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PERFORMANCE OF CONVENTIONALLY POWERED VEHICLES TESTED TO AN ELECTRIC VEHICLE TEST PROCEDURE

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16 Abstract

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The Electric and Hybrid Vehicle Program was conducted under the guidance of the then Energy Research and Development Administration (ERDA), now part of the Department of Energy.

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SUMMARY

A conventional Volkswagen Transporter, a Renault 5, an American Motors Corp. Pacer, and a U.S. Postal Service American Motors General DJ-5 delivery van were tested to an electric vehicle test procedure in order to allow direct comparison of conventional and electric vehicles. These vehicles were tested at the Transportation Research Center of Ohio Test Track near East Liberty, Ohio. The tests were conducted between July 26 and August 16, 1977. The tests are part of an Energy Research and Development Administration (ERDA) project to characterize the state-of-the-art of electric vehicles. The performance test results for the four vehicles are presented in this report.

The Volkswagen Transporter (Minibus) is a delivery van powered by a 2.0-liter, four-cylinder opposed, air-cooled, fuel-injected engine. Power is transmitted through a four-speed, manual-shift transaxle.

The Renault 5 is a passenger vehicle powered by a carbureted, 1.3-liter, four-cylinder in-line, liquid-cooled engine. Power is transmitted through a four-speed, manual-shift transaxle.

The AMC Pacer is a passenger vehicle powered by a carbureted 4.2-liter, six-cylinder in-line, liquid-cooled engine. Power is transmitted through a three-speed, manual-shift transmission and a separate differential axle assembly.

The U.S. Postal Service vehicle is an AM General DJ-5. It is powered by a carbureted, 3.8-liter, six-cylinder in-line, liquid-cooled engine. Power is transmitted through a three-speed automatic transmission and a separate differential axle assembly.

Two series of tests were conducted on the vehicles. One series was performed at a test weight equivalent to the vehicle's curb weight plus its electric vehicle counterpart's payload. The other series was performed at a test weight equivalent to the gross vehicle weight listed on

the placard attached to the vehicle body. The test weights were as follows:

Vehicle	Curb weight plus electric vehicle payload		Placard-listed gross vehicle weight	
	kg	lbm	kg	lbm
Volkswagen Transporter	2100	4630	2300	5090
Renault 5	1025	2260	1130	2490
AMC Pacer	1787	3940	1965	4330
AM General DJ-5	1500	3305	1500	3305

Acceleration times from a standing start were as follows:

Vehicle	Test speed, km/h (mph)			
	32 (20)	48 (30)	72 (45)	97 (60)
	Time to reach test speed from standing start, s			
Volkswagen Transporter	4.9	9.7	19.5	39.0
Renault 5	3.3	5.5	10.0	18.0
AMC Pacer	4.1	6.5	12.6	17.6
AM General DJ-5	4.8	8.2	11.1	20.8

Gradeability limits were as follows:

Vehicle	Gradeability limit, percent
Volkswagen Transporter	24
Renault 5	43
AMC Pacer	30
AM General DJ-5	49

The measured and corrected fuel economies for the four vehicles at both test weights are presented in tables I to VII. A fairly consistent reduction in fuel economy occurred as the test speed or test weight increased. The better fuel economy measured for the higher speed schedule D tests, as compared with the schedule B or C test results, is due to the relatively longer time and greater distance traveled at constant speed per cycle during schedule D.

INTRODUCTION

The vehicle tests and the data presented in this report are in support of Public Law 94-413 enacted by Congress on September 17, 1976. The law requires the Energy Research and Development Administration (ERDA) to develop data characterizing the state-of-the-art of electric and hybrid vehicles. The data so developed are to serve as a baseline (1) to compare improvements in electric and hybrid vehicle technologies, (2) to assist in establishing performance standards for electric and hybrid vehicles, and (3) to help guide future research and development activities.

The National Aeronautics and Space Administration (NASA), under the direction of the Electric and Hybrid Research, Development, and Demonstration Office of the Division of Transportation Energy Conservation of ERDA, has conducted track tests of electric vehicles to measure their performance characteristics and vehicle component efficiencies. The tests were conducted according to ERDA Electric and Hybrid Vehicle Test and Evaluation Procedure, described in appendix E of reference 1. This procedure is based on the Society of Automotive Engineers (SAE) J227a procedure. Seventeen electric vehicles have been tested under this phase of the program, 12 by NASA, 4 by MERADCOM, and 1 by the Canadian government. In addition, the Lewis Research Center tested conventionally powered counterparts of four of the electric vehicles under the same test procedure. The Energy Research and Development Administration provided funding support and guidance during this project.

Until now, no controlled test data had existed that would allow the performance of electric vehicles to be compared with the performance of conventionally powered vehicles of a similar type driven over the same test schedule. This report describes limited tests on four conventional vehicles according to the ERDA Electric and Hybrid Vehicle Test and Evaluation Procedure. The vehicles were selected because they are conventional counterparts of electric vehicles previously tested by NASA. Neither type of vehicle was necessarily of optimum design for the tests performed. Nevertheless, the tests do permit a useful comparison of energy economy and performance under controlled conditions.

U.S. customary units were used in the collection and reduction of data, with the exception of fuel flow and fuel temperature, which were collected in metric units. The units were converted to the International System of Units for presentation in this report. U.S. customary units are presented in parentheses. The parameters, symbols, units, and unit abbreviations used in this report are listed here for the convenience of the reader.

Parameter	Symbol	SI units		U.S. customary units	
		Unit	Abbreviation	Unit	Abbreviation
Acceleration	a	meter per second squared	m/s	mile per hour per second	mph/s
Area	---	square meter	m^2	square foot, square inch	ft^2, in^2
Correction factor	CF	------------------------	--------	------------------------	--------
Energy	---	megajoule	MJ	kilowatt hour	kWh
Energy consumption	E	megajoule per kilometer	MJ/km	kilowatt hour per mile	kWh/mile
Energy economy	---	megajoule per kilometer	MJ/km	kilowatt hour per mile	kWh/mile
Force	P	newton	N	pound force	lbf
Fuel economy	---	kilometer per liter	km/liter	miles per gallon	mpg
Integrated current	---	ampere hour	Ah	ampere hour	Ah
Length	---	meter	m	inch, foot, mile	in., ft, ---
Mass, weight	W	kilogram	kg	pound mass	lbm
Power	P	kilowatt	kW	horsepower	hp
Pressure	---	kilopascal	kPa	pound per square inch	psi
Range	---	kilometer	km	mile	---
Specific energy	---	megajoule per kilogram	MJ/kg	watt hour per pound	Wh/lbm
Specific power	---	kilowatt per kilogram	kW/kg	kilowatt per pound	kW/lbm
Speed	V	kilometer per hour	km/h	mile per hour	mph
Temperature	T	degrees Celsius	°C	degrees Fahrenheit	°F
Volume	---	cubic meter	m^3	cubic inch, cubic foot	in^3; ft^3

OBJECTIVES

The objectives of these track tests were to determine conventional vehicle performance characteristics and to compare these characteristics with those of their electric vehicle counterparts. The measured characteristics included fuel economy at constant speed and under stop-and-go driving schedules, maximum acceleration, gradeability, gradeability limit, road energy consumption, and road power.

TEST VEHICLE DESCRIPTIONS

The Volkswagen Transporter is a three-door van powered by an air-cooled, four-cylinder opposed engine of 2.0-liter displacement. Fuel flow is through an electronic injection system that uses individual injectors manifolded together.

Regular-grade gasoline is the recommended fuel. The engine and a four-speed manual transaxle are located in the rear, below the cargo area. Constant-velocity joints on the drive train permit independent suspension on all four wheels. Disk brakes are used on front wheels and drum brakes on the rear wheels. The Volkswagen Transporter is shown in figure 1.

The Renault 5 is a two-door sedan. It is powered by a liquid-cooled, four-cylinder in-line engine of 1.3-liter displacement. The fuel-air mixture is controlled by carburetion. Regular-grade gasoline is the recommended fuel. The engine and a four-speed manual transaxle are located in the front. Two drive shafts with constant-velocity joints on the drive train allow independent suspension on all four wheels. Disk brakes are used on front wheels and drum brakes on the rear wheels. The Renault 5 is shown in figure 2.

The AMC Pacer is a two-door sedan powered by a liquid-cooled, six-cylinder in-line engine of 4.2-liter displacement. The fuel-air mixture is controlled by carburetion. Unleaded gasoline is required for operation. The engine and a three-speed manual transmission are located in the front. The rear wheels are driven through the rigid differential rear axle assembly. The front wheels are independently suspended from the frame. Disk brakes are used on the front wheels and drum brakes on the rear wheels. The AMC Pacer is shown in figure 3.

The American Motors General (AMG) U.S. Postal Service DJ-5 is a two-door, single-passenger delivery vehicle. It is powered by a liquid-cooled, six-cylinder in-line engine of 3.8-liter displacement. The fuel-air mixture is metered by carburetion. Unleaded gasoline is specified for operation. The engine and a three-speed automatic transmission are located in the front. The rear wheels are driven through the rigid differential rear axle assembly. The front axle is also a rigid assembly. Drum brakes are used on all wheels. The AMG DJ-5 is shown in figure 4.

More complete descriptions of the vehicles are given in appendixes A to D.

INSTRUMENTATION

The conventional vehicles were each instrumented to measure vehicle speed, distance traveled, total fuel flow, fuel temperature, and elapsed time. The speed and distance were recorded on a two-channel, strip-chart recorder. Fuel temperature, accumulated distance, total fuel flow, and the elapsed time of the test were displayed on digital readouts.

A Nucleus Corporation Model NC-7 precision speedometer (fifth wheel) was used to measure vehicle speed and distance traveled. Auxiliary equipment used with the fifth wheel included a Model ERP-X1 pulse totalizer, a Model ESS/E expanded-scale speedometer, and a programmable digital attenuator. The fifth wheel and auxiliaries weighed about 22.7 kilograms (50 lbm). A typical installation of the fifth wheel on a test vehicle is shown in figure 5. The fifth-wheel speed was calibrated during constant-speed test runs. While the driver maintained a given constant speed, another person, standing adjacent to the vehicle path of travel, verified the vehicle speed by using a Kustom Electronics Model HR8 radar gun. The accuracy of the fifth wheel as evaluated by these checks was ±1.6 kilometers per hour (±1 mph). The fifth-wheel distance digital readout accuracy was checked against mile markers placed around the track at 0.16-kilometer (0.1-mile) intervals. The accuracy of the distance measurements was determined to be ±0.5 percent.

Accumulated fuel flow, fuel temperature, and elapsed time of each test were measured and displayed using Fluidyne Model 1250 and Model 1240 flowmeter packages. The Model 1250 displayed fuel flow in 1-cubic-centimeter increments, and the Model 1240 in 0.1-cubic-centimeter increments. The accuracy of flow measurements was 1 percent for flow rates above 0.1 cubic centimeter per second for the Model 1240, and 1 percent for flow rates above 0.3 cubic centimeter per second for the Model 1250. The accuracy was 0.5 percent for flow rates from 0.4 to 120 cubic centimeters per second for the Model 1250. The accuracy of the fuel temperatures was determined to be within ±0.5 degree Celsius and the accuracy of elapsed time measurements within 0.01 percent, on both models.

The vehicle speed and distance were recorded on Honeywell 195 Electronik two-channel, strip-chart recorders. The accuracy of this recorder is within ±0.5 percent. The recorders used during the test program were calibrated with a Hewlett-Packard Model 6920 B meter calibrator, which has a 0.2-percent-of-reading accuracy and a usable range of 0.01 to 1000 volts.

Power for the fifth wheel and inverter was provided from two 12-volt starting, lighting, and ignition (SLI) batteries that were connected in parallel and weighed about 23 kilograms (50 lbm) each. A Tripp Lite 500-watt DC/AC inverter, weighing about 9 kilograms (20 lbm), provided the AC power for the strip charts. Power for the fuel flowmeter was obtained from the vehicle's 12-volt power system.

Figure 6 shows the instrumentation installed in one of the test vehicles.

TEST PROCEDURES

The tests described in this report were performed at the Transportation Research Center of Ohio Test Track, a four-lane, 12-kilometer (7.5-mile) track located near East Liberty, Ohio. A complete description of the track is given in appendix E. When the vehicle was delivered to the test track, the pretest checks described in appendix F were conducted. The first test was a shakedown to familiarize the driver with the operating characteristics of the vehicle and to check out the instrumentation systems.

A series of tests were conducted at test weights equivalent to the curb weights of their corresponding electric vehicle counterparts. A second series was completed at test weights corresponding to the gross vehicle weight listed on the placard attached to the body of each vehicle. The AM General DJ-5 payload weight was the same in both cases and, therefore, only one test series was conducted. Vehicle test weights were as follows:

Vehicle	Curb weight plus electric vehicle payload		Placard-listed gross vehicle weight	
	kg	lbm	kg	lbm
Volkswagen Transporter	2100	4630	2300	5090
Renault 5	1025	2260	1130	2490
AMC Pacer	1787	3940	1965	4330
AM General DJ-5	1500	3305	1500	3305

Constant-speed fuel economy was measured at 40, 56, and 72 kilometers per hour (25, 35, and 45 mph) and at the maximum speeds of the electric vehicle counterparts where these speeds differed from one of the selected test speeds. Thus, the Volkswagen Transporter was tested at 69 kilometers per hour (43 mph), the AMC Pacer at 82 kilometers per hour (51 mph), and the AM General DJ-5 at 48 kilometers per hour (30 mph). Tests were run at least twice on each vehicle at each speed. All constant-speed tests were made over a distance of 12 kilometers (7.5 miles).

The 32-kilometer-per-hour (20-mph) schedule B; the 48-kilometer-per-hour (30-mph) schedule C; and the 72-kilometer-per-hour (45-mph) schedule D stop-and-go driving cycles defined in figure 7 were run with all four vehicles. Thirty-six schedule B cycles, 22 schedule C, and 9 schedule D cycles were run for distances of about 12 kilometers (7.5 miles) each.

A complete description of the cycle tests is given in ERDA Electric and Hybrid Vehicle Test and Evaluation Procedure ERDA-EHV-TEP, contained in appendix E of reference 1. A special instrument, called a cycle timer, was developed at the Lewis Research Center to assist in accurately running these tests. Details of the cycle timer are given in appendix F.

Acceleration and Coast-down Tests

The maximum acceleration of each vehicle was measured. Four runs, two on each straight section of the track, were conducted on each vehicle. Coast-down data were taken immediately after the acceleration run with the transmission selector lever placed in the neutral position. Acceleration and deceleration were measured between zero and 97 kilometers per hour (60 mph). The test specification required that the tests be conducted in opposite directions over the same surface, but track safety regulations prohibited reversing the direction of travel. However, the track has a constant and equal slope on both straight sections and the surfaces are similar. So the test data are comparable to what would have been obtained under the specified conditions.

TEST RESULTS

The data collected from the constant-speed and driving schedule tests are summarized in tables I to VII. Shown for each type of test are the ambient conditions, fuel temperature, total fuel flow, test distance, and fuel economy. Some of the tests were conducted under calm or steady low-wind conditions, and some under variable and gusty conditions. Wind conditions frequently varied around the track from the conditions at the point of measurement because of the high banked curves and the large size of the facility. Local shower conditions were experienced occasionally. When these occurred in only one portion of the track, testing was continued as long as less than 25 percent of the track was wet. Occasionally some tests were conducted in winds with measured speeds greater than the 16-kilometer-per-hour (10-mph) limit. The highest recorded average wind speed during a test was 24 kilometers per hour (15 mph). Some of the test runs were also conducted after dark using the vehicle lights. There is no indication that these variations in the test conditions significantly affected the test results.

Fuel Economy

Two tests each at constant speeds of 72, 56, and 40 kilometers per hour (45, 35, and 25 mph) and two tests each over SAE J227a schedules D, C, and B were made on each test vehicle at each test weight in order to measure fuel economy under the same test conditions as for the electric vehicle counterparts. In addition, constant-speed tests were run at 69 kilometers per hour (43 mph) on the Volkswagen Transporter, at 82 kilometers per hour (51 mph) on the AMC Pacer, and at 48 kilometers per hour (30 mph) on the AM Genral DJ-5 at each test weight. These speeds represented the maximum speeds of the electric vehicle counterparts of those vehicles. Test results for the constant-speed and cycle tests are summarized in tables I to VII.

Additional tests were conducted when repeatability within ±5 percent was not achieved in the first tests. Additional tests were performed on the Volkswagen Transporter at 72, 69, 56, and 40 kilometers per hour (45, 43, 35, and 25 mph) and under schedule C, on the Renault 5 at 56 and 50 kilometers per hour (35 and 25 mph) and under schedule C, and on the AMC Pacer at 82 and 40 kilometers per hour (51 and 25 mph) and under schedule D. Addtional tests were also required on the Renault 5 at 72, 56, and 40 kilometers per hour (45, 35, and 25 mph) because the carburetor malfunctioned and on the AMC Pacer under schedules C and B because of driver errors.

Fuel economy was calculated from the raw test data by using the procedure recommended in the SAE Fuel Economy Measurement - Road Test Procedure J1082 (ref. 2). The corrections for atmospheric pressure and fuel specific gravity variations were neglected.

The correction for atmospheric pressure variations was evaluated. Standard pressure is 98 kPa (29.00 in. Hg). The worst-case effect of this factor resulted in a 0.12 percent correction, so it was neglected. The specific gravity of the fuel was not measured during the test program because this correction is also negligible. Standard API_{gr} is 60.5°. The correction for fuel economy, as used in this report, is

$$\text{Fuel economy (mpg)} = \text{mpg} \times T_S CF_1 \times T_F CF_2$$

where

mpg measured fuel economy, miles per gallon

CF correction factor

T_S ambient air temperature, $^{\circ}F$

T_F fuel temperature, $^{\circ}F$

$$T_S CF_1 = 1 + 0.0014\ (60 - T_S)$$

and

$$T_F CF_2 = \frac{1}{1 + 0.0006\ (T_F - 60)}$$

This corrects the data to SAE standard temperature conditions of 15.6° C (60° F).

