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ENGINE PERFORMANCE TEST OF THE
1975 CHRYSLER - NISSAN MODEL CN633
DIESEL ENGINE

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INTERIM REPORT

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16. Abstract An engine test of the Chrysler-Nissan Model CN633 diesel engine was performed to determine its steady-state fuel consumption and emissions (HC, CO, NO _x) maps. The data acquired are summarized in this report.			
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PREFACE

This report, prepared by the U.S. Energy Research and Development Administration, Bartlesville Energy Research Center for the U.S. Department of Transportation, Transportation Systems Center, Power and Propulsion Branch, Cambridge MA, presents results of an automobile engine test. This represents only the second of a series of 1975 engines to be tested.

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

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1. INTRODUCTION

This report presents the data acquired from tests of a Nissan diesel engine, Model CN633. This engine is imported by Chrysler and is marketed as a Chrysler-Nissan Model CN633. The test results are sufficient to establish the steady-state maps for fuel consumption and emissions (CO, HC, NO_x) over the engine's entire operating range. This engine is one out of a series of engines tested or to be tested.

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

TABLE 1. MANUFACTURER'S ENGINE SPECIFICATIONS NISSAN MODEL CN633

Displacement.....	198 cubic inches
Maximum power.....	96 bhp at 4,000 rpm
Maximum torque.....	137.5 lb/ft at 2,000 rpm
6 cylinders, in-line:	
Bore and stroke.....	3.27" x 3.94"
Compression ratio.....	22 to 1
Combustion system.....	Swirl chamber

TABLE 2. FUEL SPECIFICATIONS

Fuel No.....	7557
Distillation, °F	
10% evaporated.....	413
50% evaporated.....	492
90% evaporated.....	578
End point.....	616
API gravity.....	35.0
FIA analysis, pct:	
Aromatics.....	32.0
Olefins.....	4.0
Paraffins.....	64.0
Sulfur, pct.....	0.31

TABLE 3. ENGINE BREAK-IN SCHEDULE

Engine speed, rpm	Torque, lb/ft	Time in mode, hr
1,280	12	1
1,600	12	1
1,600	24	2
1,920	24	2
1,920	36	2
2,240	36	2
2,240	48	2
2,560	48	2
2,560	60	2
2,720	60	2
2,720	72	2
2,880	72	1
2,880	84	1
3,040	84	1
3,200	96	1

2. ENGINE TEST REPORT

The specifications of the Nissan CN633 engine are given in table 1. A single batch of a No. 2-D diesel fuel was used throughout the test; fuel specifications are given in table 2. The engine was operated at various speeds and loads over a 24-hour period for break-in; details of break-in are given in table 3. The total engine operating time (break-in and testing) was about 100 hours. The period of testing was June 8-15, 1975.

The engine was mounted on a test stand and coupled to an eddy-current dynamometer. The engine was complete, except for fan (a cooling tower was used instead of a radiator). An alternator was included in the test set-up but was not wired into a charging system. The engine was operated at the following steady-state modes:

Speeds: 1,000; 1,600; 2,000; 2,300; 2,800; 3,300; 3,800 rpm

Loads: 0, 5, 10, 25, 50, 75, 85, 95, 100 pct of full load
(repeats at 0, 25, 50, 75, 100 pct of full load)

Idle speed loads: 0, 1, 3, 6, 9 bhp, plus lug (load equivalent to transmission in "drive") (repeats at 0, lug)

Total number of tests made.....	69
Repeats.....	37

Total number of tests	106
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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, ppm -- Beckman NDIR
 CO₂, 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. H₂O
 Smoke, pct opacity -- Celesco in-line smokemeter
 Air flow, lb/min -- Merrian 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). The following equations were applied in the computations:

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

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

$$\text{Power (bhp)} = \left(\frac{\text{Speed} \times \text{Torque}}{5252} \right) \left(\frac{736.6}{\text{Baro} - H_2O} \right) \left(\frac{t_{\text{air}} + 460}{545} \right)^{0.5}$$

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

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

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

$$\text{Mass CO} = .0263 (\text{exhaust rate}) (\text{ppm CO}) \left[\frac{1}{1 + .03 \text{ CO}_2 \left(\frac{\text{CO} + \text{CO}_2}{\text{CO} + 3\text{CO}_2} \right)} \right]$$

$$\text{Mass HC} = .0132 (\text{exhaust rate}) (\text{ppmC HC})$$

$$\text{Mass NO}_x = .0432 (\text{exhaust rate}) (\text{ppm NO}_x) \left[\frac{1}{1 + .03 \text{ CO}_2 \left(\frac{\text{CO} + \text{CO}_2}{\text{CO} + 3\text{CO}_2} \right)} \right]$$

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

$$K_H = \frac{1}{1 - .0047 (H-75)}$$

3. DISCUSSION OF TEST RESULTS

Emissions of CO and NO_x (figures 3 and 4) show a dependence on power that is typical of diesel engines. However, HC emissions patterns (figure 2) were highly irregular (although fairly repeatable at any given speed/load conditions).

Other variables (fuel rate, smoke level, throttle angle) as a function of speed and power are shown in figures 1, 5, and 6.

