Report No. DOT-TSC-OST-77-48

PERFORMANCE CHARACTERISTICS OF AUTOMOTIVE ENGINES IN THE UNITED STATES

Report No. 8--Mitsubishi Model 6DS7 Diesel Engine

W. F. Marshall
K. R. Stamper

ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION
BARTLESVILLE ENERGY RESEARCH CENTER
P.O. Box 1398
Bartlesville OK 74003

AUGUST 1977

INTERIM REPORT

DOCUMENT IS AVAILABLE TO THE U.S. PUBLIC THROUGH THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, 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

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT-TSC-OST-77-48		

4. Title and Subtitle	5. Report Date
PERFORMANCE CHARACTERISTICS OF AUTOMOTIVE ENGINES IN THE UNITED STATES Report No. 8--Mitsubishi Model 6DS7 Diesel Engine	August 1977
	6. Performing Organization Code
7. Author(s) W. F. Marshall and K. R. Stamper	8. Performing Organization Report No. DOT-TSC-OST-77-48 BERC/OP-76/33
9. Performing Organization Name and Address Energy Research & Development Administration* Bartlesville Energy Research Center P.O. Box 1398 Bartlesville OK 74003	10. Work Unit No. (TRAIS) OST714/R7508
	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 July 1975
	14. Sponsoring Agency Code

15. Supplementary Notes

*Interagency agreement with: US Department of Transportation, Transportation Systems Center, Kendall Square, Cambridge MA 02142

16. Abstract

Experimental data were obtained in dynamometer tests of the Mitsubishi Model 6DS7 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	18. Distribution Statement
IC Engines, Diesel Engines, Fuel Economy, Auto Emissions	DOCUMENT IS AVAILABLE TO THE U.S. PUBLIC THROUGH THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VIRGINIA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	34	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

PREFACE

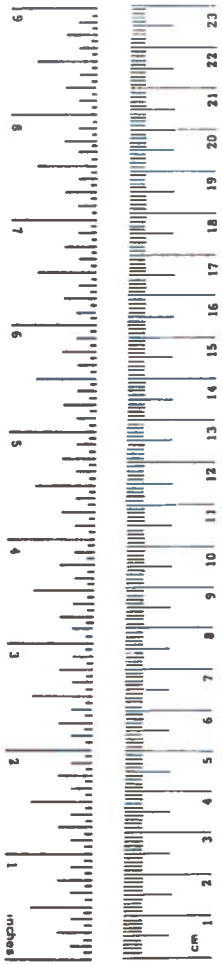
This report, prepared by the Energy Research and Development Administration, Bartlesville Energy Research Center for the U.S. Department of Transportation, Transportation Systems Center, Energy Technology Branch, Cambridge, MA, presents results of experimental work to obtain information on performance 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, Department of Transportation is the technical monitor for this project.

METRIC CONVERSION FACTORS

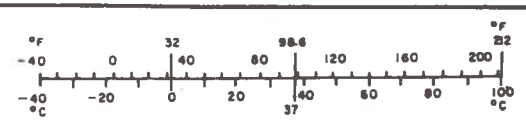
Approximate Conversions to Metric Measures

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		
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



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



1. INTRODUCTION

This report presents data acquired from tests of a Mitsubishi Model 6DS7 diesel engine. This engine is imported by Chrysler and is marketed as Chrysler Diesel Model CI655-100. The test results are sufficient to establish steady-state maps for fuel consumption and emissions (carbon monoxide, hydrocarbons, oxides of nitrogen, and smoke) over the entire operating range of the engine. This engine is one of a series tested or to be tested.

The objective of this 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

General engine specifications for the Mitsubishi diesel engine, Model 6DS7, 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 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.

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 110 hours. The period of testing was July 22-31, 1975.

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

Low speeds: 900; 1,000; 1,100 rpm

Loads: 0, 10, 25, 40, 60, 75, 90, 100 pct of full load (repeated at 0, 25, 60, 75, 100 pct of full load)

High speeds: 1,500; 1,800; 2,000; 2,400; 2,800; 3,150 rpm

Loads: 0, 10, 25, 40, 60, 75, 90, 100 pct of full load (repeated at 0, 25, 75, 100 pct of full load)

Idle: 0, 0.3, 1.1, 1.5 bhp plus lug (load equivalent to transmission in drive) (repeated at 0.3 bhp)

Number of original tests..... 69
Repeats..... 33
Total number of tests..... 102 .

The following data were recorded:

Test number
Date
Barometric pressure, mm Hg
Dew point, °F
Inlet air temperature, °F
Speed, rpm
Torque, lb-ft -- BLH strain gauge; Daytronics meter
Fuel rate, lb/hr -- FLO-TRON linear mass flowmeter
Throttle angle, degrees
CO, pct -- Beckman NDIR

CO_2, pct -- Beckman NDIR
HC, ppmC -- Custom-built heated FID
NO_x, ppm -- Thermo-Electron chemiluminescent detector
Oil temperature, °F
Oil pressure, psi
Coolant temperature, °F
Exhaust temperature, °F
Exhaust pressure, in. H_2O
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 hydrocarbons (HC), and oxides of nitrogen (NO_x) in grams per hour. The following equations were applied in the computations:

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

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

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

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

$$\text{Mass CO} = \text{(exhaust flow rate) x (concentration CO)} \times\left(\frac{\text{Mol. wt. CO}}{\text{Mol. wt. exhaust}}\right) \times \text{(correction for water removal)},$$

$$\text{Mass CO} = 0.0263\ \text{(exhaust rate)}\ \text{(ppm CO)}\left[\frac{1}{1 + 0.03\ CO_2\left(\frac{CO + CO_2}{CO + 3CO_2}\right)}\right],$$

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

$$\text{Mass } NO_x = 0.0432\ \text{(exhaust rate)}\ \text{(ppm } NO_x)\left[\frac{1}{1 + 0.03\ CO_2\left(\frac{CO + CO_2}{CO + 3CO_2}\right)}\right] \times \text{(humidity correction factor, } K_H),$$

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

TABLE 1. - MANUFACTURER'S ENGINE SPECIFICATIONS

Model number	6DS7
Displacement, cubic inches	331.4
Maximum power @ 3,150 rpm	135
Maximum torque, lb-ft @ 2,000 rpm	253
Configuration	in-line 6-cylinder
Bore, inches	3.86
Stroke, inches	4.72
Combustion system	Precombustion chamber
Compression ratio	19:1
Firing order	1-5-3-6-2-4
Fuel (minimum Cetane No.)	45
Injection pressure, psi	1,775
Injection timing, °BTC	15
Block material	Cast iron
Head material	Cast iron
Number of crankshaft main bearings	7
Number of compression rings/piston	2
Number of oil rings/piston	1
Cam drive	Gear train
Valve clearance (cold):	
Intake, inches	0.012
Exhaust, inches	0.012
Valve port size:	
Intake, inches	1.889
Exhaust, inches	1.535
Valve timing:	
Intake opens, °BTC	30
Intake closes, °ABC	66
Exhaust opens, °BBC	66
Exhaust closes, °ATC	30

TABLE 2. - FUEL ANALYSIS

Fuel No.	7559
API gravity, degrees	35.8
Distillation, °F:	
10 pct evaporated	400
50 pct "	484
90 pct "	576
End point	616
FIA analysis, pct:	
Aromatics	32.0
Olefins	4.0
Paraffins	64.0
Sulfur, pct	0.24

TABLE 3. - ENGINE BREAK-IN SCHEDULE

Engine speed, rpm	Torque, lb-ft	Time in mode, hr
1,200	24	1
1,600	24	1
1,600	48	2
1,900	48	2
1,900	72	2
2,200	72	2
2,200	104	2
2,500	104	2
2,500	125	2
2,700	125	2
2,700	150	2
2,900	150	1
2,900	161	1
3,000	161	1
3,150	176	1

3. DISCUSSION OF TEST RESULTS

Brake horsepower, torque, and brake specific fuel consumption are shown plotted against engine speed (at full rack conditions) in figure 1. The maximum brake horsepower and torque values quoted in table 1 are somewhat higher than those shown here. Fuel rate at various load conditions was repeatable over the entire operating range of the engine (figure 2).