Maximum Acceleration

The maximum acceleration of each vehicle was measured. The results of the tests are shown in figure 8 and table VIII. Higher acceleration and gradeability may be obtained with the Volkswagen Transporter by shifting at different speeds.

The average acceleration was calculated for the time period t_{n-1} to t_n from the equation

$$\bar{a}_n = \frac{V_n - V_{n-1}}{t_n - t_{n-1}}$$

and the average speed of the vehicle $\bar{V}$ from the equation

$$\bar{V} = \frac{V_n + V_{n-1}}{2}$$

Average acceleration as a function of speed is shown in figure 9 and table VIII.

Gradeability

The maximum vehicle speed on a specific grade was determined from maximum acceleration tests by using the equations

$$G = 100 \tan (\sin^{-1} 0.1026\ \bar{a}_n) \quad \text{for } V \text{ in km/h}$$

in SI units

or

$$G = 100 \tan (\sin^{-1} 0.0455\ \bar{a}_n) \quad \text{for } \bar{V} \text{ in mph}$$

in U.S. customary units

where $\bar{a}_n$ is acceleration in meters per second squared (mph/sec).

The resulting maximum negotiable grades as a function of speed are shown in figure 10 and table VIII.

Road Energy

Road energy is a measure of the energy consumed per unit of distance in overcoming the vehicle's aerodynamic and rolling resistance plus the energy consumed in the differential drive shaft and the portion of the transmission rotating when in neutral. It was obtained during coast-down, when the differential was being driven by the wheels, and thus may be different than the energy consumed when the differential is being driven by the engine.

Road energy consumption was calculated from the following equations:

$$E_n = 2.78\text{x}10^{-4} W \frac{V_{n-1} - V_n}{t_n - t_{n-1}}, \text{ MJ/km}$$

or

$$E_n = 9.07\times10^{-5} W \frac{V_{n-1} - V_n}{t_n - t_{n-1}}, \text{ kWh/mile}$$

where

W vehicle mass, kg (lbm)

V vehicle speed, km/h (mph)

t time, sec

The results of the road energy calculations are shown in figure 11 and table IX.

Road Power Requirements

The road power calculation is analogous to the road energy calculation. Road power is a measure of the power needed to overcome vehicle aerodynamic and rolling resistance plus the power losses from the differential, the drive shaft, and a portion of the transmission. The road power P_n required to propel a vehicle at various speeds is also determined from the coast-down tests. The following equations are used:

$$P_n = 3.86\times10^{-5} W \frac{V_{n-1}^2 - V_n^2}{t_n - t_{n-1}}, \text{ kW}$$

or

$$P_n = 6.08\times10^{-5} W \frac{V_{n-1}^2 - V_n^2}{t_n - t_{n-1}}, \text{ hp}$$

The results of road power calculations are shown in figure 12 and table IX.

DISCUSSION OF RESULTS

Energy consumption, acceleration, and gradeability data have been obtained for the Volkswagen Transporter (ref. 3), the Waterman Renault 5 (ref. 4), the EVA Change-of-Pace Coupe (ref. 5), and the AM General DJ-5E Electruck (ref. 6) electric vehicles. These data are compared in this section with the data obtained for their conventional vehicle counterparts carrying the same payload weight.

Energy for the electric and conventional vehicles is compared in table X. The comparison is made for the 40-kilometer-per-hour (25-mph), constant-speed tests and for the driving schedule B tests. Similar comparisons have been made for other speeds and cycles in reference 7, and the results are essentially the same. The energy economy for the conventional vehicles in kilometers per liter of gasoline (mpg) has been converted to an equivalent heat input in megajoules per kilometer (Btu/mile) by assuming a heating value for the gasoline of 32 megajoules per liter (114 800 Btu/gallon). The energy consumption for the electric vehicles was determined from track tests conducted at test conditions identical to those used in the conventional vehicle tests. These results were reported as the electric energy required to recharge the batteries divided by the distance traveled, in units of megajoules per kilometer (kWh/mile).

The quantity of heat required to produce this electrical energy was calculated by assuming that thermal energy from a fuel such as petroleum could be converted to electrical energy at the wall outlet at 33 percent efficiency. These values are tabulated in the last column in table X. Comparing the equivalent heat inputs for the conventional and electric vehicles, under these assumptions, shows that sometimes the electric vehicles require more equivalent energy for propulsion than the conventional vehicles and sometimes less. On the average, the electric vehicles require 6 percent more equivalent energy for propulsion than the conventional vehicles. A similar comparison is made in table XI for energy cost. Assuming that gasoline costs 60 cents per gallon and that electricity costs 5 cents per kilowatt-hour, the costs of propelling the electric and conventional vehicles are comparable.

The acceleration and gradeability of the conventional vehicles were measured and calculated. These values, along with an estimate of the maximum speed for the conventional vehicles, are compared with those of their electric counterparts in table XII. In all cases (acceleration, maximum speed, and gradeability), the electric vehicles performed less well than the conventional vehicles.

APPENDIX A

CONVENTIONAL VEHICLE SUMMARY DATA SHEET - VOLKSWAGEN TRANSPORTER

1.0 Vehicle manufacturer: Volkswagen Werk AG
Wolfsburg, West Germany

2.0 Vehicle: Volkswagen Transporter (van)

3.0 Price and availability: ____

4.0 Vehicle weight and load

- 4.1 Curb weight, kg (lbm): 1285 (2830)
- 4.2 Gross vehicle weight, kg (lbm): 2100 (4630)
- 4.3 Cargo weight, kg (lbm): 800 (1764)
- 4.4 Number of passengers: 9
- 4.5 Payload, kg (lbm): 815 (1800)

5.0 Vehicle size

- 5.1 Wheelbase, m (in.): 2.40 (94.5)
- 5.2 Length, m (in.): 4.51 (177.4)
- 5.3 Width, m (in.): 1.76 (67.7)
- 5.4 Height, m (in.): 1.96 (77.0)
- 5.5 Head room, m (in.): 0.97 (38)
- 5.6 Leg room, m (in.): 1.12 (44)
- 5.7 Frontal area, m^2 (ft^2): ____
- 5.8 Road clearance, cm (in.): 20 (7.8)
- 5.9 Number of seats: ____

6.0 Auxiliaries and options

- 6.1 Lights (number, type, and function): 2 head; 2 park; 2 tail; 2 turn signals (front); 2 backup; 2 interior

6.2 Windshield wipers 2

6.3 Windshield washers yes

6.4 Defroster hot air, front; electric, rear

6.5 Heater heat exchanger with gasoline boost

6.6 Radio AM

6.7 Fuel gage yes

6.8 Amperemeter no

6.9 Tachometer no

6.10 Speedometer yes

6.11 Odometer total plus trip

6.12 Right- or left-hand drive left

6.13 Transmission 4-speed manual

6.14 Regenerative braking

6.15 Mirrors 1 inside; 2 outside

6.16 Power steering no

6.17 Power brakes no

6.18 Other no air-conditioning

7.0 Engine

7.1 Type air cooled, 4 cylinder, opposed

7.2 Bore, mm (in.) 94 (3.70)

7.3 Stroke, mm (in.) 71 (2.80)

7.4 Displacement, cm^3 ($in.^3$) 1970 (120.2)

7.5 Number of main bearings 3

7.6 Compression ratio 7.3

7.7 Maximum horsepower, kW (hp) 50 (67)

7.8 Maximum torque, N-m (lbf-ft) 137 (101)

7.9 Fuel regular gasoline

7.10 Materials steel and aluminum

8.0 Capacities

8.1 Engine crankcase, liters (qt) 3.5 (3.7)

8.2 Axle lubricant, liters (qt) 1 (2.12)

8.3 Fuel tank, liters (gal) 59 (15.6)

8.4 Cooling system forced air

9.0 Body

9.1 Manufacturer and type: Volkswagen van

9.2 Materials: steel

9.3 Number of doors and type: 2 regular; 1 sliding

9.4 Number of windows and type: windshield, rear, 6 side, 2 wing

9.5 Number of seats and type: 2 bucket, 2 bench

9.6 Cargo space volume, m^3 (ft^3): 6.25 (220)

9.7 Cargo space dimensions, m (in.): 2.95×1.55×1.37 (116×61×54)

10.0 Chassis

10.1 Frame

10.1.1 Type and manufacturer: unitized; Volkswagen Werk AG

10.1.2 Materials: steel

10.1.3 Modifications: ______

10.2 Springs and shocks

10.2.1 Type and manufacturer: torsion springs; shocks

10.2.2 Modifications: ______

10.3 Axles

10.3.1 Manufacturer: ______

10.3.2 Front: independent; conventional spindle

10.3.3 Rear: independent; constant velocity, double joint

10.4 Transmission

10.4.1 Type and manufacturer: 4-speed, manual transaxle

10.4.2 Gear ratios: ______

10.4.3 Driveline ratio: ______

10.5 Steering

10.5.1 Type and manufacturer: ______

10.5.2 Turning ratio stop to stop

10.5.3 Turning diameter, m (ft) 11.6 (37 ft, 11 in.)

10.6 Brakes

10.6.1 Front disk } hydraulic, dual circuit, unassisted

10.6.2 Rear drum

10.6.3 Parking hand, cable, rear wheels

10.6.4 Regenerative no

10.7 Tires

10.7.1 Manufacturer and type Dunlop radial, load range C

10.7.2 Size 185-14

10.7.3 Pressure, kPa (psi):

Front 207 (30)

Rear 303 (40)

10.7.4 Rolling radius, cm (in.) 200.7 (79.0) front; 201.3 (79.3) rear

10.7.5 Wheel weight, kg (lbm):

Without drum 21.3 (47.0)

With drum ______

10.7.6 Wheel track, m (in.):

Front ______

Rear ______

APPENDIX B

CONVENTIONAL VEHICLE SUMMARY DATA SHEET - RENAULT 5

1.0 Vehicle manufacturer Groupe Renault
France

2.0 Vehicle Renault 5 (two-door hatchback)

3.0 Price and availability

4.0 Vehicle weight and load

4.1 Curb weight, kg (lbm) 816 (1800)

4.2 Gross vehicle weight, kg (lbm) 1007 (220)

4.3 Cargo weight, kg (lbm)

4.4 Number of passengers 4

4.5 Payload, kg (lbm) 190 (420)

5.0 Vehicle size

5.1 Wheelbase, m (in.) 2.42 (95.2)

5.2 Length, m (in.) 3.50 (137.5)

5.3 Width, m (in.) 1.44 (56.5)

5.4 Height, m (in.) 1.40 (55.1)

5.5 Head room, m (in.) 0.91 (36)

5.6 Leg room, m (in.) 1.0 (39)

5.7 Frontal area, m^2 (ft^2)

5.8 Road clearance, cm (in.) 13.0 (5.1)

5.9 Number of seats

6.0 Auxiliaries and options

6.1 Lights (number, type, and function) 2 head; 2 parking; 2 side; 2 backup

6.2 Windshield wipers 2 front; 1 rear

6.3 Windshield washers front and rear

6.4 Defroster front and rear

6.5 Heater yes

6.6 Radio yes

6.7 Fuel gage yes

6.8 Amperemeter no

6.9 Tachometer no

6.10 Speedometer yes

6.11 Odometer yes

6.12 Right- or left-hand drive left

6.13 Transmission yes

6.14 Regenerative braking

6.15 Mirrors 1 inside; 1 outside

6.16 Power steering no

6.17 Power brakes no

6.18 Other no air-conditioning

7.0 Engine

7.1 Type liquid cooled, 4 cylinder, in line

7.2 Bore, mm (in.) 73 (2.87)

7.3 Stroke, mm (in.) 77 (3.03)

7.4 Displacement, cm^3 ($in.^3$) 1289 (78.66)

7.5 Number of main bearings 5

7.6 Compression ratio 8.5

7.7 Maximum horsepower, kW (hp)

7.8 Maximum torque, N-m (lbf-ft)

7.9 Fuel regular gasoline

7.10 Materials cast iron block and head

8.0 Capacities

8.1 Engine crankcase, liters (qt) 3.2 (6.75)

8.2 Axle lubricant, liters (qt) 1.75 (3.75)

8.3 Fuel tank, liters (gal) 39 (10.3)

8.4 Cooling system 6.4 (6.75)

9.0 Body

9.1 Manufacturer and type R1228 (R5); Groupe Renault

9.2 Materials steel

9.3 Number of doors and type 2 conventional

9.4 Number of windows and type windshield; rear; 4 side

9.5 Number of seats and type 2 bucket; 1 folding bench

9.6 Carbo space volume, m^3 (ft^3) 0.25 (8.75)

9.7 Cargo space dimensions, m (in.) 89×0.65×0.43 (35×25.5×17)

10.0 Chassis

10.1 Frame

10.1.1 Type and manufacturer unitized; Groupe Renault

10.1.2 Materials steel

10.1.3 Modifications

10.2 Springs and shocks

10.2.1 Type and manufacturer torsion (front)

10.2.2 Modifications

10.3 Axles

10.3.1 Manufacturer

10.3.2 Front independent; constant velocity, double joint

10.3.3 Rear independent

10.4 Transmission

10.4.1 Type and manufacturer 4-speed manual

10.4.2 Gear ratios

10.4.3 Driveline ratio

10.5 Steering

10.5.1 Type and manufacturer

10.5.2 Turning ratio stop to stop

10.5.3 Turning diameter, m (ft) 9.78 (32 ft, 1 in.)

10.6 Brakes

10.6.1 Front disk } hydraulic, unassisted

10.6.2 Rear drum

10.6.3 Parking hand, cable

10.6.4 Regenerative no

10.7 Tires

10.7.1 Manufacturer and type Michelin radial

10.7.2 Size 145SR13

10.7.3 Pressure, kPa (psi):

Front 186 (27)

Rear 207 (30)

10.7.4 Rolling radius, m (in.) 1.71 (67.5) front; 1.73 (68) rear

10.7.5 Wheel weight, kg (lbm):

Without drum ________

With drum ________

10.7.6 Wheel track, m (in.):

Front ________

Rear ________

APPENDIX C

CONVENTIONAL VEHICLE SUMMARY DATA SHEET - AMC PACER

1.0 Vehicle manufacturer American Motors Corp.
Detroit, Mich.

2.0 Vehicle AMC Pacer (two-door hatchback sedan)

3.0 Price and availability

4.0 Vehicle weight and load
- 4.1 Curb weight, kg (lbm) 1515 (3340)
- 4.2 Gross vehicle weight, kg (lbm) 1792 (3950)
- 4.3 Cargo weight, kg (lbm)
- 4.4 Number of passengers 4
- 4.5 Payload, kg (lbm) 272 (600)

5.0 Vehicle size
- 5.1 Wheelbase, m (in.) 2.54 (100)
- 5.2 Length, m (in.) 4.32 (170.2)
- 5.3 Width, m (in.) 1.96 (77.0)
- 5.4 Height, m (in.) 1.34 (52.8)
- 5.5 Head room, m (in.) 0.97 (38.3)
- 5.6 Leg room, m (in.) 1.03 (40.7)
- 5.7 Frontal area, m^2 (ft^2)
- 5.8 Road clearance, m (in.)
- 5.9 Number of seats

6.0 Auxiliaries and options
- 6.1 Lights (number, type, and function) 2 head; 2 park; 2 tail; 2 backup; 4 turn signals

6.2 Windshield wipers 2
6.3 Windshield washers yes
6.4 Defroster front and rear
6.5 Heater yes
6.6 Radio AM/FM
6.7 Fuel gage yes
6.8 Amperemeter no
6.9 Tachometer no
6.10 Speedometer yes
6.11 Odometer yes
6.12 Right- or left-hand drive left
6.13 Transmission manual
6.14 Regenerative braking
6.15 Mirrors 1 inside; 1 outside
6.16 Power steering yes
6.17 Power brakes yes
6.18 Other air-conditioning

7.0 Engine

7.1 Type liquid cooled, 6 cylinder, in line
7.2 Bore, mm (in.) 95 (3.75)
7.3 Stroke, mm (in.) 99 (3.90)
7.4 Displacement, cm^3 ($in.^3$) 4235 (258)
7.5 Number of main bearings 7
7.6 Compression ratio 8.0
7.7 Maximum horsepower, kW (hp)
7.8 Maximum torque, N-m (lbf-ft)
7.9 Fuel unleaded gasoline
7.10 Materials cast iron block and head

8.0 Capacities

8.1 Engine crankcase, liters (qt) 4.73 (5.0)
8.2 Axle lubricant, liters (qt) 1.18 (2.5)
8.3 Fuel tank, liters (gal) 62.8 (16.6)
8.4 Cooling system 10 (10.5)

