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A Survey of Electric and Hybrid Vehicle Simulation Programs

Final Report

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CONTENTS

FIGURES

TABLES

CONTENTS (con't)

APPENDICES

ABSTRACT

This report summarizes the results of a survey conducted within the United States to determine the extent of development and capabilities of automotive performance simulation programs suitable for electric and hybrid vehicle studies. The survey was conducted for the Department of Energy by NASA's Jet Propulsion Laboratory in support of Public Law 94-413, the Electric and Hybrid Vehicle Research, Development and Demonstration Act of 1976.

I. INTRODUCTION

In 1977, the Energy Research and Development Administration, a predecessor agency of the Department of Energy (DOE), granted the Jet Propulsion Laboratory (JPL) of the California Institute of Technology a contract to monitor the development of two electric vehicles by DOE contractors. Because vehicle simulation programs were an important part of the monitoring task, JPL surveyed industry, universities, and research institutions to determine what programs were already available.

The purpose of this report is to summarize the results of that survey and to enter the information into the public domain. DOE contractors should be encouraged to use existing programs when possible, and this document provides a means for direct contact with the persons responsible for each program surveyed.

The survey was carried out by means of a questionnaire, which was designed so that it could be completed quickly and would still furnish enough information to determine if further, detailed investigation was warranted. In order to complete the study in a relatively short period of time, the survey was limited to organizations in the United States and did not take a critical look at the programs themselves. A sample questionnaire is included in Section II of this document; anyone who wishes to add information to the survey is invited to fill out the questionnaire and return it to T. A. Barber, Electric and Hybrid Vehicle System Research and Development Project Office, Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, California, 91103.

This report describes the procedure used for conducting the survey, summarizes the results of the returns, and presents the conclusions drawn. Appendices in this report are: A, Questionnaire Mailing List; B, Questionnaire Respondents; and C, Referrals. Copies of the returned questionnaires and of the additional material returned with the questionnaires are available in microfiche form from T. A. Barber at the address above.

II. BASIC SURVEY METHODOLOGY

The purpose of any survey is to gather meaningful information in a manner which allows useful analyses. This section describes both the questionnaire developed and the methodology used to conduct the survey.

A. QUESTIONNAIRE

The questionnaire was designed to be answered briefly, requiring little of the recipient's time. It was developed to provide information in four basic areas: (1) model description and status, (2) description of the program, (3) willingness to discuss further, and (4) referrals. A copy of the questionnaire is shown in Figure 1.

1. Model Description and Status

The first four questions were used to help establish what programs each recipient had and their current state of usability and availability. The recipient was asked to what extent government funding was provided (all, some, or none), in order to help establish whether the program was likely to be proprietary or in the public domain. Recipients were also asked to identify the programs that were being used for a vehicle study and to list all the programs that were in a usable state. The questionnaire further asked whether the program was available for public use.

If the existence of a program was established, the questionnaire next solicited information regarding its level of documentation. Specifically, it asked whether any reports in technical publications were available and to what degree the simulation program(s) were documented (well, partial, or not too well). These questions were asked in order to get some indication of the program's usefulness to the public and the ease with which it can be used.

Following these questions of the program's status, the recipient was then asked to respond to some questions describing the program's capability. In particular, he was asked about the capability of the model for various configurations: does it simulate heat-engine, electric, or hybrid vehicles? Two questions were asked about the type of data the program uses: the survey team was interested in the kind of driving schedules the model accommodates and whether it can accept emission maps. These answers are particularly useful to anyone desiring to compare model capabilities.

2. Description of Programs

Two questions dealt with how the program is operated and the capabilities necessary to actually execute the program. The recipient was asked to describe the program in terms of the programming language, type of computer used, approximate number of source cards, approximate number of routines, and core storage requirements. The questionnaire also asked whether the program is capable of execution in batch mode, interactive mode, or both.

VEHICLE
SIMULATION
QUESTIONNAIRE

Please provide the following information:

Your name _____

Your company _____

Your company address _____

_____

_____

Your mail stop _____

Your department _____

Your title _____

Your phone number _____

If your company does not have an automotive simulation program, go to question 15.

1. **Indicate the funding source of your simulation program(s).**

   ☐ **All government funding**

   ☐ **Some government funding**

   ☐ **No government funding**

2. **Are you currently using any of your simulation programs for some type of vehicle study?**

   ☐ **Yes** **Name of Program(s)** _____

   ☐ **No**

3. **Please list program names which are in a usable state.**

   _____

   _____

   _____

   _____

Figure 1. Vehicle Simulation Questionnaire

4. Is your program(s) available for public use?

☐ Yes

☐ No

5. Is the program(s) described in any publicly available technical publications?

☐ Yes

☐ No

6. Can your simulation program in some manner simulate or predict performance of:

☐ Heat-engine vehicles

☐ Electric vehicles

☐ Hybrid vehicles

☐ All of the above

☐ None of the above

(Please define your meaning of "Hybrid".) _____

_____

7. Please describe your program(s) in terms of:

The programming language used _____

The computer(s) it runs on _____

The approximate number of source code cards _____

The approximate number of routines _____

Core storage requirements _____

8. Your simulation program(s) is:

☐ Well documented

☐ Partially documented

☐ Not too well documented

9. If your simulator(s) can accommodate hybrid vehicles and/or heat-engine vehicles, can it accept emission maps?

☐ Yes

☐ No

Figure 1. Vehicle Simulation Questionnaire (Continuation 1)

10. Is your simulation program(s) designed for:

- ☐ Batch mode operation
- ☐ Interactive mode
- ☐ Both of the above

11. If your simulator(s) accommodates any SAE or Federal driving schedules, please indicate which ones:

- ☐ EPA urban
- ☐ EPA highway
- ☐ Some or all SAE J227 schedules
- ☐ Other_____

_____

12. Can JPL use this data in a survey report for the Department of Energy?

- ☐ Yes
- ☐ No
- ☐ Maybe (A "maybe" will be considered a "no" until resolved)

13. Are you willing to discuss your simulation program(s) further with a JPL survey team?

- ☐ Yes
- ☐ No
- ☐ Maybe

14. Have you discussed your simulation program(s) previously with JPL personnel?

- ☐ Yes Who?_____
- ☐ No

15. Please list other U.S. companies you know with automotive performance simulation programs of any type.

_____

_____

_____

_____

Figure 1. Vehicle Simulation Questionnaire (Continuation 2)

These questions were designed to tell whether the program is usable by a company that may be limited by its computer or core storage resources. By obtaining a ratio of the number of source cards to the number of routines (coupled with the programming language) one can get an idea of the complexity, modularity, and modifiability of the program.

3. Willingness to Discuss Further

The survey team was interested in knowing whether further discussions are possible. The recipient of the questionnaire was asked whether the information provided could be used in this survey for the Department of Energy. He was also asked whether he would be willing to discuss his simulation program further with the survey team or if he had had previous contact with the survey team.

4. Referrals

The final question on the survey requested a list of any U.S. companies the recipient knew to have vehicle performance simulation programs. It was hoped that this question would supplement the original list generated by the Jet Propulsion Laboratory and the Department of Energy.

B. HANDLING OF SURVEY

The survey mailing list (Appendix A) was generated by a JPL literature search utilizing the following sources*

(1) A JPL contact list generated during an in-use survey of electric vehicles performed for the Department of Energy under Interagency Agreement EC-77-A-31-1011 with NASA Lewis Research Center and DOE.

(2) A JPL-generated list of companies and individuals responding to a notice of intent to issue a Request for Proposal relating to hybrid vehicles, published in the Commerce Business Daily.

(3) A DOE-generated list of companies and individuals indicating interest in the Demonstration Program resulting from Public Law 94-413.

(4) A literature search list of companies and individuals responsible for publications on automotive simulation programs. The literature search was conducted by JPL using the databases of SDC/NTIS, NASA/RECON, and NASA/RECON with engineering index.

(5) A list of individuals and companies responsible for technical articles appearing in the open literature on topics relating to automotive engineering studies.

The questionnaire mailing was coordinated with the JPL Flight Projects and Civil Systems Procurement Section in keeping with the internal procedures and policies of the Jet Propulsion Laboratory.

*Names and addresses of individuals who were not associated with a corporate identity have been deleted to preserve personal privacy.

As each questionnaire was received by the Jet Propulsion Laboratory, it was assigned an accession number, and the name of the respondent, his company name, and the date it was received was recorded. The list of returned surveys is contained in Appendix B. If a respondent requested that his questionnaire not be used ("no" response to question 12), an accession number was assigned to the questionnaire, but the respondent was not identified, and any information he supplied was excluded from the survey.

A separate list of those respondents who supplied referrals to other companies (question 15) was recorded. This list contained the accession number and company name of the respondent, as well as the sources he referenced. Appendix C contains the accession number of the respondents and their referrals.

In addition, a graph of the accumulated number of returns over time was maintained in order to track the leveling off of the rate of returns (see Figure 2). As Figure 2 indicates, the questionnaire turnover time was fairly quick. Also, 38% of the questionnaires sent out were returned. The rapidity and volume of returns may be attributed to the simplicity of the questionnaire's design, and the stamped return envelope included with each questionnaire.

All the questionnaires that were returned, with the exception of those requested to be withheld, are contained in Appendix D.* Some respondents returned not only their questionnaires, but other material they felt was pertinent to vehicle simulation. All additional, unsolicited material can be found in Appendix E.*

*These Appendices are in Vol. II (microfiche); see Sec. I for further information.

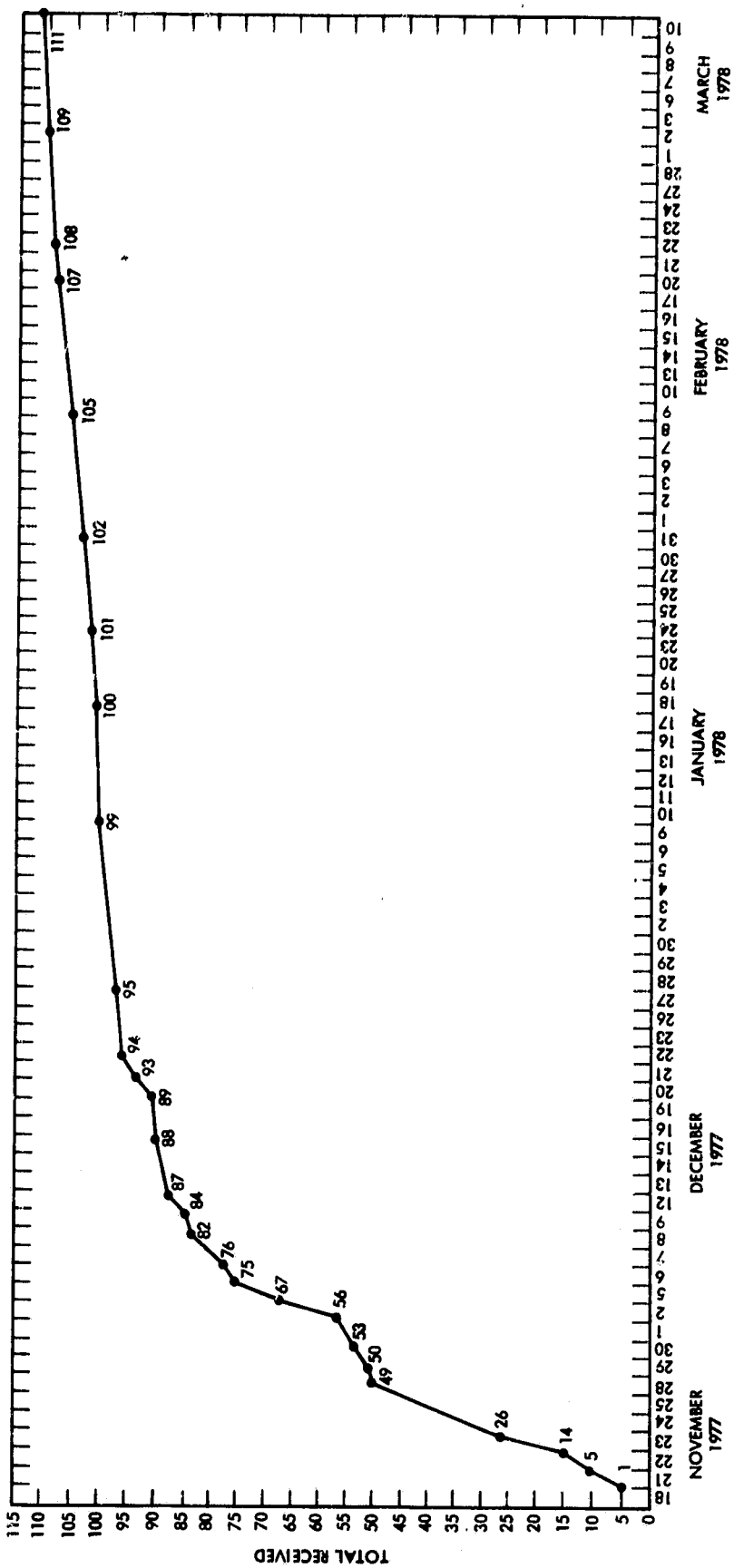

Figure 2. Vehicle Simulation Survey Return Chart

III. SUMMARY OF SURVEY RESPONSES

This section provides a summary of the various responses to the questionnaire. Of the 292 questionnaires sent out, 111 were returned. Three respondents answered "no" to question 12 and as a result have been eliminated from further consideration.

A. RESPONDENTS WITH PROGRAMS

In order to facilitate a meaningful analysis, two matrices were compiled from the data supplied by the respondents with programs. Of the 111 questionnaire respondents, 49 (or 44%) had at least one program. However, the total of respondents for an individual category or column can vary because some respondents provided multiple answers (increasing the total) and some gave "not applicable" (N/A) or "no response" (N/R) answers (decreasing the total). Each time a total varies from 49, the difference is explained.