Figure 1. - Fuel Rate at Various Speed and Load Conditions--
Nissan CN633 Diesel Engine.

Figure 2. - Hydrocarbon Emissions at Various Speed and Load Conditions--Nissan CN633 Diesel Engine.

Figure 3. - Oxides of Nitrogen Emissions at Various Speed and Load Conditions--Nissan CN633 Diesel Engine.

Figure 4. - Carbon Monoxide Emissions at Various Speed and Load Conditions--Nissan CN633 Diesel Engine.

Figure 5. - Smoke Level at Various Speed and Load Conditions--
Nissan CN633 Diesel Engine.

Figure 6. - Throttle Angle at Various Speed and Load Conditions--
Nissan CN633 Diesel Engine.

4. CONCLUSIONS

Repeatability of emission rate and fuel consumption data were satisfactory for purposes of this test.

Engine..... Nissan diesel, 193-CID
 Fuel..... 7557

Test Number.....	2	102	1	101	106	105
Test Date.....	5/ 8/75	5/15/75	5/ 8/75	5/15/75	5/15/75	5/15/75
Barometer, mm Hg.....	740.2	743.8	740.2	743.8	743.8	743.8
Humidity, grains/lb.....	64	81	64	81	81	81
Temperature, F.....	82	78	81	78	78	81
Engine speed, rpm.....	550	550	650	650	650	650
Torque, lb-ft.....	15.8	11.0	0.0	0.0	9.4	24.8
Power, bhp*.....	1.7	1.2	0.0	0.0	1.2	3.1
Fuel rate, lb/hr.....	.7	1.2	1.2	.9	1.2	1.9
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	0.0	1.5	1.9	0.0	3.0	5.0
Concentrations, dry basis:						
CO, %.....	.0300	.0255	.0300	.0310	.0224	.0202
CO2, %.....	3.34	2.32	1.72	1.91	2.50	3.57
O2, %.....						
HC, ppmC.....	143	175	245	262	187	194
NOx, ppm.....	55	140	67	63	110	180
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	14.6	13.5	17.8	17.1	13.4	11.9
HC.....	3.5	4.6	7.3	7.3	5.6	5.7
NOx**.....	4.2	12.5	6.2	5.9	11.1	17.9
Oil temperature, F.....	162	161	159	169	165	165
Oil pressure, psi.....	25	23	23	25	28	28
Coolant temperature, F.....	166	165	167	165	165	167
Exhaust temperature, F.....	178	134	196	131	168	200
Exhaust pressure, in H2O...	1.2	.5	1.5	.5	.2	.3
Exhaust flow, lb/min.....	1.92	2.05	2.30	2.14	2.33	2.32
Smoke, % opacity.....	1.7	1.5	1.7	1.9	2.2	2.2

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

Engine..... Nissan diesel, 193-CID
 Fuel..... 7557

Test Number.....	104	103	11	100	10	9
Test Date.....	5/15/75	5/15/75	5/ 9/75	5/15/75	5/ 9/75	5/ 9/75
Barometer, mm Hg.....	743.8	743.8	745.5	743.8	740.2	740.2
Humidity, grains/lb.....	81	81	81	81	64	64
Temperature, F.....	78	78	80	78	81	77
Engine speed, rpm.....	650	650	1000	1000	1000	1000
Torque, lb-ft.....	50.0	76.0	1.2	.8	6.8	13.6
Power, bhp*.....	6.2	9.4	.2	.2	1.3	2.6
Fuel rate, lb/hr.....	3.1	4.3	1.7	1.4	2.0	2.4
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	8.5	12.0	11.0	11.5	11.0	12.0
Concentrations, dry basis:						
CO, %.....	.0159	.0116	.0594	.0532	.0496	.0375
CO2, %.....	5.17	7.18	2.00	1.91	2.43	2.74
O2, %.....						
HC, ppmC.....	163	172	827	567	597	294
NOx, ppm.....	240	290	39	45	55	89
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	9.8	7.0	56.7	51.0	44.4	34.0
HC.....	5.0	5.2	39.6	27.3	26.9	13.4
NOx**.....	24.9	29.7	6.3	7.3	7.7	12.6
Oil temperature, F.....	167	166	172	170	181	170
Oil pressure, psi.....	23	23	37	40	34	38
Coolant temperature, F.....	167	170	165	167	168	167
Exhaust temperature, F.....	227	199	213	156	258	250
Exhaust pressure, in H2O...	1.0	1.0	2.6	1.0	2.5	2.9
Exhaust flow, lb/min.....	2.45	2.47	3.71	3.72	3.49	3.54
Smoke, % opacity.....	2.4	2.4	3.6	2.4	2.7	2.4

* Corrected - SAE J616b.
 ** Corrected for humidity.