9.0 Body

9.1 Manufacturer and type American Motors Corp. two-door hatchback sedan

9.2 Materials steel

9.3 Number of doors and type 2 conventional

9.4 Number of windows and type windshield; rear; 4 side; 2 wing

9.5 Number of seats and type 2 bucket; 1 folding bench

9.6 Cargo space volume, m^3 (ft^3) ______

9.7 Cargo space dimensions, m (in.) ______

10.0 Chassis

10.1 Frame

10.1.1 Type and manufacturer unitized; American Motors Corp.

10.1.2 Materials steel

10.1.3 Modifications ______

10.2 Springs and shocks

10.2.1 Type and manufacturer oleo shocks; coil springs, front

10.2.2 Modifications ______

10.3 Axles

10.3.1 Manufacturer ______

10.3.2 Front conventional spindle

10.3.3 Rear rigid differential axle assembly

10.4 Transmission

10.4.1 Type and manufacturer 3-speed manual

10.4.2 Gear ratios ______

10.4.3 Driveline ratio ______

10.5 Steering

10.5.1 Type and manufacturer ______

10.5.2 Turning ratio stop to stop

10.5.3 Turning diameter, m (ft) 11.3 (37.0)

10.6 Brakes

10.6.1 Front disk } hydraulic, vacuum assisted

10.6.2 Rear drum

10.6.3 Parking foot-operated cable to rear brakes

10.6.4 Regenerative no

10.7 Tires

10.7.1 Manufacturer and type Goodyear radial

10.7.2 Size DR78-14

10.7.3 Pressure, kPa (psi):

Front 220 (32)

Rear 220 (32)

10.7.4 Rolling radius, m (in.) 1.98 (78) front and rear

10.7.5 Wheel weight, kg (lbm):

Without drum

With drum

10.7.6 Wheel track, m (in.):

Front

Rear

APPENDIX D

CONVENTIONAL VEHICLE SUMMARY DATA SHEET - AM GENERAL DJ-5

1.0 Vehicle manufacturer AM General Corp.
South Bend, Indiana

2.0 Vehicle AM General DJ-5 (two-door delivery van)

3.0 Price and availability

4.0 Vehicle weight and load

4.1 Curb weight, kg (lbm) 1179 (2600)

4.2 Gross vehicle weight, kg (lbm) 1497 (3300)

4.3 Cargo weight, kg (lbm)

4.4 Number of passengers 1

4.5 Payload, kg (lbm) 317.5 (700)

5.0 Vehicle size

5.1 Wheelbase, m (in.) 2.10 (82.5)

5.2 Length, m (in.) 3.35 (132)

5.3 Width, m (in.) 1.53 (60)

5.4 Height, m (in.) 1.83 (72)

5.5 Head room, m (in.) 1.02 (40)

5.6 Leg room, m (in.) 1.07 (42)

5.7 Frontal area, m^2 (ft^2)

5.8 Road clearance, cm (in.) 17.8 (7)

5.9 Number of seats

6.0 Auxiliaries and options

6.1 Lights (number, type, and function) 2 head; 2 tail; 2 turn signals

6.2 Windshield wipers 2
6.3 Windshield washers yes
6.4 Defroster yes
6.5 Heater yes
6.6 Radio no
6.7 Fuel gage yes
6.8 Amperemeter no
6.9 Tachometer no
6.10 Speedometer yes
6.11 Odometer yes
6.12 Right- or left-hand drive right
6.13 Transmission automatic
6.14 Regenerative braking
6.15 Mirrors 3 outside; 1 inside
6.16 Power steering no
6.17 Power brakes no
6.18 Other no air-conditioning

7.0 Engine

7.1 Type liquid cooled, 6 cylinder, in line
7.2 Bore, mm (in.) 95 (3.75)
7.3 Stroke, mm (in.) 89 (3.50)
7.4 Displacement, cm^3 ($in.^3$) 3801 (232)
7.5 Number of main bearings 7
7.6 Compression ratio 8.0
7.7 Maximum horsepower, kW (hp)
7.8 Maximum torque, N-m (lbf-ft)
7.9 Fuel unleaded gasoline
7.10 Materials cast iron

8.0 Capacities

8.1 Engine crankcase, liters (qt) 4.73 (5.0)
8.2 Axle lubricant, liters (qt) 1.18 (1.25)
8.3 Fuel tank, liters (gal) 41.5 (11)
8.4 Cooling system 10 (10.5)

9.0 Body

9.1 Manufacturer and type AM General Corp. DJ-5 delivery van

9.2 Materials steel

9.3 Number of doors and type 2 sliding side doors; rear hinge

9.4 Number of windows and type windshield; 2 side; rear

9.5 Number of seats and type 1 bucket

9.6 Cargo space volume, m^3 (ft^3) ____

9.7 Cargo space dimensions, m (in.) ____

10.0 Chassis

10.1 Frame

10.1.1 Type and manufacturer unitized; AM General

10.1.2 Materials steel

10.1.3 Modifications ____

10.2 Springs and shocks

10.2.1 Type and manufacturer oleo shocks; leaf springs

10.2.2 Modifications ____

10.3 Axles

10.3.1 Manufacturer ____

10.3.2 Front rigid

10.3.3 Rear rigid assembly with differential

10.4 Transmission

10.4.1 Type and manufacturer Warner gear, 3-speed automatic

10.4.2 Gear ratios ____

10.4.3 Driveline ratio ____

10.5 Steering

10.5.1 Type and manufacturer ____

10.5.2 Turning ratio stop to stop

10.5.3 Turning diameter, m (ft) 9.63 (31 ft, 7 in.)

10.6 Brakes

10.6.1 Front drum } hydraulic, unassisted

10.6.2 Rear drum }

10.6.3 Parking hand, cable, rear brakes

10.6.4 Regenerative no

10.7 Tires

10.7.1 Manufacturer and type Goodyear radial

10.7.2 Size CR78-15

10.7.3 Pressure, kPa (psi):

Front 124 (18)

Rear 165 (24)

10.7.4 Rolling radius, m (in.) 2.00 (78.7) front and rear

10.7.5 Wheel weight, kg (lbm):

Without drum ___

With drum ___

10.7.6 Wheel track, m (in.):

Front ___

Rear ___

APPENDIX E

DESCRIPTION OF VEHICLE TEST TRACK

All the tests were conducted at the Transportation Research Center (TRC) of Ohio (shown in fig. E-1). This facility was built by the State of Ohio and is now operated by a contractor and supported by the State of Ohio. It is located 72 kilometers northwest of Columbus along U.S. route 33 near East Liberty, Ohio.

The test track is a 12-kilometer (7.5-mile) continuous loop 1.6 kilometers (1 mile) wide and 5.6 kilometers (3.5 mile) long. Three concrete lanes 11.0 meters (36 ft) wide in the straightaways and 12.8 meters (42 ft) wide in the curves make up the high-speed test area. The lanes were designed for speeds of 129, 177, and 225 kilometers per hour (80, 110, and 140 mph) with zero lateral acceleration in the curves. The 3.0-kilometer- (1.88-mile-) long straightaways are connected to the constant 731-meter- (2400-ft-) radius curves by a short variable-radius transition section. Adjacent to the inside concrete lane is a 3.66-meter- (12-ft-) wide asphalt berm. This berm is only banked slightly to provide a drainage slope. An additional asphalt lane 3.66 meters (12 ft) wide is located adjacent to the outside lane on the straightaways. The constant-speed and cycle tests were conducted on the inside asphalt lanes because all these tests were conducted at relatively low speeds. The acceleration and coast-down tests were conducted on the straight outside asphalt lanes because these were more alike than the two inside asphalt lanes and because it was the portion of the track least likely to encounter traffic interference. The track has a constant 0.228 percent north-to-south downslope. The TRC complex also has a 20-hectare (5-acre) vehicle dynamics area, and a 2740-meter- (9000-ft-) long skid pad for the conduct of braking and handling tests.

APPENDIX F

VEHICLE PREPARATION AND TEST PROCEDURE

Vehicle Preparation

When a vehicle was received at the test track, it was checked to assure that it was ready for testing. These checks were recorded on a vehicle preparation check sheet such as the one shown in figure F-1. The vehicle was examined for physical damage when it was removed from the transport truck and before it was accepted from the shipper. Before the vehicle was operated, a complete visual check was made of the entire vehicle.

The vehicle was weighed as received (curb weight). Sufficient ballast was added so that the combined weight of the vehicle, driver, navigator, fuel, and instrumentation was equal to the desired test weight. The vehicle test weight for the first series of tests was the curb weight plus the payload weight of the electric vehicle counterpart. In the second series of tests the test weight was the manufacturer's recommended maximum vehicle gross weight.

The wheel alignment was checked, compared, and corrected to the manufacturer's recommended values. The Renault wheels were too small to accommodate the available equipment for verifying camber and caster. Therefore, only toe-in was adjusted on that vehicle. Wheels were checked for brake drag. Tire pressures were adjusted to the values specified for use at the vehicle gross weight.

Test Procedure

Each day, before the start of testing, a run schedule was issued for vehicles to be tested on that particular day. A blank run schedule is shown in figure F-2. The first item on the run schedule calls for completion of the pretest checklist. A copy of the pretest checklist is shown in figure F-3.

Data taken before, during, and after each test are entered on the track data sheet. Sample track data sheets are shown in figure F-4. Separate sheets for the schedule B, C, and D runs (fig. F-4(b)) were completed. The data taken included

(1) Vehicle tire pressures

(2) Fifth-wheel tire pressure

(3) Vehicle test weight total and for front and rear wheels

(4) Weather information

(5) Time at start of test

(6) Time at completion of test

(7) Duration of test, seconds

(8) Fifth-wheel distance count, feet

(9) Odometer reading before and after test

(10) Total fuel flow, cubic centimeters

(11) Fuel temperature, degrees Celsius

During the cycle tests the following additional data were also taken:

(12) Number of cycles

(13) Distance traveled for each cycle (cumulative), miles

(14) Fuel flow after each cycle (cumulative), cubic centimeters

To prepare for testing, the tire pressures were adjusted to specification. Operation and adjustment settings of the speedometer, the expanded-scale speedometer, the strip-chart zeros and spans, the speed and distance strip-chart traces, and the fuel flow and fuel temperature indications were all verified. The vehicle was then driven to the weight scale. Weight distribution was measured and recorded. The fifth wheel was then lowered and the spring preload adjusted. The instrumentation was turned on, the vehicle was driven to the track, and one lap was completed to warm up the vehicle and instrumentation and to check the vehicle operation.

After the warmup lap the vehicle was stopped. Vehicle, type of test, date, tire pressure, test weight, weather, fuel temperature, odometer reading, and starting time were recorded on the track data sheet. The date, vehicle, test, chart speed, and pen spans were noted on the strip chart. The test lap was then completed.

After the vehicle was stopped again, the track data sheet was completed. This included recording tire pressures, weather, odometer reading, completion time, fuel temperature, accumulated fuel flow, accumulated test time, number of cycles, and fifth-wheel digital distance readout.

The procedure following the warmup lap was then repeated for the next test run, and for each succeeding test, until the vehicle was returned to the workroom. Whenever the vehicle was returned to the workroom or deactivated for a significant time between test laps, another lap was driven to warm up the vehicle before the run schedule was resumed.

When the final test of the day was completed and the track data sheet was filled out, post-test operations were commenced per the post-test checklist shown in figure F-5. All instrumentation power was turned off, the instrumentation battery was disconnected, and the fifth wheel was raised. The vehicle was then driven back to the workroom. The specific gravities of the instrument batteries were checked, and the batteries were put on charge at an appropriate charge rate.

The engineer conducting the test completed an engineering data sheet, shown in figure F-6, for each test lap completed. This data sheet provides a brief summary of the significant test information, including the engineer's evaluation of the test and a record of problems, malfunctions, changes to instrumentation, etc., that occurred during the test.

Weather Data

Wind velocity, ambient temperature, and barometric pressure were measured at the beginning and end of each test. The wind anemometer was located about 1.8 meters (6 ft) from ground level near the center of the east straightaway (fig. E-1). The ambient air temperature and barometric pressure were measured in the control tower adjacent to the anemometer, but at a higher elevation. During many test runs the winds were variable and gusty. The wind conditions were displayed on undamped meters, making it virtually impossible to obtain accurate measurements under variable and/or gusty conditions. The ground elevation at the anemometer was 3 meters higher than the track elevation, which meant the wind was measured above the path of the vehicles. Also, the large physical size and high, banked curves of the track frequently resulted in local wind conditions that differed from the recorded values.

Cycle Timer

The cycle timer was designed to assist the vehicle driver in accurately driving SAE schedules B, C, and D. The required test profile is permanently stored on a programmable read-only memory (PROM), which is the heart of the instrument. This profile is continuously reproduced on one needle of a dual-movement analog meter shown in the figure. The second needle is connected to the output of the fifth wheel, and the driver "matches needles" to accurately drive the required schedule.

One second before each speed transition (e.g., acceleration to cruise or cruise to coast), a signal sounds to forewarn the driver of a change. A longer duration signal sounds after the idle period to emphasize the start of a new cycle. The total number of test cycles driven is stored in a counter and can be displayed at any time with a pushbutton (to conserve power).

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TABLE I. - RESULTS OF CONSTANT-SPEED AND DRIVING SCHEDULE TESTS ON VOLKSWAGEN TRANSPORTER AT TEST WEIGHT[a] OF 2100 KILOGRAMS (4630 lbm)

(a) SI units

Test date	Test condition (constant speed, km/h; or driving schedule)	Wind direction, deg	Wind velocity, km/h	Air temperature, °C	Fuel flow temperature, °C	Total fuel flow, cm³	Fuel economy, km/liter	Test distance, km	Remarks
8/14/77	72	200	13	26	29	1139	10 4	12 0	---
	72	200	16	29	35	1069	11.0		---
	72	180	16	29	--	1072	11.1		Fuel temperature not recorded
	69	200	13	27	33	1033	11 5		---
	69	160	16	28	34	1101	11 3	12 7	---
	56	220	13	2	35	968	12.3	12 0	---
	56	160	13	28	33	913	12 9	12 0	---
8/5/77	56	220	19	29	37	947	12 9	12 4	---
8/4/77	40	200	13	28	35	1013	11 7	12.0	Third-gear operation
		180	11	27	33	989	12 0		Third-gear operation
		180	11	27	--	842	14 1		Fourth-gear operation, fuel temperature not recorded
		180	13	27	--	816	14.5		Fourth-gear operation, fuel temperature not recorded
	D	200	16	28	37	1683	7.87	13 4	---
	D	220	16	26	32	1655	8 00	13.4	---
	C	220	16	29	36	1579	7 92	12.7	---
8/5/77	C	220	19	29	37	1634	7 38	12 2	---
	C	200	19	32	37	1666	7.30	12 4	---
8/4/77	B	210	14	30	39	1735	6.87	12.0	---
8/5/77	B	220	19	27	35	1774	6.74	12 0	---

(b) U S. customary units

Test date	Test condition (constant speed, mph, or driving schedule)	Wind direction, deg	Wind velocity, mph	Air temperature, °F	Fuel flow temperature, °F	Total fuel flow, in³	Fuel economy, mpg	Test distance, miles	Remarks
8/4/77	45	200	8	79	84	69 5	24.7	7 5	---
	45	200	10	85	95	65 2	26.2		---
	45	180	10	85	---	65 4	26.1		Fuel temperature not recorded
	43	200	8	80	91	63 0	27 2		---
	43	160	10	83	93	67.2	26.8	7.9	---
	35	220	8	81	95	59 1	29.0	7 5	---
	35	160	8	83	91	55 7	30.6	7 5	---
8/5/77	35	220	12	84	99	57 8	30 4	7.7	---
8/4/77	25	200	8	82	97	61.8	27 7	7 5	Third-gear operation
		180	7	81	91	60 4	28.3		Third-gear operation
		180	7	81	---	51.4	33.3		Fourth-gear operation, fuel temperature not recorded
		180	8	81	---	49.8	34.4		Fourth-gear operation, fuel temperature not recorded
	D	200	10	83	99	102 7	18.5	8.3	---
	D	220	10	78	90	101 0	18.8	8.3	---
	C	220	10	85	97	96.4	18 6	7.9	---
8/5/77	C	220	12	85	99	99 7	17.4	7 6	---
	C	200	12	89	99	101 7	17 2	7 7	---
8/4/77	B	210	9	86	102	105.9	16 2	7.5	---
8/5/77	B	220	12	80	95	108.3	15.9	7.5	---

[a]Curb weight of conventional vehicle plus electric vehicle payload

TABLE II. - RESULTS OF CONSTANT-SPEED AND DRIVING SCHEDULE TESTS ON RENAULT 5 AT TEST WEIGHT[a] OF 1025 KILOGRAMS (2260 lbm)

(a) SI units

Test date	Test condition (constant speed, km/h, or driving schedule)	Wind direction, deg	Wind velocity, km/h	Air temperature, °C	Fuel flow temperature, °C	Total fuel flow, cm^3	Fuel economy, km/liter	Test distance, km	Remarks
8/1/77	72	290	10	21	25	988	12.1	12.0	Carburetor malfunction
8/2/77	72	200	8	21	23	670	17.8	↓	-------------------
	72	200	10	27	30	680	17.3	↓	-------------------
8/1/77	56	290	11	22	25	849	14.0	↓	Carburetor malfunction
8/2/77	56	180	8	22	23	597	19.9	↓	-------------------
	56	215	10	26	30	591	20.1	↓	-------------------
8/1/77	40	290	10	22	27	1060	11.3	↓	Third-gear operation, carburetor malfunction
8/2/77	↓	180	13	23	25	754	15.8	↓	Third-gear operation
8/5/77	↓	220	19	31	34	831.5	14.1	↓	Third-gear operation
8/2/77	↓	200	10	26	30	521	22.7	↓	Fourth-gear operation
	↓	200	10	26	30	517	22.9	↓	Fourth-gear operation
	D	180	13	23	28	892	14.2	12.8	-------------------
	D	180	10	24	28	897	14.4	13.0	-------------------
	C	220	11	27	30	994	12.6	12.7	-------------------
	C	180	10	24	29	1094	10.9	12.0	-------------------
8/5/77	C	220	24	31	33	1034	11.7	12.4	-------------------
8/1/77	B	310	16	24	29	1232	9.86	12.2	-------------------
8/2/77	B	200	11	24	30	1214	10.1	12.4	-------------------