1. Model Description and Status

The first matrix (see Table 1, pages 5-1 to 5-21) summarizes the information contained in Questions 3, 4, 8, 5, 6, 9, 11, 1, and 2 of the questionnaire. A dashed line indicates that separate information was given for more than one program. Additionally, in hindsight, it became apparent that question 2 was unclear to some of the respondents. It was JPL's intention to solicit computer program names; however, sometimes the respondent supplied project names, task names, study names, etc.

a. Public Availability of Program(s). The respondents with programs were further categorized in an attempt to ascertain which programs were publicly available and which ones were not. Of the 49 respondents with programs, Respondent/Accession No. 83 was excluded due to a "no response" answer to the question dealing with public availability and Respondent/Accession No. 104 was included twice since information was provided for both publicly available and not available programs. Thus, the total remains 49.

Of these 49 responses, 24 (49%) are available to the public; 25 (51%) are not available to the public.

b. Documentation Level. The level of documentation in relation to the public availability of the programs is shown in Table 2. For the purpose of this analysis, the number of respondents with publicly available programs has been adjusted to 28 since several have multiple programs and provided a separate level of documentation for each one.

c. Public Availability of Program Description. The degree to which the programs are described in a publicly available source is shown in Table 3. The total for the programs available to the public has been increased to 27, since one respondent had 4 programs and supplied a separate response for each.

Table 2. Documentation Level

Program Availability	Documentation Level			Total
	Well	Partial	Not Too Well	
Publicly Available	10 (36%)	11 (39%)	7 (25%)	28
Not Available	8 (32%)	10 (40%)	7 (28%)	25

Table 3. Degree to Which Programs are Described in a Publicly Available Source

Program Availability	Described in Publicly Available Source		Total
	Yes	No	
Publicly Available	13 (48%)	14 (52%)	27
Not Available	8 (33%)	16 (67%)	24

The total for the programs not publicly available has been decreased by 1, to 24, because one respondent did not provide an answer for this question.

d. Level of Government Funding. The level of government funding provided for the programs is given in Table 4. The total for the programs not publicly available has been reduced to 24 because one respondent did not furnish an answer to this question.

e. Type of Vehicle(s) Simulated. Next, an analysis to ascertain the type of vehicle(s) which could be simulated was conducted using all respondents with programs. Of these 49 respondents, three supplied information on two programs, and one was disqualified because an answer was not provided to this question (No. 6 on the questionnaire), making a total of 51 answers. Table 5 summarizes the results.

f. Driving Schedules Accepted. The driving schedules that could be accepted by the various programs were then examined. Again, of the 49 respondents, two supplied information on two programs and five were disqualified

Table 4. Level of Government Funding

Program Availability	Level of Government Funding			Total
	All	Some	None	
Publicly Available	11 (46%)	8 (33%)	5 (21%)	24
Not Available	0 (0%)	5 (21%)	19 (79%)	24

Table 5. Type of Vehicle Simulated

Type of Vehicle Simulated	No. in Group	% of Total
Electric	41	80
Heat Engine	33	65
Hybrid	29	57
All Vehicle Types	21	41

due to an N/A or an N/R answer to this question (No. 11), leaving a total of 46. The results are summarized in Table 6.

2. Program Description

The second matrix (see Table 7, pages 6-1 to 6-12) summarizes the information contained in questions 7 and 10. As in the first matrix, a dashed line indicates that discernible information was given for more than one program.

a. Programming Language Used. Of the 49 respondents, nine gave multiple answers and three were eliminated from consideration because they did not provide an answer to this question. Therefore, the total number of responses is 55.

A breakdown of the various programming languages used is shown in Table 8.

Table 6. Driving Schedules Accepted

Driving Schedules Accepted	No. in Group	% of Total
EPA Urban	24	52
EPA Highway	23	50
Some/All SAE J227	34	74
Other	26	57

Table 8. Programming Languages Used

Programming Language Used	No. in Group	% of Total
FORTRAN	41	75
BASIC	5	9
PL/I	3	5
CSSL	2	4
Others	4	7

b. Mode of Operation. Of the 49 respondents, three were eliminated because they did not provide an answer to this question, leaving a remaining total of 46. The breakdown is shown in Table 9.

3. Willingness to Discuss (Questions 13 and 14)

Of the 49 respondents with programs, 39 (80%) indicated a definite willingness to discuss their programs further with the survey team; 10 (20%) indicated that they would possibly be willing to discuss their programs with the team. No respondents indicated they would be unwilling to have further discussion. Moreover, 15 respondents (31%) reported that they had already discussed their simulation program(s) with JPL personnel at one time or another.

B. RESPONDENTS WITHOUT PROGRAMS

Of the 111 respondents, 59 (53%) did not have programs. Some of these respondents did, however, provide referral information.

C. REFERRALS

Question No. 15 solicited information regarding other U.S. companies known to have automotive performance simulation programs of any type. Of the 111 questionnaire respondents, 36 (32%) provided a referral to at least one other company known to have a simulation program. Further examination of this data revealed that 40 companies had been referred. Of these 40 companies, 22 (55%) were on the original mailing list and had been sent a questionnaire. Appendix C contains a listing (by respondent/accession no.) of the various referrals.

Table 9. Mode of Operation

Mode of Operation	No. in Group	% of Total
Batch	18	39
Interactive	13	28
Both	15	33

IV. SUMMARY AND CONCLUSIONS

While this survey is not exhaustive, it is fairly comprehensive and does meet its objective of placing a summary of a wide variety of vehicle simulation programs into the public domain. Of the publicly available programs, ten were purported to be well documented and an additional 11 to be partially documented. Thirteen were described in publicly available technical reports. Another 25 respondents indicated they had programs that are not publically available. Some of these may be useful if arrangements can be made regarding their proprietary nature.

Altogether, 111 programs were identified as being in a usable state. The complexity of the existing programs spans a range from a page of simple desktop calculator instructions to 300,000 lines of a high-level programming language. The capability to simulate electric vehicles was most common, heat-engines second, and hybrid vehicles least common. Batch-operated programs are slightly more common than interactive ones, and one-third can be operated in either mode. The most commonly used language was FORTRAN, the language typically used by engineers. The higher-level simulation languages (e.g. SIMSCRIPT, GPSS, SIMULA) used by "model builders" were conspicuously lacking.

While no respondents indicated that they would be unwilling to discuss their programs further with the survey team, 15 (almost one-third) indicated that they had already discussed their programs previously with some JPL personnel. There appears to be a genuine willingness on the part of industry, universities, and research institutes to share their work.

Readers of this report who are interested in using one of the existing programs can readily do so by contacting the respondent at the address shown in Appendix B. Readers are also encouraged to supplement this survey's information when they know of an existing program not already included. All correspondence should be directed to T. A. Barber, Project Manager, Electric and Hybrid Vehicle System Research and Development Project, Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, California, 91103.

TABLE 1. MODEL DESCRIPTION AND STATUS

Table 1. Model Description and Status. (N/A = not applicable; N/R = no response.)

Respondent Accession No.	Name of Program(s) in Usable State	Publicly Available?	Documentation Level	Described in Available Publication?	Type of Vehicle(s) Simulated	Can It Accept Emission Maps?	Which Driving Schedules Can It Accept?	Level of Government Funding	Name(s) of Currently Used Programs
6	BATTERY TEST PROGRAM --- DUAL MODE AUTOMOBILE SIMULATION	No	Partial	No	Electric --- Heat-engine Electric Hybrid	No	Other - Any preprogrammed trip	None	BATTERY TEST PROGRAM
9	MING12; EVNMTR; LA4NEW	No	Not too well	Yes	Electric	N/A	EPA Urban EPA Highway Some/all SAE J227; Other-Arbitrary Cycles	Some	DOE "NEAR TERM ELECTRIC VEHICLE"
10	ELECTRIC VEHICLE PERFORMANCE	Yes	Not too well	No	Electric Hybrid	No	Other (no description provided)	None	ELECTRIC VEHICLE PERFORMANCE
11	ELVEC	Yes	Partial	No	Heat-engine Electric Hybrid	No	EPA Urban EPA Highway All SAE J227 Other - SAE Metro, SAE Residential, Constant Speed, European FAKRA	All	Studies funded by Electric & Hybrid Vehicle R&D Act PL 94-413

Table 1. Model Description and Status. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Name of Program(s) in Usable State	Publicly Available?	Documentation Level	Described in Available Publication?	Type of Vehicle(s) Simulated	Can It Accept Emission Maps?	Which Driving Schedules Can It Accept?	Level of Government Funding	Name(s) of Currently Used Programs
16	N/R	No	Partial	No	Electric Hybrid	No	Some/all SAE J227	None	J227 B, C, D; RANGE SIMULATOR
17	HYBRID VEHICLE PERFORMANCE PROGRAM HYBRID VEHICLE LIFE CYCLE COST PROGRAM	No	Well	No	Heat-engine Electric Hybrid	Yes	EPA Urban EPA Highway Some/all SAE J227	None	ELECTRIC & HYERID VEHICLE DESIGN
20	EVRANGE; FECON; EVPERF; ACCELM; EVSCR; ACCELA; EVSEP; RACE	No	Not too well	No	Heat-engine Electric	No	Some/all SAE J227 Other - Arbitrary	None	ELECTRIC VEHICLE DESIGN
22	VROOM EV227	Yes	Partial Not too well	No	Heat-engine Electric	Yes	Other-Any inputted cycle SAE J227 A&D	Some	None

Table 1. Model Description and Status. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Name of Program(s) in Usable State	Publicly Available?	Documentation Level	Described in Available Publication?	Type of Vehicle(s) Simulated	Can It Accept Emission Maps?	Which Driving Schedules Can It Accept?	Level of Government Funding	Name(s) of Currently Used Programs
23	None	No	Partial	Yes	Electric Hybrid	Yes	Other - Statistical distributions of vehicle velocity-acceleration events	Some	None
24	N/R	Yes	Not too well	No	Heat-engine	Yes	EPA Urban EPA Highway	All	AUTO TECH ASSESS
30	EVSIM.FORT; ACCSIM. FORT	No	Partial	Yes	Electric	N/A	EPA Urban EPA Highway Some/all SAE J227 Other - SAE J1082, SCOTT	None	N/R
31	No program names	Yes	Not too well	No	Heat-engine Electric Hybrid	No	N/R	Some	TUNNEL ENTRANCE SAFETY

Table 1. Model Description and Status. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Name of Program(s) in Usable State	Publicly Available?	Documentation Level	Described in Available Publication?	Type of Vehicle(s) Simulated	Can It Accept Emission Maps?	Which Driving Schedules Can It Accept?	Level of Government Funding	Name(s) of Currently Used Programs
32	HYBRID AUTOMOBILE PERFORMANCE SIMULATION PROGRAM	No	Well	Yes	Heat-engine Electric Hybrid	Yes	Other-Any that is inputted	Some	None
37	HYBRID VEHICLE SIMULATION COMPUTER PROGRAM POWER TRAIN COMPONENT SIZING PROGRAM ENERGY CONSERVATION & EMISSIONS PROGRAM	Yes	Partial	Yes	Heat-Engine Electric Hybrid	Yes	EPA Urban EPA Highway Some/all SAE J227	All	HYBRID VEHICLE TECHNOLOGY CONSTRAINTS AND APPLICATION ASSESSMENT STUDY (DOT)

Table 1. Model Description and Status. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Name of Program(s) in Usable State	Publicly Available?	Documentation Level	Described in Available Publication?	Type of Vehicle(s) Simulated	Can It Accept Emission Maps?	Which Driving Schedules Can It Accept?	Level of Government Funding	Name(s) of Currently Used Programs
47	#77010, #77012 (EV Acceleration Performance) #77011 (EV Steady-State Performance) VSIMA1 (EV Analog Simulation)	No	Partial	No	Electric	N/A	Some/all SAE J227 Other-USPS Test Cycle	None	77010; 77011; 77012; VSIMA1
48	AUTOMOBILE PERFORMANCE STUDY & EVALUATION AUTOMOBILE RESISTANCE USING COASTING TIMING	No	Not too well	No	Heat-engine Electric Hybrid	Yes	Some/all SAE J227	None	GENERAL AUTOMOBILE SIMULATION PROGRAM (GASP)

Table 1. Model Description and Status. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Name of Program(s) in Usable State	Publicly Available?	Documentation Level	Described in Available Publication?	Type of Vehicle(s) Simulated	Can It Accept Emission Maps?	Which Driving Schedules Can It Accept?	Level of Government Funding	Name(s) of Currently Used Programs
58	ELCARIO	No	Well	No	Electric	N/A	Some/all SAE J227	None	NEAR-TERM ELECTRIC VEHICLE PROGRAM -- PHASE II
59	HYBRID	No	Not too well	No	Heat-engine Electric Hybrid	Yes	EPA Urban EPA Highway Some/all SAE J227 Other - any schedule where speed is specified in one (or multi) second intervals. Max = 1099 velocities.	None	None

Table 1. Model Description and Status. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Name of Program(s) in Usable State	Publicly Available?	Documentation Level	Described in Available Publication?	Type of Vehicle(s) Simulated	Can It Accept Emission Maps?	Which Driving Schedules Can It Accept?	Level of Government Funding	Name(s) of Currently Used Programs
61	AUTOMOTIVE PROPULSION SIMULATOR (APS) CARSIM FLYWHEEL AUTOMOTIVE PROPULSION SIMULATOR HYBRID CAR SIMULATOR	Yes	Partial	Yes No Yes No	Heat-engine Electric Hybrid	Yes	EPA Urban EPA Highway	All	FLYWHEEL AUTOMOTIVE PROPULSION SIMULATOR; CARSIM; HYBRID CAR SIMULATOR
65	HVHP (Hybrid Vehicle Handling Program); TVDS3 (Three Dimensional Vehicle Simulation); HSRI Articulated Vehicle Simulation	Yes	Well	Yes	Heat-engine Electric Hybrid	Yes	Other - NHTSA Vehicle Handling Test Procedures	All	3 NHTSA Research Programs: 2 FHWA Research Programs