Exhaust emissions of CO are shown plotted against power at various engine speeds (figure 3). The exhaust emission rates of HC and NO_x (figures 4 and 5) are repeatable even at engine speeds below 1,500 rpm; the size of the scale is such that the figures do not give this appearance initially. A plot of exhaust stream opacity versus power (figure 6) exhibits a dependence on power that is typical of diesel engines.

4. CONCLUSIONS

Repeatability of emission rates, fuel consumption, smoke levels, and engine performance was satisfactory for the purposes of this test.

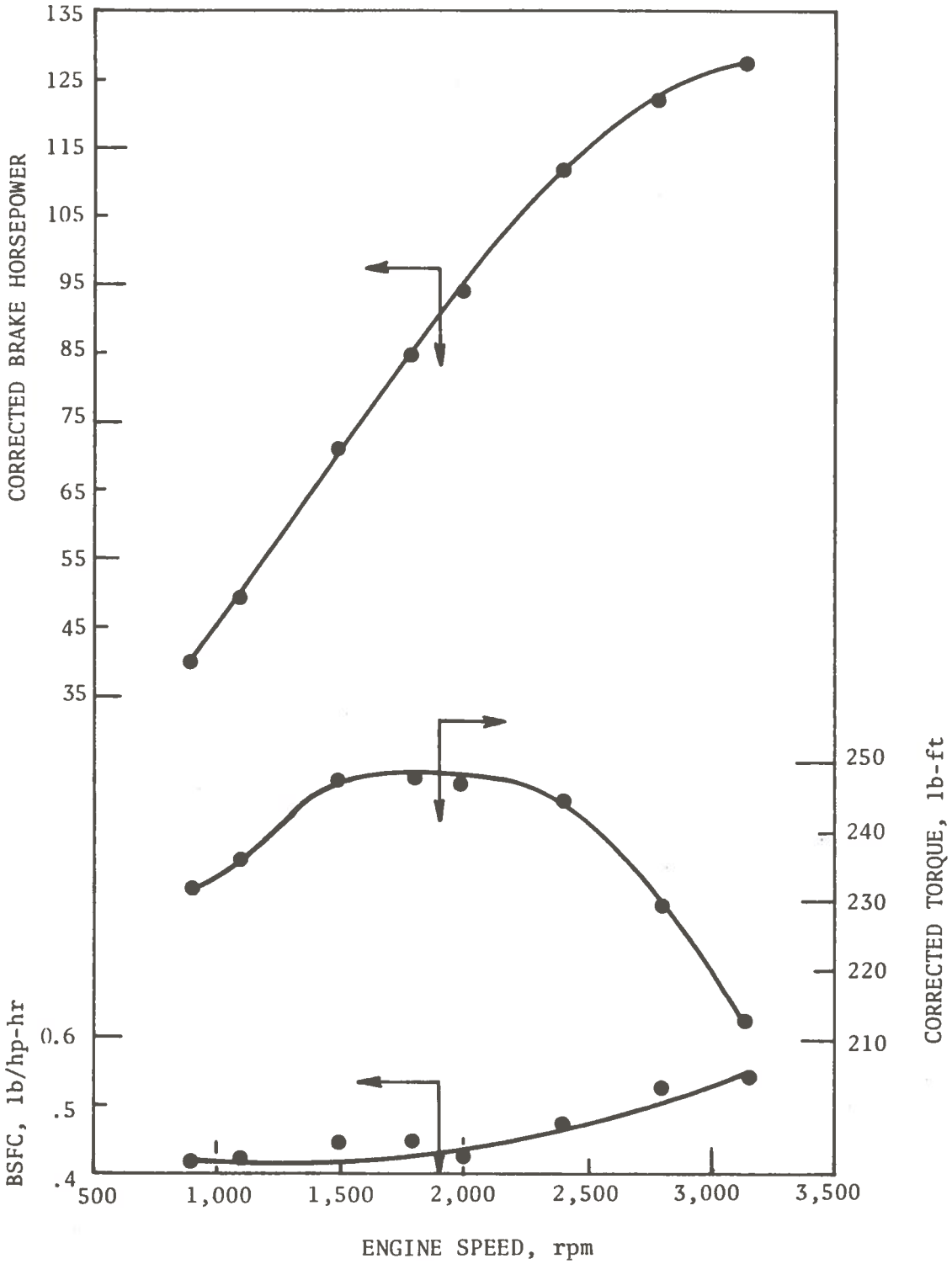


FIGURE 1. - BRAKE SPECIFIC FUEL CONSUMPTION, MAXIMUM TORQUE, AND BRAKE HORSEPOWER VERSUS ENGINE RPM AT FULL RACK--MITSUBISHI DIESEL ENGINE.