Engine..... Nissan diesel, 198-CID
 Fuel..... 7557

Test Number.....	8	99	7	98	6	97
Test Date.....	5/ 9/75	5/15/75	5/ 9/75	5/15/75	5/ 8/75	5/15/75
Barometer, mm Hg.....	740.2	743.8	740.2	743.8	740.2	743.8
Humidity, grains/lb.....	64	81	64	81	64	81
Temperature, F.....	77	78	77	79	87	76
Engine speed, rpm.....	1000	1000	1000	1000	1000	1000
Torque, lb-ft.....	34.1	34.4	68.0	69.0	100.4	103.8
Power, bhp*.....	6.5	6.6	13.0	13.2	19.4	19.7
Fuel rate, lb/hr.....	3.5	3.7	5.6	5.7	8.1	8.1
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	13.5	15.0	18.0	18.0	23.0	24.0
Concentrations, dry basis:						
CO, %.....	.0269	.0251	.0185	.0133	.0356	.0511
CO2, %.....	4.00	4.30	6.45	6.42	9.52	9.52
O2, %.....						
HC, ppmC.....	129	156	149	136	146	234
NOx, ppm.....	170	170	285	295	375	385
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	24.2	22.6	16.4	11.8	28.6	45.0
HC.....	5.8	7.1	6.6	6.1	5.9	10.4
NOx**.....	23.9	25.8	39.6	44.2	47.1	57.2
Oil temperature, F.....	170	171	148	173	175	174
Oil pressure, psi.....	37	39	47	38	37	37
Coolant temperature, F.....	168	169	167	170	171	171
Exhaust temperature, F.....	333	227	425	320	655	429
Exhaust pressure, in H2O...	3.0	2.0	4.2	3.0	5.1	5.0
Exhaust flow, lb/min.....	3.56	3.57	3.60	3.59	3.35	3.67
Smoke, % opacity.....	1.5	1.5	2.0	1.9	4.0	5.3

* Corrected - SAE J816b.

** Corrected for humidity.

Engine..... Nissan diesel, 198-CID
 Fuel..... 7557

Test Number.....	5	4	3	96	20	95
Test Date.....	5/ 8/75	5/ 8/75	5/ 8/75	5/15/75	5/ 9/75	5/15/75
Barometer, mm Hg.....	740.2	740.2	740.2	743.8	745.5	743.8
Humidity, grains/lb.....	64	64	64	81	81	81
Temperature, F.....	86	85	84	77	88	76
Engine speed, rpm.....	1000	1000	1000	1000	1600	1600
Torque, lb-ft.....	115.4	129.2	136.2	139.0	1.8	.8
Power, bhp*.....	22.2	24.9	26.2	26.5	.6	.2
Fuel rate, lb/hr.....	9.7	11.1	12.7	13.1	3.1	3.3
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	26.0	29.0	36.0	36.5	17.0	16.5
Concentrations, dry basis:						
CO, %.....	.0987	.1854	1.3445	.9816	.0730	.0680
CO2, %.....	11.25	13.09	13.89	13.62	2.05	2.00
O2, %.....						
HC, ppmC.....	357	485	1843	2202	1764	1245
NOx, ppm.....	370	320	245	275	42	50
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	68.5	127.9	1066.1	845.0	101.8	106.6
HC.....	12.4	16.8	73.3	95.1	123.5	98.0
NOx**.....	40.1	34.5	30.3	40.0	9.9	13.2
Oil temperature, F.....	178	174	172	174	181	179
Oil pressure, psi.....	37	37	37	37	46	47
Coolant temperature, F.....	165	174	174	165	168	169
Exhaust temperature, F.....	752	866	912	532	244	181
Exhaust pressure, in H2O...	6.1	7.1	7.9	8.5	5.0	6.0
Exhaust flow, lb/min.....	2.94	2.97	3.46	3.74	5.42	6.09
Smoke, % opacity.....	11.2	15.7	50.7	43.0	3.1	2.7

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

Engine..... Nissan diesel, 193-CID
 Fuel..... 7557

Test Number.....	19	18	17	94	16	93
Test Date.....	5/ 9/75	5/ 9/75	5/ 9/75	5/15/75	5/ 9/75	5/15/75
Barometer, mm Hg.....	745.5	745.5	745.5	743.8	745.5	743.8
Humidity, grains/lb.....	81	81	81	81	81	81
Temperature, F.....	92	84	91	75	89	77
Engine speed, rpm.....	1600	1600	1600	1600	1600	1600
Torque, lb-ft.....	7.0	13.7	32.8	33.6	66.8	67.8
Power, bhp*.....	2.2	4.2	10.2	10.2	20.7	20.7
Fuel rate, lb/hr.....	3.8	4.4	6.8	6.1	10.6	9.2
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	18.9	20.1	21.0	21.0	26.0	24.9
Concentrations, dry basis:						
CO, %.....	.0758	.0816	.0793	.0691	.0418	.0542
CO2, %.....	2.45	2.74	3.96	3.90	6.57	6.39
O2, %.....						
HC, ppmC.....	1827	1665	1797	1402	264	318
NOx, ppm.....	53	67	130	150	265	270
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	104.2	115.0	117.6	102.8	61.5	77.6
HC.....	126.0	117.8	133.8	104.7	19.5	22.9
NOx**.....	12.3	15.9	32.5	37.7	65.8	65.3
Oil temperature, F.....	181	182	185	184	187	185
Oil pressure, psi.....	55	49	47	47	46	47
Coolant temperature, F.....	169	168	168	170	171	170
Exhaust temperature, F.....	266	301	372	274	581	368
Exhaust pressure, in H2O...	11.0	6.1	7.0	6.0	8.5	9.5
Exhaust flow, lb/min.....	5.36	5.51	5.86	5.88	5.97	5.79
Smoke, % opacity.....	3.6	3.1	1.7	2.0	1.0	1.0

