U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

Federal Regulations Needing Amendment to Stimulate the Production and Introduction of Electric/Solar Vehicles

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A Report To Congress
January 1990

Prepared in Response to: Section 7
P.L. 100-494, October 14, 1988
Alternative Motor Fuels Act of 1988
In Consultation With
The Environmental Protection Agency and
The Department of Energy

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SECTION I: INTRODUCTION

A. Purpose

The purpose of this report is to inform the Congress of:

1. the regulations in place which affect electric vehicles (EVs) and solar powered vehicles (SPVs),
2. existing regulations which are barriers to EV and SPV production and introduction into commerce,
3. the effect of EV use on air quality,
4. the Department's recommendation for amendment of existing regulations and promulgation of new regulations for furthering the production and use of EVs.

Only recommendations which could be implemented through regulations promulgated under standing legislation have been considered. Regulations which would require legislative action to empower a department or agency to promulgate regulations "to stimulate the production and introduction of electric vehicles into commerce" have not been considered. Particularly, the many suggestions dealing with subsidies, tax incentives, and accelerated depreciation schedules for EV and battery manufacturers and EV purchasers are not discussed here.

B. Summary

Three questions are posed by Section 7 of the Alternative Motor Fuels Act of 1988 (P.L. 100-494):

1. Should current regulations be amended or additional regulations be promulgated to stimulate the production and introduction of EVs into commerce?

2. What would be the effect of EV use on air quality?

3. Is it feasible or desirable to promulgate regulations to stimulate production and introduction of solar powered vehicles into commerce?

The categories of federal regulations considered for this report were safety, emissions, and consumer protection. Other regulations which may be relevant to EV commercialization (e.g., control of electric power rates) are the responsibility of the individual state and local governments.

It was found that no current regulations act as a barrier to the introduction of EVs into commerce. The present stimulatory regulation, the Corporate Average Fuel Economy (CAFE) credit for EVs, is not sufficient to bring EVs into production, but should be maintained. The petroleum equivalency factors in this regulation expired in 1987, but are currently being updated by DOE. There is a strong consensus among the various groups engaged in EV development and research, that automobile manufacturers retain the

option to include equivalent petroleum-based fuel economy values for EVs in their corporate average fuel economy (10 CFR Part 474), provided EVs are not used to determine the manufacturer's capability for purposes of establishing a fuel economy standard.

No future regulations which could be promulgated under standing legislation would be sufficient to accelerate the introduction of EVs. Some regulations, for which authority does exist, may need amendment and others could be initiated to meet societal goals (air quality and safety) and reduce uncertainty on the part of the manufacturers as to government requirements for these vehicles in mass production.

The main barriers to large scale introduction of EVs have been initial cost and performance (range, acceleration, and top speed) when compared to conventional vehicles. The issue of range (generally 60 miles, but demonstrated to be 120 miles by the GM Impact prototype) is a matter of refueling time. A conventional vehicle's range is a function of fuel tank size and fuel used per mile traveled, however "range" is seldom discussed for conventional vehicles since refueling takes only a few minutes and the range is generally considered adequate by consumers. In areas where fuel is readily available, range becomes effectively infinite. EVs, on the other hand, currently require 8 to 12 hours (overnight) for refueling--charging the battery pack--during which they are

unavailable for use. Again, the GM prototype is claimed to recharge more rapidily, in a period of only two hours.

In preparation of this report the Environmental Protection Agency (EPA) has projected benefits, compared with conventional vehicles, in reduced milligram per mile of emissions of carbon monoxide, formaldehyde, methane, and volatile organic compounds (VOC) with the present level of controls on power plants for these pollutants. On the same basis, the milligram per mile emissions of particulate, sulfur dioxide, and possibly oxides of nitrogen would be increased with EVs. These estimates are based on the 1988 power plant fuel mix.

Regulatory action which applies to EVs will also apply to SPVs. The technological readiness and experience of SPVs at this time is so limited that it is not possible to define SPV-specific regulations.

Most interested parties agreed that, assuming a market for EVs develops, the EVs to be introduced should meet all applicable Federal Motor Vehicle Safety Standards (FMVSS), some of which may need amendment to include language relevant to EV operation and components; further, EV-specific safety standards should be considered by the National Highway Traffic Safety Administration at such time as the need becomes apparent, the regulation becomes practicable and objective test procedures are available.

Several interested parties suggested that regulations might be developed allowing power plants to "trade-off" stack emissions for introducing EVs, either selling them to other fleets or using them in their own fleets. This would be viable only for power plants required to meet certain standards at 40 CFR Part 60.