(b) U.S. customary units

Test date	Test condition (constant speed, mph, or driving schedule)	Wind direction, deg	Wind velocity, mph	Air temperature, °F	Fuel flow temperature, °F	Total fuel flow, in^3	Fuel economy, mpg	Test distance, miles	Remarks
8/1/77	45	290	6	70	77	60.3	28.6	7.5	Carburetor malfunction
8/2/77	45	200	5	70	73	40.9	42.1	↓	-------------------
	45	200	6	80	86	41.5	41.1	↓	-------------------
8/1/77	35	290	7	71	77	51.8	33.2	↓	Carburetor malfunction
8/2/77	35	180	5	71	73	36.4	47.2	↓	-------------------
	35	215	6	79	86	36.1	47.4	↓	-------------------
8/1/77	25	290	6	71	81	64.7	26.7	↓	Third-gear operation, carburetor malfunction
8/2/77	↓	180	8	73	77	46.0	37.3	↓	Third-gear operation
8/5/77	↓	220	12	87	93	50.7	33.4	↓	Third-gear operation
8/2/77	↓	200	6	79	86	31.8	53.8	↓	Fourth-gear operation
	↓	200	6	79	86	31.5	54.2	↓	Fourth-gear operation
8/2/77	D	180	8	74	82	54.4	33.5	7.9	-------------------
	D	180	6	75	82	54.7	33.9	8.1	-------------------
	C	220	7	80	86	60.7	29.7	7.9	-------------------
	C	180	6	76	84	66.8	25.7	7.5	-------------------
8/5/77	C	220	15	87	91	63.1	27.6	7.7	-------------------
8/1/77	B	310	10	75	84	75.2	23.1	7.6	-------------------
8/2/77	B	200	7	76	86	74.1	23.8	7.7	-------------------

[a]Curb weight of conventional vehicle plus electric vehicle payload

TABLE III. - RESULTS OF CONSTANT-SPEED AND DRIVING SCHEDULE TESTS ON AMC PACER AT TEST WEIGHT[a] OF 1787 KILOGRAMS (3940 lbm)

(a) SI units

Test date	Test condition (constant speed, km/h; or driving schedule)	Wind direction, deg	Wind velocity, km/h	Air temperature, °C	Fuel flow temperature, °C	Total fuel flow, cm^3	Fuel economy, km/liter	Test distance, km	Remarks
7/28/77	82	170	13	28	32	1151	10 3	12 0	--------------------
7/29/77	82	180	10	23	26	1166	10.1	↓	--------------------
7/28/77	72	180	13	28	31	1086	10.8	↓	--------------------
7/29/77	72	160	10	23	28	1089	10.9	↓	--------------------
7/28/77	56	170	11	28	30	981	12.0	↓	--------------------
7/29/77	56	170	10	23	28	979	12 2	↓	--------------------
7/28/77	40	160	11	27	30	979	12 1	↓	--------------------
7/29/77	40	170	10	23	27	1012	11 8	↓	--------------------
7/28/77	D	160	11	27	30	1570	8 35	13.4	--------------------
7/29/77	D	180	13	23	28	1553	8 49	13 3	--------------------
7/28/77	C	160	11	27	29	2045	6 09	12.6	Driving error
7/29/77	C	170	13	23	28	1770	6 90	12 3	--------------------
8/4/77	C	180	16	29	32	1762	6 69	12 0	--------------------
7/28/77	B	160	10	26	29	2887	4 11	12 0	Driving error
7/29/77	↓	160	14	23	29	2252	5 45	12.3	--------------------
8/4/77	↓	160	16	28	30	1983	6.18	12.5	--------------------
8/5/77	↓	220	19	28	31	1959	6.17	12 4	--------------------

(b) U.S customary units

Test date	Test condition (constant speed, mph, or driving schedule)	Wind direction, deg	Wind velocity, mph	Air temperature, °F	Fuel flow temperature, °F	Total fuel flow, in^3	Fuel economy, mpg	Test distance, miles	Remarks
7/28/77	51	170	8	83	90	70.2	24 3	7 5	--------------------
7/29/77	51	180	6	73	79	71.2	24.1	↓	--------------------
7/28/77	45	180	8	83	88	66 3	25.7	↓	--------------------
7/29/77	45	160	6	73	82	66.5	25 9	↓	--------------------
7/28/77	35	170	7	82	86	59.9	28 4	↓	--------------------
7/29/77	35	170	6	74	82	59 7	28 8	↓	--------------------
7/28/77	25	160	7	81	86	59 7	28 6	↓	--------------------
7/29/77	25	170	6	74	81	61 8	27 8	↓	--------------------
7/28/77	D	160	7	80	86	95.8	19 6	8.3	--------------------
7/29/77	D	180	8	74	82	94.8	20.0	8.3	--------------------
7/28/77	C	160	7	80	84	124 8	14 3	7.9	Driving error
7/29/77	C	170	8	74	82	108 0	16 3	7.7	--------------------
8/4/77	C	180	10	85	90	107.5	15.8	7.6	--------------------
7/28/77	B	160	6	78	84	176.2	9 71	7.5	Driving error
7/29/77	↓	160	9	74	84	137.4	12 8	7.6	--------------------
8/4/77	↓	160	10	83	86	121 0	14.5	7 8	--------------------
8/5/77	↓	220	12	83	88	119.5	14.7	7.7	--------------------

[a]Curb weight of conventional vehicle plus electric vehicle payload.

TABLE IV. - RESULTS OF CONSTANT-SPEED AND DRIVING SCHEDULE TESTS ON AM GENERAL DJ-5 AT TEST WEIGHT[a] OF 1500 KILOGRAMS (3305 lbm)

(a) SI units

Test date	Test condition (constant speed, km/h; or driving schedule)	Wind direction, deg	Wind velocity, km/h	Air temperature, °C	Fuel flow temperature, °C	Total fuel flow, cm³	Fuel economy, km/liter	Test distance, km
8/4/77	72	210	19	29	34	1418	8.33	12.0
	72	210	16	29	↓	1397	8.44	↓
	56	210	19	30	↓	1224	9.65	↓
	56	210	16	30	↓	1239	9.51	↓
7/27/77	48	90	10	23	29	1177	10.1	↓
7/28/77	48	110	6	20	24	1149	10.4	↓
7/27/77	40	90	11	23	29	1136	10.5	↓
7/28/77	40	140	8	22	25	1135	10.5	↓
7/27/77	D	70	11	23	28	1791	7.26	13.2
7/28/77	D	140	11	27	32	1776	7.36	13.3
7/27/77	C	40	8	23	29	1694	7.04	12 0
7/28/77	C	140	10	27	32	1746	6.87	12.2
7/27/77	B	30	6	23	30	1961	6 09	12.0
7/28/77	B	160	8	25	30	1923	6.05	11.7

(b) U.S. customary units

Test date	Test condition (constant speed, mph; or driving schedule)	Wind direction, deg	Wind velocity, mph	Air temperature, °F	Fuel flow temperature, °F	Total fuel flow, in³	Fuel economy, mpg	Test distance, miles
8/4/77	45	210	12	84	93	86.5	19.7	7.5
	45	210	10	85	↓	85 3	19 9	↓
	35	210	12	86	↓	74.7	22.8	↓
	35	210	10	85	↓	75 6	22.5	↓
7/27/77	30	90	6	73	84	71.8	24.0	↓
7/28/77	30	110	4	68	75	70.1	24.7	↓
7/27/77	25	90	7	73	84	69.3	24.9	↓
7/28/77	25	140	5	71	77	69.3	24.8	↓
7/27/77	D	70	7	74	82	109.3	17.2	8.2
7/28/77	D	140	7	80	88	108.4	17 4	8.3
7/27/77	C	40	5	74	84	103.4	16.7	7.5
7/28/77	C	140	6	81	90	106.5	16.3	7.6
7/27/77	B	30	4	74	86	119.7	14.4	7.5
7/28/77	B	160	5	76	86	117.3	14.3	7.3

[a]Curb weight of conventional vehicle plus electric vehicle payload

TABLE V. - RESULTS OF CONSTANT-SPEED AND DRIVING SCHEDULE TESTS ON VOLKSWAGEN TRANSPORTER AT TEST WEIGHT[a] OF 2300 KILOGRAMS (5090 lbm)

(a) SI units

Test date	Test condition (constant speed, km/h, or driving schedule)	Wind direction, deg	Wind velocity, km/h	Air temperature, °C	Fuel flow temperature, °C	Total fuel flow, cm^3	Fuel economy, km/liter	Test distance, km	Remarks
8/9/77	72	180	11	25	36	1157	10.4	12.0	--------------------
8/10/77	72	180	18	23	28	1171	10.2	↓	--------------------
8/9/77	69	180	11	25	35	1086	11.1	↓	--------------------
8/10/77	69	220	16	23	29	1138	10.5	↓	--------------------
	69	220	13	23	29	1108	10.8	↓	--------------------
8/9/77	56	180	11	26	35	1026	11.8	12.2	--------------------
8/10/77	56	240	19	23	29	1035	11.6	12.0	--------------------
8/9/77	40	170	8	25	33	982	12.2	↓	Fourth-gear operation
8/10/77	↓	290	16	23	29	1031	11.6	↓	Fourth-gear operation
8/11/77	↓	220	11	22	28	948	12.6	↓	Fourth-gear operation
8/9/77	↓	180	11	26	33	1094	10.9	↓	Third-gear operation
8/10/77	↓	270	24	23	30	1135	10.5	↓	Third-gear operation
8/9/77	D	140	11	24	32	1653	7.88	13.0	--------------------
8/10/77	D	220	14	25	33	1667	7.67	12.9	--------------------
8/9/77	C	170	13	24	33	1699	7.25	12.4	--------------------
8/10/77	C	220	16	26	34	1676	7.25	12.2	--------------------
8/9/77	B	160	11	24	35	1798	6.79	12.2	--------------------
8/10/77	B	220	16	27	34	1832	6.69	12.4	--------------------

(b) U.S. customary units

Test date	Test condition (constant speed, mph, or driving schedule)	Wind direction, deg	Wind velocity, mph	Air temperature, °F	Fuel flow temperature, °F	Total fuel flow, in^3	Fuel economy, mpg	Test distance, miles	Remarks
8/9/77	45	180	7	77	97	70.6	24.4	7.5	--------------------
8/10/77	45	220	10	73	82	71.5	24.0	↓	--------------------
8/9/77	43	180	7	77	95	66.3	26.0	↓	--------------------
8/10/77	43	220	10	73	84	69.4	24.8	↓	--------------------
	43	220	8	74	84	67.6	25.4	↓	--------------------
8/9/77	35	180	7	78	95	62.6	27.9	7.6	--------------------
8/10/77	35	240	12	74	84	63.2	27.2	7.5	--------------------
8/9/77	25	170	5	77	91	59.9	28.7	↓	Fourth-gear operation
8/10/77	↓	290	10	73	84	62.9	27.4	↓	Fourth-gear operation
8/11/77	↓	220	7	72	82	57.9	29.8	↓	Fourth-gear operation
8/9/77	↓	180	7	79	91	66.8	25.8	↓	Third-gear operation
8/10/77	↓	270	15	74	86	69.3	24.9	↓	Third-gear operation
8/9/77	D	140	7	75	90	100.9	18.5	8.1	--------------------
8/10/77	D	220	9	77	91	101.7	18.1	8.0	--------------------
8/9/77	C	170	8	76	91	103.7	17.1	7.7	--------------------
8/10/77	C	220	10	78	93	102.3	17.1	7.6	--------------------
8/9/77	B	160	7	76	95	109.7	16.0	7.6	--------------------
8/10/77	B	220	10	80	93	111.8	15.7	7.7	--------------------

[a]Placard-listed gross vehicle weight

TABLE VI. - RESULTS OF CONSTANT-SPEED AND DRIVING SCHEDULE TESTS ON RENAULT 5 AT TEST WEIGHT[a] OF 1130 KILOGRAMS (2490 lbm)

(a) SI units

Test date	Test condition (constant speed, km/h; or driving schedule)	Wind direction, deg	Wind velocity, km/h	Air temperature, °C	Fuel flow temperature, °C	Total fuel flow, cm^3	Fuel economy, km/liter	Test distance, km	Remarks
8/9/77	72	180	13	26	30	673 6	17 7	12 0	--------------------
8/11/77	72	220	11	22	26	662 0	18 1	↓	--------------------
8/9/77	56	200	13	26	30	600 1	19 9	↓	--------------------
8/11/77	56	220	7	23	25	568 0	21 0	↓	--------------------
8/12/77	56	40	6	18	21	619 2	19 5	↓	--------------------
8/9/77	40	140	14	27	33	746 9	15 9	↓	Third-gear operation
8/11/77	↓	220	7	23	26	753 6	15 9	↓	Third-gear operation
8/9/77	↓	150	13	27	30	536 0	22.2	↓	Fourth-gear operation
8/11/77	↓	180	13	26	30	512 6	23 2	↓	Fourth-gear operation
8/11/77	↓	220	24	23	25	507 8	23 5	↓	Fourth-gear operation
8/9/77	D	200	19	23	25	1084 7	13 4	14.6	--------------------
8/11/77	D	180	13	27	30	959 9	13 7	13.4	--------------------
8/10/77	C	210	14	24	26	920 4	13 5	12.6	--------------------
8/11/77	C	200	16	27	32	900 3	12 8	11.7	--------------------
8/12/77	C	70	6	19	22	943.0	13 1	12 4	--------------------
8/10/77	B	200	18	27	20	1216 9	9.77	12 0	--------------------
8/11/77	B	200	16	28	34	1240.3	9 59	12 0	--------------------

(b) U S customary units

Test date	Test condition (constant speed, mph, or driving schedule)	Wind direction, deg	Wind velocity, mph	Air temperature, °F	Fuel flow temperature, °F	Total fuel flow, in^3	Fuel economy, mpg	Test distance, miles	Remarks
8/9/77	45	180	8	79	86	41.1	41 7	7 5	--------------------
8/11/77	45	220	7	72	70	40.4	42.6	↓	--------------------
8/9/77	35	200	8	79	86	36 6	46.7	↓	--------------------
8/11/77	35	220	6	73	77	34.7	49 5	↓	--------------------
8/12/77	35	40	4	64	70	37 8	45 9	↓	--------------------
8/9/77	25	140	9	80	91	45 6	37.6	↓	Third-gear operation
8/11/77	↓	220	6	74	79	46 0	37.4	↓	Third-gear operation
8/9/77	↓	150	8	80	86	32 7	52 2	↓	Fourth-gear operation
8/11/77	↓	180	8	79	86	31 3	54.7	↓	Fourth-gear operation
8/11/77	↓	220	6	73	77	31 0	55.4	↓	Fourth-gear operation
8/9/77	D	200	12	73	77	66 2	31 5	9.1	--------------------
8/11/77	D	180	8	80	86	58 6	32 2	8 3	--------------------
8/10/77	C	210	9	75	70	56 2	31 8	7 8	--------------------
8/11/77	C	200	10	81	90	54 9	30 3	7 3	--------------------
8/12/77	C	70	4	66	72	57 5	30 9	7 7	--------------------
8/10/77	B	200	11	80	86	74 3	23 0	7 5	--------------------
8/11/77	B	200	10	82	93	75.7	22 6	7 5	--------------------

[a] Placard-listed gross vehicle weight

TABLE VII. - RESULTS OF CONSTANT-SPEED AND DRIVING SCHEDULE TESTS ON AMC PACER AT TEST WEIGHT[a] OF 1965 KILOGRAMS (4330 lbm)

(a) SI units

Test date	Test condition (constant speed, km/h; or driving schedule)	Wind direction, deg	Wind velocity, km/h	Air temperature, °C	Fuel flow temperature, °C	Total fuel flow, cm^3	Fuel economy, km/liter	Test distance, km
8/16/77	82	210	19	28	31	1269	9.38	12.0
	82	160	8	23	26	1248	9.59	↓
	82	160	8	23	27	1325	9.04	
8/12/77	72	20	8	17	21	1174	10.3	
8/15/77	72	20	3	23	28	1144	10.4	
8/12/77	56	20	8	17	21	1063	11.3	
8/15/77	56	160	5	24	28	1052	11.4	
8/12/77	40	30	6	17	21	1103	10.9	
8/16/77	40	200	10	23	28	1127	10.6	
	40	220	21	27	30	1113	10.6	
8/12/77	D	30	6	19	25	1667	7.74	12.9
8/15/77	D	160	5	25	30	1709	7.37	12.7
8/16/77	D	210	--	24	29	1721	7.36	12.7
8/12/77	C	45	5	19	26	1915	6.30	12.0
8/15/77	C	200	5	26	35	1983	6.08	12.0
8/12/77	B	130	8	21	27	2036	6.00	12.2
8/15/77	B	290	5	27	33	2116	5.69	12.4

(b) U.S. customary units

Test date	Test condition (constant speed, mph, or driving schedule)	Wind direction, deg	Wind velocity, mph	Air temperature, °F	Fuel flow temperature, °F	Total fuel flow, in^3	Fuel economy, mpg	Test distance, miles
8/16/77	51	210	12	80	88	77.4	22.1	7.5
8/16/77	51	160	5	73	79	76.2	22.5	↓
8/16/77	51	160	5	73	81	80.9	21.3	
8/12/77	45	20	5	63	70	71.6	24.2	
8/15/77	45	120	2	74	82	69.8	24.6	
8/12/77	35	20	5	63	70	64.9	26.8	
8/15/77	35	160	3	75	82	64.2	26.7	
8/12/77	25	30	4	63	70	67.3	25.8	
8/16/77	25	200	6	74	82	68.8	25.0	
	25	220	13	81	86	67.9	25.1	
8/12/77	D	30	4	66	77	101.7	18.2	8.0
8/15/77	D	160	3	77	86	104.3	17.3	7.9
8/16/77	D	210	7	76	84	105.0	17.3	7.9
8/12/77	C	45	3	67	79	116.9	14.8	7.5
8/15.77	C	200	3	79	95	121.0	14.4	7.5
8/12/77	B	130	5	70	80	124.2	14.1	7.6
8/15/77	B	290	3	80	91	129.1	13.6	7.7

[a]Placard-listed gross vehicle weight.