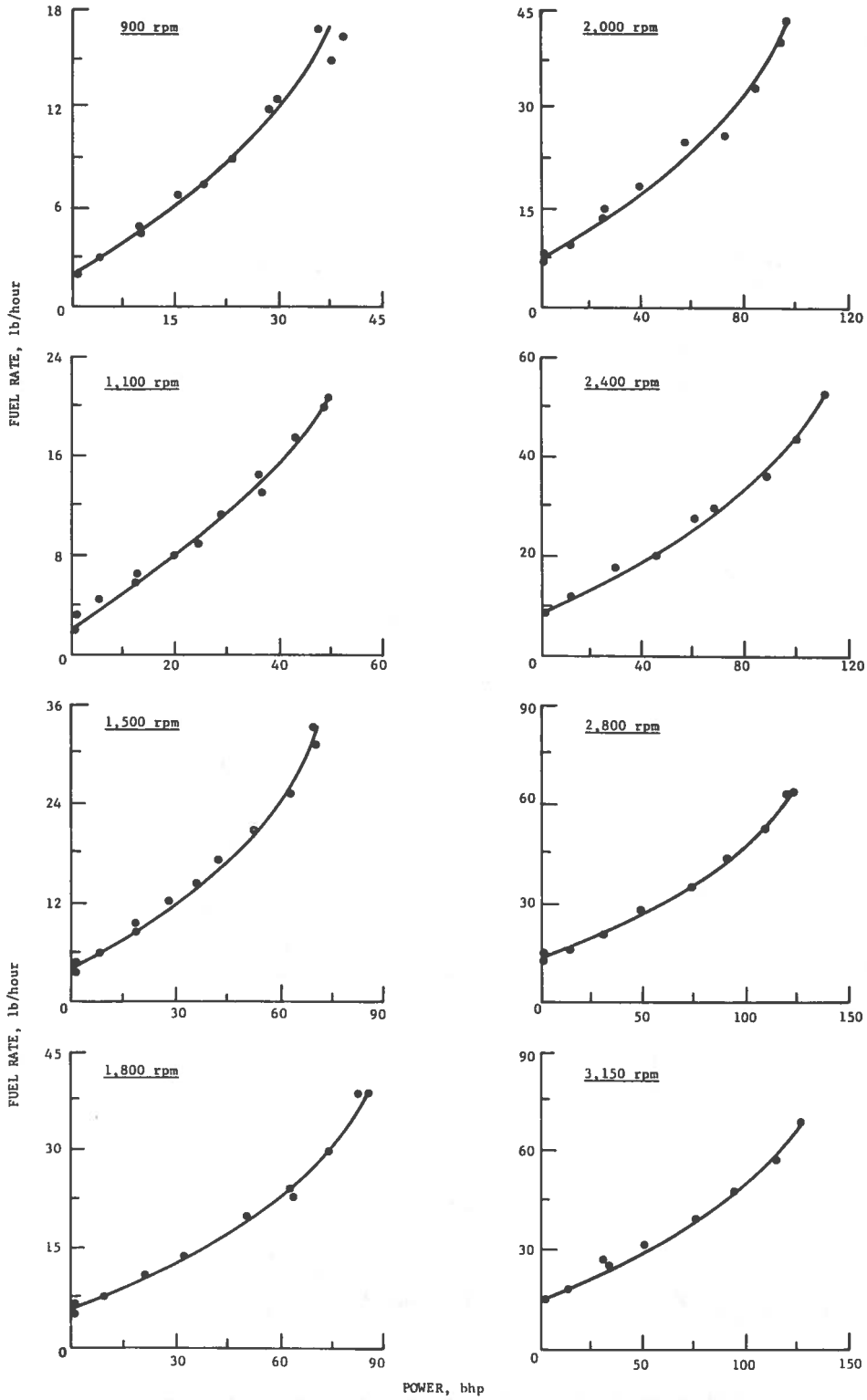


FIGURE 2. - FUEL RATE VERSUS POWER AT SEVERAL SPEEDS--MITSUBISHI DIESEL ENGINE

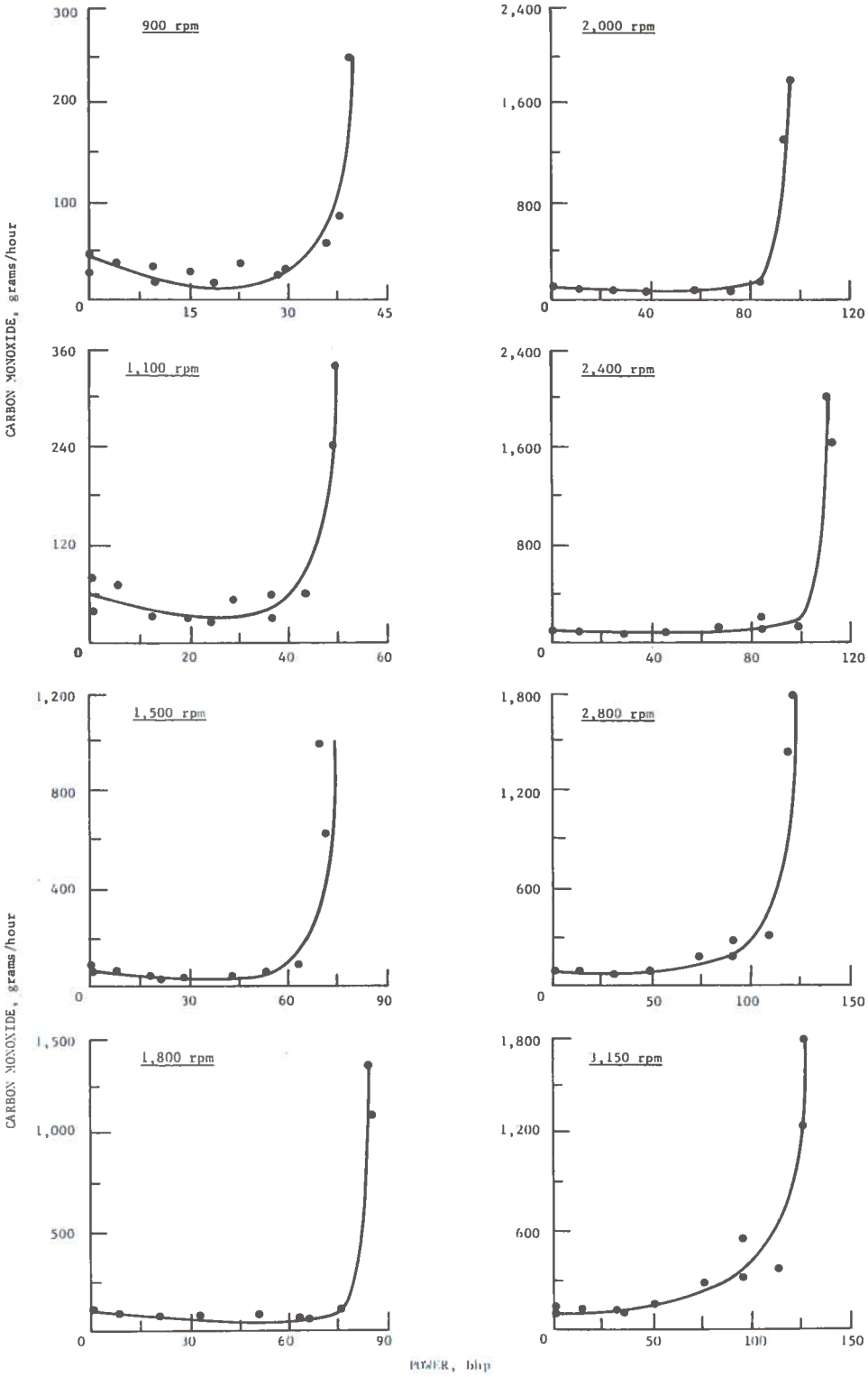


FIGURE 3. - CARBON MONOXIDE EMISSIONS VERSUS POWER AT SEVERAL SPEEDS--MITSUBISHI DIESEL ENGINE.

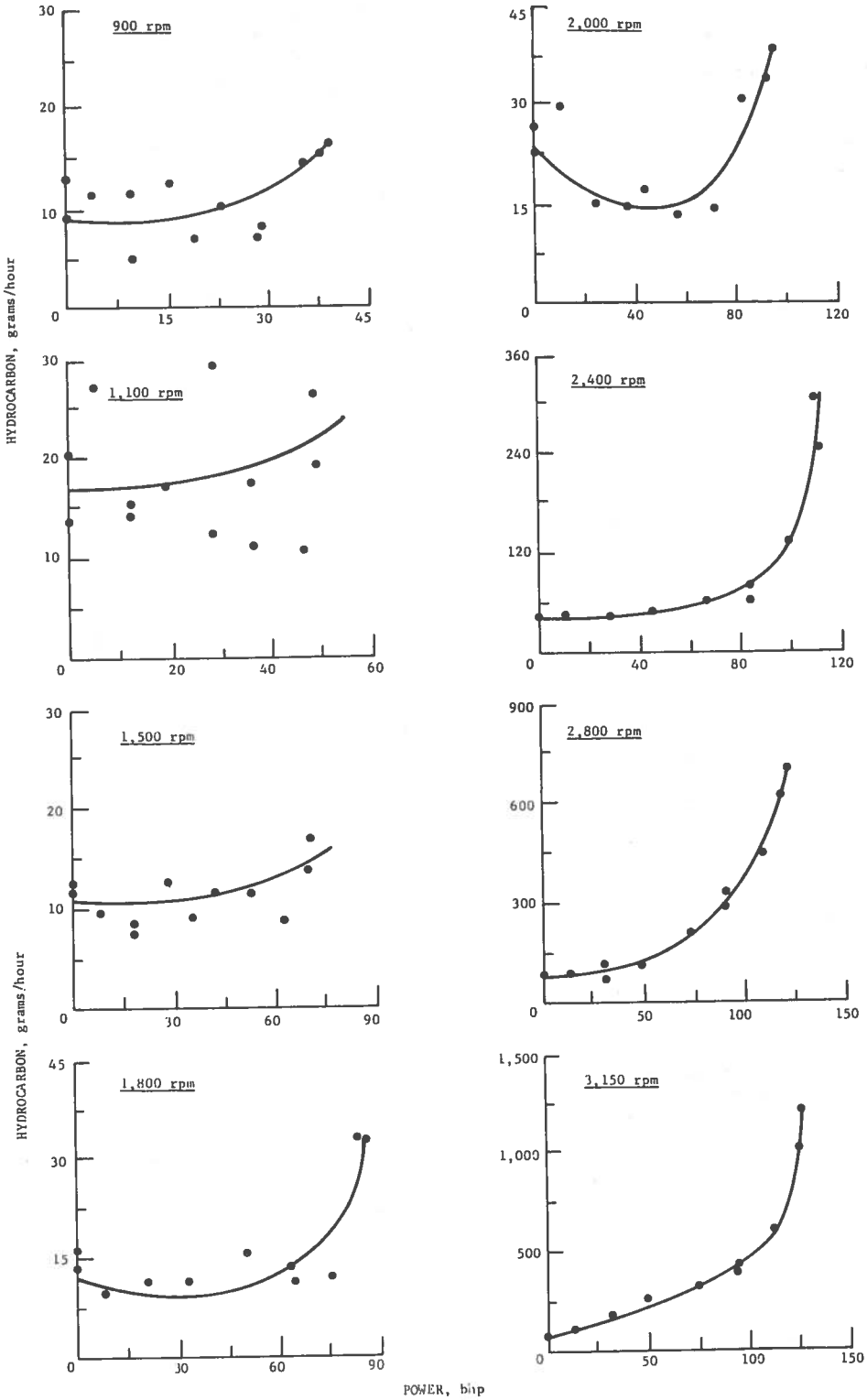


FIGURE 4. - HYDROCARBON EMISSIONS VERSUS POWER AT SEVERAL SPEEDS--MITSUBISHI DIESEL ENGINE.