C. Background

1. Legislative and Regulatory

The only legislation dealing exclusively with the development of EVs was the Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1976 (as amended by the Federal Energy Administration Act of 1978 and the Chrysler Corporation Loan Guarantee Act of 1979), administered by the Department of Energy. Light vans and subcompact cars that are operating in U.S. fleets do so under the Test and Evaluation activities of the DOE's Electric and Hybrid Vehicles Program. During FY 1988, over 300 DOE EVs were assigned to ten private and public sector fleets, the largest of which is the U.S. Navy's fleet of approximately 220 EVs. These demonstration fleets test not only new vehicles, but new types of batteries and vehicle components (air conditioning, heating, brakes, etc.). A report to Congress is submitted annually on the Electric and Hybrid Vehicles Program from the DOE Assistant Secretary for Conservation and Renewable Energy [1,2].

Under authority of the Act, regulations at 10 CFR Part 474 provided a method for calculating fuel economy of EVs to include EV production in an automobile manufacturer's Corporate Average Fuel Economy (CAFE). Section 18 of the Chrysler Corporation Loan Guarantee Act of 1979 required the Secretary of Energy to "conduct a seven-year evaluation program of the inclusion of electric vehicles ... in the calculation of average fuel economy ... and to determine the value and implications of such inclusion as an incentive for the early initiation of industrial engineering development and initial commercialization of electric vehicles in the United States." A report was submitted to Congress in 1987 on the results of this evaluation program which concluded "the EV CAFE provision has not yet provided the desired incentive to assist in the commercialization of electric vehicles in the United States," and, "According to the responses received from the automobile manufacturers, the provision has not provided an incentive for the early initiation of industrial engineering development for electric vehicles" [3]. The petroleum equivalency factors in this regulation expired in 1987 with no manufacturer ever taking advantage of the EV fuel economy calculation. The Electric and Hybrid Vehicle Loan Guaranty Program established by regulation at 10 CFR Part 791 attempted to "encourage and assist qualified borrowers to accelerate development ... of electric and hybrid vehicles for introduction into the Nation's transportation fleet." Two loan guarantees were issued; the program expired in September of 1983.

Legislation covering motor vehicles in general, specifically the FMVSSs at 49 CFR Part 571 also apply to EVs. Since 1974, six requests for exemptions from FMVSS have been granted to five different companies for electric vehicles; the last was granted seven years ago. The standards involved were:

FMVSS 101 Controls and displays

103 Windshield defrosting and defogging systems

104 Windshield wiping and washing systems

105 Hydraulic brake systems

108 Lamps, reflective devices, and associated equipment

119 New pneumatic tires for vehicles other than passenger cars

201 Occupant protection in interior impact

202 Head restraints

203 Impact protection for the driver from the steering control system

204 Steering control rearward displacement

206 Door locks and door retention components

207 Seating systems

208 Occupant crash protection

210 Seat belt assembly anchorages

212 Windshield mounting

214 Side door strength

215 Bumper standard

216 Roof crush resistance-passenger cars

301 Fuel system integrity

302 Flammability of interior materials

Exemptions were granted for one or two years and involved the National Highway Traffic Safety Administration's (NHTSA) concern for encouraging the development of low emissions vehicles [4]. The EVs concerned in these exemptions were not of the same level of development as today's EV concept vehicles.

Section 13(d) of the Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1976 (P.L. 94-413) required the Secretary of Transportation to conduct a study and report to Congress on the "current and future applicability of safety standards and regulations to electric and hybrid vehicles." A report was submitted in January of 1978 which concluded that even for the first demonstration fleet to be purchased under P.L. 94-413, "the same level of safety should be provided ... as currently exists in conventional vehicles. Certain penalties in cost, performance, or marketability may result. There are examples, however, of electric vehicles which satisfy or come close to satisfying minimum safety requirements, indicating that safety compromises may not be necessary to encourage and promote the use of electric vehicles. In fact, a relaxation of safety requirements at this time could be counterproductive" [5].

2. Electric Vehicle Technology and Demand Issues

Factors describing the state of EV technology are performance (range, acceleration, and top speed) and battery type and the life cycle of the battery. These factors, as estimated by the Electric Power Research Institute, are summarized in the Table I-1 below by the year they are projected to be available for use [6]. In addition, data from the January 3, 1989, GM Impact press release is included.