Table 1. Model Description and Status. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Name of Program(s) in Usable State	Publicly Available?	Documentation Level	Described in Available Publication?	Type of Vehicle(s) Simulated	Can It Accept Emission Maps?	Which Driving Schedules Can It Accept?	Level of Government Funding	Name(s) of Currently Used Programs
67	HVSIM (Hybrid Vehicle Simulator); AVDS (Articulated Vehicle Dynamic Simulation); 3DVS (3-Dimensional Vehicle Simulation); TRANSIM (Transportation Simulator); WRECKER (Finite Element Analysis Model for Vehicle Crashworthiness)	No	Partial	No	Heat-engine Electric Hybrid	No	EPA Urban EPA Highway Some/all SAE J227 Other-JAPINEES 10 & 11 Mode	None	HVSIM

Table 1. Model Description and Status. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Name of Program(s) in Usable State	Publicly Available?	Documentation Level	Described in Available Publication?	Type of Vehicle(s) Simulated	Can It Accept Emission Maps?	Which Driving Schedules Can It Accept?	Level of Government Funding	Name(s) of Currently Used Programs
68	DRIVING SIMULATOR	No	Well	Yes	Heat-engine Electric Hybrid	N/A	N/A	N/R	HUMAN PERFORMANCE IN SIMULATED DRIVING
69	MISSION ANALYSIS	No	Partial	No	Electric	No	Some/all SAE J227	None	None
70	APS (Automotive Propulsion Simulation Program) FEMP (Flywheel Energy Management Propulsion) RUN MODULE CAR SIMULATION	Yes	Well Not too well Partial Partial	Yes	Heat-engine Electric Hybrid	Yes	EPA Urban EPA Highway Some/all SAE J227 Other - ACCEL, CRUISE	All	APS (Automotive Propulsion Simulation Program); FLYWHEEL PROPULSION SIMULATION

Table 1. Model Description and Status. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Name of Program(s) in Usable State	Publicly Available?	Documentation Level	Described in Available Publication?	Type of Vehicle(s) Simulated	Can It Accept Emission Maps?	Which Driving Schedules Can It Accept?	Level of Government Funding	Name(s) of Currently Used Programs
73	TRCLMB; EVACCE; EVSAE	Yes	Partial	No	Heat-engine Electric	N/R	Some/all SAE J227	Some	PEVCON ELECTRIC VEHICLE; NCHRP PROJECT 20-7; TASK10 "REVIEW OF TRUCK/ WEIGHT/ HORSEPOWER RATIO"
74	TCAPE; PERFOR	Yes	Well	No	Heat-engine	No	Other - originated city, suburban & highway cycles for a truck	None	TCAPE
76	VEHICLE ENERGY CONSUMPTION PROGRAM; BATTERY ENERGY AVAILABLE PROGRAM	Yes	Partial	Yes	Electric	No	Some/all SAE J227 Other	None	None

Table 1. Model Description and Status. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Name of Program(s) in Usable State	Publicly Available?	Documentation Level	Described in Available Publication?	Type of Vehicle(s) Simulated	Can It Accept Emission Maps?	Which Driving Schedules Can It Accept?	Level of Government Funding	Name(s) of Currently Used Programs
77	N/R	No	Not too well	No	Hybrid	Yes	Some/all SAE J227; Other - Minneapolis driving cycle, self defined	None	None
80	CARSIM (Manual Transmission) APS (Automatic Transmission)	Yes	Well	No	Heat-engine	Yes	EPA Urban EPA Highway Other - Sinusoidal road; level road of constant speeds 0-90 sec. acceleration	All	CARSIM; APS (Automotive Propulsion Simulation)
83	GPSIM	N/R	Well	Yes	Heat-engine Electric Hybrid	Yes	EPA Urban EPA Highway Some/all SAE J227 Other - All GM, any USA-specified schedule	None	GPSIM

Table 1. Model Description and Status. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Name of Program(s) in Usable State	Publicly Available?	Documentation Level	Described in Available Publication?	Type of Vehicle(s) Simulated	Can It Accept Emission Maps?	Which Driving Schedules Can It Accept?	Level of Government Funding	Name(s) of Currently Used Programs
84	EVSP (Electric Vehicle Simulation Program)	Yes	Not too well	No	Electric	N/A	Some/all SAE J227	All	EVSP
85	D2.F4 (All-electric vehicle); P1 (Engine-Battery parallel hybrid vehicle); SERHYB (Turbine-Battery series hybrid vehicle); FWHYB (Flywheel-Battery hybrid vehicle)	No	Not too well	Yes	Heat-engine Electric Hybrid	Yes	EPA Urban EPA Highway All SAE J227 Other - Taxi, UPS, ECE, Ford City, Ford Suburban	None	D2.F4; P1; SERHYB; FWHYB

Table 1. Model Description and Status. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Name of Program(s) in Usable State	Publicly Available?	Documentation Level	Described in Available Publication?	Type of Vehicle(s) Simulated	Can It Accept Emission Maps?	Which Driving Schedules Can It Accept?	Level of Government Funding	Name(s) of Currently Used Programs
86	Unnamed	Yes	Not too well	No	Heat-engine Electric	No	Some/all SAE J227	None	N/R
87	COMPUTER DESIGN AND SIMULATION OF A HYDRAULIC HYBRID VEHICLE POWER TRAIN	Yes	Partial	Yes	Heat-engine Hybrid	Yes	EPA Urban EPA Highway Some/all SAE J227	None	None
89	VEHICLE FUEL ECONOMY PROGRAM	Yes	Partial	No	Heat-engine Hybrid	No	EPA Urban EPA Highway Some/all SAE J227	All	VEHICLE FUEL ECONOMY PROGRAM
91	N/R	No	Well	N/R	Heat-engine Electric Hybrid	N/R	Other - any can be accommodated	None	ELECTRIC VEHICLE

Table 1. Model Description and Status. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Name of Program(s) in Usable State	Publicly Available?	Documentation Level	Described in Available Publication?	Type of Vehicle(s) Simulated	Can It Accept Emission Maps?	Which Driving Schedules Can It Accept?	Level of Government Funding	Name(s) of Currently Used Programs
92	VEHBASIC; VEHIPERF; CVRT; P1; NEWD2.F4	No	Not too well	No	Heat-engine Electric Hybrid	Yes	EPA Urban EPA Highway Some/all SAE J227; Other - SAE Driving Cycle, Corporate Cycles	Some	TOFEP
93	HVOSM; SMAC; GUARD; BARRIER VII; CRUNCH; ADUMMY	Yes	Well	Yes	Electric Hybrid	No	N/R	Some	HVOSM; SMAC; GUARD; BARRIER VII; CRUNCH; ADUMMY
96	GPSIM	No	Partial	Yes	Heat-engine	Yes	EPA Urban EPA Highway Some/all SAE J227	None	GPSIM

Table 1. Model Description and Status. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Name of Program(s) in Usable State	Publicly Available?	Documentation Level	Described in Available Publication?	Type of Vehicle(s) Simulated	Can It Accept Emission Maps?	Which Driving Schedules Can It Accept?	Level of Government Funding	Name(s) of Currently Used Programs
97	SINGLE SHAFT GAS TURBINE/CV TRANSMISSION SPLIT FLOW COMPRESSOR-SINGLE SHAFT GAS TURBINE SI ENGINE/ FLYWHEEL HYBRID DUAL SHAFT GAS TURBINE/ TORQUE CONVERTER GAS TURBINE ELECTRIC HYBRID SI ELECTRIC HYBRID	No	Partial	No	Heat-engine Electric Hybrid	Yes	EPA Urban EPA Highway Some/all SAE J227	None	SI ENGINE/ FLYWHEEL HYBRID

Table 1. Model Description and Status. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Name of Program(s) in Usable State	Publicly Available?	Documentation Level	Described in Available Publication?	Type of Vehicle(s) Simulated	Can It Accept Emission Maps?	Which Driving Schedules Can It Accept?	Level of Government Funding	Name(s) of Currently Used Programs
98	EVSIM	No	Well	No	Electric	No	EPA Urban EPA Highway Some/all SAE J227	None	EVSIM
100	CYCLIC SIMULATION OF VEHICLE PERFORMANCE STEADY STATE PERFORMANCE SIMULATION/VEHICLE PARAMETRIC SENSITIVITY STUDY	No	Well	Yes	Heat-engine Electric Hybrid	Yes	EPA Urban Some/all SAE J227 Other - any cycle inputted point-by-point	Some	CYCLIC SIMULATION OF VEHICLE PERFORMANCE; STEADY STATE PERFORMANCE SIMULATION/VEHICLE PARAMETRIC SENSITIVITY STUDY
103	N/R	No	Well	No	Electric	N/A	Some/all SAE J227 Other - Post Office Driving Cycle	None	ELECTRIC VEHICLE TRACTIVE PERFORMANCE

Table 1. Model Description and Status. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Name of Program(s) in Usable State	Publicly Available?	Documentation Level	Described in Available Publication?	Type of Vehicle(s) Simulated	Can It Accept Emission Maps?	Which Driving Schedules Can It Accept?	Level of Government Funding	Name(s) of Currently Used Programs
104	KINEMATICS; VEHICLE/ GUIDEWAY DYNAMICS; HUMAN INTERACTION; MERGE; STATION; COARSE NETWORK SIMULATION; DETAILED NETWORK SIMULATION	Yes	Well	Yes	Electric	N/A	N/R	All	PERSONAL RAPID TRANSIT/ URBAN DEPLOYABILITY PROGRAMS
	FLETSM	No	Partial	No	Heat-engine Hybrid	N/R	Some/all SAE J227; Other - Cycles including terrain effects	None	FLETSM (FLET SIMULATION)
105	EASY-EHV; EASY-SIMWEST	Yes	Well	Yes	Heat-engine Electric Hybrid	Yes	EPA Urban EPA Highway Some/all SAE J227	Some	EASY PROGRAM

Table 1. Model Description and Status. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Name of Program(s) in Usable State	Publicly Available?	Documentation Level	Described in Available Publication?	Type of Vehicle(s) Simulated	Can It Accept Emission Maps?	Which Driving Schedules Can It Accept?	Level of Government Funding	Name(s) of Currently Used Programs
106	PHASE III; PHASE II; TBS; BRAKES2	Yes	Well	Yes	N/R	No	N/R	Some	YAW DIVERGENCE OF COMMERCIAL VEHICLES; INFLUENCE OF INCREASED SIZE AND WEIGHT; DIRECTIONAL RESPONSE OF TRACTOR-SEMI-TRAILER VEHICLES
107	AUTOMOTIVE FUEL ECONOMY SIMULATION PROGRAM	Yes	Partial	No	Heat-engine	Yes	EPA Urban EPA Highway	Some	AUTOMOTIVE FUEL ECONOMY SIMULATION PROGRAM

Table 1. Model Description and Status. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Name of Program(s) in Usable State	Publicly Available?	Documentation Level	Described in Available Publication?	Type of Vehicle(s) Simulated	Can It Accept Emission Maps?	Which Driving Schedules Can It Accept?	Level of Government Funding	Name(s) of Currently Used Programs
108	HVOSM (HIGHWAY VEHICLE OBJECT SIMULATION MODEL) CVS (CRASH VICTIM SIMULATION) CRASH (IMPACT SPEED RECON-STRUCTION PROGRAM) SMAC (ACCIDENT RECON-STRUCTION PROGRAM)	Yes	Well	Yes	Heat-engine Electric Hybrid	No	EPA Urban EPA Highway Some/all SAE J227	Some	HVOSM; CVS; CRASH; SMAC

Table 1. Model Description and Status. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Name of Program(s) in Usable State	Publicly Available?	Documentation Level	Described in Available Publication?	Type of Vehicle(s) Simulated	Can It Accept Emission Maps?	Which Driving Schedules Can It Accept?	Level of Government Funding	Name(s) of Currently Used Programs
109	PARAMET	Yes	Well	Yes	Electric	N/A	EPA Urban EPA Highway Some/all SAE J227 Other - any user defined	All	ELECTRIC AND HYBRID VEHICLE SYSTEM RESEARCH AND DEVELOPMENT PROJECT (DOE)

TABLE 7. PROGRAM DESCRIPTION

Table 7. Program Description. (N/A = not applicable; N/R = no response.)