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

Engine..... Nissan diesel, 193-CID
 Fuel..... 7557

19

Test Number.....	15	92	14	13	12	91
Test Date.....	5/ 9/75	5/15/75	5/ 9/75	5/ 9/75	5/ 9/75	5/15/75
Barometer, mm Hg.....	745.5	743.8	745.5	745.5	745.5	743.8
Humidity, grains/lb.....	81	81	81	81	81	81
Temperature, F.....	89	77	88	85	83	78
Engine speed, rpm.....	1600	1600	1600	1600	1600	1600
Torque, lb-ft.....	101.8	102.2	116.0	130.0	137.0	138.4
Power, bhp*.....	31.5	31.2	35.8	40.0	42.0	42.3
Fuel rate, lb/hr.....	14.5	11.4	15.2	16.7	18.0	17.8
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	30.5	29.0	33.9	35.5	36.5	36.5
Concentrations, dry basis:						
CO, %.....	.0394	.0375	.0413	.0328	.3380	.2002
CO2, %.....	9.42	8.74	10.68	12.57	13.35	13.35
O2, %.....						
HC, ppmC.....	260	268	239	583	920	1069
NOx, ppm.....	330	350	330	320	300	340
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	52.1	52.1	56.0	44.3	436.1	279.0
HC.....	17.3	18.6	16.3	39.6	59.6	74.8
NOx**.....	73.6	82.0	75.4	72.9	65.3	80.0
Oil temperature, F.....	189	136	190	185	188	187
Oil pressure, psi.....	47	45	47	47	47	46
Coolant temperature, F.....	172	171	173	171	165	170
Exhaust temperature, F.....	779	463	905	1049	1093	628
Exhaust pressure, in H2O...	10.0	10.0	12.0	12.5	13.2	14.0
Exhaust flow, lb/min.....	5.50	5.74	5.71	5.79	5.57	6.01
Smoke, % opacity.....	1.7	1.0	3.1	7.6	14.7	11.6

* Corrected - SAE J816b.

** Corrected for humidity.

Engine..... Nissan diesel, 190-CID
 Fuel..... 7557

Test Number.....	29	90	28	27	26	89
Test Date.....	5/ 9/75	5/15/75	5/ 9/75	5/ 9/75	5/ 9/75	5/15/75
Barometer, mm Hg.....	745.5	743.3	745.5	745.5	745.5	743.8
Humidity, grains/lb.....	71	81	71	71	71	81
Temperature, F.....	79	75	79	79	79	76
Engine speed, rpm.....	2000	2000	2000	2000	2000	2000
Torque, lb-ft.....	1.8	.8	7.8	14.2	33.6	29.2
Power, bhp*.....	.7	.3	3.0	5.4	12.8	11.1
Fuel rate, lb/hr.....	4.5	4.6	5.2	5.8	7.4	7.4
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	17.5	17.0	17.9	18.5	20.0	20.5
Concentrations, dry basis:						
CO, %.....	.0736	.0816	.0691	.0647	.0491	.0452
CO2, %.....	3.10	2.10	2.56	2.94	3.84	3.71
O2, %.....						
HC, ppmC.....	1671	1640	1441	1513	1413	1388
NOx, ppm.....	40	44	60	74	125	150
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	135.9	152.0	131.8	115.5	87.3	82.1
HC.....	154.9	153.3	137.9	135.6	126.0	126.5
NOx**.....	11.9	13.8	18.5	21.3	35.8	46.0
Oil temperature, F.....	187	187	187	189	190	193
Oil pressure, psi.....	50	50	49	49	50	50
Coolant temperature, F.....	168	169	168	169	170	171
Exhaust temperature, F.....	271	198	305	329	381	320
Exhaust pressure, in H2O...	8.2	8.0	8.5	9.0	9.5	10.5
Exhaust flow, lb/min.....	7.24	7.23	7.44	6.99	7.02	7.16
Smoke, % opacity.....	3.5	3.5	3.1	2.4	1.7	1.5

* Corrected - SAE J816b.