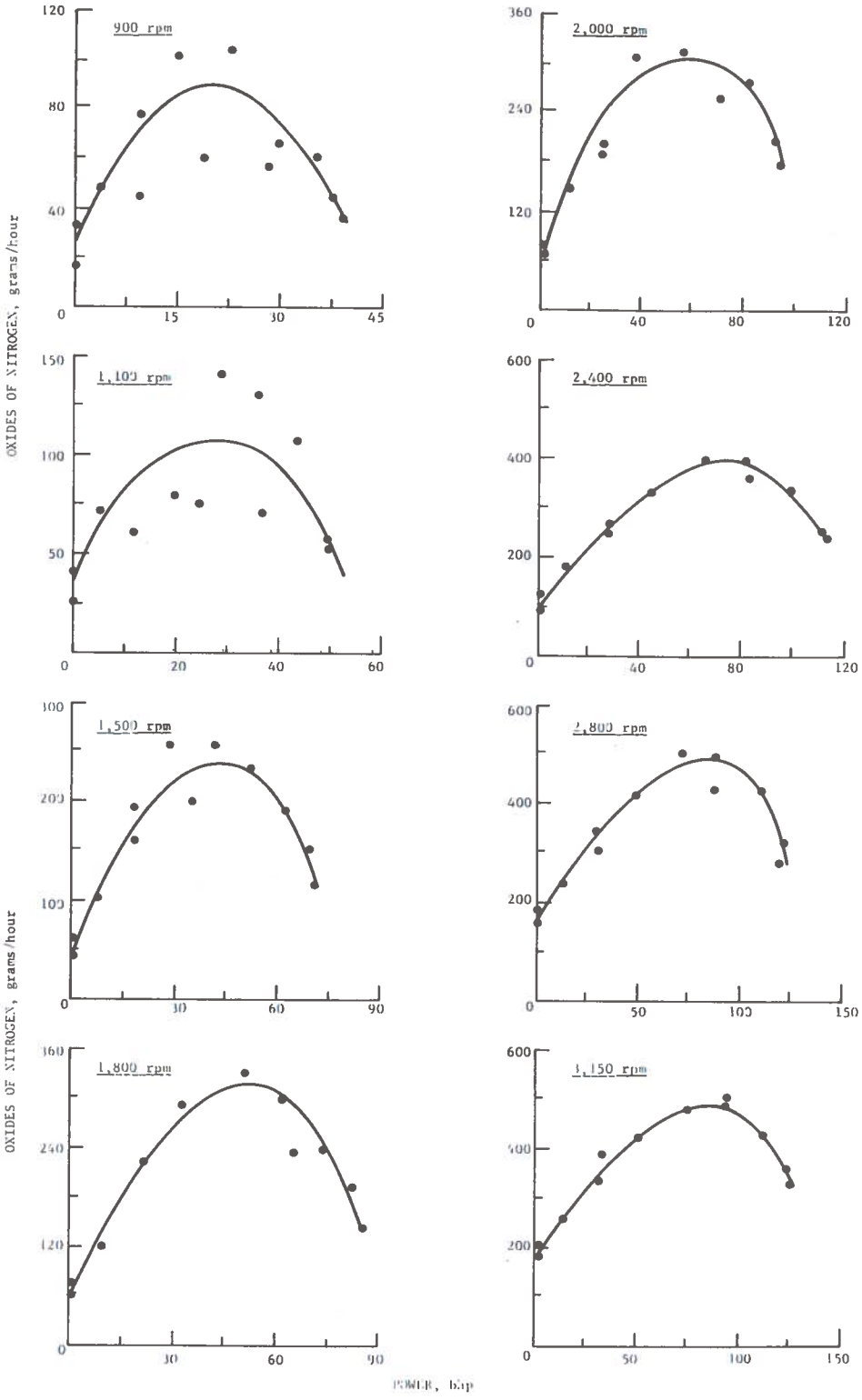


FIGURE 5. - OXIDES OF NITROGEN EMISSIONS VERSUS POWER AT SEVERAL SPEEDS--MITSUBISHI DIESEL ENGINE.

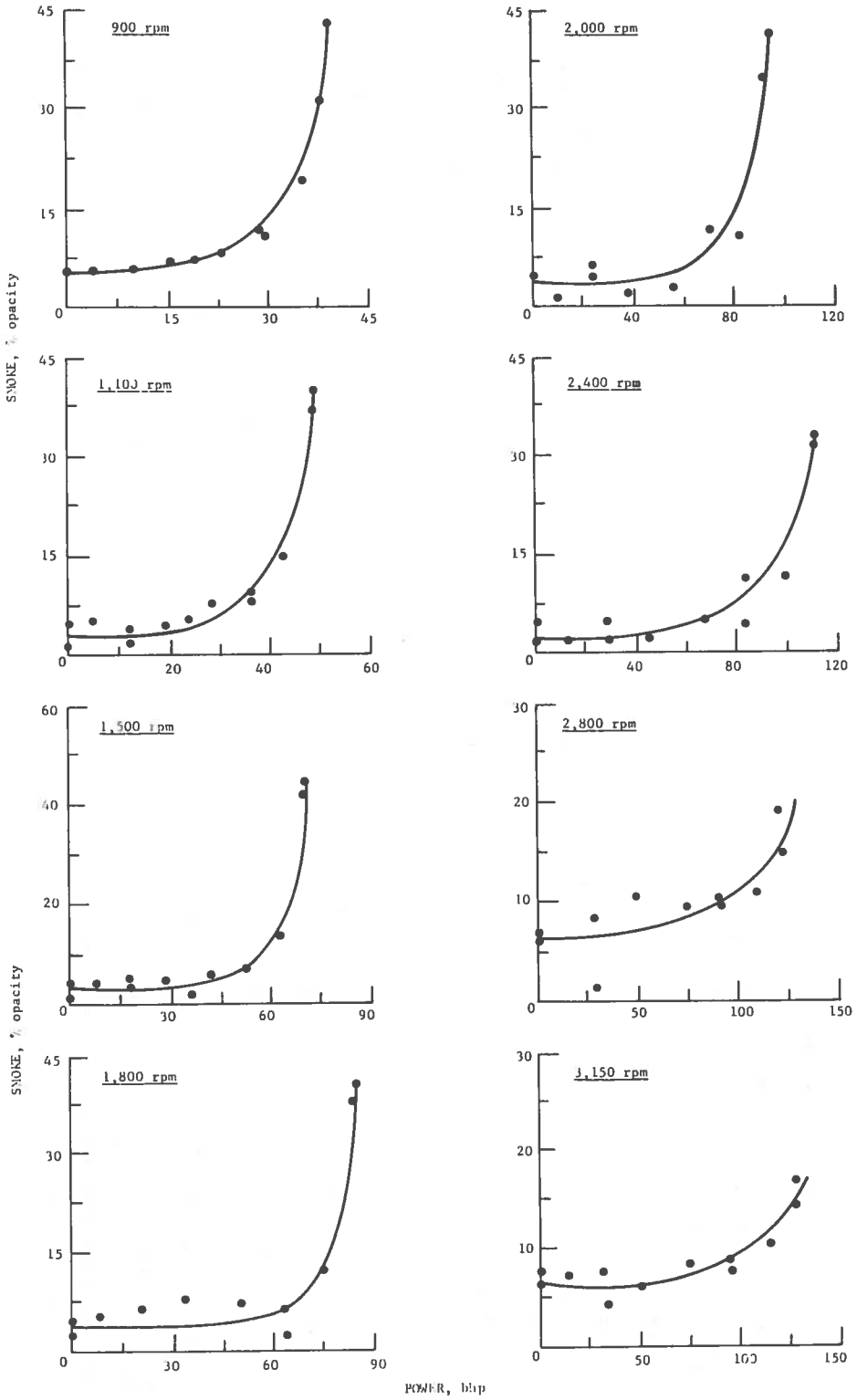


FIGURE 6. - EMISSIONS OF SMOKE VERSUS POWER AT SEVERAL SPEEDS--MITSUBISHI DIESEL ENGINE.