Respondent Accession No.	Program Name(s)	Programming Language	No. of Source Code Cards	No. of Routines	Avg. No. of Cards per Routine	Computers on Which Program Operates	Core Storage Requirements	Mode of Operation
6	BATTERY TEST PROGRAM	ANALOG	N/R	N/R	---	N/R	N/R	Batch
	DUAL MODE AUTOMOBILE SIMULATION	CSSL III	1,000	20	50	CDC 6500	80K-100K	Batch
9	MING12; EVNMTR; LA4NEW	FORTRAN	2,000/ea	10/ea	200	UNIVAC 1100	20 BLOCKS/ea	Batch
10	ELECTRIC VEHICLE PERFOR-MANCE	BASIC	N/R	N/R	---	Small	8K	Batch Interactive
11	ELVEC	FORTRAN	5,000	50	100	IBM UNIVAC CDC	220K bytes	Batch Interactive
16	N/R	BASIC	N/R	N/R	---	DEC PDP 11	N/R	Interactive

Table 7. Program Description. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Program Name(s)	Programming Language	No. of Source Code Cards	No. of Routines	Avg. No. of Cards per Routine	Computers on Which Program Operates	Core Storage Requirements	Mode of Operation
17	HYBRID VEHICLE PERFOR-MANCE	FORTRAN V	1,500	15	100	UNIVAC 1100	20K words	Batch
	HYBRID VEHICLE LIFE CYCLE COST	FORTRAN V	500	15	33	UNIVAC 1100	N/R	Batch
20	EVRANGE; FECON; EVPERF; ACCELM; EVSCR; ACCELA; EVSEP;RACE	BASIC FORTRAN IV	N/R	N/R	---	CYPHER-NETICS	N/R	Interactive
22	VROOM; EV227	FORTRAN IV	N/R	N/R	---	G.E. TYMSHARE SYSTEM	N/R	Interactive
23	None	N/R	N/R	N/R	---	IBM 360/ 75	N/R	Batch Interactive
24	N/R	FORTRAN/HPL	500	3	167	HP 2100 HP 9825	16K	Interactive

Table 7. Program Description. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Program Name(s)	Programming Language	No. of Source Code Cards	No. of Routines	Avg. No. of Cards per Routine	Computers on Which Program Operates	Core Storage Requirements	Mode of Operation
30	EVSIM.FORT; ACCSIM.FORT	FORTRAN	1700	15	113	IBM 370	80K bytes	Batch
31	No program names	FORTRAN ASSEMBLY	None	7	---	EAI Pacer 100, General Purpose Analog	60K	Interactive
32	HYBRID; AUTOMOBILE PERFOR-MANCE SIMULATION PROGRAM	FORTRAN IV	2,000	53	38	CDC 6600	124K words (octal)	Batch
37	POWER TRAIN COMPONENT SIZING	FORTRAN	2,000	20	100	CDC 7600	130K-160K words	Batch
	ENERGY CON-SERVATION & EMIS-SIONS	FORTRAN	3,500	20	175	CDC 7600	130K-160K words	Batch

Table 7. Program Description. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Program Name(s)	Programming Language	No. of Source Code Cards	No. of Routines	Avg. No. of Cards per Routine	Computers on Which Program Operates	Core Storage Requirements	Mode of Operation
47	#77010; #77012; #77011; VSIMA1	BASIC FORTRAN	N/A	Varies	---	HP-9830 Honeywell 1648	Varies - 15K words and up	Interactive
48	AUTOMOBILE PERFOR-MANCE STUDY & EVALUATION AUTOMOBILE RESISTANCE USING COASTING TIMING	FORTRAN	1200	6	200	IBM 360 & 370	90K	Batch Interactive
58	ELCARIO	FORTRAN IV	700	5	140	H-605	10K words	Interactive
59	HYBRID	FORTRAN IV	435	55	8	EAI 640	15,232 16-bit words	Batch
61	AUTOMOTIVE PROPULSION SIMULATOR CARSIM	FORTRAN	100-4000	5-50	---	UNIVAC 1110	N/R	Batch

Table 7. Program Description. (N/A = not applicable; N/R = no response.) (cont't)

Respondent Accession No.	Program Name(s)	Programming Language	No. of Source Code Cards	No. of Routines	Avg. No. of Cards per Routine	Computers on Which Program Operates	Core Storage Requirements	Mode of Operation
61 (con't)	FLYWHEEL AUTOMOTIVE PROPULSION SIMULATOR HYBRID CAR SIMULATOR							
65	HVHP; TVDS3; HSRI	FORTRAN IV	4,000	20	2000	IBM 360/91 EAI 680	175K bytes	Interactive
67	HVSIM; AVDS; 3DVS; TRANSIM; WRECKER	FORTRAN V	N/R	N/R	---	UNIVAC 1108	N/R	Batch
68	DRIVING SIMULATOR	N/R	N/R	N/R	---	N/R	N/R	N/A
69	MISSION ANALYSIS	FORTRAN IV	N/R	5	---	IBM 370	8K	Batch Interactive
70	APS; FEMP; RUN MODULE; CAR SIMULATION	FORTRAN IV	1000	40	25	UNIVAC 1110 HARRIS /6	N/R	Batch

Table 7. Program Description. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Program Name(s)	Programming Language	No. of Source Code Cards	No. of Routines	Avg. No. of Cards per Routine	Computers on Which Program Operates	Core Storage Requirements	Mode of Operation
73	TRCLMB; EVACCE; EVSAE	FORTRAN	400	6	67	IBM 370/ 168	40K	Batch
74	TCAPE; PERFOR	FORTRAN	Not known	10	---	Digital equip	N/R	Interactive
76	VEHICLE ENERGY CONSUMP-TION PROGRAM BATTERY ENERGY AVAILABLE PROGRAM	Coded sequence of arith operations	4	2	---	Monroe Model 1655 Desktop	N/A	Interactive
77	N/R	FORTRAN	200	N/A	---	Honeywell Network Time Share	2-3K	Batch Interactive
80	CARSIM	FORTRAN IV	630	5	126	XEROX Sigma CDC 6000 IBM 360	32K bytes	Batch
	APS		N/R	40	---		54K bytes	

Table 7. Program Description. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Program Name(s)	Programming Language	No. of Source Code Cards	No. of Routines	Avg. No. of Cards per Routine	Computers on Which Program Operates	Core Storage Requirements	Mode of Operation
83	GPSIM	PL/I	300,000	90	3,333	IBM 370/ 145 and up	430K bytes	Interactive Batch
84	EVSP	FORTRAN for CSMP III (CSSL)	400-500	4	100-125	IBM 370/ 195	200K bytes	Batch
85	D2.F4	FORTRAN IV	N/R	N/R	---	DEC 10	N/R	Interactive
	P1			12				
	SERHYB			N/R				
	FWHYB			N/R				
86	Unnamed	FORTRAN IV	1200	7	171	UNIVAC 1108	60K	Batch
87	COMPUTER DESIGN AND SIMULATION OF A HYDRAULIC HYBRID VEHICLE POWER TRAIN	FORTRAN V	850	2	425	UNIVAC	25K	Batch

Table 7. Program Description. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Program Name(s)	Programming Language	No. of Source Code Cards	No. of Routines	Avg. No. of Cards per Routine	Computers on Which Program Operates	Core Storage Requirements	Mode of Operation
89	VEHICLE FUEL ECONOMY PROGRAM	FORTRAN	1000	10	100	IBM 360 UNIVAC 110	N/R	Batch Interactive
91	N/R	FORTRAN	8" (~1,150)	N/R	---	CDC 6600	N/R	Batch Interactive
92	VEHBASIC; VEHIPERF; CVRT, P1; NEWD2.F4	BASIC FORTRAN STRUCTURED FORTRAN	N/R	N/R	---	DEC 10 HONEYWELL 6000	N/R	Batch Interactive
93	HVOSM; SMAC; GUARD; BARRIER VII; CRUNCH; ADUMMY	FORTRAN	N/R	N/R	---	Amdahl 470 V/6	N/R	N/R
96	GPSIM	PL/I	2 boxes (4,000)	50	80	IBM 370/ 168	500K	Batch

Table 7. Program Description. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Program Name(s)	Programming Language	No. of Source Code Cards	No. of Routines	Avg. No. of Cards per Routine	Computers on Which Program Operates	Core Storage Requirements	Mode of Operation
97	SINGLE SHAFT GAS TURBINE/CV TRANS-MISSION SPLIT FLOW COMPRESSOR-SINGLE SHAFT GAS TURBINE SI ENGINE/ FLYWHEEL HYBRID DUAL SHAFT GAS TURBINE/ TORQUE CONVERTER GAS TURBINE ELECTRIC HYBRID SI ELECTRIC HYBRID	FORTRAN	N/R	N/R	---	IBM	N/R	Batch Interactive
98	EVSIM	PL/I	1,000	7	143	IBM 370	267K bytes	Batch Interactive

Table 7. Program Description. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Program Name(s)	Programming Language	No. of Source Code Cards	No. of Routines	Avg. No. of Cards per Routine	Computers on Which Program Operates	Core Storage Requirements	Mode of Operation
100	CYCLIC SIMULATION OF VEH. PERF STEADY STATE PERF SIMULATION/ VEHICLE PARAMETRIC SENSI-TIVITY STUDY	FORTRAN IV	200	20	10	All larger computers	550K	Batch
103	N/R	FORTRAN	N/R	6	---	IBM 370 (VM)	60K bytes	Interactive
104	KINEMATICS VEHICLE/ GUIDEWAY DYNAMICS HUMAN INTERAC-TION MERGE STATION	FORTRAN	8000	500	16	IBM 360 & 370	N/R	Interactive Batch

Table 7. Program Description. (N/A = not applicable; N/R = no response.) (con't)

Respondent Accession No.	Program Name(s)	Programming Language	No. of Source Code Cards	No. of Routines	Avg. No. of Cards per Routine	Computers on Which Program Operates	Core Storage Requirements	Mode of Operation
104 (con't)	COARSE NETWORK SIMULATION							
	DETAILED NETWORK SIMULATION						800K bytes	
	FLETSM	FORTRAN IV	150	N/R	---	IBM 360/ 65	46K	Batch
105	EASY-EHV; EASY- SIMWEST	FORTAN IV	20,000	145	138	CDC 6600 CYBER 175	100K (octal)	Batch
106	PHASE III; PHASE II; TBS; BRAKES2	FORTRAN IV	8000	35	229	IBM 370 AMDAHL 470 V/6	90K words	Batch Interactive
107	AUTOMOTIVE FUEL ECONOMY SIMULATION PROGRAM	FORTRAN IV	600	4	150	UNIVAC 1108 HONEYWELL 6607	60K words	Batch Interactive
108	HVOSM; CVS; CRASH; SMAC	N/R	N/R	N/R	---	N/R	N/R	N/R
109	PARAMET	FORTRAN IV	2000	19	105	IBM 370	Unknown	Interactive

APPENDIX A

QUESTIONNAIRE MAILING LIST

Mailing Number	Addressee	Respondent Accession Number*
1	AAI Corporation Attn: Mr. D. W. Buark, Mgr. Industrial Division P. O. Box 6767 Baltimore, MD 21204	
2	Advanced Kinetics Inc. 1231 Victoria Street Costa Mesa, CA 92627	1
3	Advanced Systems Laboratory Engineering Attn: Robert Schwartz Program Manager 495 South Fairview Avenue Goleta, CA 93017	
4	Aerophysics Company Attn: Dr. Gabriel D. Boehler 3500 Connecticut Avenue, N.W. Washington, DC 20008	
5	The Aerospace Corporation Environment & Energy Conservation Division Attn: Merrill G. Hinton Group Director, Mobile Systems P. O. Box 92957 Los Angeles, CA 90009	37
6	AiResearch (Garrett Corporation) Attn: Bob Rowlett Program Manager 2525 W. 190th Street Torrance, CA 90509	9

*Respondents are listed in Appendix B. Only the responses that could be clearly identified with an addressee on the original mailing list are referenced here. In some cases, the individual who replied was not the one to whom the questionnaire was addressed. Names and addresses of individuals who were not associated with a corporate identity have been deleted to preserve personal privacy.

Mailing Number	Addressee	Respondent Accession Number
7	AiResearch Manufacturing Company A Division of the Garrett Corporation Attn: Arthur E. Raynard Engineering 2525 West 190th Street Torrance, CA 90509	17
8	ALCOA Attn: Mrs. Margaret Brammer 1200 Ring Building Washington, D. C. 20036	
9	J. R. Allsup Bartlesville Energy Research Center Bartlesville, OK	
10	Alturdyne Attn: Frank Verbene 8050 Armour Street San Diego, CA 92111	8
11	Amectran Attn: Mr. Ed Ramirez, President 1545 West Mockingbird Suite 4020 Dallas, TX 75235	
12	American Motors Automotive Advanced Engineering Attn: Robert A. Peterson, Chief Engineer 14250 Plymouth Road Detroit, MI 48227	
13	AMF Advance Systems Laboratory Attn: Mr. H. M. Siegel, V. P. Automotive Operations 495 So. Fairfield Ave. Goleta, CA 93017	
14	Aqualab, Inc. Attn: Mr. W. J. Cartner President Rt. 20 at Valley Lane Streamwood, IL 60103	

Mailing Number	Addressee	Respondent Accession Number
15	Jeffrey L. Arias Engineering Services 9241 Cord Avenue Downey, CA 90240	63
16	ARK Research Attn: Mr. Eugene Findl 55 Rome Street Farmingdale, NY 11735	
17	Atomics International Attn: Mr. S. Sudar Box 309 Canoga Park, CA 91304	
18	A. C. Autern Manufacturers' Representative Pan Am Bldg., Suite 303-E 200 Park Ave. New York City, NY 10017	
19	Battery Power Unit Company Attn: Darwin H. Dykes Route 3 Golden, CO 80401	
20	Battronic Truck Corporation Attn: Harry D. Yoder President 3rd and Walnut Streets Boyertown, PA 19512	
21	Battelle Memorial Institute Attn: H. D. Moran 505 King Ave. Columbus, OH 43201	
22	Mr. Vid Beldavs - 1011 Cummins Engine Co., Inc. Columbus, IN 47201	
23	Bernert International Engineers Attn: Mr. B. W. Bernert 7615 Greenback Lane Citrus Heights, CA 95610	18

Mailing Number	Addressee	Respondent Accession Number
24	Billings Energy Corporation Attn: Mr. Hadden P. O. Box 555 Provo, UT 84601	25
25	Dr. James D. Birkett Arthur D. Little Inc. Acorn Park Cambridge, MA 02140	
26	Mr. David P. Bloomfield Giner, Inc. 14 Spring Street Waltham, MA 02154	
27	Boeing Attn: John L. Gunter Energy Technology Applications Division P. O. Box 24346 Seattle, WA 98124	105
28	Boeing Engineering & Construction Company Attn: Mr. R. M. Little, 8K-50 P. O. Box 3707 Seattle, WA 98124	
29	Bogue Electric Manufacturing Company Attn: Mr. Anthony Sabbatino Executive Vice President 100 Pennsylvania Avenue Patterson, NJ 07509	29
30	P. F. Bohn John Hopkins University Laurel, MD	65
31	Bonal Corporation Attn: Mr. August G. Hebel, Jr. 1257 Eighteenth Street Detroit, MI 48216	21
32	Booz, Allen & Hamilton, Inc. Attn: Mr. Barnhart 4733 Bethesda Ave. Bethesda, MD 20014	
33	Borisoff Engineering 7726 Burnet Avenue Van Nuys, CA 91405	33