** Corrected for humidity.

Engine..... Nissan diesel, 193-CID
 Fuel..... 7557

21

Test Number.....	25	88	24	87	23	22
Test Date.....	5/ 9/75	5/15/75	5/ 9/75	5/15/75	5/ 9/75	5/ 9/75
Barometer, mm Hg.....	745.5	743.8	745.5	743.8	745.5	745.5
Humidity, grains/lb.....	71	81	71	81	71	71
Temperature, F.....	79	76	79	77	79	81
Engine speed, rpm.....	2000	2000	2000	2000	2000	2000
Torque, lb-ft.....	67.2	69.2	101.0	101.2	114.2	126.6
Power, bhp*.....	25.6	26.4	38.5	38.7	43.5	48.4
Fuel rate, lb/hr.....	11.5	12.2	15.6	17.8	18.6	21.0
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	24.5	24.5	29.5	29.0	32.0	34.0
Concentrations, dry basis:						
CO, %.....	.0702	.0828	.0418	.0511	.0347	.0691
CO2, %.....	6.11	6.45	9.02	9.42	10.68	12.32
O2, %.....						
HC, ppmC.....	1214	992	294	351	227	388
NOx, ppm.....	220	275	320	350	330	330
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	126.5	148.2	72.2	88.7	58.7	113.5
HC.....	109.8	89.1	25.5	30.6	19.3	32.0
NOx**.....	63.9	83.1	89.1	102.5	90.0	87.5
Oil temperature, F.....	193	196	196	198	199	200
Oil pressure, psi.....	49	49	48	49	48	48
Coolant temperature, F.....	171	171	171	173	172	172
Exhaust temperature, F.....	589	475	812	603	945	1073
Exhaust pressure, in H2O...	10.5	12.0	12.3	16.0	14.2	15.2
Exhaust flow, lb/min.....	7.27	7.25	7.16	7.22	7.12	7.02
Smoke, % opacity.....	1.4	.8	2.0	1.5	4.2	8.3

* Corrected - SAE J816b.

** Corrected for humidity.

Engine..... Nissan diesel, 198-CID
 Fuel..... 7557

Test Number.....	21	86	38	85	37	36
Test Date.....	5/ 9/75	5/15/75	5/ 9/75	5/15/75	5/ 9/75	5/ 9/75
Barometer, mm Hg.....	745.5	743.8	745.5	743.8	745.5	745.5
Humidity, grains/lb.....	71	81	71	81	71	71
Temperature, F.....	83	76	77	73	77	78
Engine speed, rpm.....	2000	2000	2300	2300	2300	2300
Torque, lb-ft.....	134.6	138.0	.8	1.2	7.2	13.7
Power, bhp*.....	51.6	52.7	.4	.5	3.2	6.0
Fuel rate, lb/hr.....	23.0	23.4	5.2	4.8	6.1	6.6
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	36.5	36.5	17.5	17.0	19.0	19.5
Concentrations, dry basis:						
CO, %.....	.2202	.3909	.0816	.0913	.0852	.0781
CO2, %.....	13.35	13.89	2.25	2.25	2.64	2.94
O2, %.....						
HC, ppmC.....	1006	1221	1724	1139	1685	1780
NOx, ppm.....	325	320	43	54	65	77
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	353.0	619.4	147.0	138.5	181.7	162.0
HC.....	30.9	97.1	155.9	118.0	120.4	185.3
NOx**.....	84.0	85.6	12.5	18.8	22.4	25.8
Oil temperature, F.....	196	195	194	185	193	194
Oil pressure, psi.....	50	49	50	50	50	50
Coolant temperature, F.....	170	174	171	170	171	171
Exhaust temperature, F.....	1177	735	296	224	324	345
Exhaust pressure, in H2O...	17.0	18.5	10.5	10.0	10.5	11.0
Exhaust flow, lb/min.....	6.92	6.88	7.01	8.03	8.33	8.13
Smoke, % opacity.....	10.0	11.2	3.5	2.9	4.2	3.5

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

Engine..... Nissan diesel, 198-CID
 Fuel..... 7557

Test Number.....	35	84	34	83	33	82
Test Date.....	5/ 9/75	5/14/75	5/ 9/75	5/14/75	5/ 9/75	5/14/75
Barometer, mm Hg.....	745.5	742.0	745.5	742.0	745.5	742.0
Humidity, grains/lb.....	71	71	71	71	71	71
Temperature, F.....	79	78	81	81	81	81
Engine speed, rpm.....	2300	2300	2300	2300	2300	2300
Torque, lb-ft.....	34.2	34.4	68.4	68.0	102.8	102.8
Power, bhp*.....	15.0	15.2	30.1	30.0	45.3	45.5
Fuel rate, lb/hr.....	9.5	9.5	13.3	13.6	18.8	20.2
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	21.0	21.5	25.9	24.5	29.0	29.5
Concentrations, dry basis:						
CO, %.....	.0594	.0647	.0491	.0522	.0691	.0724
CO2, %.....	4.25	4.33	6.42	6.42	9.32	9.93
O2, %.....						
HC, ppmC.....	1418	1839	1265	1444	413	521
NOx, ppm.....	175	195	270	300	345	380
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	124.7	137.1	101.1	107.5	134.1	139.5
HC.....	149.4	195.6	130.7	149.2	40.3	50.4
NOx**.....	59.3	66.8	89.7	99.8	108.0	118.3
Oil temperature, F.....	198	200	201	202	205	207
Oil pressure, psi.....	49	49	50	49	50	49
Coolant temperature, F.....	172	172	172	171	173	173
Exhaust temperature, F.....	498	355	622	471	384	661
Exhaust pressure, in H2O...	12.5	13.0	19.0	16.0	18.0	19.5
Exhaust flow, lb/min.....	8.32	8.41	8.33	8.33	8.07	8.05
Smoke, % opacity.....	2.0	2.1	1.2	1.0	1.7	1.0