TABLE VIII. - ACCELERATION AND GRADEABILITY CHARACTERISTICS OF FOUR CONVENTIONAL VEHICLES

(a) Volkswagen Transporter

Vehicle speed		Time to reach designated vehicle speed, s	Acceleration		Gradeability, percent
km/h	mph		m/s^2	mph/s	
0	0	0	0	0	0
2.0	1.2	.4	2.03	4.09	19.1
4.0	2.5	.6	2 00	4.47	20.9
6.0	3.7	.9	2.06	4 61	21.6
8.0	5.0	1.2	2 18	4.88	23.0
10.0	6.2	1.4	2.20	4 91	23.1
12 0	7.5	1 7	2 29	5.12	24.1
14.0	8 7	1 9	2 15	4 81	22,6
16.0	9 9	2.2	2 04	4 57	21.4
18 0	11.2	2.5	1 93	4 31	20 1
20.0	12.4	2.8	2 01	4 49	21.0
22.0	13 7	3.0	2.09	4.68	21.0
24 0	14 9	3 3	1.89	4.22	19 7
26.0	16.2	3 6	1.15	2 58	11.9
28 0	17.4	4.7	.70	1.56	7.2
30 0	18 7	5 3	1.06	2.37	10.9
32.0	19.9	5.8	1 31	2 94	13.6
34.0	21.1	6 2	1 28	2 86	13.2
36.0	22.4	6.7	1 28	2.86	13.2
38.0	23.6	7 1	1 36	3.03	14 0
40.0	24.9	7.5	1 33	2.96	13.7
42.0	26.1	7.9	1.32	2.95	13 7
44.0	27.4	8.3	1 25	2 80	13 0
46.0	28.6	8 8	1 27	2 85	13.2
48.0	29.8	9.2	84	1.82	8.6
50.0	31 1	10 9	46	1 03	4 7
52.0	32.3	11 9	.69	1.53	7.0
54.0	33.6	12 6	74	1.65	7.6
56.0	34.8	13.4	.73	1.62	7.5
58 0	36.1	14.1	.74	1.65	7.6
60.0	37.3	14 9	.70	1.56	7.2
62.0	38.5	15.7	.71	1.60	7.3
64.0	39.8	16 4	.78	1.74	8.0
66.0	41.0	17.1	.76	1.60	7.8
68.0	42.3	17 9	.72	1.61	7.4
70.0	43.5	18 7	.69	1.55	7.1
72.0	44 8	19 5	.63	1.40	6.4
74.0	46.9	20.5	.61	1.35	6.2
76.0	47.2	21.4	48	1.08	4.9
78 0	48.5	23.0	30	67	3.1
80.0	49.7	25 2	.28	63	2.9
82.0	51.0	27.0	.34	77	3.5
84.0	52.2	28.5	.35	78	3.6
86.0	53.5	30.0	.32	.71	3.2
88.0	54.7	32 0	.32	.72	3.3
90.0	55.9	33.7	.33	.74	3.4
92.0	57 2	35.4	.31	70	3.2
94.0	58.4	37.3	32	.73	7.3

(b) Renault 5

Vehicle speed		Time to reach designated vehicle speed, s	Acceleration		Gradeability, percent
km/h	mph		m/s^2	mph/s	
0	0	0	0	0	0
2.0	1.2	.4	2.46	5.49	26.0
4.0	2.5	.5	3.46	7.74	37.9
6.0	3.7	.7	3 71	8.30	41.1
8.0	5.0	.8	3.89	8.69	43.4
10.0	6.2	1.0	3.34	7.47	36.5
12.0	7 5	1.2	2.79	6.23	29 8
14.0	8 7	1.4	2.89	6.46	31.0
16.0	9.9	1.5	2.90	6.48	31.1
18.0	11.2	1.7	2 67	5.97	28.5
20.0	12 4	2.0	2.57	5.75	27.3
22.0	13.7	2.2	2.77	6.20	29.6
24.0	14.9	2.4	2 89	6.47	31 0
26.0	16.2	2.6	2.86	6.40	30 7
28 0	17.4	2.8	2.89	6.47	31.1
30.0	18.7	2.9	2 74	6.13	29 3
32.0	19.9	3.2	2.51	5.62	26 6
34.0	21.1	3.4	2.49	5.58	26 4
36 0	22.4	3.6	2.41	5.38	25.4
38.0	23.6	3.9	2.26	5.04	28 8
40.0	24.9	4.1	2.27	5.09	24.0
42.0	26.1	4.3	2.09	4.68	21.9
44 0	27.4	4.6	1.60	3.57	16.6
46.0	28.6	5 1	1.55	3.47	16 1
48.0	29 8	5.4	1.86	4.15	19.4
50.0	31.1	5.7	1.78	3.99	18.6
52.0	32 3	6 0	1.64	3.67	17 1
54.0	33 6	6 3	1.80	4 02	18 7
56.0	34.8	6.6	1 67	3.73	17 4
58.0	36.1	7.0	1.46	3.26	15.1
60.0	37.3	7 4	1.49	3.34	15.5
62.0	38.5	7 8	1.42	3.17	14.7
64.0	39.8	8.2	1.33	2.97	13.7
66.0	41 0	8 6	1.34	2.99	13.9
68.0	42 3	9.0	1.34	3.00	13.9
70.0	43 5	9 4	1.29	2.89	13.4
72.0	44.8	9.9	1.20	2.69	12.4
74.0	46.0	10 4	.94	2.09	9.7
76.0	47.2	11 1	.84	1.87	8.6
78 0	48.5	11 7	.92	2 07	9.5
80 0	49.7	12.3	.94	2.10	9.7
82 0	51.0	12 9	.90	2 01	9 3
84.0	52.2	13 6	.92	2.05	9.4
86 0	53.5	14 1	.95	2 12	9.8
88 0	54 7	14.8	.86	1.92	8.8
90 0	55.9	15.4	.82	1 83	8.4
92.0	57.2	16.1	.80	1.78	8.2
94 0	58.4	16.8	.73	1 63	7.5

TABLE VIII - Concluded.

(c) AMC Pacer

Vehicle speed, km/h	Vehicle speed, mph	Time to reach designated vehicle speed, s	Acceleration, m/s^2	Acceleration, mph/s	Gradeability, percent
0	0	0	0	0	0
2.0	1.2	.4	1.68	3.76	17.5
4.0	2.5	.7	2.07	4.63	21.7
6.0	3.7	.9	2.20	4.91	23.1
8.0	5.0	1.2	2.19	4.90	23.1
10.0	6.2	1.4	2.36	5.28	24.9
12.0	7.5	1.7	2.79	6.24	29.8
14.0	8.7	1.8	2.52	5.64	26.8
16.0	9.9	2.1	2.02	4.53	21.2
18.0	11.2	2.4	2.36	5.28	24.9
20.0	12.4	2.6	2.39	5.34	25.2
22.0	13.7	2.9	2.25	5.04	23.7
24.0	14.9	3.1	2.42	5.41	25.6
26.0	16.2	3.3	2.32	5.20	24.5
28.0	17.4	3.6	2.20	4.92	23.1
30.0	18.7	3.8	2.15	4.80	22.5
32.0	19.9	4.1	2.19	4.91	23.1
34.0	21.2	4.3	2.49	5.56	26.4
36.0	22.4	4.5	2.44	5.45	25.8
38.0	23.6	4.8	2.26	5.05	23.8
40.0	24.9	5.0	2.25	5.03	23.7
42.0	26.1	5.3	2.42	5.42	25.7
44.0	27.4	5.6	2.30	5.14	24.2
46.0	28.6	5.8	2.03	4.54	21.3
48.0	29.8	6.0	2.04	4.56	21.4
50.0	31.1	6.3	1.97	4.41	20.6
52.0	32.3	6.6	1.65	3.69	17.2
54.0	33.6	7.0	1.19	2.66	12.3
56.0	34.8	7.6	1.13	2.54	11.7
58.0	36.1	8.0	1.43	3.20	14.8
60.0	37.3	8.4	1.52	3.40	15.8
62.0	38.5	8.7	1.43	3.20	14.8
64.0	39.8	9.1	1.36	3.04	14.1
66.0	41.0	9.6	1.34	3.00	13.9
68.0	42.3	10.0	1.40	3.13	14.5
70.0	43.5	10.4	1.46	3.28	15.2
72.0	44.8	10.7	1.38	3.09	14.3
74.0	46.0	11.2	1.28	2.87	13.3
76.0	47.2	11.6	1.28	2.87	13.3
78.0	48.5	12.0	1.23	2.76	12.7
80.0	49.7	12.5	1.33	2.98	13.8
82.0	51.0	12.9	1.33	2.98	13.8
84.0	52.2	13.3	1.33	2.98	13.8
86.0	53.5	13.7	1.26	2.83	13.1
88.0	54.7	14.2	1.01	2.26	10.4
90.0	55.9	14.8	.83	1.86	8.5
92.0	57.2	15.6	.63	1.42	6.5
94.0	58.4	16.6	.60	1.33	6.1
96.0	59.7	17.5	.65	1.45	6.6

(d) AM General DJ-5

Vehicle speed, km/h	Vehicle speed, mph	Time to reach designated vehicle speed, s	Acceleration, m/s^2	Acceleration, mph/s	Gradeability, percent
0	0	0	0	0	0
2.0	1.2	.5	1.95	4.35	20.3
4.0	2.5	.7	3.27	7.32	35.6
6.0	3.7	.9	4.17	9.32	47.2
8.0	5.0	1.0	4.29	9.61	49.0
10.0	6.2	1.1	3.77	8.44	41.9
12.0	7.5	1.3	3.28	7.34	35.7
14.0	8.7	1.5	3.36	7.52	36.7
16.0	9.9	1.6	3.23	7.22	35.1
18.0	11.2	1.8	3.30	7.38	35.9
20.0	12.4	2.0	3.49	7.81	38.3
22.0	13.7	2.2	3.24	7.25	35.2
24.0	14.9	2.3	2.90	6.50	31.2
26.0	16.2	2.5	2.28	5.11	24.1
28.0	17.4	2.8	2.31	5.17	24.4
30.0	18.7	3.0	2.56	5.73	27.2
32.0	19.9	3.2	2.51	5.61	26.6
34.0	21.1	3.5	2.43	5.44	25.7
36.0	22.4	3.7	2.19	4.90	23.0
38.0	23.6	4.0	1.89	4.22	19.7
40.0	24.9	4.3	1.79	4.01	18.7
42.0	26.1	4.6	1.84	4.11	19.2
44.0	27.4	4.9	1.67	3.73	17.3
46.0	28.6	5.3	1.47	3.29	15.3
48.0	29.8	5.7	1.59	3.57	16.6
50.0	31.1	6.0	1.48	3.32	15.4
52.0	32.3	6.4	1.46	3.26	15.1
54.0	33.6	6.8	1.46	3.26	15.1
56.0	34.8	7.2	1.37	3.07	14.2
58.0	36.1	7.6	1.40	3.13	14.5
60.0	37.3	8.0	1.37	3.06	14.2
62.0	38.5	8.4	1.32	2.96	13.7
64.0	39.8	8.8	1.16	2.60	12.0
66.0	41.0	9.4	.94	2.11	9.7
68.0	42.3	10.0	.97	2.17	10.0
70.0	43.5	10.5	1.02	2.29	10.5
72.0	44.8	11.1	.89	1.99	9.2
74.0	46.0	11.8	.86	1.92	8.8
76.0	47.2	12.4	.82	1.83	8.4
78.0	48.5	13.2	.82	1.88	8.4
80.0	49.7	13.8	.86	1.92	8.8
32.0	51.0	14.5	.71	1.59	7.3
34.0	52.2	15.4	.69	1.53	7.0
86.0	53.5	16.1	.74	1.66	7.6
88.0	54.7	16.8	.68	1.52	7.0
90.0	55.9	17.8	.66	1.47	6.7
92.0	57.2	18.6	.62	1.39	6.4
94.0	58.4	19.6	.55	1.23	5.6
96.0	59.7	20.6	.58	1.30	6.0

TABLE IX - ROAD ENERGY CONSUMPTION AND ROAD POWER REQUIREMENTS OF FOUR CONVENTIONAL VEHICLES

(a) Volkswagen Transporter

Vehicle speed		Time, s	Road energy consumed		Road power required	
km/h	mph		MJ/km	kWh/mile	kW	hp
96.0	59.7	0	0	0	0	0
94.0	58.4	1.4	.905	.405	23.64	31.70
92.0	57 2	2.6	.906	405	23.14	31 03
90.0	55.9	4.0	.834	373	20.84	27 95
88.0	54.7	5.4	.803	359	19.62	26.31
86.0	53 5	6.9	.767	343	18 32	24.57
84.0	52.2	8.4	.733	.328	17.10	22.93
82.0	51.0	10.1	.761	.340	17.32	23.22
80.0	49.8	11.5	.786	.351	17.46	23.42
78.0	48.5	13.1	.680	304	14.73	19.75
76.0	47.2	15.0	661	.295	13.95	18 70
74.0	46.0	16.7	.621	278	12 76	17 11
72.0	44.7	18 8	.662	296	13.23	17.74
70.0	43.5	20.3	668	299	12.98	17.41
68.0	42.3	22.5	.584	.261	11 03	14.79
66.0	41.0	24.3	.607	.271	11.12	14 91
64 0	39.8	26 3	.573	256	10 18	13.65
62.0	38.5	28.4	.529	237	9 11	12 22
60.0	37.3	30.7	.555	248	9 25	12.40
58 0	36.0	32.7	.542	242	8.73	11.70
56.0	34.8	35.1	.503	.225	7.82	10.48
54.0	33.6	37 3	.523	.234	7.85	10.52
52.0	32.3	39 6	.497	.222	7.18	9.63
50.0	31.1	42.0	.473	.212	6 57	8.81
48.0	29.8	44.5	.448	200	5.97	8.01
46.0	28.6	47.3	.420	188	5 36	7.19
44.0	27.3	50.1	.445	.199	5 44	7.29
42.0	26.1	52.5	.430	.192	5.02	6.73
40.0	24.9	55.6	.413	.184	4.58	6.14
38.0	23.6	58.2	407	.182	4 30	5.76
36.0	22.4	51 3	.371	166	3 71	4.98
34.0	21.1	64.5	.339	.152	3.20	4.30
32 0	19.9	58.3	.338	.151	3.01	4.03
30.0	18 6	71.5	.347	.155	2.89	3.88
28.0	17.4	75.0	329	147	2.56	3 43
26.0	16 2	78.6	331	.148	2.39	3.20
24.0	14 9	82.1	.311	.139	2 07	2.78
22.0	13.7	86.1	277	.124	1.69	2.27
20.0	12.4	90.5	.288	.129	1 60	2 14
18.0	11.2	94.3	287	.128	1.44	1.92
16.0	9.9	98.7	.248	.111	1.10	1.48
14.0	8.7	103.7	.246	.110	.96	1.28
12.0	7.5	108.2	.267	.119	.89	1.19
10.0	6.2	112 5	.253	.113	.70	94
8 0	5.0	117.5	.234	.105	52	70
6.0	3.7	122.5	.236	.106	.39	.53
4.0	2 5	127 4	.243	109	.27	.36
2.0	1.2	132.1	.210	094	.12	.16

(b) Renault 5

Vehicle speed		Time, s	Road energy consumed		Road power required	
km/h	mph		MJ/km	kWh/mile	kW	hp
96.0	59 7	0	0	0	0	0
94.0	58.4	1.1	512	229	13.37	17 92
92.0	57.2	2.2	.505	.226	12.91	17.31
90.0	55.9	3.3	.449	.201	11.22	15.04
88.0	54.7	4 7	397	.178	9.71	13.02
86.0	53.4	6.1	.391	.175	9.33	12 51
84.0	52 2	7.6	399	.178	9.30	12.47
82.0	51.0	8.0	.385	.172	8.76	11 75
80.0	49 7	10.5	.354	.158	7.86	10.54
78.0	48.5	12.1	.353	.158	7.65	10.26
76.0	47.2	13.7	343	.153	7 24	9.71
74.0	46.0	15.4	.367	164	7 55	10.12
72.0	44.7	16.8	354	158	7.07	9.48
70.0	43.5	18.6	316	141	6 14	8.23
68 0	42.3	20.3	.324	.145	6.11	8.19
66 0	41.0	22.0	.310	.139	5 68	7.62
64.0	39.8	23.9	.314	148	5.58	7.48
62.0	38.5	25.6	.313	.140	5.38	7.22
60.0	37.3	27.5	.274	.122	4.56	6.12
58 0	36.0	29.7	.252	.112	4.05	5.43
56.0	34.8	32.0	.250	112	3.88	5.21
54.0	33 6	34.2	.247	.110	3.70	4.96
52.0	32.3	36.5	.240	108	3 47	4.66
50.0	31.1	38.9	.242	.108	3.36	4.50
48.0	29.8	41 2	.230	.103	3.06	4.10
46.0	28.6	43.8	.227	.102	2.90	3 89
44 0	27.3	46.1	.223	100	2.73	3.66
42.0	26.1	48.8	.205	.091	2.39	3.20
40 0	24.9	51.6	.211	.095	2.35	3.15
38.0	23.6	54.1	.202	.090	2 13	2.85
36.0	22.4	57.2	175	.078	1.75	2.35
34.0	21 1	60.5	.183	.082	1.72	2.31
32.0	19 9	63 4	185	.083	1.65	2.21
30 0	18 6	66 6	.173	.078	1.44	1.94
28.0	17.4	69 8	167	.075	1.30	1.74
26.0	16.2	73.3	165	.074	1 19	1.60
24.0	14.9	76.6	.161	.072	1.07	1.44
22.0	13.7	80.2	155	.070	.95	1.27
20.0	12.4	83.8	151	.067	.84	1.12
18.0	11.2	87.7	.144	.064	.72	97
16 0	9.9	91.6	.136	.061	.61	.81
14.0	8.7	95.9	.128	.057	.50	.67
12 0	7.5	100.4	.126	.056	.42	.56
10.0	6 2	104.8	.134	.060	.37	.50
8.0	5.0	108 7	.125	.056	28	.37
6.0	3.7	113.9	114	.051	.19	.25
4.0	2 5	118.6	110	.049	.12	.16
2.0	1 2	124.1	.118	.053	.07	.09

TABLE IX. - Concluded.