Engine..... Mitsubishi diesel, 330-CID
Fuel..... 7559

Test Number.....	1	2	3	4	5	6
Test Date.....	7/22/75	7/22/75	7/22/75	7/22/75	7/22/75	7/22/75
Barometer, mm Hg.....	743.0	743.0	743.0	743.0	743.0	743.0
Humidity, grains/lb.....	80	80	80	80	80	80
Temperature, F.....	81	81	84	86	85	80
Engine speed, rpm.....	800	750	900	900	900	900
Torque, lb-ft.....	2.2	30.0	229.0	206.0	172.0	134.0
Power, bhp*.....	.3	4.3	39.7	35.8	29.8	23.1
Fuel rate, lb/hr.....	2.0	3.0	16.5	17.0	12.5	9.0
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	2.5	2.5	40.5	5.0	4.5	4.3
Concentrations, dry basis:						
CO, %.....	.0232	.0109	.2605	.0594	.0319	.0255
CO2, %.....	2.15	3.41	13.62	11.36	8.93	7.47
O2, %.....						
HC, ppmC.....	124	95	341	301	170	149
NOx, ppm.....	149	250	213	368	430	475
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	32.5	21.6	249.3	57.9	29.4	33.6
HC.....	7.1	2.0	16.4	14.7	7.9	9.9
NOx**.....	28.5	46.5	34.7	59.7	65.8	104.0
Oil temperature, F.....	174	175	177	179	179	177
Oil pressure, psi.....	55	55	56	56	56	55
Coolant temperature, F.....	173	175	177	182	181	174
Exhaust temperature, F.....	190	252	987	886	684	561
Exhaust pressure, in H20...	0.0	1.0	5.0	4.0	2.5	2.0
Exhaust flow, lb/min.....	4.47	4.40	4.15	4.13	3.81	5.39
Smoke, % opacity.....	2.5	3.0	43.4	19.4	10.8	8.3

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

Engine..... Mitsubishi diesel, 330-CID
Fuel..... 7559

Test Number.....	7	8	9	10	11	12
Test Date.....	7/22/75	7/22/75	7/22/75	7/22/75	7/22/75	7/22/75
Barometer, mm Hg.....	743.0	743.0	743.0	743.0	743.0	743.0
Humidity, grains/lb.....	80	80	80	80	80	80
Temperature, F.....	80	79	79	79	86	78
Engine speed, rpm.....	900	900	900	900	1100	1100
Torque, lb-ft.....	90.0	56.0	22.4	1.0	233.0	207.0
Power, bhp*.....	15.5	9.6	3.9	.2	49.5	43.6
Fuel rate, lb/hr.....	6.8	5.0	3.0	2.0	21.0	17.6
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	4.0	3.5	3.3	3.3	40.5	7.5
Concentrations, dry basis:						
CO, %.....	.0206	.0244	.0269	.0347	.3223	.0394
CO2, %.....	5.60	4.21	2.88	2.12	13.22	11.72
O2, %.....						
HC, ppmC.....	133	172	161	186	361	135
NOx, ppm.....	455	350	205	138	320	410
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	27.9	32.9	37.7	48.0	345.6	62.1
HC.....	12.4	11.6	11.3	12.9	19.4	10.7
NOx**.....	102.4	78.3	47.7	31.7	57.0	107.5
Oil temperature, F.....	178	178	176	175	181	179
Oil pressure, psi.....	55	55	55	55	57	57
Coolant temperature, F.....	174	173	171	171	176	179
Exhaust temperature, F.....	437	330	254	208	1076	914
Exhaust pressure, in H20...	2.0	2.0	1.0	1.0	5.0	4.0
Exhaust flow, lb/min.....	5.44	5.34	5.48	5.37	4.62	6.70
Smoke, % opacity.....	6.7	5.7	5.4	5.1	40.4	15.1

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

Engine..... Mitsubishi diesel, 330-CID
Fuel..... 7559

Test Number.....	13	14	15	16	17	18
Test Date.....	7/22/75	7/22/75	7/22/75	7/22/75	7/22/75	7/22/75
Barometer, mm Hg.....	743.0	743.0	743.0	743.0	743.0	743.0
Humidity, grains/lb.....	80	80	80	80	80	80
Temperature, F.....	78	78	85	84	77	77
Engine speed, rpm.....	1100	1100	1100	1100	1100	1100
Torque, lb-ft.....	173.0	138.0	93.0	58.0	23.0	1.2
Power, bhp*.....	36.4	29.0	19.7	12.3	4.8	.3
Fuel rate, lb/hr.....	14.5	11.5	8.0	6.5	4.5	3.0
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	7.5	7.0	6.3	6.0	6.0	5.5
Concentrations, dry basis:						
CO, %.....	.0365	.0333	.0264	.0291	.0413	.0461
CO2, %.....	9.42	7.47	5.32	3.96	2.94	2.12
O2, %.....						
HC, ppmC.....	218	355	303	265	321	239
NOx, ppm.....	480	510	415	315	245	145
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	59.1	55.2	30.3	33.7	70.4	79.0
HC.....	17.7	29.5	17.5	15.4	27.5	20.5
NOx**.....	129.1	140.5	79.1	60.7	69.5	41.3
Oil temperature, F.....	182	182	183	182	181	180
Oil pressure, psi.....	56	56	57	57	56	56
Coolant temperature, F.....	176	176	177	174	172	171
Exhaust temperature, F.....	724	580	437	339	273	221
Exhaust pressure, in H20...	3.0	2.0	2.0	1.5	1.0	1.0
Exhaust flow, lb/min.....	6.74	6.77	4.59	4.58	6.68	6.65
Smoke, % opacity.....	9.4	7.8	4.3	3.6	5.1	4.6

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

Engine..... Mitsubishi diesel, 330-CID
Fuel..... 7559

Test Number.....	19	20	21	22	23	24
Test Date.....	7/22/75	7/22/75	7/22/75	7/22/75	7/22/75	7/22/75
Barometer, mm Hg.....	743.0	743.0	743.0	743.0	743.0	743.0
Humidity, grains/lb.....	80	80	80	80	80	80
Temperature, F.....	77	77	77	77	76	76
Engine speed, rpm.....	1500	1500	1500	1500	1500	1500
Torque, lb-ft.....	246.0	221.0	185.0	148.0	98.0	62.0
Power, bhp*.....	70.7	63.5	53.2	42.5	28.1	17.8
Fuel rate, lb/hr.....	31.5	25.5	21.0	17.5	12.2	9.2
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	37.0	12.5	12.0	12.0	11.0	11.0
Concentrations, dry basis:						
CO, %.....	.4723	.0394	.0228	.0167	.0150	.0176
CO2, %.....	14.73	12.45	9.93	7.91	5.89	4.46
O2, %.....						
HC, ppmC.....	129	78	104	103	110	72
NOx, ppm.....	425	525	640	700	690	510
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	1004.6	84.8	49.8	36.9	33.6	40.1
HC.....	13.8	8.4	11.5	11.4	12.4	8.2
NOx**.....	150.2	187.9	232.3	257.2	256.7	193.1
Oil temperature, F.....	187	189	190	191	191	190
Oil pressure, psi.....	59	59	59	59	59	59
Coolant temperature, F.....	181	180	179	178	178	174
Exhaust temperature, F.....	1214	104	790	648	484	381
Exhaust pressure, in H20...	8.0	7.0	5.0	4.0	3.0	3.0
Exhaust flow, lb/min.....	9.30	9.21	9.13	9.07	9.01	9.05
Smoke, % opacity.....	42.6	13.4	6.7	5.7	4.6	5.1

* Corrected - SAE J816b.