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

Engine..... Nissan diesel, 193-CID
 Fuel..... 7557

Test Number.....	32	31	30	31	47	80
Test Date.....	5/ 9/75	5/ 9/75	5/ 9/75	5/14/75	5/ 9/75	5/14/75
Barometer, mm Hg.....	745.5	745.5	745.5	742.0	745.5	742.0
Humidity, grains/lb.....	71	71	71	71	81	71
Temperature, F.....	82	82	80	81	77	77
Engine speed, rpm.....	2300	2300	2300	2300	2800	2800
Torque, lb-ft.....	117.0	128.6	137.0	138.2	1.0	.8
Power, bhp*.....	51.6	56.7	60.2	61.1	.5	.4
Fuel rate, lb/hr.....	22.8	26.4	26.8	26.6	7.0	7.6
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	33.0	34.5	36.5	36.5	18.5	18.0
Concentrations, dry basis:						
CO, %.....	.0615	.1512	.3276	.3382	.0647	.0674
CO2, %.....	10.91	12.96	13.48	13.89	2.72	2.66
O2, %.....						
HC, ppmC.....	479	525	1351	1959	1443	1798
NOx, ppm.....	350	335	335	345	94	95
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	111.6	284.2	630.4	636.4	177.3	184.1
HC.....	43.7	49.5	130.5	185.0	198.4	246.6
NOx**.....	102.5	101.6	104.0	104.7	43.4	41.9
Oil temperature, F.....	206	206	196	206	206	206
Oil pressure, psi.....	50	50	50	49	52	51
Coolant temperature, F.....	173	173	171	173	171	171
Exhaust temperature, F.....	983	1163	1173	861	351	293
Exhaust pressure, in H2O...	19.0	20.5	21.7	21.0	19.0	19.0
Exhaust flow, lb/min.....	7.66	8.08	8.32	81.60	10.71	10.67
Smoke, % opacity.....	2.7	4.5	7.6	9.5	2.0	1.4

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

Engine..... Nissan diesel, 190-010
 Fuel..... 7557

Test Number.....	46	45	44	79	43	78
Test Date.....	5/ 9/75	5/ 9/75	5/ 9/75	5/14/75	5/ 9/75	5/14/75
Barometer, mm Hg.....	745.5	745.5	745.5	742.0	745.5	742.0
Humidity, grains/lb.....	81	81	81	71	81	71
Temperature, F.....	77	77	78	77	79	77
Engine speed, rpm.....	2800	2800	2800	2800	2800	2800
Torque, lb-ft.....	7.0	14.0	34.3	33.4	65.0	66.8
Power, bhp*.....	3.8	7.5	13.7	17.9	34.9	35.9
Fuel rate, lb/hr.....	9.4	9.7	12.0	12.3	16.0	18.4
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	20.0	20.0	23.0	22.0	26.5	26.0
Concentrations, dry basis:						
CO, %.....	.0669	.0702	.0713	.0900	.0542	.0764
CO2, %.....	3.00	3.29	4.62	4.51	6.27	6.91
O2, %.....						
HC, ppmC.....	1691	1897	1786	2056	1722	1837
NOx, ppm.....	110	130	210	245	330	430
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	188.5	184.0	176.5	243.5	132.6	195.3
HC.....	239.1	249.6	221.9	279.2	211.5	235.7
NOx**.....	52.3	57.5	87.7	107.1	136.1	177.6
Oil temperature, F.....	206	207	203	203	212	201
Oil pressure, psi.....	52	50	50	52	50	52
Coolant temperature, F.....	172	172	172	172	173	171
Exhaust temperature, F.....	381	378	485	404	651	493
Exhaust pressure, in H2O...	22.0	19.5	19.0	20.0	22.0	23.0
Exhaust flow, lb/min.....	11.04	10.30	9.85	10.76	9.39	10.40
Smoke, % opacity.....	2.4	3.3	4.4	3.5	3.5	3.5

* Corrected - SAE J8165.

** Corrected for humidity.

Engine..... Nissan diesel, 100-CTD
 Fuel..... 7557

Test Number.....	42	77	41	40	39	76
Test Date.....	5/ 9/75	5/13/75	5/ 9/75	5/ 9/75	5/ 9/75	5/13/75
Barometer, mm Hg.....	745.5	742.0	745.5	745.5	745.5	742.0
Humidity, grains/lb.....	81	69	81	81	81	69
Temperature, F.....	80	77	81	81	78	77
Engine speed, rpm.....	2800	2800	2800	2800	2800	2800
Torque, lb-ft.....	98.0	100.4	111.0	124.8	132.0	133.6
Power, bhp*.....	52.7	53.9	59.7	67.2	70.8	71.7
Fuel rate, lb/hr.....	23.3	24.6	27.4	30.7	32.2	33.0
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	30.0	30.0	32.5	35.5	36.5	36.5
Concentrations, dry basis:						
CO, %.....	.0876	.1463	.1034	.1512	.2352	.2656
CO2, %.....	9.02	9.62	10.47	11.84	12.83	13.62
O2, %.....						
HC, ppmC.....	1154	1490	906	967	1952	1766
NOx, ppm.....	380	410	380	380	360	375
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	210.8	352.3	280.1	351.3	542.8	608.5
HC.....	139.3	180.1	123.2	112.8	226.2	203.1
NOx**.....	154.2	157.7	173.6	148.9	140.1	137.2
Oil temperature, F.....	216	215	216	219	203	242
Oil pressure, psi.....	50	50	50	50	52	50
Coolant temperature, F.....	173	173	173	174	173	175
Exhaust temperature, F.....	895	927	1025	1185	1107	1225
Exhaust pressure, in H2O...	25.5	28.0	31.5	32.0	33.0	32.0
Exhaust flow, lb/min.....	9.98	10.05	11.39	9.89	9.91	9.91
Smoke, % opacity.....	2.4	2.0	2.0	3.1	6.4	5.3

* Corrected - SAE J816b.