(c) AMC Pacer

Vehicle speed		Time, s	Road energy consumed		Road power required	
km/h	mph		MJ/km	kWh/mile	kW	hp
96.0	59.7	0	0	0	0	0
94.0	58.4	1.6	.697	.311	18.19	24.39
92.0	57.2	2.9	.675	.302	17.23	23.11
90.0	55.9	4.6	.635	.284	15.87	21.29
88.0	54.7	6.1	.650	.291	15.89	21.31
86.0	53.4	7.7	.589	.264	14.08	18.88
84.0	52.2	9.4	.578	.258	13.47	18.07
82.0	51.0	11.1	.587	.262	13.36	17.92
80.0	49.7	12.8	.578	.258	12.84	17.22
78.0	48.5	14.5	.553	.247	11.98	16.06
76.0	47.2	16 4	.526	.235	11.11	14 90
74.0	46.0	18 4	.512	.229	10.52	14.11
72.0	44.7	20.3	.505	226	10.09	13.53
70.0	43.5	22.3	.496	222	9.64	12.93
68.0	42.3	24.4	.479	214	9.04	12.12
66.0	41.0	26.5	.454	.203	8.31	11.15
64.0	39.8	28.8	.432	.193	7.37	10.29
62.0	38.5	31.1	444	.198	7.64	10.24
60.0	37.3	33.3	.439	.196	7.32	9.81
58.0	36.0	35.7	.416	186	6.69	8.98
56.0	34.8	38.0	.416	.186	6.47	8.67
54.0	33.6	40.4	397	.177	5 95	7.98
52.0	32.3	43.1	.370	.165	5.34	7.16
50.0	31.1	45.8	.377	.169	5.24	7.03
48.0	29.8	48.4	.386	.172	5.14	6.89
46.0	28.6	51.0	.358	.160	4.58	6.14
44.0	27.3	54.0	.344	.154	4.20	5.63
42.0	26.1	56.8	.335	.150	3.91	5.25
40.0	24.9	59.9	.341	.152	3.78	5.08
38.0	23.6	62.7	.327	146	3.45	4.62
36.0	22.4	66.1	.292	131	2.92	3.91
34.0	21.1	69.5	.296	132	2.79	3.74
32.0	19.9	72.8	.289	.129	2 57	3.44
30.0	18.6	76.5	.272	.121	2.26	3.03
28.0	17.4	80.2	.265	.118	2.06	2.76
26.0	16.2	83 9	.259	.116	1.87	2.50
24.0	14.9	87.9	.251	.112	1.67	2.24
22.0	13.7	91.9	.251	.112	1.53	2.06
20.0	12.4	95.8	.255	.114	1.42	1 90
18.0	11.2	99.7	.241	.108	1.21	1.62
16.0	9.9	104.1	.226	.101	1.00	1.35
14.0	8.7	108.5	.215	.096	.83	1.12
12.0	7.5	113.4	.214	.096	.71	.96
10.0	6.2	117.9	.211	.094	.59	.78
8.0	5.0	122.9	.206	.092	.46	.62
6.0	3.7	127.6	.201	.090	.33	45
4.0	2.5	132.9	.181	.081	.20	.27
2.0	1.2	138.6	.179	.080	10	.13

(d) AM General DJ-5

Vehicle speed		Time, s	Road energy consumed		Road power required	
km/h	mph		MJ/km	kWh/mile	kW	hp
98.0	60.9	0	0	0	0	0
96.0	59.7	.7	1 075	.480	28.65	38.42
94.0	58.4	1.6	.985	.440	25.71	34.47
92 0	57.2	2.4	.915	.409	23.37	31.33
90.0	55.9	3.5	.827	.370	20.66	27.71
88.0	54.7	4.4	.871	.389	21.28	28.54
86.0	53.4	5.4	.803	.359	19.18	25.72
84.0	52.2	6.5	.770	.344	17.97	24.10
82.0	51.0	7.6	.745	.333	16.96	22 74
80.0	49.7	8.7	.718	.321	15.98	21.39
78.0	48.5	9 9	.722	.323	15.64	20.98
76.0	47.2	11 0	705	.315	14.88	19.95
74.0	46.0	12.2	634	.283	13.03	17.47
72.0	44.7	13.7	.530	.282	12.60	16.90
70.0	43.5	14.9	.711	.318	13.82	18.54
68.0	42.3	16.0	.679	.303	12.82	17.19
66.0	41.0	17.4	.585	.262	10.72	14.38
64 0	39.8	18.9	.570	255	10.14	13.59
62.0	38.5	20.3	568	.254	9.77	13.10
60.0	37 3	21.8	525	.235	8.74	11.72
58.0	36.0	23.5	.472	.211	7.60	10.19
56.0	34.8	25.3	.436	.195	6.78	9 10
54.0	33.6	27.3	.444	.198	6.65	8.92
52.0	32.3	29.1	.460	.206	6.65	8.91
50.0	31.1	30 9	.425	.190	5.90	7.92
48.0	29.8	33.0	.400	.179	5.33	7.14
46.0	28.6	35.1	.390	.174	4.98	6.68
44.0	27.3	37.3	.375	.168	4 58	6.15
42.0	26.1	39.5	.362	.162	4.22	5.66
40.0	24.9	41.9	.335	.150	3.72	4.99
38.0	23.6	44.5	.323	.145	3.41	4.58
36.0	22 4	47.0	.321	.144	3.21	4.30
34.0	21.1	49.7	.312	.140	2.95	3.96
32.0	19.9	52.4	.304	.136	2.70	3.62
30.0	18.6	55.2	.290	.130	2.41	3.24
28.0	17.4	58.1	.262	.117	2.04	2.74
26.0	16.2	61.5	244	.109	1.76	2.36
24.0	14.9	65.0	.241	.108	1.60	2.15
22.0	13.7	68.5	232	.104	1.42	1.90
20.0	12.4	72.1	.226	.101	1.26	1.69
18.0	11.2	75.8	.216	.097	1.08	1.45
16.0	9.9	79.8	.204	.091	.91	1.22
14.0	8.7	84.0	.205	.091	.80	1.07
12.0	7.5	88.0	.195	.087	.65	.87
10.0	6.2	92.5	.187	.094	.52	.70
8.0	5.0	96.9	.191	.086	.43	.57
6.0	3.7	101.2	.182	.081	.30	.41
4.0	2.5	106.0	.167	.075	.19	.25
2.0	1.2	111.2	.175	.078	.10	.13

TABLE X. - ENERGY USAGE OF CONVENTIONAL AND ELECTRIC VEHICLES

(a) SI units

Vehicle	Test condition[a]	Conventional vehicle[b]		Electric vehicle	
		Average energy consumption			
		Energy economy, km/liter	Equivalent heat input, MJ/km	Energy consumption (100 percent efficiency), MJ/km	Equivalent heat input (33 percent efficiency), MJ/km
Volkswagen Transporter	Constant speed	14.3	2.26	1.07	3.18
	Driving schedule	6.80	4.71	1.83	5.56
Renault 5	Constant speed	22.8	1.40	.51	1.55
	Driving schedule	10.0	3.21	.74	2.19
AMC Pacer	Constant speed	11.9	2.67	1.12	3.38
	Driving schedule	6.17	5.15	1.59	4.77
AM General DJ-5	Constant speed	10.5	3.04	1.16	3.57
	Driving schedule	6.07	5.27	1.72	5.17

(b) U.S. customary units

Vehicle	Test condition[a]	Conventional vehicle[b]			Electric vehicle		
		Average energy consumption					
		Energy economy, mpg	Equivalent heat input		Energy consumption (100 percent efficiency), kWh/mile	Equivalent heat input (33 percent efficiency)	
			kWh/mile	Btu/mile		kWh/mile	Btu/mile
Volkswagen Transporter	Constant speed	33.3	1.01	3450	0.48	1.42	4850
	Driving schedule	16.0	2.10	7180	.82	2.49	8480
Renault 5	Constant speed	54.0	.62	2130	.23	.69	2360
	Driving schedule	23.5	1.43	4890	.33	.98	3330
AMC Pacer	Constant speed	28.2	1.19	4070	.50	1.51	5150
	Driving schedule	14.6	2.30	7860	.71	2.13	7270
AM General DJ-5	Constant speed	24.8	1.36	4630	.52	1.60	5450
	Driving schedule	14.3	2.35	8030	.77	2.31	7880

[a]Constant speed = 40 km/h (25 mph), driving schedule B.

[b]Energy consumption for conventional vehicles based on lower heating value of gasoline, 32 MJ/liter (114 800 Btu/gal).

TABLE XI. - AVERAGE ENERGY COST FOR CONVENTIONAL AND ELECTRIC VEHICLES

Vehicle	Test condition[a]	Conventional vehicle		Electric vehicle	
		Average energy cost[b]			
		¢/km	¢/mile	¢/km	¢/mile
Volkswagen Transporter	Constant speed	1.1	1.8	1.5	2.4
	Driving schedule	2.4	3.7	2.6	4.1
Renault 5	Constant speed	.7	1.1	.7	1.2
	Driving schedule	1.6	2.6	1.1	1.7
AMC Pacer	Constant speed	1.3	2.1	1.6	2.5
	Driving schedule	2.6	4.1	2.2	3.6
AM General DJ-5	Constant speed	1.5	2.4	1.6	2.6
	Driving schedule	2.6	4.2	2.4	3.9

[a]Constant speed = 40 km/h (25 mph); driving schedule B.

[b]Energy cost based on 5¢/kWh for electricity and 16¢/liter (60¢/gal) for gasoline.

TABLE XII. - TRACK PERFORMANCE DATA FOR CONVENTIONAL AND ELECTRIC VEHICLES

Vehicle	Conventional vehicle	Electric vehicle	Conventional vehicle		Electric vehicle		Conventional vehicle	Electric vehicle
	Time to accelerate from 0 to 48 km/h (0 to 30 mph), s		Maximum speed				Gradeability (maximum grade at 40 km/h (25 mph)), percent	
			km/h	mph	km/h	mph		
Volkswagen Transporter	9	14	>100	>60	70	43	13	7
Renault 5	6	20	>125	>80	56	35	23	3
AMC Pacer	6	17	>125	>80	82	51	23	6
AM General DJ-5	6	23	>100	>60	48	30	18	4

Figure 1. - Volkswagen Transporter.

Figure 2. - Renault 5.

Figure 3. - AMC Pacer.

Figure 4. - AM General DJ-5.

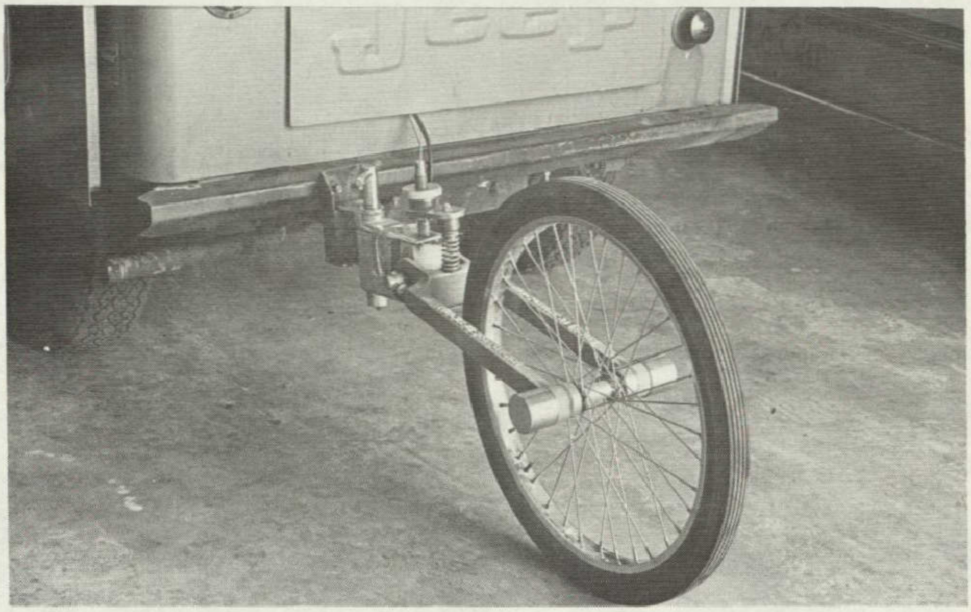


Figure 5. - Typical installation of fifth-wheel on test vehicle.

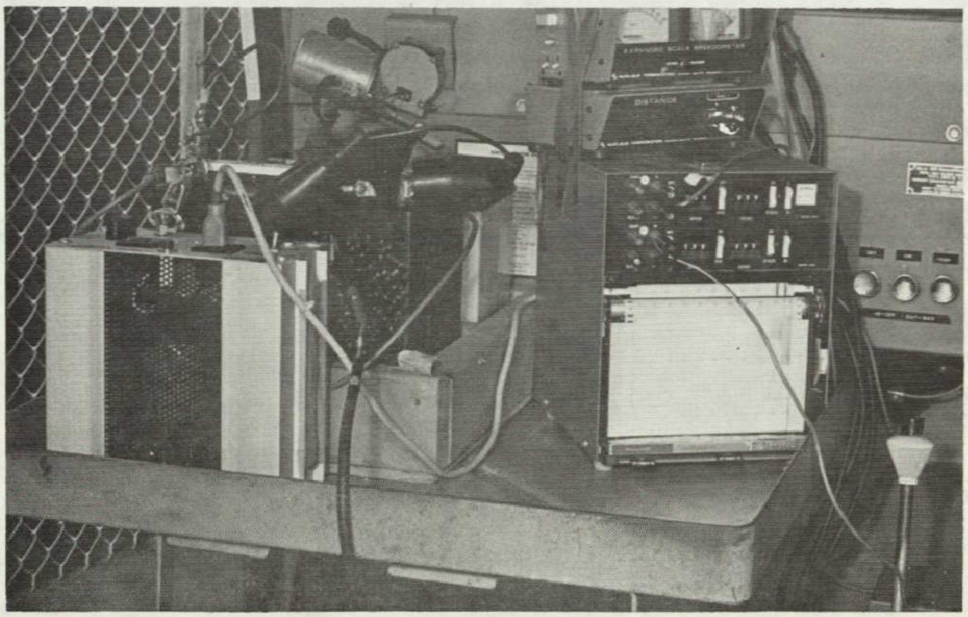
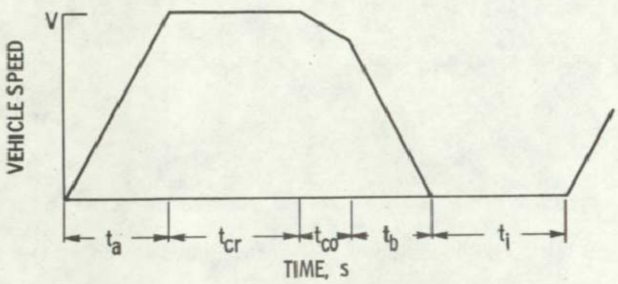
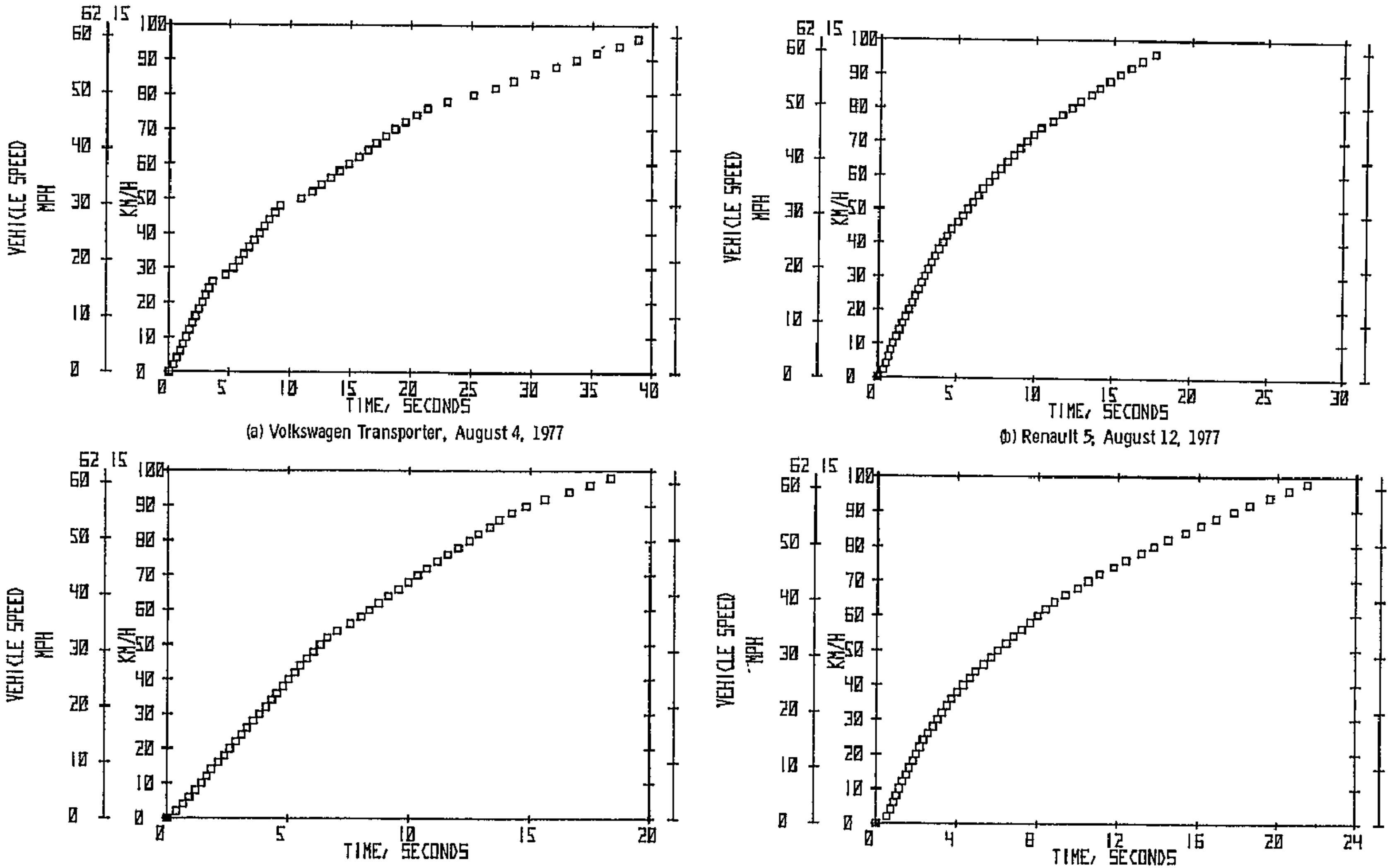


Figure 6. - Instrumentation installed in test vehicle.