** Corrected for humidity.

Engine..... Mitsubishi diesel, 330-CID
Fuel..... 7559

Test Number.....	25	26	27	28	29	30
Test Date.....	7/22/75	7/22/75	7/22/75	7/22/75	7/22/75	7/22/75
Barometer, mm Hg.....	743.0	743.0	743.0	743.0	743.0	743.0
Humidity, grains/lb.....	80	80	80	80	80	80
Temperature, F.....	75	75	75	75	74	74
Engine speed, rpm.....	1500	1500	1800	1800	1800	1800
Torque, lb-ft.....	25.0	1.4	246.0	221.0	185.0	148.0
Power, bhp*.....	7.2	.4	84.8	76.1	63.7	50.9
Fuel rate, lb/hr.....	6.0	4.5	38.2	29.5	23.5	19.6
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	10.5	10.0	37.0	15.2	15.0	14.5
Concentrations, dry basis:						
CO, %.....	.0255	.0328	.5157	.0422	.0237	.0211
CO2, %.....	3.10	2.22	14.73	12.45	9.83	7.91
O2, %.....						
HC, ppmC.....	80	97	250	97	104	121
NOx, ppm.....	260	155	440	575	700	755
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	59.8	78.9	1363.7	105.0	61.5	55.4
HC.....	9.5	11.7	33.1	12.1	13.6	15.9
NOx**.....	101.4	62.0	193.4	237.8	301.9	329.4
Oil temperature, F.....	188	187	199	199	199	198
Oil pressure, psi.....	58	58	59	59	59	59
Coolant temperature, F.....	174	173	183	180	180	177
Exhaust temperature, F.....	290	239	1278	1037	827	663
Exhaust pressure, in H20...	3.0	2.5	9.0	7.0	5.0	4.5
Exhaust flow, lb/min.....	9.20	9.35	11.57	10.64	10.84	10.77
Smoke, % opacity.....	4.3	4.1	38.4	12.3	6.2	7.3

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

Engine..... Mitsubishi diesel, 330-CID
Fuel..... 7559

Test Number.....	31	32	33	34	35	36
Test Date.....	7/22/75	7/22/75	7/22/75	7/22/75	7/22/75	7/22/75
Barometer, mm Hg.....	743.0	743.0	743.0	743.0	743.0	743.0
Humidity, grains/lb.....	80	80	80	80	80	80
Temperature, F.....	73	73	73	72	72	71
Engine speed, rpm.....	1800	1800	1800	1800	2000	2000
Torque, lb-ft.....	98.0	62.0	25.0	1.6	246.0	221.0
Power, bhp*.....	33.7	21.3	8.6	.5	94.0	84.3
Fuel rate, lb/hr.....	14.0	11.0	7.5	5.5	40.0	33.0
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	14.5	14.0	13.5	13.2	37.0	18.0
Concentrations, dry basis:						
CO, %.....	.0185	.0193	.0264	.0337	.4558	.0432
CO2, %.....	5.82	4.52	3.16	2.32	14.73	12.32
O2, %.....						
HC, ppmC.....	83	82	71	97	290	234
NOx, ppm.....	650	495	260	150	460	600
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	50.1	51.8	72.0	93.4	1256.8	122.9
HC.....	11.2	11.0	9.7	13.5	40.1	33.4
NOx**.....	292.3	220.7	117.8	69.1	210.8	283.8
Oil temperature, F.....	196	195	192	190	200	202
Oil pressure, psi.....	59	59	59	59	60	60
Coolant temperature, F.....	177	176	174	173	184	180
Exhaust temperature, F.....	505	405	306	256	1300	1067
Exhaust pressure, in H20...	4.5	4.5	4.0	4.0	9.0	8.0
Exhaust flow, lb/min.....	10.89	10.66	10.70	10.78	12.06	12.16
Smoke, % opacity.....	7.8	6.5	5.4	4.6	35.2	10.6

* Corrected - SAE J816b.

** Corrected for humidity.

Engine..... Mitsubishi diesel, 330-CID
Fuel..... 7559

Test Number.....	37	38	39	40	41	42
Test Date.....	7/22/75	7/22/75	7/22/75	7/22/75	7/22/75	7/22/75
Barometer, mm Hg.....	743.0	743.0	743.0	743.0	743.0	743.0
Humidity, grains/lb.....	80	80	80	80	80	80
Temperature, F.....	88	73	75	88	78	88
Engine speed, rpm.....	2000	2000	2000	2000	2000	2000
Torque, lb-ft.....	185.0	148.0	98.0	62.0	27.0	.8
Power, bhp*.....	72.2	56.7	37.7	24.2	10.4	.3
Fuel rate, lb/hr.....	26.0	25.0	18.0	13.0	9.5	7.0
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	13.5	20.0	18.5	17.5	19.0	17.0
Concentrations, dry basis:						
CO, %.....	.0211	.0193	.0176	.0206	.0237	.0323
CO2, %.....	9.42	7.73	5.32	4.39	3.32	2.37
O2, %.....						
HC, ppmC.....	112	83	90	119	187	184
NOx, ppm.....	635	600	585	450	280	150
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	52.7	62.0	56.7	53.6	77.1	85.6
HC.....	14.0	13.4	14.5	15.5	30.5	24.5
NOx**.....	263.4	320.5	313.2	194.7	151.4	66.1
Oil temperature, F.....	204	196	200	201	200	199
Oil pressure, psi.....	59	60	60	59	60	60
Coolant temperature, F.....	179	180	178	177	178	175
Exhaust temperature, F.....	878	700	535	442	335	285
Exhaust pressure, in H20...	7.0	8.5	7.0	6.0	5.0	5.0
Exhaust flow, lb/min.....	10.39	13.17	12.96	10.33	12.78	10.31
Smoke, % opacity.....	11.1	2.5	1.5	4.1	1.0	4.0

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

Engine..... Mitsubishi diesel, 330-CID
Fuel..... 7559

Test Number.....	43	44	45	46	47	48
Test Date.....	7/24/75	7/24/75	7/24/75	7/24/75	7/24/75	7/24/75
Barometer, mm Hg.....	744.0	744.0	744.0	744.0	744.0	744.0
Humidity, grains/lb.....	79	79	79	79	79	79
Temperature, F.....	81	81	78	79	78	77
Engine speed, rpm.....	2400	2400	2400	2400	2400	2400
Torque, lb-ft.....	240.0	216.0	180.0	144.0	97.0	60.0
Power, bhp*.....	111.7	100.6	83.6	66.9	45.0	27.8
Fuel rate, lb/hr.....	53.0	43.8	36.0	29.5	20.5	17.5
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	41.0	26.0	27.0	26.0	24.0	25.5
Concentrations, dry basis:						
CO, %.....	.5860	.0552	.0532	.0310	.0228	.0159
CO2, %.....	14.03	11.34	9.62	7.91	5.89	4.46
O2, %.....						
HC, ppmC.....	1757	738	421	324	267	226
NOx, ppm.....	440	590	660	665	560	425
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	2030.8	191.4	193.7	114.2	81.7	60.1
HC.....	305.7	128.5	77.0	59.8	48.0	42.8
NOx**.....	253.0	339.4	398.7	406.3	332.8	266.4
Oil temperature, F.....	215	214	201	212	211	205
Oil pressure, psi.....	60	60	61	60	60	62
Coolant temperature, F.....	182	182	180	181	179	178
Exhaust temperature, F.....	1350	1150	897	757	588	478
Exhaust pressure, in H2O...	19.0	18.0	15.0	14.0	11.0	10.0
Exhaust flow, lb/min.....	15.08	14.75	15.18	15.11	14.42	15.01
Smoke, % opacity.....	32.9	11.1	4.1	4.6	2.0	1.5