** Corrected for humidity.

Engine..... Nissan diesel, 190-CID
 Fuel..... 7557

Test Number.....	56	70	55	54	53	69
Test Date.....	5/13/75	5/13/75	5/13/75	5/13/75	5/13/75	5/13/75
Barometer, mm Hg.....	742.0	742.0	742.0	742.0	742.0	742.0
Humidity, grains/lb.....	69	69	69	69	69	69
Temperature, F.....	77	77	78	78	77	75
Engine speed, rpm.....	3300	3300	3300	3300	3300	3300
Torque, lb-ft.....	2.4	1.0	6.0	12.8	31.0	32.4
Power, bhp*.....	1.5	.6	3.8	8.1	19.7	20.5
Fuel rate, lb/hr.....	9.4	9.5	11.3	11.6	14.1	16.3
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	18.5	19.0	19.9	20.5	22.0	23.0
Concentrations, dry basis:						
CO, %.....	.0702	.0913	.0747	.0781	.0793	.1129
CO2, %.....	3.00	3.00	3.29	3.72	4.98	4.98
O2, %.....						
HC, ppmC.....	1499	1639	1604	1932	2322	1936
NOx, ppm.....	110	120	125	175	285	300
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	222.3	280.7	229.0	238.3	235.4	346.1
HC.....	238.3	252.8	246.8	295.9	346.0	297.9
NOx**.....	55.6	58.9	61.2	85.3	135.1	146.9
Oil temperature, F.....	213	214	213	215	218	217
Oil pressure, psi.....	52	51	51	51	51	51
Coolant temperature, F.....	170	171	170	170	173	172
Exhaust temperature, F.....	393	415	413	449	540	557
Exhaust pressure, in H2O...	23.0	25.0	27.5	28.0	28.0	30.0
Exhaust flow, lb/min.....	12.41	12.05	12.05	12.04	11.26	12.25
Smoke, % opacity.....	1.2	1.5	1.7	2.4	2.7	4.2

* Corrected - SAE J816b.

** Corrected for humidity.

Engine..... Nissan diesel, 193-CID
 Fuel..... 7557

Test Number.....	52	68	51	67	50	49
Test Date.....	5/13/75	5/13/75	5/13/75	5/13/75	5/ 9/75	5/ 9/75
Barometer, mm Hg.....	742.0	742.0	742.0	742.0	745.5	745.5
Humidity, grains/lb.....	69	69	69	69	81	81
Temperature, F.....	78	76	78	81	81	81
Engine speed, rpm.....	3300	3300	3300	3300	3300	3300
Torque, lb-ft.....	62.4	64.0	93.2	93.6	105.2	118.0
Power, bhp*.....	39.7	40.6	59.3	59.7	67.0	75.1
Fuel rate, lb/hr.....	22.4	22.2	31.1	27.7	33.7	37.6
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	26.0	26.9	30.9	30.0	32.0	34.5
Concentrations, dry basis:						
CO, %.....	.1081	.1034	.1034	.1129	.1129	.1512
CO2, %.....	7.39	6.89	10.04	9.52	10.25	12.08
O2, %.....						
HC, ppmC.....	2877	2490	2264	1966	1430	1575
NOx, ppm.....	500	370	550	460	440	420
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	323.3	312.9	314.4	313.5	327.7	424.5
HC.....	431.8	378.2	345.5	278.4	208.3	222.0
NOx**.....	238.8	178.8	267.1	207.2	215.4	198.9
Oil temperature, F.....	227	224	233	227	236	237
Oil pressure, psi.....	51	51	51	51	52	52
Coolant temperature, F.....	173	171	173	174	174	175
Exhaust temperature, F.....	747	725	927	939	1068	1229
Exhaust pressure, in H2O...	37.5	27.0	41.5	36.0	44.0	45.0
Exhaust flow, lb/min.....	12.22	12.31	12.73	11.75	12.17	11.98
Smoke, % opacity.....	4.4	3.8	4.7	2.6	3.6	3.1