Mailing Number	Addressee	Respondent Accession Number
34	Boulder Engineering Inc. Attn: Mr. Ralph Fryer P. O. Box 358 Erie, CO 80516	
35	Boulder Engineering Inc. Attn: Dr. Paul Zanoni P. O. Box 358 Erie, CO 80516	
36	Bradley Automotive Attn: Mr. Carey Bradley 495 Shelard Plaza 400 County Road 18 South Minneapolis, MN 55426	
37	Bradley Automotive Attn: Mr. Patrick Ramazier, Chief Engineer 14414 - 21st Avenue North Plymouth, MN 55441	
38	Peter Bressier Design Associates Attn: Doug Genercux, Associate 114 Haudain Street Philadelphia, PA 19147	
39	William M. Brobeck & Associates Attn: Mr. Warren Eukel 1235 Tenth Street Berkeley, CA 94710	
40	William H. Brobeck & Associates Attn: Francis C. Younger 1235 Tenth Street Berkeley, CA 94710	
41	Mr. James Brown United Technology Power Systems Div. P. O. Box 109 South Windsor, CT 06074	
42	Robert Busch Corporation Attn: H. P. Lachner 2800 South 25th Ave. Broadview, IL 60153	

Mailing Number	Addressee	Respondent Accession Number
43	CALSPAN Corporation Attn: D. H. Bock P. O. Box 235 Buffalo, NY 14221	104
44	Carnegie Mellon University Electric Engineering Department Attn: Dr. Ronald Krutz Pittsburgh, PA 15213	
45	Center for Environmental and Energy Studies Attn: Dr. Kenneth D. Johnson, Director P. O. Box 1247 Huntsville, AL 35807	
46	A. A. Chilenskas Argonne National Laboratory 9800 South Cass Ave. Argonne, IL 60439	84
47	B. C. Christenson Battelle - Columbus Lab 505 King Ave. Columbus, OH 43201	
48	Chrysler Corporation Defense Space Group P. O. Box 757 Detroit, MI 48231	
49	Mr. George Ciprios, Project Head Electrochemical Technology Exxon Research & Engineering Co. Government Research Laboratories P. O. Box 8 Linden, NJ 07036	
50	Clark County Transportation Study Attn: David Young 118 S. Fourth Street Las Vegas, NV 89101	7
51	Compass Industries, Inc. 715 15th Street Hermosa Beach, CA 90254	

Mailing Number	Addressee	Respondent Accession Number
52	Computer Sciences Corporation Attn: Program Development, Admin. Office 6565 Arlington Boulevard Falls Church, VA 22046	41
53	Consultant, Ltd. Attn: Mr. Clarence R. Jones President 3445 Walton Way P. O. Box 1508 Augusta, GA 30903	
54	Copper Development Assoc. Attn: Mr. Gene Kinelski P. O. Box 716 McLean, VA 22101	
55	Copper Development Association Attn: Don Miner, Manager 430 N. Woodward Avenue Birmingham, MI 48011	
56	M. A. Cordner Sundstrand Aviation Rockford, IL	
57	Creative Automotive Research Attn: Erwin A. Ulbrich, Chief Engineer 8136 Byron Road, Suite G Whittier, CA 90606	6
58	Creative Research Attn: Larry Nalley, President P. O. Box 186 Roebuck, SC 29376	
59	Cummins Engine Co., Inc. Attn: Mr. Vid Beldavs - 1011 Columbus, IN 47201	
60	Decision Planning Corporation Attn: Kathy Houghtaling 3184 A. Airway Avenue Costa Mesa, CA 92626	

Mailing Number	Addressee	Respondent Accession Number
61	John Z. Delorean Corp. Attn: Mr. M. R. Harvey P. O. Box 427 Bloomfield Hills, MI 48013	
62	Derl Manufacturing Company Attn: Mr. Erwin Meeks 2730 N. Slater Avenue Compton, CA 90222	
63	Design Plus Attn: Donald May 1739 Woodmoor Drive Monument, CO 80132	
64	Diagnostic & Inspection Service Co. Attn: Richard Bird 6140 West Chestnut Avenue Littleton, CO 80123	
65	Die Mesh Corporation Attn: Mr. Domenic Borello, President 629 Fifth Avenue Pelham, NY 10803	
66	Dimension V. Inc. Attn: James H. Muir, President 598 Seabreeze Drive Indialantic, FL 32903	52
67	Mr. Douglas Dow Consulting Engineer P. O. Box 14078 Detroit, MI 48214	72
68	Dynamic Science Inc. Attn: Bert Enserink Director, Technical Support Services 1859 West Pinnacle Peak Road Phoenix, AZ 85027	36
69	Eaton Corporation Attn: Dr. Lamont Eltinge 26201 Northwestern Highway Southfield, MI 48076	

Mailing Number	Addressee	Respondent Accession Number
70	Edwards Electronics Corp. Attn: Bill Edwards 44 Railroad Ave. Glen Head, NY 11545	44
71	EIC Corporation Attn: Mr. S. E. Bascom Office Administrator 55 Chapel Street Newton, MA 02158	
72	EIC, Inc. Attn: Mr. John McHardy 55 Chapel Street Newton, MA 02158	
73	Elcar Corporation Attn: Leon Shalmasarian President 2118 Bypass Road P. O. Box 937 Elkhart, IN 46514	
74	F. T. Elder University of Wisconsin 1500 Johnson Dr. Madison, WI 53706	87
75	Electra-Van A Division of Jet Industries Attn: William Bales, President 2503 Edgewater Drive Austin, TX 78746	
76	Electric Auto Association Attn: Walter V. Laski President 1674 Merrill Dr., No. 12 San Jose, CA 95124	
77	Electric Auto Corporation Attn: Robert Aronson, Consultant P. O. Box 11,414 Caparra, PR 00922	

Mailing Number	Addressee	Respondent Accession Number
78	Electric Dynamics Corporation Attn: James C. Boylan President 607 North Main Street Plainwell, MI 49080	15
79	Electric Fuel Propulsion Attn: Robert Aronson, President 2237 Elliott Avenue Troy, MI 48084	
80	Electric Passenger Cars, Inc. Attn: P. H. Rubie, President 5127 Galt Way San Diego, CA 92117	
81	Electric Power Research Institute Dept. of Energy Management & Utilization Technology Attn: Dr. Fritz R. Kalhammer 3412 Hillview Avenue P. O. Box 19412 Palo Alto, CA 94303	39
82	Electric Power Research Institute Fuel Cells and Chemical Energy Conversion Attn: Mr. Arnold Fickett, Program Manager P. O. Box 10412 Palo Alto, CA 94303	
83	Electric Vehicle Associates Attn: Warren Harhay, President 9100 Bank Street Cleveland, OH 44125	16
84	Electric Vehicle Council Attn: Mr. Edward Campbell, Sec. 90 Park Ave. New York, NY 10016	28
85	Electric Vehicle Council Attn: Mr. Charles Zegers 90 Park Avenue New York, NY 10016	

Mailing Number	Addressee	Respondent Accession Number
86	Electric Vehicle Engineering Attn: Wayne Goldman, President P. O. Box 1 Lexington, MA 02173	
87	Electric Vehicles of Ohio Attn: Robert D. Childs 9135 Fernwood Drive Olmsted Falls, OH 44138	26
88	Encomp Systems, Limited Attn: J. Pugliso 50 Union Avenue Irvington, NJ 07111	
89	Energy Research Corporation Attn: Mr. Bernard Baker Three Great Pasture Road Danbury, CT 06810	
90	Energy Research and Generation, Inc. Attn: Mr. Glen M. Benson, PhD 952 57th Street Oakland, CA 94608	
91	Environmental Homes & Systems Attn: Mr. Steven Shurtz 3285 Circle S. Drive Ammon, ID 83401	
92	Environmental Research Institute of Michigan Attn: Mr. William M. Brown, President P. O. Box 618 Ann Arbor, MI 48107	
93	ESB Incorporated Attn: Dr. George Kugler P. O. Box 336 Yardley, PA 19067	59
94	ESB Incorporated Attn: Mr. C. F. Viglotti, Corporate Technical Rep. 1000 - 16th Street NW Washington, DC 20036	

Mailing Number	Addressee	Respondent Accession Number
95	ESB Incorporated Attn: Jim Norberg P. O. Box 8109 Philadelphia, PA 19101	
96	EVC, Inc. Attn: Mr. Strumpell 9016 Aviation Blvd. Inglewood, CA 90301	81
97	Exxon Enterprises Attn: R. L. Ricci P. O. Box 192 Florham Park, NY 07932	30
98	Exxon Research and Engineering Co. Government Research Laboratories Attn: Mr. George Ciprios, Project Head Electrochemical Technology P. O. Box 8 Linden, NH 07036	
99	Eyeball Engineering Electric Vehicles and Components Attn: Ed Rannberg 7915 Spohn Ave. Fontana, CA 92335	
100	Fairchild Republic Division Manned Space Systems Engineer Attn: Mr. Bert Cooper, Program Manager Farmingdale, Long Island, NY 11735	
101	Federal Power Commission Attn: Walter S. Lusby Room 9200 Washington, DC 20426	
102	Fiber Science, Inc. 222 West 2700 South Salt Lake City, UT 84115	
103	Mr. Arnold Fickett, Program Manager Fuel Cells & Chemical Energy Conversion Electric Power Research Institute P. O. Box 10412 Palo Alto, CA 94303	

Mailing Number	Addressee	Respondent Accession Number
104	Mr. Eugene Findl ARK Research 55 Rome Street Farmingdale, NY 11735	
105	Fluid Drive Engineering Co. Attn: Joseph Saliber 313 Hibbard Road Wilmette, IL 00091	
106	FMC Corporation Engineered Systems Division Attn: Jeanne H. Jones 328 Brokaw Road, Box 450 Santa Clara, CA 95052	69
107	Ford Motor Company Attn: Mr. Jack Collins Suite 200, Parkland Towers East 1 Parklane Boulevard Dearborn, MI 48126	
108	Ford Motor Company Advanced Engineering Dept. (Design Center) Attn: Mr. John La Ford 21175 Oakwood Blvd. Dearborn, MI 48124	
109	Ford Motor Company Electrical Systems Department Attn: Mr. Lewis E. Unnewehr Room S-2106 P. O. Box 2053 Dearborn, MI 48121	85
110	Ford Motor Company Systems Research Lab Attn: Dr. David F. Moyer, Director Box 2053 Dearborn, MI 49121	
111	Albert J. Forte Associates Attn: Mr. Albert J. Forte, Jr. 7700 Arlington Blvd. Suite 100 Falls Church, VA 22046	

Mailing Number	Addressee	Respondent Accession Number
112	The Franklin Institute Attn: E. B. Rosenberg Proposals Manager 20th and Parkway Philadelphia, PA 19103	31
113	Friends of the Sun 210 Main Street Brattleboro, VT 05301	
114	Future Concepts Attn: Kenneth C. MacNeill P. O. Box 9478 Winter Haven, FL 33880	
115	Garrett Corporation Attn: Mr. J. Martin Market Analyst P. O. Box 92245 Los Angeles, CA 90009	
116	Garrett Corporation Attn: Mr. Gene Souva 9851 Sepulveda Los Angeles, CA 90009	
117	G.B.E.V. Attn: Bud Rogan 224 Hannes Street Silver Spring, MD 20901	
118	GEL Inc. Attn: Ralph Zito 1511 Peaco Street Durham, NC 27701	
119	General Electric Research and Development Center Attn: Mr. A. M. Bueche, Vice President 1 River Road Schenectady, NY 12306	58
120	General Electric Co. Attn: Robert J. Hofmann 1501 Roanoke Boulevard Salem, VA 24153	

Mailing Number	Addressee	Respondent Accession Number
121	G.E. Co., Direct Energy Conv. Attn: Mr. James G. McElroy 50 Fortham Rd., Bldg. 1A Wilmington, MA 01887	
122	General Electric Research & Development Attn: Robert Guess Program Manager P. O. Box 8 Schenectady, NY 12301	75
123	General Motors Corporation Delco Electronics Division Attn: Mr. B. J. Collins 6767 Hollister Avenue Goleta, CA 93017	
124	General Motors Technical Center General Motors Transportation Systems Division Attn: Mr. Edwin Bowen Warren, MI 48090	
125	General Motors Technical Center General Motors Transportation Systems Div. Attn: Mr. Walt Cattin Warren, MI 48090	83
126	General Motors Technical Center General Motors Transportation Systems Division Attn: Ron Cousineau Marketing Manager Warren, MI 48090	
127	General Motors Technical Center General Motors Transportation Systems Division Attn: Mr. S. Romano, Mgr., Systems Applications Warren, MI 48090	
128	Georgia Tech Attn: Mr. Steve Dickerson Mechanical Engineering Atlanta, GA 30332	
129	Gilbert Associates Attn: Steven Griffith Suite 1201 1828 L Street N.W. Washington, DC 20036	42

Mailing Number	Addressee	Respondent Accession Number
130	Global Scientific Consultants, Inc. Attn: Mr. Vincent E. Carman, President 10320 N.E. Marx Street Portland, OR 97220	
131	Globe Union Inc. Globe Battery Division Attn: Mr. Vincent Hasall 5757 North Green Bay Ave. Milwaukee, WI 53201	54
132	Dr. G. Goodman Globe Union Inc. P. O. Box 591 Milwaukee, WI 53201	13
133	Gould, Inc. Attn: David Douglas V.P. Contract Research 40 Gould Center Rolling Meadows, IL 60008	47
134	Gould, Inc. Attn: Mr. Richard Steiner 30 Gould Center Rolling Meadows, IL 60008	
135	GSE, Inc. Attn: Vincent E. Carman, President 11125 S.W. Barbur Bl. Portland, OR 97219	
136	Gulf and Western Advanced Development & Engineering Center Attn: M.I. Weiss, Associate Director, Operations 101 Chester Road Swarthmore, PA 19081	
137	Individual (Name and address with-held from publication)	
138	Dr. Douglas Hamilton Department of Electrical Engineering University of Arizona Tucson, AZ 85721	