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

Engine..... Mitsubishi diesel, 330-CID
Fuel..... 7559

Test Number.....	49	50	51	52	53	54
Test Date.....	7/24/75	7/24/75	7/24/75	7/24/75	7/24/75	7/24/75
Barometer, mm Hg.....	744.0	744.0	744.0	744.0	744.0	744.0
Humidity, grains/lb.....	79	79	79	79	79	79
Temperature, F.....	78	78	82	82	82	81
Engine speed, rpm.....	2400	2400	2300	2800	2800	2800
Torque, lb-ft.....	23.0	.8	223.0	200.0	167.0	134.0
Power, bhp*.....	10.7	.4	122.0	109.5	91.4	73.3
Fuel rate, lb/hr.....	12.0	9.0	64.0	52.5	43.5	35.0
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	25.0	2[illegible].0	41.0	35.0	34.8	34.0
Concentrations, dry basis:						
CO, %.....	.0176	.0233	.4340	.0747	.0636	.0403
CO2, %.....	3.38	2.57	13.62	11.72	9.62	7.91
O2, %.....						
HC, ppmC.....	236	222	3445	2173	1553	946
NOx, ppm.....	235	190	480	630	715	720
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	66.9	86.5	1797.5	311.9	268.3	171.8
HC.....	45.0	41.3	716.0	455.4	328.8	202.3
NOx**.....	179.8	117.0	329.9	436.5	500.5	509.3
Oil temperature, F.....	208	208	227	231	232	230
Oil pressure, psi.....	60	60	60	60	60	60
Coolant temperature, F.....	177	177	134	183	181	180
Exhaust temperature, F.....	381	320	1410	1180	990	819
Exhaust pressure, in H20...	9.5	8.0	28.0	24.0	21.0	19.0
Exhaust flow, lb/min.....	14.94	14.48	17.94	17.75	17.59	17.50
Smoke, % opacity.....	1.5	1.3	15.1	11.1	9.4	9.4

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

Engine..... Mitsubishi diesel, 330-CID
Fuel..... 7559

Test Number.....	55	56	57	58	59	60
Test Date.....	7/24/75	7/24/75	7/24/75	7/24/75	7/24/75	7/24/75
Barometer, mm Hg.....	744.0	744.0	744.0	744.0	744.0	744.0
Humidity, grains/lb.....	79	79	79	79	79	79
Temperature, F.....	81	81	79	79	86	85
Engine speed, rpm.....	2800	2800	2800	2800	3150	3150
Torque, lb-ft.....	89.0	56.0	23.0	.6	205.0	184.0
Power, bhp*.....	48.7	30.6	12.6	.3	127.4	114.3
Fuel rate, lb/hr.....	27.5	20.0	16.0	12.0	69.0	58.0
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	34.0	34.0	33.5	33.5	41.0	40.5
Concentrations, dry basis:						
CO, %.....	.0211	.0176	.0176	.0202	.4394	.0876
CO2, %.....	6.04	4.93	3.34	3.16	13.75	11.84
O2, %.....						
HC, ppmC.....	484	491	374	334	5987	2954
NOx, ppm.....	585	480	330	250	485	625
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	90.9	76.8	77.8	89.5	1796.1	362.1
HC.....	104.6	107.6	83.0	74.4	1228.3	612.8
NOx**.....	418.3	347.3	242.1	183.9	328.9	428.6
Oil temperature, F.....	226	227	226	226	237	235
Oil pressure, psi.....	60	60	60	60	59	59
Coolant temperature, F.....	179	178	177	177	184	184
Exhaust temperature, F.....	643	551	460	406	1447	1250
Exhaust pressure, in H20...	17.0	16.0	14.0	12.5	34.0	30.0
Exhaust flow, lb/min.....	17.38	17.41	17.46	17.39	17.72	17.59
Smoke, % opacity.....	10.6	8.5	6.7	6.5	14.6	10.6

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

Engine..... Mitsubishi diesel, 330-CID
Fuel..... 7559

Test Number.....	61	62	63	64	65	66
Test Date.....	7/24/75	7/24/75	7/24/75	7/24/75	7/24/75	7/24/75
Barometer, mm Hg.....	744.0	744.0	744.0	744.0	744.0	744.0
Humidity, grains/lb.....	79	79	79	79	79	79
Temperature, F.....	84	83	82	81	81	81
Engine speed, rpm.....	3150	3150	3150	3150	3150	3150
Torque, lb-ft.....	153.0	123.0	82.0	51.0	21.0	.6
Power, bhp*.....	94.9	76.2	50.8	31.5	13.0	.4
Fuel rate, lb/hr.....	47.5	40.0	31.5	26.0	18.0	15.5
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	40.0	40.0	40.0	39.5	39.5	39.0
Concentrations, dry basis:						
CO, %.....	.1295	.0817	.0319	.0255	.0255	.0237
CO2, %.....	9.72	8.00	6.42	5.25	4.21	3.49
O2, %.....						
HC, ppmC.....	2056	1505	1226	808	488	311
NOx, ppm.....	710	700	595	470	355	255
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	541.7	282.3	137.7	111.1	111.3	103.9
HC.....	431.6	321.1	265.7	176.8	106.9	68.3
NOx**.....	492.8	493.7	426.2	339.7	257.2	185.5
Oil temperature, F.....	243	243	232	238	237	236
Oil pressure, psi.....	59	59	59	59	59	59
Coolant temperature, F.....	181	181	181	179	179	179
Exhaust temperature, F.....	1009	853	696	594	514	457
Exhaust pressure, in H20...	26.0	23.0	20.0	19.0	17.0	16.5
Exhaust flow, lb/min.....	17.47	17.48	17.47	17.44	17.30	17.26
Smoke, % opacity.....	7.8	8.6	6.2	7.8	7.3	7.5

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

Engine..... Mitsubishi diesel, 330-CID
Fuel..... 7559

Test Number.....	67	68	69	70	71	72
Test Date.....	7/24/75	7/24/75	7/24/75	7/24/75	7/25/75	7/25/75
Barometer, mm Hg.....	744.0	744.0	744.0	744.0	745.0	745.0
Humidity, grains/lb.....	79	79	79	79	70	70
Temperature, F.....	83	83	83	82	81	83
Engine speed, rpm.....	900	900	900	900	900	1100
Torque, lb-ft.....	222.0	167.0	111.0	56.0	.2	233.0
Power, bhp*.....	38.4	28.8	19.2	9.7	.0	49.1
Fuel rate, lb/hr.....	15.0	12.0	7.5	4.5	2.0	20.0
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	40.5	4.5	4.2	3.7	3.0	40.5
Concentrations, dry basis:						
CO, %.....	.0925	.0273	.0185	.0185	.0300	.2202
CO2, %.....	12.57	8.83	6.27	3.96	2.02	13.48
O2, %.....						
HC, ppmC.....	338	157	153	112	196	477
NOx, ppm.....	290	380	405	300	110	290
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	83.9	24.2	16.4	16.6	27.2	246.4
HC.....	15.4	7.0	6.8	5.1	8.9	26.8
NOx**.....	43.6	55.8	59.7	44.7	16.2	52.6
Oil temperature, F.....	195	184	181	181	179	181
Oil pressure, psi.....	54	56	55	55	55	56
Coolant temperature, F.....	169	173	173	175	172	184
Exhaust temperature, F.....	957	666	465	328	213	1076
Exhaust pressure, in H2O...	4.0	3.0	2.0	1.5	1.0	5.0
Exhaust flow, lb/min.....	3.88	3.66	3.59	3.55	3.52	4.84
Smoke, % opacity.....	31.4	11.7	6.7	5.1	5.1	37.6

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

Engine..... Mitsubishi diesel, 330-CID
Fuel..... 7559

Test Number.....	73	74	75	76	77	78
Test Date.....	7/25/75	7/25/75	7/25/75	7/25/75	7/25/75	7/25/75
Barometer, mm Hg.....	745.0	745.0	745.0	745.0	745.0	745.0
Humidity, grains/lb.....	70	70	70	70	70	70
Temperature, F.....	82	81	80	97	81	82
Engine speed, rpm.....	1100	1100	1100	1100	1500	1500
Torque, lb-ft.....	175.0	117.0	58.0	.2	248.0	124.0
Power, bhp*.....	36.8	24.6	12.2	.0	71.3	35.7
Fuel rate, lb/hr.....	13.0	9.0	5.5	2.0	33.5	14.5
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	6.2	5.8	7.0	5.5	40.5	12.0
Concentrations, dry basis:						
CO, %.....	.0264	.0211	.0139	.0347	.3538	.0137
CO2, %.....	9.12	6.27	4.08	2.12	13.62	6.42
O2, %.....						
HC, ppmC.....	196	217	243	245	191	96
NOx, ppm.....	375	400	310	140	400	660
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	30.1	24.4	22.1	38.7	627.8	25.7
HC.....	11.2	12.6	14.3	13.7	17.0	9.0
NOx**.....	69.4	75.2	58.9	25.3	115.1	201.0
Oil temperature, F.....	182	183	178	180	186	190
Oil pressure, psi.....	56	56	57	55	59	59
Coolant temperature, F.....	179	175	176	171	178	178
Exhaust temperature, F.....	740	523	335	221	1166	550
Exhaust pressure, in H2O...	3.0	2.5	2.0	1.0	10.0	3.5
Exhaust flow, lb/min.....	4.73	4.68	4.64	4.33	7.68	7.60
Smoke, % opacity.....	7.8	5.1	1.5	1.0	45.2	1.3

