rpm.....	2000	2400	2400	2400	2400	2400
Torque, lb-ft.....	0.0	114.0	68.0	46.0	29.0	11.0
Power, bhp*.....	0.0	51.5	30.8	20.8	13.1	5.0
Fuel rate, lb/hr.....	3.7	21.0	15.0	11.0	7.5	5.0
Ignition timing, deg BTC....						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	15.6	19.0	16.5	16.0	15.0	14.6
Concentrations, dry basis:						
CO, %.....	.0211	.0275	.0282	.0282	.0300	.0347
CO2, %.....	2.22	15.47	6.42	4.98	3.84	2.94
O2, %.....						
HC, ppmC.....	159	112	108	110	105	131
NOx, ppm.....	45	415	315	210	130	80
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	37.0	55.4	58.5	60.1	62.9	73.0
HC.....	14.0	11.4	11.2	11.8	11.0	13.8
NOx**.....	12.6	138.6	107.6	75.7	44.8	27.7
Oil temperature, F.....	207	215	220	220	220	218
Oil pressure, psi.....	60	75	70	70	70	70
Coolant temperature, F.....	188	188	175	188	191	191
Exhaust temperature, F.....	286	1020	658	545	435	365
Exhaust pressure, in H2O....	5.0	13.0	11.0	10.0	8.0	8.0
Exhaust flow, lb/min.....	6.81	8.53	8.40	8.51	8.27	8.23
Smoke, % opacity.....	3.8	.7	1.7	1.5	2.4	2.6

* Corrected - SAE J816b.
** Corrected for humidity.

Engine..... Mercedes diesel, 183-CID
 Fuel..... 7559

	91 10/ 1/75	92 10/ 1/75	93 10/ 1/75	94 10/ 1/75	95 10/ 1/75	96 10/ 1/75
Test Number.....						
Test Date.....						
Barometer, mm Hg.....	752.1	752.1	752.1	752.1	752.1	752.1
Humidity, grains/lb.....	76	76	76	76	76	76
Temperature, F.....	80	80	81	80	80	81
Engine speed, rpm.....	2400	3000	3000	3000	3000	3000
Torque, lb-ft.....	0.0	107.0	64.0	43.0	28.0	11.0
Power, bhp*.....	0.0	60.2	36.0	24.2	15.8	6.2
Fuel rate, lb/hr.....	4.1	28.0	17.0	14.0	11.0	8.5
Ignition timing, deg BTC.....						
Manifold vacuum, in Hg.....	14.2	19.0	16.8	16.0	15.4	14.5
Throttle angle, deg.....						
Concentrations, dry basis:						
CO, %.....	.0375	.0300	.0337	.0347	.0365	.0466
CO2, %.....	2.22	10.68	6.57	5.46	4.33	3.61
O2, %.....						
HC, ppmC.....	130	99	95	86	93	118
NOx, ppm.....	55	470	340	250	150	110
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	84.5	79.5	90.0	93.0	97.5	125.6
HC.....	14.7	13.1	12.7	11.6	12.5	16.0
NOx**.....	20.4	205.1	149.4	110.2	66.0	48.8
Oil temperature, F.....	218	233	242	239	232	230
Oil pressure, psi.....	70	75	71	73	75	75
Coolant temperature, F.....	189	175	190	185	191	188
Exhaust temperature, F.....	320	1084	770	620	502	440
Exhaust pressure, in H2O.....	7.0	22.0	19.0	16.0	14.0	14.0
Exhaust flow, lb/min.....	8.76	11.16	10.83	10.74	10.60	10.62
Smoke, % opacity.....	2.7	1.2	3.5	2.6	2.4	3.3

* Corrected - SAE J816b.
 ** Corrected for humidity.

Mercedes diesel, 183-CID
7559

	97	98	99	100	101	102
Test Number.....	10/ 1/75	10/ 1/75	10/ 1/75	10/ 1/75	10/ 1/75	10/ 1/75
Test Date.....	752.1 76 81	752.1 76 81	752.1 76 80	752.1 76 81	752.1 76 81	752.1 76 81
Barometer, mm Hg.....	3000	3500	3500	3500	3500	3500
Humidity, grains/lb.....	2.0	95.0	57.0	38.0	24.0	10.0
Temperature, F.....	1.1	62.3	37.4	24.9	15.8	6.6
Engine speed, rpm.....	6.6	33.0	24.0	18.0	14.6	13.5
Torque, lb-ft.....						
Power, bhp*.....						
Fuel rate, lb/hr.....						
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....	14.2	19.0	16.9	16.0	15.3	14.5
Throttle angle, deg.....						
Concentrations, dry basis:						
CO, %.....	.0466	.0523	.0415	.0471	.0491	.0604
CO2, %.....	2.83	10.47	7.22	5.96	4.85	4.21
O2, %.....						
HC, ppmC.....	120	119	108	114	116	148
NOx, ppm.....	70	480	350	280	185	140
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	127.2	100.8	151.7	150.4	156.6	194.9
HC.....	16.9	18.7	17.3	18.3	18.6	24.0
NOx**.....	31.4	246.6	183.7	147.1	97.1	74.3
Oil temperature, F.....	251	244	244	251	243	245
Oil pressure, psi.....	75	74	75	74	75	73
Coolant temperature, F.....	188	184	191	187	192	190
Exhaust temperature, F.....	391	1137	795	715	618	582
Exhaust pressure, in H2O...	14.0	31.0	27.0	27.0	23.0	23.0
Exhaust flow, lb/min.....	10.68	15.11	13.01	12.86	12.72	12.79
Smoke, % opacity.....	3.1	1.7	3.5	4.2	4.0	4.5

* Corrected - SAE J816b.
** Corrected for humidity.

Mercedes diesel, 183-CID
7559

	103 10/1/75	104 10/16/75	105 10/16/75	106 10/16/75	107 10/16/75
Engine.....					
Fuel.....					
Test Number.....					
Test Date.....					
Barometer, mm Hg.....	752.1	744.7	744.7	744.7	744.7
Humidity, grains/lb.....	76	65	65	65	65
Temperature, F.....	81	81	81	81	81
Engine speed, rpm.....	3500	700	700	700	700
Torque, lb-ft.....	1.0	0.0	10.0	20.0	30.0
Power, bhp*.....	.7	0.0	1.5	2.7	4.0
Fuel rate, lb/hr.....	11.5	1.5	1.7	2.1	2.5
Ignition timing, deg BTC.....					
Manifold vacuum, in Hg.....					
Throttle angle, deg.....	14.2	0.0	2.0	0.0	0.0
Concentrations, dry basis:					
CO, %.....	.064	.0163	.0167	.0167	.0189
CO2, %.....	5.61	2.57	3.05	3.72	4.33
O2, %.....					
HC, ppmC.....	164	205	148	131	125
NOx, ppm.....	105	80	120	160	190
Air-fuel ratio.....					
Emission rates, g/hr:					
CO.....	204.9	8.0	9.0	9.0	10.1
HC.....	26.0	5.0	4.0	3.5	3.4
NOx**.....	54.7	6.3	10.5	15.7	16.3
Oil temperature, F.....	241	206	196	187	188
Oil pressure, psi.....	74	18	21	23	24
Coolant temperature, F.....	188	182	188	189	188
Exhaust temperature, F.....	525	230	228	258	288
Exhaust pressure, in H2O.....	21.0	0.0	1.0	1.0	1.0
Exhaust flow, lb/min.....	12.48	1.92	2.11	2.11	2.12
Smoke, % opacity.....	4.4	2.0	2.6	2.7	3.1

* Corrected - SAE J816b.
** Corrected for humidity.