Mailing Number	Addressee	Respondent Accession Number
139	Individual (Name and address with-held from publication)	
140	Helio Precision Products, Inc. Civil Air Terminal Attn: Mr. Lynn Bollinger Hanscom Field Bedford, MA 01730	
141	City of Henderson Attn: Robert Wilson Planner 243 Water Henderson, NV 89051	
142	Honeywell - Urban and Environmental Systems Attn: Mr. Jerry Moylan 2600 Ridgway Parkway Minneapolis, MN 55413	77
143	Hunter Manufacturing Company Attn: Mr. John S. Kennedy, Jr. Sales Mgr. Military Prod. 30525 Aurora Road Solon, OH 44139	46
144	Hybrid Motors, Inc. Attn: Mr. Alan Hirasuna 712 Narcissus Avenue Corona Del Mar, CA 92625	
145	IIT Research Institute Attn: Mr. Gastone Chingari 1825 K. Street Washington, DC 20006	67
146	IIT Research Institute Attn: Mr. I. B. Fieldhouse 10 West 35th Street Chicago, IL 60616	
147	IIT Research Institute Attn: Mr. Owen Viergutz 10 West 35th Street Chicago, IL 60616	

Mailing Number	Addressee	Respondent Accession Number
148	IMI Inc. Attn: Mr. Gerald L. Mahoney 2000 N. Highway 67 Florissant, MO 63033	
149	International Energy Systems Corp. Attn: Mr. John A. Bowles 3000 Sand Hill Road Menlo Park, CA 94025	51
150	Individual (Name and address with-held from publication)	
151	Jet Industries, Inc. Suite 414 1200 Westlake Avenue, E. Seattle, WA 98109	
152	JMJ Electronics Corporation V. P. Marketing & Development Attn: Ms. Marie Hinshaw Miskovsky P. O. Box 25971 Oklahoma City, OK 73125	
153	D. W. Kassekert Westinghouse Electric Research and Development Beulah Road Pittsburgh, PA 15235	
154	Kaylor Energy Products Attn: Mr. Roy Kaylor, President 1918 Minelto Avenue Menlo Park, CA 94025	10
155	Individual (Name and address with-held from publication)	2
156	Kinergy Research & Development Attn: Laura Omohundro P. O. Box 1128 Wake Forest, NC 27587	57
157	Mr. Fred Klemsch Consultant 730 - 24th Street, N.W. Washington, DC 20037	

Mailing Number	Addressee	Respondent Accession Number
158	Individual (Name and address with-held from publication)	
159	KORFF Corporation Attn: Mr. Walter H. Korff President and Gen. Mgr. 449 North Lamer Street Burbank, CA 91506	12
160	A. Kusko U. S. Dept. of Transportation Transportation Systems Center Cambridge, MA	
161	LAD Industries Attn: Lester A. Daggett President 1555 W. Anaheim Long Beach, CA 90813	
162	Lavelle Aircraft Co. Attn: Mr. R. Wilks Sterling Street Newtown, PA 18940	
163	Lawrence Livermore Laboratory Attn: Dick Epps P. O. Box 808 Livermore, CA 94550	
164	Lead Industries Association Attn: Connel A. Baker 292 Madison Ave. New York, NY 10017	
165	Lead Industries Association Attn: Courvel A. Bauer, Jr. 292 Madison Ave. New York, NY 10017	
166	Lectran Attn: Ray L. Boeger 5452 Business Drive Huntington Beach, CA 92649	99

Mailing Number	Addressee	Respondent Accession Number
167	Lester Equipment Manufacturing Co., Inc. Attn: Don Wilson 2840 Coronado Street Anaheim, CA 92806	88
168	LILCO Attn: Mr. Dan Carolin 250 Old Country Road Mineola, NY 11501	
169	A. W. Liles Exxon Enterprises Inc. P. O. Box 192 Florham Park, NY 07932	
170	Linear Alpha Co., Inc. Attn: Dr. E. H. Wakefield 1927 Sherman Avenue Evanston, IL 60201	91
171	Individual (Name and address with-held from publication)	
172	Individual (Name and address with-held from publication)	27
173	LPI Data Communications Systems, Inc. Attn: Mr. Warren Barnhart 146 N. 13th Street Philadelphia, PA 19107	
174	A. Mac'D Engineering 1A033 1235 Ashland Ave. Wilmette, IL 60091	
175	A. C. Malliaris U. S. Dept. of Transportation Transportation Systems Center Cambridge, MA.	
176	Management Consultant Services Attn: Mr. Charles Klabosh P. O. Drawer 5690 Jacksonville, FL 32207	

Mailing Number	Addressee	Respondent Accession Number
177	Marshall Oil Company, Inc. Attn: Herbert Marshall President P. O. Box 1123 Wake Forest, NC 27587	
178	Maxon Industries, Inc. Attn: Murray Lugash 1960 E. Slauson Avenue Huntington Park, CA 90255	
179	M. B. Associates Bollinger Canyon Road San Ramon, CA 94583	79
180	McDonnell Douglas Astronautics Company Donald W. Douglas Laboratories Attn: Mr. George D. Morse, Marketing Manager 2955 George Washington Way Richland, WA 99352	
181	Mr. James G. McElroy G.E. Co., Direct Energy Conv. 50 Fordham Rd., Bldg. 1A Wilmington, MA 01887	
182	McKee Engineering Corporation Attn: Robert McKee, President 411 West Colfax Palatine, IL 60067	19
183	MGA Research Corporation Attn: Mr. Rudy H. Arendt Cambridge Square Building 4245 Union Road Buffalo, NY 14225	
184	Mechanical Technology, Inc. Attn: Mr. R. Hohenberg 968 Albany Shaker Road Latham, NY 12110	32
185	Mechanical Technology, Inc. Attn: Dr. Beno Sternlicht Technical Director 968 Albany Shaker Road Latham, NY 12110	

Mailing Number	Addressee	Respondent Accession Number
186	Melcon Systems Design Consultants Attn: Thomas R. Seaton 1200 Quail Street, Suite 150 Newport Beach, CA 92660	5
187	Metal Specialists Inc. Attn: Fred Homann, President 16440 Common Road Roseville, MI 48066	35
188	Meteor Research Limited Attn: Mr. W. H. Fengler 29440 Calahan Avenue Roseville, MI 48066	90
189	L. E. Miller Eagle-Picher Industries Inc. P. O. Box 47 Joplin, MO 64801	
190	Minicars, Inc. Attn: Mr. Donald Wahl 35 La Patera Lane Goleta, CA 93017	80
191	Mr. John N. Murray, Project Manager Teledyne Energy Systems 110 West Timonium Rd. Timonium, MD 21093	
192	Murrill Motors Co. Madison Plaza Professional Park 5777 Madison Ave., Suite 880 Sacramento, CA 95841	38
193	J. D. Musil Iowa State University Cooper Hall (EE) Ames, IA 50011	78
194	Narama Ventures Attn: Roger A. Wendt Box 192 Londonderry, NH 03053	

Mailing Number	Addressee	Respondent Accession Number
195	National Economic Research Associates Consulting Economists Attn: V. A. Donahue 225 Franklin Street Boston, MA 02110	
196	National Motors Corp. Attn: Warren H. Barnhart P. O. Box 1523 Lancaster, PA 17604	
197	National Motors Corp. Attn: Darryl Kane, President P. O. Box 1523 Lancaster, PA 17604	110
198	Northwestern University Electric Engineering Department Attn: Dr. Gordon Murphy 2145 Sheridan Road Evanston, IL 60201	
199	Northwind Power Company Attn: Mr. David Sellers P. O. Box 315 Warren, VT 05674	
200	NUS Corporation Attn: Evelyn Veeder Four Research Place Rockville, MD 20850	4
201	Individual (Name and address with-held from publication)	
202	ONAN Corporation Attn: David Burns, Staff Engineer 1400 - 73rd Ave., N.E. Minneapolis, MN 55432	
203	ONAN Corporation Attn: Peter H. Cerf 1400 73rd Avenue N.E. Minneapolis, MN 55432	

Mailing Number	Addressee	Respondent Accession Number
204	Individual (Name and address with-held from publication)	
205	Dr. B. B. Owens Gould Inc. P. O. Box 3140 St. Paul, MN 55165	
206	Packaged Promotions, Inc. Attn: Mr. Al Masters 549 W. Randolph Chicago, IL 60606	
207	Individual (Name and address with-held from publication)	
208	Prestolite Company Attn: Mr. Jack Carey 511 Hamilton Street Toledo, OH 43694	103
209	Progress Industries, Inc. Attn: Ken Busche 7290 Murdy Circle Huntington Beach, CA 92647	
210	Proposal Management, Inc. Attn: Charles A. Mirenda 121 N. Orianna Street Philadelphia, PA 19106	
211	Prototype Development Associated Inc. Attn: John Slaughter 1740 Garry Avenue Santa Ana, CA 92705	
212	Power Electronics Assoc., Inc. Attn: Mr. Francis C. Schwarz Round Hill Road Lincoln, MA 01773	
213	Powertrain, Inc. Attn: Mr. Alfred Blackerby 3665 S. 300 West Salt Lake City, UT 84115	43

Mailing Number	Addressee	Respondent Accession Number
214	Purdue University Krannert Graduate School of Management Attn: Professor Donald King West Lafayette, IN 47907	
215	Raytheon Company Attn: Mr. Eugene McManus, Marketing Manager Bedford, MA	45
216	REI Attn: E. Papandreas 1209 Lake Avenue Lake Worth, FL 33460	100
217	Research Design and Development Lab. Attn: Mr. B. B. Criswell 2285 Dresden Drive Chamblee, GA 30341	
218	Research Laboratories General Motors Technical Center Attn: Dr. Paul Chenea, Vice President Warren, MI 48090	
219	Rockwell International Atomics International Division Attn: Mr. J. D. Gylfe, Director Marketing 8900 De Soto Ave. Canoga Park, CA 91305	
220	Rockwell International Rocketdyne Division Attn: Mr. R. E. Aukerman, Manager Business Development 6633 Canoga Avenue Canoga Park, CA 91304	
221	Rockwell International Rocketdyne Division Attn: Dr. D. E. Davis 6633 Canoga Avenue Canoga Park, CA 91304	
222	Individual (Name and address with-held from publication)	

Mailing Number	Addressee	Respondent Accession Number
223	RMS International Attn: Frank Rymer 900 S. Wash Street Falls Church, VA 22046	
224	Dr. A. J. Salkino ESB Inc. 19 West College Ave. Yardley, PA 19067	
225	Salsbury Industries Attn: Mr. John Fraher 1010 East 62nd Street Los Angeles, CA 90001	3
226	Salt River Project Attn: Mr. Lee Athmar, Manager P. O. Box 1980 Phoenix, AZ 85001	
227	H. J. Schwartz NASA Lewis Research Center 21000 Brookpark Rd. Cleveland, OH 44135	
228	Individual (Name and address with-held from publication)	
229	Science Applications, Inc. Attn: E. J. McGrath, Vice President 1200 Prospect St. P. O. Box 2351 La Jolla, CA 92038	
230	Sebring Vanguard Attn: Robert Beaumont President 9130 Red Branch Road Columbia, MD 21044	102
231	Sierra Solar Systems, Inc. Attn: Mr. Karl R. Steward P. O. Box 310 Nevada City, CA 95959	34

Mailing Number	Addressee	Respondent Accession Number
232	Simulation Physics, Inc. Attn: Mr. T. E. Wilber Patriot Park Bedford, MA 01730	
233	Paul R. Skipps 3E Vehicles P. O. Box 19409 San Diego, CA 92119	
234	Solar Division of International Harvester Attn: Payne Johnson, Director, Public Relations and Advertising 2200 Pacific Hwy. P. O. Box 80966 San Diego, CA 92138	
235	South Coast Technology, Inc. Attn: Harold M. Siegel P. O. Box 3265 Santa Barbara, CA 93105	22
236	Southern California Edison Company Attn: David L. Harbaugh, P.E. 7830 Otis Avenue Huntington Park, CA 90255	60
237	Southern Illinois University at Carbondale Dept. of Design Attn: Richard E. Archer Carbondale, Illinois 62901	
238	Southwest Research Institute 8500 Culelra Road P. O. Drawer 28510 San Antonio, TX 78284	
239	Sowers, Wood & Associates, Inc. Attn: Jim Sowers, Managing Director P. O. Box 241 Old Greenwich, CT 06870	
240	Individual (Name and address with-held from publication)	

Mailing Number	Addressee	Respondent Accession Number
241	R. H. Sparks MS M1/1208 TRW Systems Inc. One Space Park Redondo Beach, CA 90278	71
242	SRI International Attn: Phillip J. O'Donnell, Contract Relations 333 Ravenswood Avenue Menlo Park, CA 94025	
243	Stackhouse Associates Attn: Terry Kirk P. O. Box 164 Manhattan Beach, CA 90266	
244	Stearman Aircraft Products Corp. Attn: Ronald Stearman P. O. Box 156 Valley Center, KS 67147	
245	Stewart-Warner Corporation Attn: M. E. Boland 425 - 13th Street, N.W. Washington, DC 20004	
246	Stitts Research and Development Attn: Edward W. Stitt Highway 23 Churchtown, PA 17510	50
247	Structural Plastics, Inc. Attn: William Gillespie, President 1133 S. 120th East Avenue Tulsa, OK 74128	
248	System Development Corporation Attn: Emma Cook 7929 Westpark Drive McLean, VA 77101	56
249	System Development Corporation Attn: Mr. Joseph F. Selement, Director Program Development 7929 Westpark Drive McLean, VA 77101	