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

Engine..... Mitsubishi diesel, 330-CID
Fuel..... 7559

Test Number.....	79	80	81	82	83	84
Test Date.....	7/26/75	7/25/75	7/25/75	7/26/75	7/26/75	7/26/75
Barometer, mm Hg.....	743.0	745.0	745.0	743.0	743.0	743.0
Humidity, grains/lb.....	105	70	70	105	105	105
Temperature, F.....	87	86	86	88	87	90
Engine speed, rpm.....	1500	1500	1800	1800	1800	2000
Torque, lb-ft.....	62.0	1.0	249.0	185.0	1.0	246.0
Power, bhp*.....	18.2	.3	86.6	65.2	.4	96.8
Fuel rate, lb/hr.....	9.0	4.0	38.5	22.5	6.0	44.0
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	11.0	10.0	40.5	15.5	14.0	40.5
Concentrations, dry basis:						
CO, %.....	.0159	.0337	.5157	.0202	.0319	.7283
CO2, %.....	4.42	2.17	13.89	9.42	2.27	14.16
O2, %.....						
HC, ppmC.....	78	126	308	105	135	310
NOx, ppm.....	480	135	420	620	140	410
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	29.5	65.8	1089.1	42.8	75.9	1802.6
HC.....	7.3	12.3	32.7	11.2	16.1	38.5
NOx**.....	158.0	42.7	143.8	233.2	59.0	180.0
Oil temperature, F.....	190	187	194	195	194	202
Oil pressure, psi.....	59	59	59	59	59	60
Coolant temperature, F.....	177	174	180	179	175	181
Exhaust temperature, F.....	392	235	1285	820	261	1345
Exhaust pressure, in H20...	2.0	2.5	8.5	5.0	4.0	10.5
Exhaust flow, lb/min.....	7.37	7.59	9.17	8.82	9.25	10.79
Smoke, % opacity.....	3.0	.5	40.8	2.0	2.3	42.1

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

Engine..... Mitsubishi diesel, 330-CID
Fuel..... 7559

Test Number.....	85	86	87	88	89	90
Test Date.....	7/25/75	7/25/75	7/26/75	7/26/75	7/26/75	7/25/75
Barometer, mm Hg.....	745.0	745.0	743.0	743.0	743.0	745.0
Humidity, grains/lb.....	70	70	105	105	105	70
Temperature, F.....	84	82	91	89	85	84
Engine speed, rpm.....	2000	2000	2400	2400	2400	2400
Torque, lb-ft.....	62.0	.2	239.0	179.0	60.0	.2
Power, bhp*.....	24.0	.1	113.5	84.8	28.3	.1
Fuel rate, lb/hr.....	14.0	7.5	53.5	36.0	17.0	9.0
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	19.0	18.0	40.5	26.0	25.0	23.5
Concentrations, dry basis:						
CO, %.....	.0228	.0347	.5354	.0347	.0193	.0282
CO2, %.....	4.46	2.42	13.39	9.42	4.58	2.57
O2, %.....						
HC, ppmC.....	125	184	1590	401	238	246
NOx, ppm.....	455	150	450	660	430	170
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	62.7	100.1	1646.2	107.5	63.0	93.5
HC.....	17.3	26.7	245.4	62.3	39.1	41.0
NOx**.....	203.1	70.1	245.4	362.7	249.0	91.4
Oil temperature, F.....	201	201	218	218	215	211
Oil pressure, psi.....	59	60	60	60	60	60
Coolant temperature, F.....	177	175	183	181	178	175
Exhaust temperature, F.....	440	286	1379	916	481	330
Exhaust pressure, in H2O...	7.0	6.0	17.5	13.5	10.0	8.5
Exhaust flow, lb/min.....	10.93	11.23	13.36	12.90	12.99	12.93
Smoke, % opacity.....	6.2	3.8	32.9	10.8	4.6	4.1

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

Engine..... Mitsubishi diesel, 330-CID
Fuel..... 7559

Test Number.....	91	92	93	94	95	96
Test Date.....	7/25/75	7/25/75	7/26/75	7/25/75	7/25/75	7/25/75
Barometer, mm Hg.....	745.0	745.0	743.0	745.0	745.0	745.0
Humidity, grains/lb.....	70	70	105	70	70	70
Temperature, F.....	85	85	85	83	86	87
Engine speed, rpm.....	2800	2800	2800	2800	3150	3150
Torque, lb-ft.....	222.0	167.0	57.0	.2	205.0	153.0
Power, bhp*.....	121.5	91.4	31.5	.1	126.9	95.0
Fuel rate, lb/hr.....	63.5	43.0	20.5	13.5	69.0	48.0
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	40.5	33.5	30.5	31.5	40.5	40.0
Concentrations, dry basis:						
CO, %.....	.4016	.0425	.0176	.0228	.3119	.0736
CO2, %.....	13.89	9.62	4.85	3.10	13.48	9.62
O2, %.....						
HC, ppmC.....	3452	1553	352	371	5075	1948
NOx, ppm.....	490	720	470	250	550	760
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	1442.7	158.0	64.8	89.3	1263.2	308.9
HC.....	622.4	289.7	65.1	73.0	1031.6	410.2
NOx**.....	285.5	434.2	306.7	158.9	361.3	517.3
Oil temperature, F.....	226	230	220	227	235	240
Oil pressure, psi.....	60	60	60	60	60	59
Coolant temperature, F.....	183	180	178	178	184	182
Exhaust temperature, F.....	1405	983	536	414	1399	1025
Exhaust pressure, in H20...	25.0	20.0	12.0	13.0	29.0	24.0
Exhaust flow, lb/min.....	15.59	15.50	14.67	15.36	17.51	17.50
Smoke, % opacity.....	19.4	10.3	1.0	5.9	16.9	9.2

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

Engine..... Mitsubishi diesel, 330-CID
Fuel..... 7559

Test Number.....	97	98	99	100	101	102
Test Date.....	7/26/75	7/26/75	7/26/75	7/26/75	7/26/75	7/26/75
Barometer, mm Hg.....	743.0	743.0	743.0	743.0	743.0	743.0
Humidity, grains/lb.....	105	105	105	105	105	105
Temperature, F.....	86	85	81	82	82	82
Engine speed, rpm.....	3150	3150	800	800	800	800
Torque, lb-ft.....	53.0	1.0	0.0	2.0	7.0	10.0
Power, bhp*.....	33.2	.6	0.0	.3	1.1	1.5
Fuel rate, lb/hr.....	25.5	15.5	2.0	2.0	2.0	2.0
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	38.0	36.0	0.0	0.0	0.0	0.0
Concentrations, dry basis:						
CO, %.....	.0220	.0211	.0310	.0365	.0319	.0273
CO2, %.....	5.18	3.38	2.07	2.12	2.27	2.27
O2, %.....						
HC, ppmC.....	833	310	245	215	169	160
NOx, ppm.....	530	275	110	110	130	150
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	93.4	87.0	28.1	34.5	28.7	24.6
HC.....	177.5	64.2	11.1	10.2	7.6	7.2
NOx**.....	399.0	201.1	17.7	18.5	20.8	24.0
Oil temperature, F.....	232	232	171	173	174	177
Oil pressure, psi.....	60	59	56	56	56	56
Coolant temperature, F.....	180	178	174	174	175	175
Exhaust temperature, F.....	599	433	199	203	211	214
Exhaust pressure, in H20...	16.5	13.0	.5	1.0	.5	.5
Exhaust flow, lb/min.....	16.98	16.21	3.51	3.67	3.50	3.50
Smoke, % opacity.....	4.3	6.2	1.1	1.5	1.8	1.6

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