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

Engine..... Nissan diesel, 100-CID
 Fuel..... 7557

Test Number.....	48	66	65	75	64	63
Test Date.....	5/ 9/75	5/13/75	5/13/75	5/13/75	5/13/75	5/13/75
Barometer, mm Hg.....	745.5	742.0	742.0	742.0	742.0	742.0
Humidity, grains/lb.....	81	69	69	69	69	69
Temperature, F.....	81	77	79	75	78	79
Engine speed, rpm.....	3300	3300	3800	3800	3800	3800
Torque, lb-ft.....	124.6	128.0	1.0	1.2	5.2	12.2
Power, bhp*.....	79.3	81.2	.7	.9	3.8	9.0
Fuel rate, lb/hr.....	41.0	38.5	12.8	14.0	13.4	15.3
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	36.5	36.5	21.0	20.5	20.1	22.0
Concentrations, dry basis:						
CO, %.....	.2352	.2453	.0852	.1367	.1058	.1129
CO2, %.....	13.09	13.62	3.60	3.70	3.67	4.21
O2, %.....						
HC, ppmC.....	3033	2649	1106	1369	1610	1699
NOx, ppm.....	400	410	175	160	180	240
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	681.6	685.1	307.9	506.4	374.0	396.4
HC.....	441.1	371.3	200.6	254.5	285.6	299.4
NOx**.....	195.5	182.9	101.0	94.7	101.6	134.6
Oil temperature, F.....	234	222	224	228	225	225
Oil pressure, psi.....	52	51	52	51	52	52
Coolant temperature, F.....	175	174	171	172	171	171
Exhaust temperature, F.....	1330	1273	454	495	481	720
Exhaust pressure, in H2O...	51.0	42.0	35.0	37.0	34.0	37.0
Exhaust flow, lb/min.....	12.48	12.08	14.24	14.62	13.94	13.92
Smoke, % opacity.....	6.2	4.5	2.2	2.9	2.4	2.7

* Corrected - SAE J816B.
 ** Corrected for humidity.

Engine..... Nissan diesel, 193-CED
 Fuel..... 7557

Test Number.....	62	74	61	74	60	72
Test Date.....	5/13/75	5/13/75	5/13/75	5/13/75	5/13/75	5/13/75
Barometer, mm Hg.....	742.0	742.0	742.0	742.0	742.0	742.0
Humidity, grains/lb.....	69	69	69	69	69	69
Temperature, F.....	80	75	79	75	81	78
Engine speed, rpm.....	3800	3800	3800	3800	3800	3800
Torque, lb-ft.....	27.2	30.0	55.0	30.0	84.2	88.0
Power, bhp*.....	20.0	22.0	40.4	22.0	62.1	64.7
Fuel rate, lb/hr.....	18.5	20.7	25.4	20.7	34.7	37.8
Ignition timing, deg BTC...						
Manifold vacuum, in Hg.....						
Throttle angle, deg.....	23.5	24.0	27.0	24.0	30.5	32.0
Concentrations, dry basis:						
CO, %.....	.1152	.1271	.1176	.1271	.0952	.1367
CO2, %.....	4.98	5.39	7.06	5.39	9.83	10.25
O2, %.....						
HC, ppmC.....	1975	1923	2494	1923	3198	3211
NOx, ppm.....	330	360	540	360	575	560
Air-fuel ratio.....						
Emission rates, g/hr:						
CO.....	399.4	464.1	404.4	464.1	320.7	479.1
HC.....	343.7	352.4	430.5	352.4	540.6	564.9
NOx**.....	182.7	209.9	296.5	209.9	309.3	313.4
Oil temperature, F.....	228	233	234	233	239	240
Oil pressure, psi.....	52	51	52	51	52	52
Coolant temperature, F.....	172	173	173	173	173	174
Exhaust temperature, F.....	720	643	743	643	981	1036
Exhaust pressure, in H2O...	39.5	42.0	42.0	42.0	53.0	55.0
Exhaust flow, lb/min.....	13.35	14.64	14.01	14.64	14.07	14.71
Smoke, % opacity.....	3.6	3.6	4.2	3.6	3.6	3.1

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

Engine..... Nissan diesel, 1200-CCD
 Fuel..... 7557

Test Number.....	59	58	57	71
Test Date.....	5/13/75	5/13/75	5/13/75	5/13/75
Barometer, mm Hg.....	742.0	742.0	742.0	742.0
Humidity, grains/lb.....	69	69	69	69
Temperature, F.....	81	91	79	76
Engine speed, rpm.....	3800	3800	3800	3800
Torque, lb-ft.....	93.2	105.8	111.4	117.0
Power, bhp*.....	68.6	79.0	82.0	85.7
Fuel rate, lb/hr.....	34.8	41.5	46.6	45.5
Ignition timing, deg BTC...				
Manifold vacuum, in Hg.....				
Throttle angle, deg.....	32.0	34.5	36.5	36.5
Concentrations, dry basis:				
CO, %.....	.1200	.1731	.2504	.2707
CO2, %.....	10.36	11.84	13.22	13.62
O2, %.....				
HC, ppmC.....	3642	3258	4399	3664
NOx, ppm.....	570	540	510	490
Air-fuel ratio.....				
Emission rates, g/hr:				
CO.....	402.6	552.2	839.1	894.6
HC.....	613.4	521.6	739.9	607.8
NOx**.....	305.4	275.1	272.9	258.6
Oil temperature, F.....	241	242	234	235
Oil pressure, psi.....	52	52	52	52
Coolant temperature, F.....	174	175	175	175
Exhaust temperature, F.....	1064	1220	1282	1342
Exhaust pressure, in H2O...	52.0	55.0	67.0	64.0
Exhaust flow, lb/min.....	14.09	13.58	14.45	14.30
Smoke, % opacity.....	3.6	2.7	4.4	4.2

* Corrected - SAE J816b.

** Corrected for humidity.