Mailing Number	Addressee	Respondent Accession Number
250	Techmedia Corporation 121 N. Orianna Street Philadelphia, PA 19106	
251	Technical Operations, Inc. Savcon Division Attn: Sonja Sokol 40 South Avenue Burlington, MA 01803	
252	Teledyne Energy Systems Attn: Mr. John N. Murray, Project Manager 110 West Timonium Rd. Timonium, MD 21093	66
253	Tetra Hedron, Inc. 7605 Convoy Ct. San Diego, CA 92111	
254	Texas A&M Research Foundation Attn: Mrs. Glenna M. Brundidge P. O. Faculty Exchange H College Station, TX 77843	
255	Texas A&M University Highway Safety Research Center Texas Transportation Institute Attn: Mr. Don L. Ivey, Head College Street, TX 77843	93
256	Trafalgar Limited 4109 Jackson Road Ann Arbor, MI 48103	94
257	Transoceanic Attn: Mr. Jack Redmond 901 Mayfair Champaign, IL 61820	
258	Trans Systems Corporation Attn: Mrs. Elizabeth Beyer 118 Park Street, S.E. Vienna, VA 22180	62

Mailing Number	Addressee	Respondent Accession Number
259	Triad Services Attn: Michael Pocabello, President 10611 Haggerty Street Dearborn, MI 48126	20
260	TRW, Inc. Energy Systems Group of TRW, Inc. Attn: Dr. George H. Gelb One Space Park R1/1086 Redondo Beach, CA 90278	23
261	Turelec, Incorporated Attn: Mr. Harry Grepke 1915 29th Avenue, N.W. Brandenton, FL 33505	
262	Unique Mobility, Inc. Attn: John Gould, President 3720 South Jason Englewood, CO 80110	
263	United Technology Power Systems Div. Attn: Mr. James Brown P. O. Box 109 South Windsor, CT 06074	
264	University of Arizona Department of Electrical Engineering Attn: Dr. Douglas Hamilton Tucson, AZ 85721	
265	University of California, Irvine Mechanical Engineering Department Attn: Mr. Paul Arthur Irvine, CA 92717	
266	University of Colorado Dept. of Electrical Engineering Attn: George Gless Boulder, CO 80302	82
267	University of Florida Dept. of Mechanical Engineering Attn: Vernon P. Roan Gainsville, FL 32611	

Mailing Number	Addressee	Respondent Accession Number
268	University of Michigan Mechanical Engineering Attn: Gene E. Smith, Associate Professor Ann Arbor, MI 48104	
269	University of Michigan Highway Safety Research Institute Attn: Mr. Len Newland Ann Arbor, MI 48109	106
270	University of Virginia Department of Electrical Engineering Attn: Dr. Gerald Cook Charlottsville, VA 22901	
271	University of Virginia School of Engineering and Applied Science Attn: Professor Eugene S. McVey Charlottesville, VA 22901	
272	University of Wisconsin Engineering Research Building Attn: Professor Norman Beachley 1500 Johnson Drive Madison, WI 53706	61
273	University of Wisconsin Engineering Research Building Attn: Prof. A. Frank 1500 Johnson Drive Madison, WI 53706	70
274	USERDA Chicago Operations Office Attn: John Purcell 175 W. Jackson Street Chicago, IL 60604	
275	Vehicle Systems Development Corporation Attn: Mr. Robert W. Forsyth, President 1251 W. Ninth Street P. O. Box 346 Upland, CA 91786	

Mailing Number	Addressee	Respondent Accession Number
276	Vicom International, Inc. Attn: Mr. Don Jensen 200 Park Avenue Suite 303 East New York, NY 10017	
277	Virginia Polytechnic Institute and State University Attn: Mr. Norman E. Lau Blacksburg, VA 24061	68
278	C. H. Waterman Industries Attn: C. H. Waterman, President White Pond Road Athol, MA 01331	64
279	Wed Enterprises Attn: Bill Watkins Sr. Project Engineer 1401 Flower Street Glendale, CA 91201	
280	Western Automation Inc. Attn: Douglas K. Robinson 621-D West Valencia Drive Fullerton, CA 92632	
281	Western Research Industries 3013 West Sahara Ave. Las Vegas, NV 89102	
282	Westinghouse Research Laboratories Energy Systems Research Attn: Dr. Daniel Berg, Director Beulah Road Pittsburgh, PA 15235	
283	Dr. F. Will General Electric Company Research and Development Labs P. O. Box 43 Schenectady, NY 12301	
284	Williams Research Corporation Attn: Mr. William Bauer 2280 W. Maple Road Walled Lake, MI 48088	107

Mailing Number	Addressee	Respondent Accession Number
285	Individual (Name and address with-held from publication)	
286	Wolverine Diesel Power Co. Attn: J. F. Corcoran, President 2880 Aero Park Drive Traverse City, MI 49684	
287	Wood-Ivey Systems Corporation Attn: Mr. Ivey P. O. Box 4609 Winterpark, FL 32793	14
288	Andrew Wortman Developments Aero-Propulsion Consulting Attn: Mr. A. Wortman 406 Alta Avenue Santa Monica, CA 90402	48
289	Mr. Victor Wouk Consultant 342 Madison Avenue, Suite 831 New York City, NY 10017	111
290	Yardney Electric Corp. Attn: Mr. Steve Schiffer 82 Mechanic Street Pawcatuck, CT 02891	76
291	Individual (Name and address with-held from publication)	49
292	Zeonics Corporation Attn: Mr. Al Long 4085 Chain Bridge Road Fairfax, VA 22030	

APPENDIX B

QUESTIONNAIRE RESPONDENTS

Respondent Accession Number	Respondent
1	R. L. Gradishar Secretary-Treasurer Advanced Kinetics, Inc. 1231 Victoria St. Costa Mesa, CA 92627
2	**Individual** **(Name and address with-held from publication)** Forwarded his questionnaire to: Mr. J. R. Harkness Vice President Briggs and Stratton Co. Milwaukee, WI
3	John P. Fraher President Management Salsbury Industries 1010 E. 62 St. Los Angeles, CA Phone: (213) 232-6181
4	Evelyn L. Veeder Proposal Coordinator Federal Government Operations NUS Corporation 4 Research Place Rockville, MD 20850 Phone: (301) 948-7010
5	Howard J. Reid Consultant Melcon Systems Design Consultants 1200 Quail St. Newport Beach, CA 92660 Phone: (714) 752-8636

Respondent Accession Number	Respondent
6	Erwin A. Ulbrich Chief Engineer Creative Automotive Research Division Twenty First Century Electric Vehicles Bldg. G 8136 Byron Rd. Whittier, CA 90606 Phone: (213) 593-1246 Home Phone: (213) 696-4886
7	David Yancy Principal Planner Regional Street and Highway Commission Clark County Transportation Study P. O. Box 396 Las Vegas, NE 89101 Phone: (702) 386-4011 extension 484
8	Frank Verbeke President Alturdyne 8050 Armour San Diego, CA 92111 Phone: (714) 565-2131
9	B. H. Rowlett Program Manager 93-8 AiResearch Mfg. Co. 2525 W. 190th St. Torrance, CA 90509 Phone: (213) 323-9500 extension 3638
10	Roy Kaylor President Kaylor Energy Products 1918 Menalto Ave. Menlo Park, CA 94025 Phone: (415) 325-6900
11	John Brennand Member of Technical Staff General Research Corporation P. O. Box 3587 Santa Barbara, CA 93105 Phone: (805) 964-7724

Respondent Accession Number	Respondent
12	Walter H. Korff President and General Manager Korff Corp. 449 N. Lamer St. Burbank, CA 91506 Phone: (213) 848-2239
13	G. Goodman Manager Corporate Applied Research Group Globe-Union Inc. 5757 N. Green Bay Ave. Milwaukee, WI 53201 Phone: (414) 228-2364
14	H. Reese Ivey Vice President Wood-Ivey Systems Corp. P. O. Box 4609 Winter Park, FL 32793 Phone: (305) 678-6116
15	James C. Boylan President Electric Dynamics Corporation (Corporation is being 607 North Main Street liquidated) Plainwell, MI 49080
16	Warren Harhay President Electric Vehicle Associates Inc. 9100 Bank St. Cleveland, OH 44125 Phone: (216) 524-8418
17	Arthur E. Raynard Senior Project Engineer 93-8 AiResearch Manufacturing Company T-41 Building 36 2525 West 190th Street Torrance, CA 90509 Phone: (213) 323-9500 extension 2881

Respondent Accession Number	Respondent
18	Bogdan W. Bernert President B. I. E. - Bernert International Engineers 7615 Greenback Lane Citrus Heights, CA 95610 Phone: (916) 726-0450
19	Robert S. McKee President McKee Engineering Corp. 411 W. Colfax St. Palatine, IL 60067 Phone: (312) 358-6773
20	M. A. Pocobello President Triad Services, Inc. 10611 Haggerty St. Dearborn, MI 48126 Phone: (313) 584-0751
21	August G. Hebel, Jr. Chairman - Chief Executive Officer Practical Research Bonal Corporation 1257 18th St. Detroit, MI 48216 Phone: (313) 496-1740
22	Robert Schwarz Director of Engineering South Coast Technology P. O. Box 3265 Santa Barbara, CA 93105 Phone: (805) 964-4749
23	George H. Gelb Mgr. Energy Applications Advanced Technology Laboratory TRW Systems and Energy R1/1086 One Space Park Redondo Beach, CA 90278 Phone: (213) 535-2500

Respondent Accession Number	Respondent
24	R. W. Burn Research Supervisor U.S.D.O.E. Bartlesville Energy Research Center P. O. Box 1398 Bartlesville, OK 74003 Phone: (918) 336-2400
25	Vaughn R. Anderson Director of Hydrogen Engine/Vehicle Research Hydrogen Engine/Vehicle Division Billings Energy Corp. 2000 E. Billings Ave. P. O. Box 555 Provo, UT 84601 Phone: (801) 375-0000
26	Robert D. Childs Electric Vehicles of Ohio 9135 Fernwood Drive Olmsted Falls, OH 44138
27	Elmo M. Long Director St. Elmo Hybrids 1048 Van de Venter Street W. Palm Beach, Florida 33405 Phone: (305) 832-6986
28	Edward A. Campbell Executive Secretary Electric Vehicle Council 90 Park Avenue New York, NY 10016 Phone: (212) 573-8785
29	Benjamin Barron Technical Director Bogue Electric Manufacturing Company 100 Pennsylvania Avenue Patterson, NJ 07509 Phone: (201) 525-2200

Respondent Accession Number	Respondent
30	R. L. Ricci Project Manager Electric Power Conversion Systems Exxon Enterprises Inc. P. O. Box 192 Florham Park, NJ 07932 Phone: (201) 474-5274
31	C. A. Belsterling, Mgr., E.E. Franklin Institute Research Labs Ben Franklin Parkway Philadelphia, PA 19103 Phone: (215) 448-1235
32	Antonio F. Artiles Analytical Engineer Engineering Dept., R&D Division Mechanical Technology Inc. 968 Albany Shaker Rd. Latham, NY 12110 Phone: (518) 785-2435
33	B. Borisoff, P. E. Borisoff Engineering Co. Electric Transportation Equipment 7726 Burnet Avenue Van Nuys, CA 91405 Phone: (213) 988-5630
34	Karl R. Stewart Exec. Vice President Sierra Solar Systems, Inc. P. O. Box 310 Nevada City, CA 95959 Phone: (916) 272-3444
35	Roger H. Ducoffre Director of Sales Metal Specialists, Inc. 16440 Common Road Roseville, MI 48066 Phone: 773-0800
36	Bert Enserink Director, Technical Operations Dynamic Science, Inc. 1850 W. Pinnacle Peak Rd. Phoenix, AZ 85047 Phone: (602) 942-3300

Respondent Accession Number	Respondent
37	Lester Forrest Director, Vehicle Performance Office Mobile Systems Group The Aerospace Corporation Continental Bldg., Rm. 602 2350 East El Segundo Blvd. El Segundo, CA 90245 Phone: (213) 648-5752
38	Raymond Jacobs Vice President Management - Finance Murrill Motors 6163 Auburn Blvd. Citrus Heights, CA 95610 Phone: (916) 723-3377
39	E. A. Gillis Project Manager, Fuel Cell Systems Energy Management & Utilization Technology Dept. Electric Power Research Institute P. O. Box 10412 Palo Alto, CA 94303 Phone: (415) 493-4800 extension 108
40	Requested Information be Withheld
41	William E. Peugh Director, Program Development Computer Sciences Corporation M/C-B500 1616 N. Ft. Myer Drive, Suite 1209 Arlington, VA 22209 Phone: (703) 841-0250
42	Steven K. Griffith Planning Engineer Program Development Gilbert Associates, Inc. Suite 201 1828 L. St. N.W. Washington, DC 20036 Phone: (202) 331-0252

Respondent Accession Number	Respondent
43	A. A. Blackerby President Corporate Power-Train, Inc. 3665 South 300 West Salt Lake City, UT 84115 Phone: (801) 261-1616
44	W. C. Edwards President Edwards Electronic Corp. 44 Railroad Ave. Glenhead, NY 11545 Phone: (516) 759-1226
45	Eugene McManus Marketing Manager, Laboratory Support Technology Marketing and Planning Raytheon Company M1-46 Hartwell Road Bedford, MA 01730 Phone: (617) 274-7100 extension 4019
46	John Kennedy Hunter Mfg. Co. 30525 Aurora Rd. Solon, OH 44139
47	C. C. Christianson Associate Director - Energy Research Gould Laboratories - Energy Research Gould Inc. 40 Gould Center Rolling Meadows, IL 60008 Phone: (312) 640-4410
48	Dr. Andrew Wortman Principal Engineer AWD Inc. 406 Alta Ave. Santa Monica, CA 90402 Phone (213) 394-7332