TEST PARAMETER	SAE SCHEDULES		
	B	C	D
MAX. SPEED, V, mph	20	30	45
ACCEL. TIME, t_a, s	19	18	28
CRUISE TIME, t_{cr}	19	20	50
COAST TIME, t_{co}	4	8	10
BRAKE TIME, t_b	5	9	9
IDLE TIME, t_i	25	25	25

Figure 7. - SAE J227a driving cycle schedules.



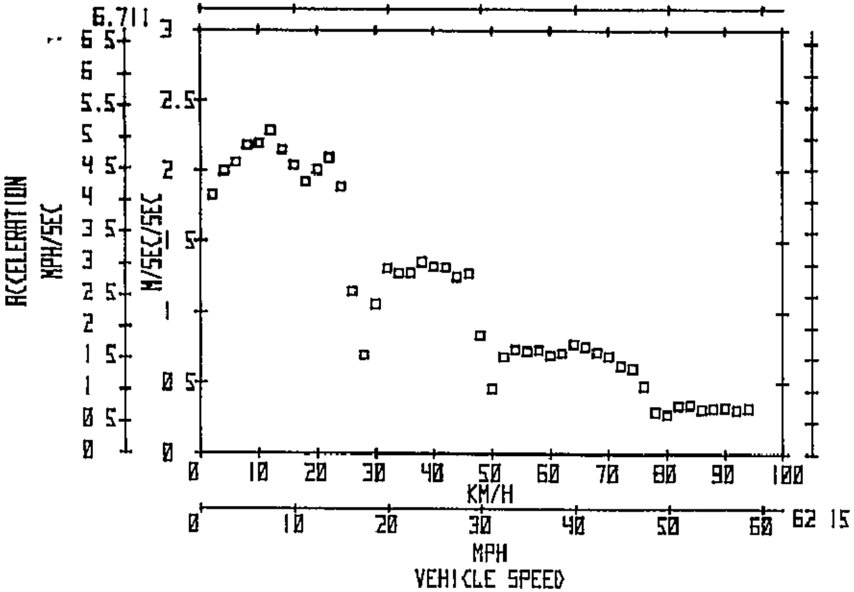
(a) Volkswagen Transporter, August 4, 1977

(b) Renault 5, August 12, 1977

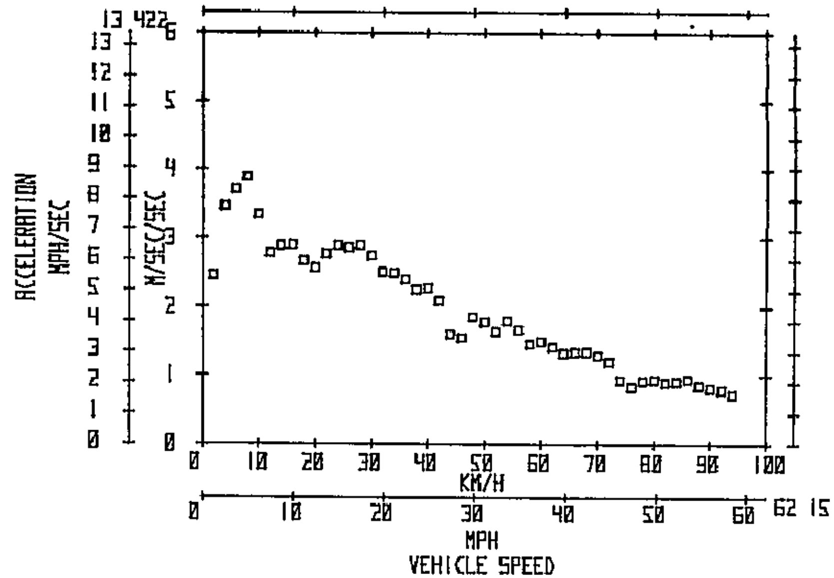
(c) AMC Pacer, July 29, 1977

(d) AM General DJ-5, July 28, 1977

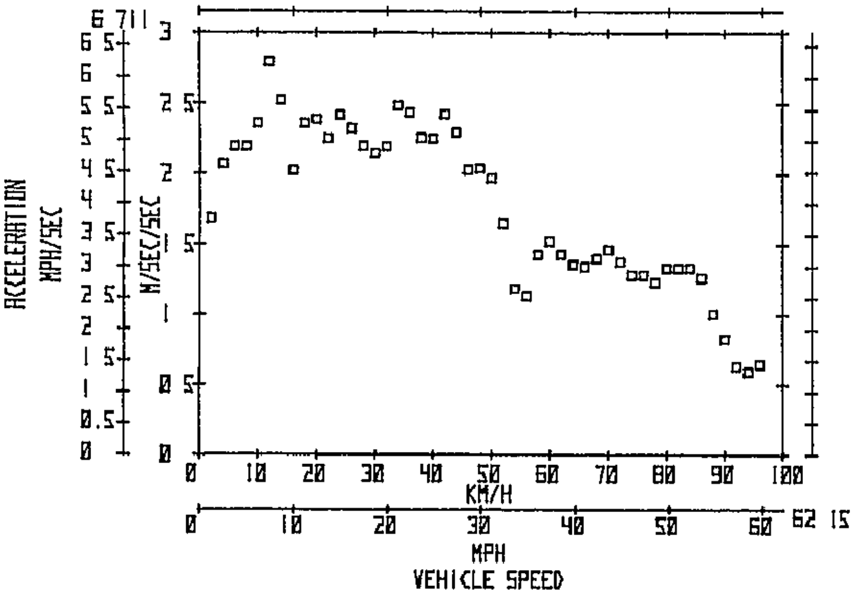
Figure 8 - Vehicle acceleration for four conventional vehicles



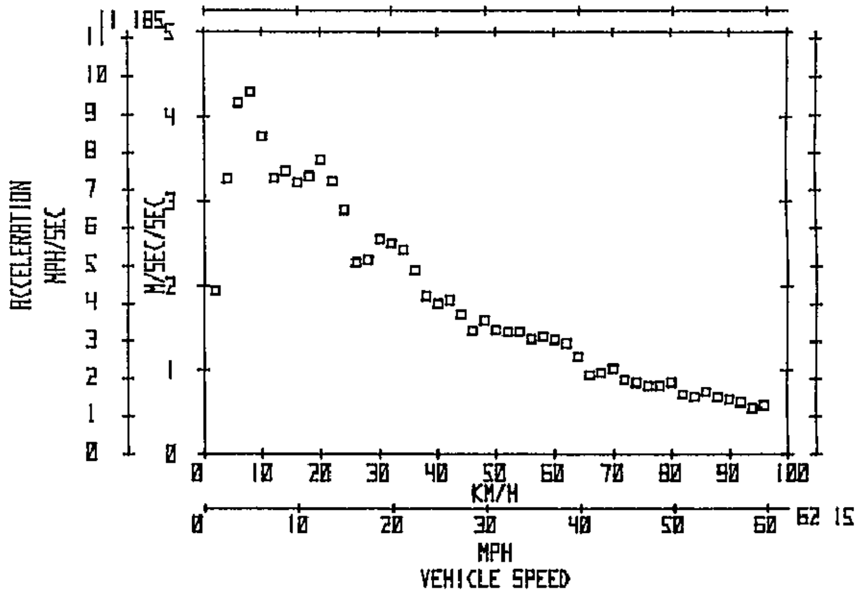
(a) Volkswagen Transporter; August 4, 1977



(b) Renault 5; August 12, 1977.

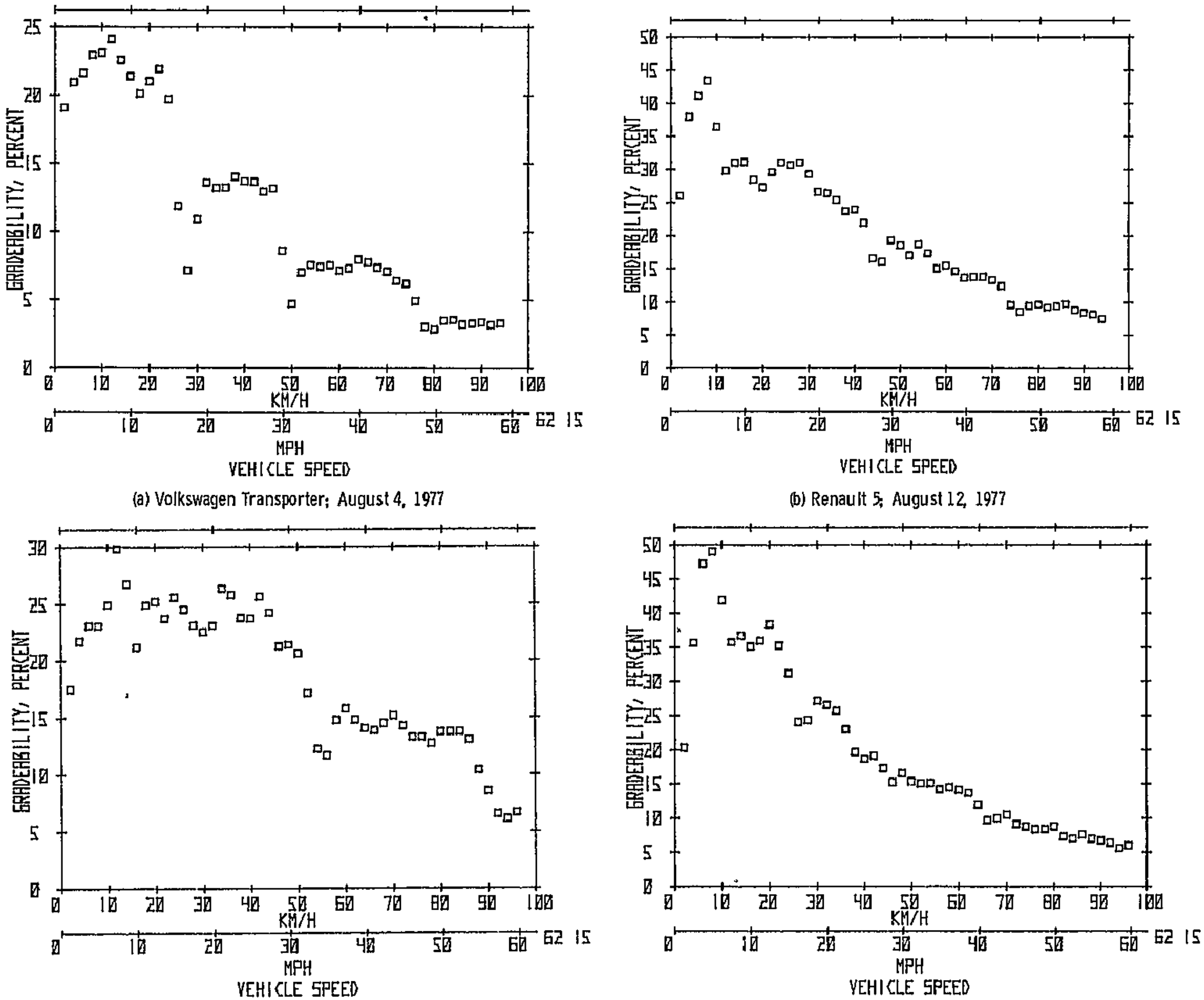


(c) AMC Pacer, July 29, 1977.



(d) AM General DJ-5.

Figure 9. - Acceleration as a function of speed for four conventional vehicles.



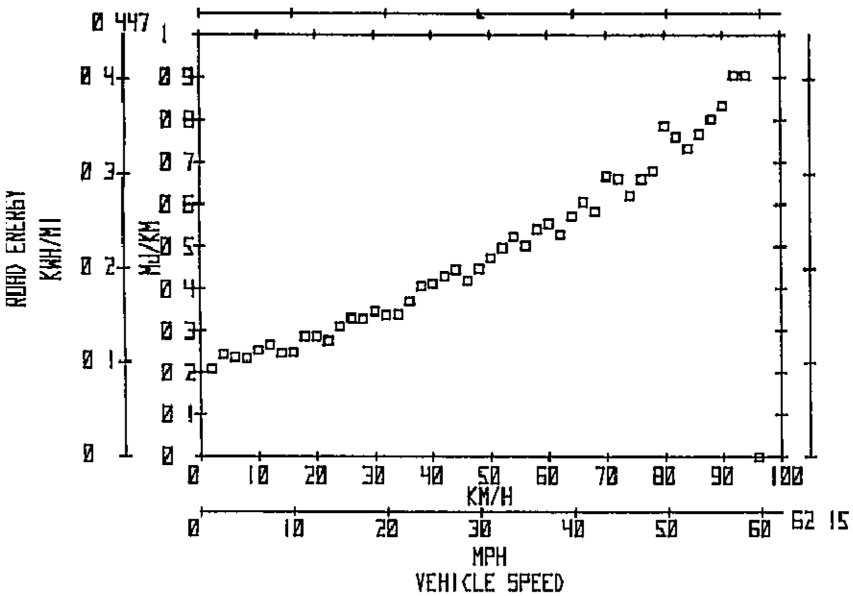
(a) Volkswagen Transporter; August 4, 1977

(b) Renault 5; August 12, 1977

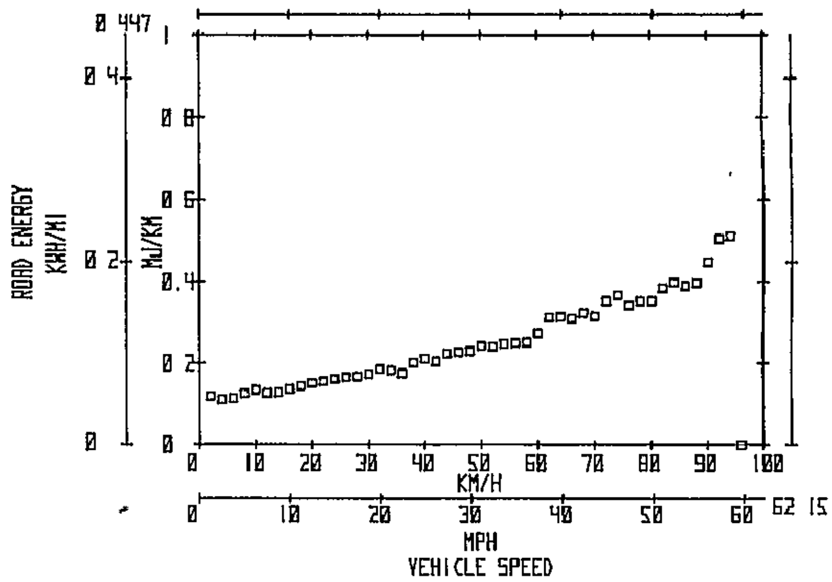
(c) AMC Pacer, July 29, 1977.