Respondent Accession Number	Respondent
49	Paul Zaneni President Boulder Engineering, Inc. 3827 Thunderbird Dr. #46 Boulder, CO 80303 Phone: (303) 499-6757
50	Edward W. Stitt Research and Development Stitts Research and Development Highway 23 Churchtown, PA 17510 Phone: (215) 445-6821
51	John A. Bowles Director International Energy Systems Corporation 3000 Sand Hill Road Menlo Park, CA 94025 Phone: (415) 854-1124
52	J. Muir President Dimension V Inc. 598 Seabreeze Dr. Indialantic, FL 32903 Phone: (305) 724-1414
53	Bob Evans President Titan, Inc. P. O. Box 912, Temple City, CA 91780, Phone: (213) 286-1739 7915 Spohn Ave., Fontana, CA 92335, Phone: (714) 823-2114
54	Edward N. Mrotek Product Development Engineer Battery Engineering Globe Union Inc. 3XE 5757 N. Green Bay Ave. Milwaukee, WI 53201 Phone: (414) 228-2424
55	Requested information be withheld

Respondent Accession Number	Respondent
56	Fred A. Cohan Vice President System Engineering System Development Corp. 52-19 2500 Colorado St. Santa Monica, CA 90406 Phone: (213) 829-9562
57	Laura L. Omohundro Executive Assistant Kinergy Research & Development P. O. Box 1128 820 South Main Street Wake Forest, NC 27587 Phone: (919) 876-4963 (Research) (919) 556-2141
58	Raymond J. Twardzik System Engineer Corporate Research & Development General Electric Co. Bldg. 37-2083 Schenectady, NY 12345 Phone: (518) 385-0091
59	Theodore W. Blickwedel Senior Scientist ESB Technology Center (ESB Inc.) 19 West College Ave. Yardley, PA 19067 Phone: (215) 493-3601 extension 305
60	David L. Harbaugh, P.E. Automotive Engineer Automotive Services Southern California Edison Co. 7830 Otis Avenue. Huntington Park, CA 90255 Phone: (213) 570-1822
61	Norman H. Beachley Assoc. Professor Mechanical Engineering University of Wisconsin - Madison 1513 University Ave. Madison, WI 53706 Phone: (608) 262-3594

Respondent Accession Number	Respondent
62	John C. M. Wu President Trans Systems Corporation 118 Park St., S.E., Madison Bldg. Vienna, VA 22180 Phone: (703) 281-4498 (703) 281-1500
63	J. Arias Jeffrey L. Arias Engineering Services 9241 Cord Ave. Downey, CA 90240 Phone: (213) 801-4086
64	Albert Shelman Sales Manager Sales C. H. Waterman Industries White Pond Rd. Athol, MA 01331 Phone: (617) 249-6801 (212) 755-1077
65	Paul F. Bohn Section Supervisor Applied Physics Laboratory 1-E-156 Johns Hopkins Road Laurel, MD 20810 Phone: (301) 953-7100 extension 2193
66	Paul J. Dick Manager Advanced Programs Teledyne Energy Systems 110 W. Timonium Road Timonium, MD 21093 Phone: (301) 252-8220 Ext. 211, 212
67	Dennis W. Hanify Manager Mechanical & Systems Research IIT Research Institute 10 W. 35th St. Chicago, IL 60616 Phone: (312) 567-4751

Respondent Accession Number	Respondent
68	Dr. Walter W. Wierwille Professor IEOR Dept. Virginia Polytechnic Inst. & State Univ. 142 Whittemore Hall Blacksburg, VA 24061
69	David G. Curphey Manager, Civil Agencies Sector Government Operations Engineered Systems Div. FMC Corporation 328 Brokaw Road Santa Clara, CA 95050 Phone: (408) 289-2372
70	Prof. Andrew Frank Dept. of Elec. & Comp. Engr. University of Wisconsin - Madison 909 ERB 1500 Johnson Drive Madison, WI 53706 Phone: (608) 262-1577
71	R. H. Sparks MS M1/1208 TRW Systems Incorporated One Space Park Redondo Beach, CA 90278
72	Douglas Dow Consulting Engineer D. D. Consortium P. O. Box 14078 Detroit, MI 48214 Phone: (313) VA1-4900
73	Gordon F. Hayhoe Assistant Professor The Pennsylvania Transportation Institute Research Building B The Pennsylvania State University University Park, PA 16802 Phone: (814) 865-1891

Respondent Accession Number	Respondent
74	Gene W. Brown Sales Engineer Sales Engineering International Harvester 3301 Wayne Trace Ft. Wayne, IN 46803 Phone: (219) 461-6160
75	Dr. F. Will General Electric Co. Research and Development Labs. P. O. Box 43 Schenectady, NY 12301
76	John H. Kennedy Staff Director, NBDC Nickel Battery Development Center Yardney Electric Corp. 82 Mechanic Street Pawcatuck, CT 06379 Phone: (203) 599-1100 extension 368
77	Richard A. Evans Section Chief Energy Resources Center Honeywell Inc. MN17 T123 2600 Ridgway Parkway Minneapolis, MN 55413 Phone: (612) 378-4232
78	J. D. Musil Associate Professor Dept. of Electrical Engineering Iowa State University 107 Coover Hall Ames, IA Phone: (515) 294-4072
79	James L. Boyland Vice President MBA Associates San Ramon, CA 94583

Respondent Accession Number	Respondent
80	Michael Orchowski Senior Staff Analyst Minicars, Inc. 35 La Patera Lane Goleta, CA 93017 Phone: (805) 964-6271 extension 45
81	Mr. Strumpell EVC, Inc. 9016 Aviation Blvd. Inglewood, CA 90301
82	George E. Gless Professor Electrical Engineering University of Colorado ECOT 2-32 Boulder, CO 80309 Phone: (303) 492-7003
83	D. T. Lewis Sr. Staff Project Engineer Advance Product Engineering General Motors Corporation APE/2-E General Motors Technical Center Warren, MI 48090 Phone: (313) 575-1153
84	Fred Hornstra/William H. DeLuca, E.E. Chemical Engineering Div. Argonne National Laboratory 9700 S. Cass Ave. Bldg. 205 Argonne, IL 60439 Phone: (312) 739-7711 extension 5889
85	Lewis E. Unnewehr Principal Staff Engineer Electrical Systems Ford Motor Co. Research Lab, Rm. 3036 Box 2053 Dearborn, MI 48121

Respondent Accession Number	Respondent
86	Joseph M. Saluaggio Research Associate University of Alabama in Huntsville Johnson Environmental & Energy Center Box 1247 Huntsville, AL 35803
87	Frederick T. Elder Elder Engineering 7788 Cherry Wood Verona, WI 53593 Phone: (608) 836-3969
88	Don P. Wilson President Lester Equipment Mfg. Co., Inc. 2840 Coronado St. Anaheim, CA 92806 Phone: (714) 630-2260
89	Harold H. Valentine Section Head - Propulsion Systems Analysis Systems Analysis & Assessment Office NASA-LeRC 500-125 21000 Brookpark Road Cleveland, OH 44135 Phone: FTS 294-6347
90	W. H. Fengler Manufacturing Engineering Meteor Research Ltd. 29440 Calahan Road, Roseville, MI 48066, Phone: (313) 779-6800 23651 Fordson Drive, Dearborn, MI 48124, Phone: (313) 562-7629
91	Ernest H. Wakefield President Linear Alpha Inc. 1927 Sherman Ave. Evanston, IL 60201
92	B. T. Macauley/E. J. Peters/D. H. Anderson KO507 - New Concepts Research Department Ford Motor Company Scientific Research Lab. - Room S-1055 Dearborn, MI 48121 Phone: 32-29345/59-41563/32-21504

Respondent Accession Number	Respondent
93	D. L. Ivey Assistant Director & Head Highway Safety Research Center Texas Transportation Institute Texas A&M University College Station, TX Phone: (713) 845-1711
94	L. E. Waldorf Trafalgar, Ltd. 4109 Jackson Rd. Ann Arbor, MI 48103 Phone: (313) 769-3033
95	Requested information be withheld
96	Paul T. Vickers Asst. Dept. Head Engine Research Research Labs G. M. Corp. 12 Mile & Mound Roads Warren, MI 48090 Phone: (313) 575-2993
97	John S. Collman Department Head Power Systems General Motors Research Laboratories Warren, MI 48090 Phone: (313) 575-3144
98	Tsih C. Wang Assistant Head Electrical Engineering General Motors Corporation General Motors Research Laboratories Warren, MI 48090 Phone: (313) 575-3119
99	Cecil E. Dietrich President American Electric Car Company, Lectran Division 5452 Business Drive Huntington Beach, CA Phone: (714) 898-3933 (213) 431-3903

Respondent Accession Number	Respondent
100	W. A. Buzzell Senior Project Engineer Engineering REI 1209 Lake Ave. Lake Worth, FL 33460 Phone: (305) 588-1148
101	Gerald J. Roth Branch Chief/Technological Capabilities Branch Defense Intelligence Agency (DT-1A) Washington, DC 20301 Phone: OX-45860
102	Robert Sanders Vice President/Operations Sebring Vanguard Inc. P. O. Box 1479 Sebring, FL 33870 Phone: (813) 655-1835
103	Ralph W. Holmes Senior Engineer, Electric Vehicle Systems Mechanical Systems Engineering Prestolite, Electrical Division 511 Hamilton Street Toledo, OH 43694 Phone: (419) 244-2811
104	Ditmar H. Bock Principal Physicist Electronics (Defense Analyzer Systems) Calspan Corporation Box 235 Buffalo, NY 14221 Phone: (716) 632-7500 extension 781
105	John L. Gunter Manager New Business Development Boeing Computer Services Energy Technology Applications Division 38-09 P. O. Box 24346 Seattle, WA 98124 Phone: (206) 433-1373

Respondent Accession Number	Respondent
106	Paul Fancher Research Scientist Physical Factors Division University of Michigan Highway Safety Research Institute Huron Pkwy and Baxter Rd. Ann Arbor, MI 48109 Phone: (313) 764-2168
107	William Bauer Chief Applications Engineer Williams Research Corporation B2-1A 2280 W. Maple Road Walled Lake, MI 48088 Phone: (313) 624-5200
108	Patrick M. Miller President MGA Research Corporation 4245 Union Road Buffalo, NY 14225 Phone: (716) 634-6950
109	Phil Chapman Task Area Manager Vehicle Systems Modeling and Simulation Electrochemical Power Group Jet Propulsion Laboratory M/S 198-220 4800 Oak Grove Dr. Pasadena, CA 91103 Phone: (213) 354-7693
110	Darryl L. Kane President National Motors Corporation Post Office Box 1523 Lancaster, PA 17601 Phone: (717) 299-7349
111	Victor Wouk Victor Wouk Associates 342 Madison Avenue Suite 831 New York, NY 10017

APPENDIX C

REFERRALS

Respondent Accession Number	Referrals
2	J. R. Harkness Vice President Briggs and Stratton Co. Milwaukee, WI
13	Exxon
14	The major automotive companies [did not note any specifically]
16	Triad Services Dearborn, MI
	General Electric
17	University of Wisconsin
	TRW
	Aerospace Corp.
	Ford Motor Co.
	Lawrence Livermore Laboratory
	Exxon
21	Williams Research Walled Lake, MI
	American Motors Southfield, MI
24	General Motors
	Ford
34	Aero Power 2398 4th Street Berkeley, CA 94710
35	Dana Corp. - Parish Division

Respondent Accession Number	Referrals
39	Meradcom Fort Belvoir, VA 22060 Attn: Dr. J. Huff
	Ford Motor Company
	Los Alamos Scientific Laboratory
	TRW
43	International Harvester Fort Wayne, IN
46	International Harvester Fort Wayne, IN
54	General Electric Company Corporate Research and Development P. O. Box 43 (Bldg. 37, Room 2083B) Schenectady, NY 12301 Attn: Mr. E. A. Rowland
56	System Control, Inc. 1801 Page Mill Rd. Palo Alto, CA 94304 Attn: H. Solomon
57	Professor Andrew A. Frank School of Engineering University of Wisconsin
60	Orshansky Transmission Corp. San Diego, CA
61	General Motors
	Ford
63	Orshansky Transmission Corp. 5141 Santa Fe St. San Diego, CA 92109 Attn: Peter Houtley
65	Calspan Corp. Highway Safety Research Institute University of Michigan

Respondent Accession Number	Referrals
70	Ford
	General Motors
72	The University of Michigan College of Engineering Attn: David V. Ragone, Dean Ann Arbor, MI 48104 Phone: (313) 764-8470
	Wayne State University College of Engineering Attn: Dean Stynes Room 141 - 5050 Anthony Wayne Drive Detroit, MI 48202 Phone: (313) 577-3775 (Note: extensive experience in crash studies)
	University of Detroit Attn: Dr. Thomas Manos College of Engineering and Science 4001 West McNichols Detroit, MI 48221 Phone: (313) 927-1216
	Lawrence Institute of Technology Attn: Dr. Stephen R. Davis Dean, School of Engineering 2100 West 10 Mile Road Southfield, MI 48075 Phone: (313) 356-0200
	Creative Industries of Detroit Attn: Richard S. Leasia 3080 East Outer Drive Detroit, MI 48234 Phone: (313) 366-3020
74	Cummins
	VMS
	Detroit Diesel
	PREPP
	Caterpillar

Respondent Accession Number	Referrals
	International Harvester Engineering Research 7 South 600 County Line Rd. Hinsdale, IL 60521 Attn: Gene Wallace
76	Ford
	A. D. Little
	General Motors
80	General Motors
85	Garrett AiResearch
	General Motors
	General Electric
	Westinghouse
	General Research
	Exxon
86	Chrysler Corp.
87	Professors Beachley and Frank University of Wisconsin Madison, WI
90	Ford Motor Company Product Engineering Dearborn, MI
92	General Motors
	Chrysler
	American Motors Corp.
	TECO
	Aerojet - General
	General Electric
	Eaton

Respondent Accession Number	Referrals
94	General Motors
	University of Michigan
95	Triad Services Detroit, MI
	General Electric Corporate Research and Development Schnectady, NY
98	General Electric
	Ford
	TRW Systems
103	ASL Goleta, CA
106	Cummins Engines
108	Calspan Corporation
111	Mechanical Technology, Inc. 968 Albany-Shaker Road Latham, NY 12110