(d) AM General DJ-5; July 28, 1977

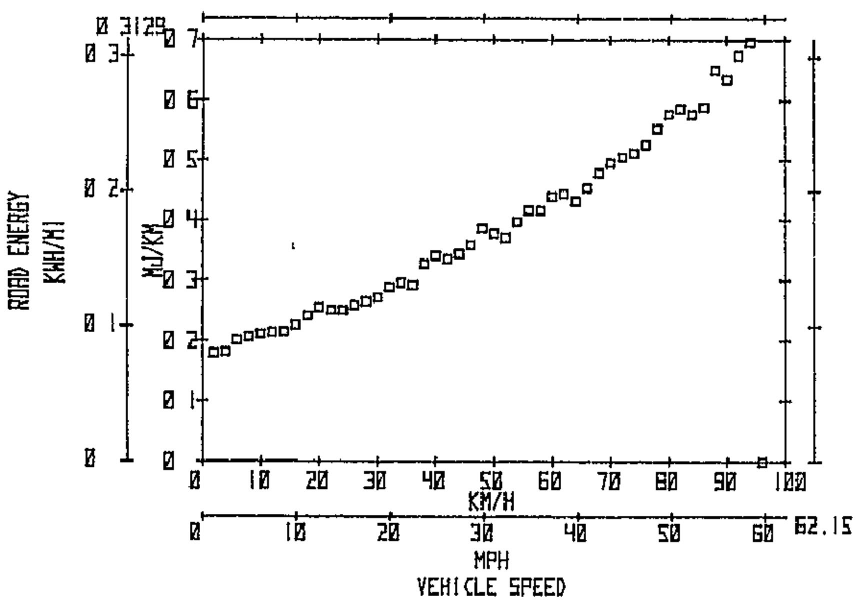
Figure 10. - Gradeability as a function of speed for four conventional vehicles



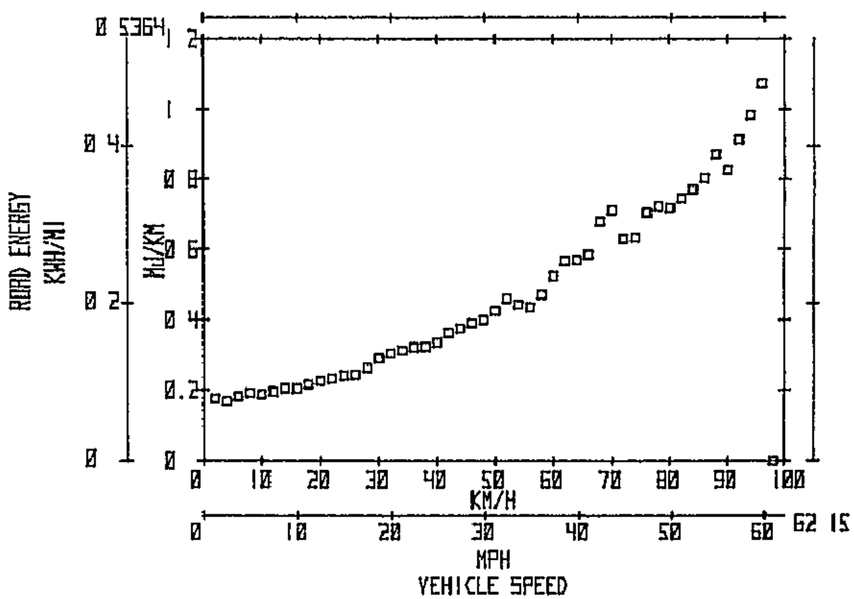
(a) Volkswagen Transporter; August 4, 1977.



(b) Renault 5; August 12, 1977



(c) AMC Pacer, July 29, 1977.



(d) AM General DJ-5; July 28, 1977.

Figure 11. - Road energy as a function of speed for four conventional vehicles.

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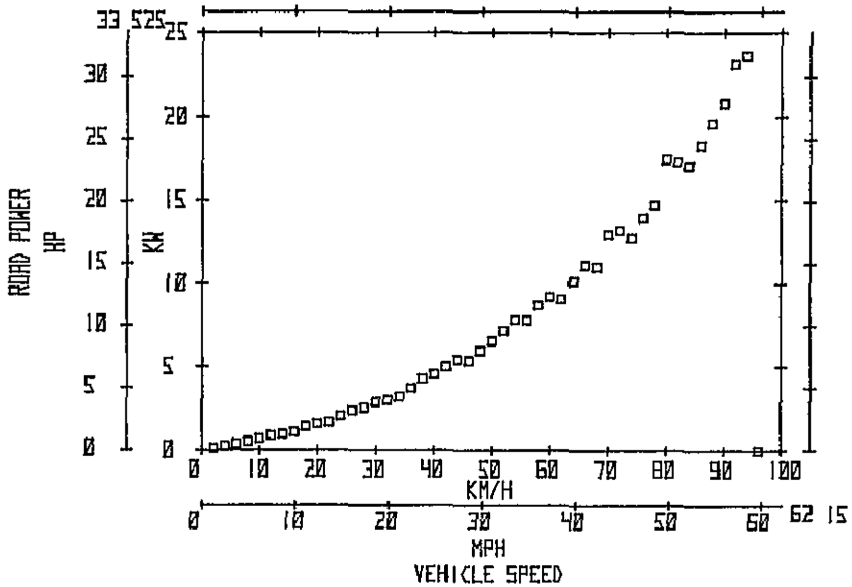
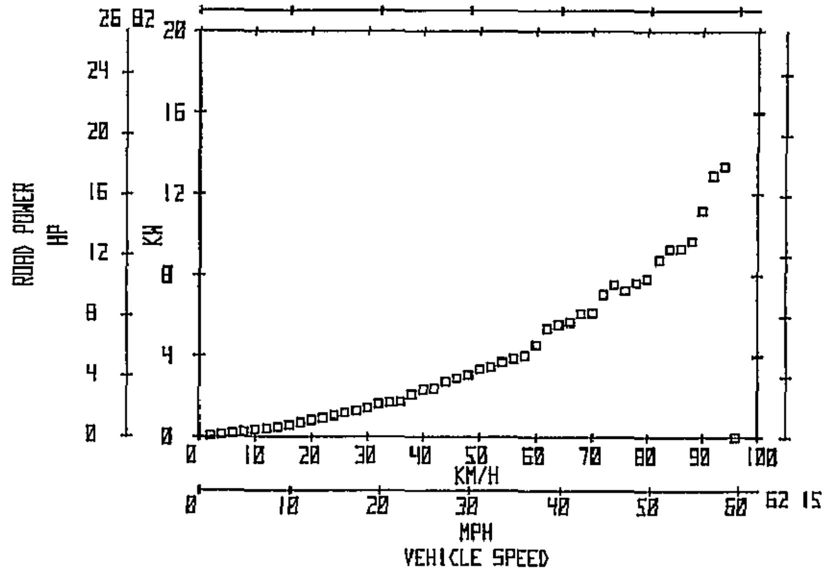
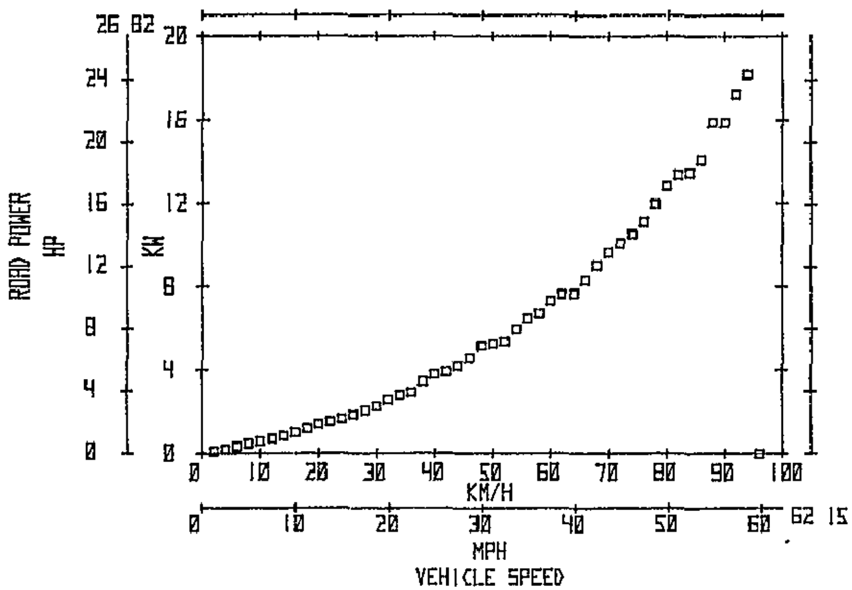


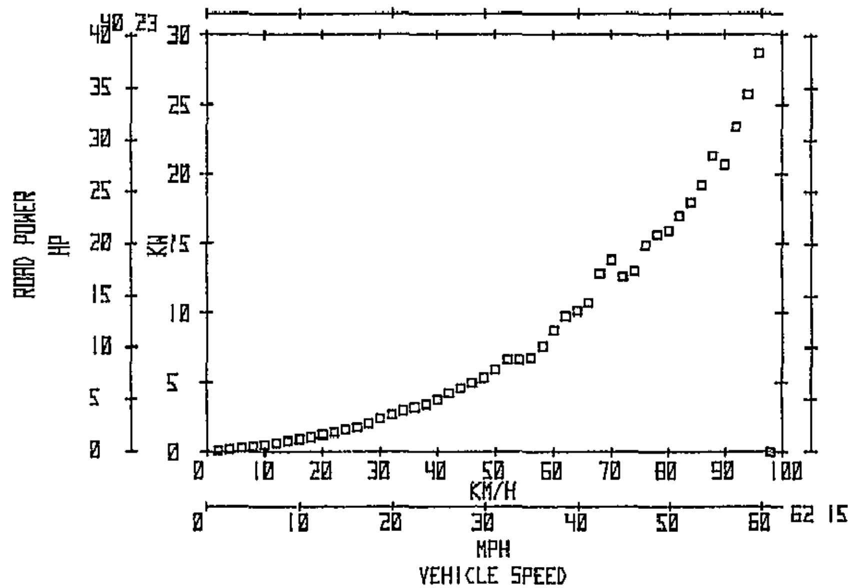
(a) Volkswagen Transporter; August 4, 1977.



(b) Renault 5; August 12, 1977



(c) AMC Pacer, July 29, 1977.



(d) AM General DJ-5.

Figure 12. - Road power as a function of speed for four conventional vehicles.

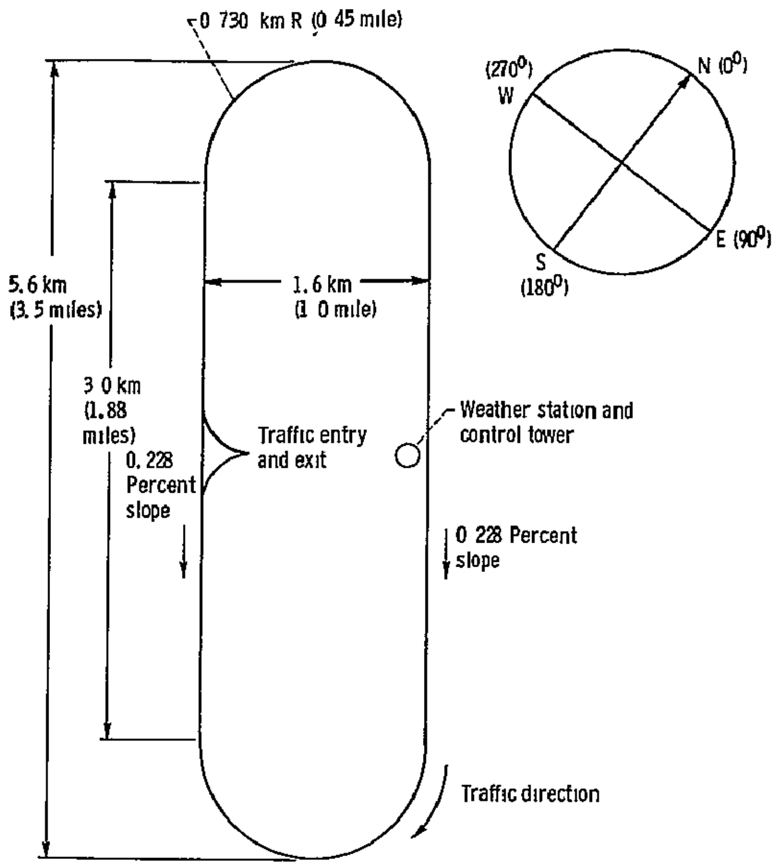


Figure E-1 - Characteristics of Transportation Research Center Test Track, East Liberty, Ohio.

1. Vehicle ____________
2. Date received ____________
3. Checked for damage - date ____________
4. Wheel alignment - date ____________
5. Battery checked and equalized - date ____________
6. Curb weight determined, lbm ____________ Date ____________
7. Gross vehicle weight, lbm ____________
8. 300-Ampere test - date ____________
9. Manufacturers recommendations:
   Maximum speed, mph ____________
   Tire pressures, psi Front ____________; Rear ____________
   Driving procedures ____________

Figure F-1 - Vehicle preparation check sheet

1 Complete pretest checklist

2. Complete one lap at _______ mph for warmup immediately prior to beginning test runs

3. Range tests - one full lap at each vehicle speed, in the order listed
   a _________ mph
   b _________ mph
   c _________ mph
   d 25 mph

   Chart speed, 1 in/min. Do not begin test run until desired constant range speed is attained Start fuel and distance count. On completion of test lap, put fuel flow and distance measurements on hold prior to decelerating to a stop.

4. Cycle tests - one full lap (minimum) of each cycle, in the order listed
   a. Schedule D
   b. Schedule C
   c. Schedule B

   Chart speed, 20 sec/in for the first three cycles and the last three cycles The remaining cycles should be run with chart speed at 1 min/in Record fuel flow and distance cumulative readings for each cycle

5 Maximum acceleration (without spinning wheels) to 60 mph and coast down to full stop with transmission in neutral Perform a minimum of two accelerations and coastdowns on each outside track straight section Chart speed at 5 sec/in Record fuel flow at end of each acceleration and at end of each coastdown Record distance for one acceleration on each track straightaway and for one coastdown on each track straightaway

6 Repeat step 5 to _________ mph

7 Complete posttest checklist

Figure F-2. - Blank run schedule for conventional vehicle tests

1 Check 5th-wheel tire pressure and vehicle tire pressure.
2 Take 12-volt batteries off charge Check water; add water if necessary.
3. Plug in 12-volt power to 5th wheel.
4 Check operations and settings of 5th wheel.
   Start with a full tank of gas.
   Light expanded scale and set to test to be performed
   Light and zero distance readout.
   Set interface box for strip chart at 10, on, and reset
5 Spin up 5th wheel and check -
   Speedometer reading
   Distance counter recording
   Speed indication on strip chart
   Distance indication on strip chart
   Speed and timing indication on beeper
6 Reset interface box for strip chart to 1000
7 Plug strip charts into inverter
8. Switch on inverter.
9 Turn on strip charts and check for inking and paper, see if chart drive is working
10. Turn off strip charts and inverter Unplug 5th wheel from 12-volt source Turn off interface boxes and distance counter readout
11. Set chart scales.

Vehicle speed - red	0 V	4 44 V	0 - 50 mph
Vehicle distance - blue	0 V	50 V	1000 ft/pulse

   Chart speed _________ min/in.
12 Put documents on strip charts: time, date, vehicle red and blue units, test to be performed, and chart speed
13 Drive vehicle onto scales (Test weight includes driver) Ballast, raise 5th wheel
14 Lower 5th wheel. Set hub loading (5 lb above hub weight)
15 Drive vehicle onto track
16 Turn on -
   Inverter
   Recorders (Document time on chart paper)
   Interface box for distance readout (On, reset Check that selector is in "100" position.)
   Interface box for distance recorder (On, reset Check that selector is in "1000" position)
   Distance readout. (On, reset, count "on.")
   Plug 5th wheel into 12-volt supply
17. Be sure data sheet is properly filled out to this point.
18. Proceed with test

Figure F-3 - Pretest checklist for conventional vehicles

Vehicle __________ Test __________ Date __________

Driver __________ Navigator __________

Tire pressure before test, psi

Right front ______ Left front ______ Right rear ______ Left rear ______

Tire pressure after test, psi

Right front ______ Left front ______ Right rear ______ Left rear ______

Fifth-wheel tire pressure, psi __________ (calibrated, ________ psi)

Test vehicle weight, lbm

Right front ______ Left front ______ Right rear ______ Left rear ______

Total front ______ Total rear ______ Total ______

Weather conditions:	Initial	During test	Final
Temperature, °F			
Wind speed, mph			
Wind direction			
Barometric pressure, in Hg			

	Start	Stop
Time		
Odometer reading, miles		
Fuel flow, cm^3/mile		
Tire pressure, kPa		
Fuel temperature, °F		

Number of cycles __________ Fifth-wheel distance count, ft __________

Notes: __________

(a) All tests

Number of cycles	Cumulative fuel flow, cm^3	Cumulative distance traveled, miles
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		

(b) Driving schedule tests

Figure F-4 - Track data sheets

1. Note time immediately at completion of test Turn off key switch
2. Complete track data sheet Do not turn off instrument power until all test run readings have been documented:
   - Odometer at stop
   - 5th-wheel counter
   - Gas flow reading
   - Weather data
   - Number of cycles (if applicable)
   - Fuel temperature
3. Turn off distance counter, interface boxes, strip-chart recorders, and inverter. Disconnect 5th wheel from 12-volt source.
4. Raise 5th wheel
5. Check specific gravity on instrument batteries.
6. Put 12-volt instrument batteries on charge

Figure F-5 - Post-test checklist for conventional vehicles.

Vehicle ______________ Test ____________ Date ______________

Engineer ____

Reason for test (checkout, component check, scheduled test, etc.) ____________

____

Limitation on test (malfunction, data system problem, brake drag, etc.) ____________

____

Changes to vehicle prior to test (repair component, change battery, adjust brakes, etc)

____

Weather conditions,

Temperature, ^{o}F ____________; wind speed, mph ______________

Wind direction ____________; barometric pressure, in Hg ____________

Other ____

Test results·

Test duration, h ____________, range, miles ______________

Number of cycles ____________; fuel temperature, ^{o}C ____________

Fuel flow (total), cm^3 ________________________________

Fuel economy ______________ mpg ______________ cm^3/mile

Was planned driving schedule followed? ______________________

General comments ______________________________

____

____

____

____

____

Figure F-6 - Engineering data sheet.