Table I-1. State of EV Technology Factors

Time Frame	1990	1992		1995-97	
Type	lg vans	lg vans	mini vans	sm car	GM Impact 2-passenger
Range(miles)	60	100	120	100+	124
0-3-mph Accel(sec)	12-13	10-11	7	5	
0-60mph Accel(sec)					8
Top Speed(mph)	50-55	55-60	70	70+	100+
Use	urban fleets	urban fleets	urban fleets	personal commuting	personal commuting
Battery type	lead-acid	advanced lead-acid	nickel-iron	Na-S* LiFe-S**	lead-acid
Life Cycle(kmi)	30	30	60	75	24

*Sodium-sulfur
**Lithium iron-sulfur

Two factors are involved in a discussion of the cost of electric vehicles: initial purchase cost and life-cycle cost. The initial purchase price of EVs in the near term is expected to be as much as 40% higher than comparable conventional vehicles due to low-volume production and the cost of the battery. In the area of life-cycle cost, which includes operating cost and salvage value, EVs are expected to be more competitive. EVs in demonstration fleets have shown a longer useful life and much less maintenance requirements than conventional vans [1].

Because of their limited performance, the most likely initial area for introduction of EVs into commerce is expected to be vans in urban delivery and service fleets, especially in areas of the country which have serious air quality problems and are considered "nonattainment" areas with respect to the Clean Air Act. The City of Los Angeles recently requested proposals for plans to stimulate EV market penetration in Southern California. The city council stated that "Th air quality situation in Southern California is such that bold and imaginative actions must be taken if this area is ever to meet the Federal Clean Air Act Standards. ... Speedy production and distribution of EVs that operate on batteries, rather than fossil fuels, could significantly alleviate air pollution problems." That city is considering ordinances such as restricting the use of internal combustion engine (ICE) delivery vans, thereby creating a market for EVs [7].

It is the consensus of the literature and interested parties that the major difficulty in introducing EVs into commerce is the present lack of demand for these vehicles in the marketplace. Without a reasonable market for EVs, manufacturers are hesitant to enter into a program of high-volume production. Without a market created by local ordinance for environmental reasons, EVs will have to compete in the marketplace with conventional vehicles. The California Electric Vehicle Task Force outlines the barriers to EV introduction as:

1. High near-term electric vehicle cost due to low sales volume in the early development stages.
2. Inadequate battery performance to meet the needs of a broad market.
3. Limited EV travel range between charges.
4. Lack of an infrastructure tailored to electric vehicles. Systems for distribution, sales, service, charging, parts, warranties, resale markets, etc., are needed.
5. Lack of effective market forces reflecting public policy. There is a need for temporary incentives and, under some critical situations, mandates for potential EV suppliers and users.
6. There is a lack of vehicle choices to meet the needs of a broad market beyond that served by commercial vans.

7. Uncertainties in technological development especially in the likelihood of the success and the timeliness needed for the completion of advanced batteries.
8. Lack of public experience with modern EV technology. There is a need for ways of demonstrating the advantages of EVs and overcoming consumer resistance to change [9].

M. DeLuchi et al state in the conclusion of their analytical work at the University of California at Davis:

> Although the successful commercialization of such EVs is far from guaranteed, no longer does it depend on breakthroughs -- successful market penetration probably would result if incremental progress typical of the last 10 years continues, and if the lower bound cost estimates are realized [10].

Several interested parties suggested that the Federal government and utilities should take the lead in fostering public interest and confidence in EVs by procuring them for their own fleets.

Electric power generating companies, public and private, are major stakeholders in the introduction of EVs into commerce by virtue of the fact that these companies would supply the power, and most likely the infrastructure, for recharging EVs. Utilities are eager

to level the time of day use of power by selling electricity during the night. Most EV recharging, especially in the initial use of EVs in urban delivery fleets, would be done overnight. It is possible to meter such electricity use separately from other power use and thereby charge discounted rates to encourage off-peak power consumption. Most utilities contacted felt there would be no state Public Utility Commission restriction against special time-of-use rates.

Because EVs would be recharged primarily during off-peak hours, introduction of their use is not expected to result in the need for additional power generating capacity before the end of this century. In Southern California, additional capacity would be required when the number of EVs in service reaches 2 million, however Southern California Edison estimates the market penetration of EVs in its operating area by the year 2010 at a total fleet of 500,000 vehicles [9,11].

D. Methodology

In the preparation of the report, the Department of Transportation (DOT) consulted with the Environmental Protection Agency (EPA) and the Department of Energy (DOE) and Section VI, "Air Pollutant Emissions from Electric Vehicle Use," was written by the EPA. The most recent literature on EVs (up to May 1989) was reviewed and analyzed from the perspective of Section 7 of P.L. 100-494. An

effort was made to elicit the views of all stakeholders. Representatives from the auto industry, electric utilities, fleet operators, electric vehicle developers, and California state and Los Angeles city agencies have commented on the potential of stimulating the introduction of EVs into commerce. There is general agreement that urban fleet operations in localities out of compliance with the Clean Air Act are potentially the best application of first generation modern EVs. Therefore, a special effort was made to obtain the views from stakeholders in the South Coast Basin (Los Angeles) area of California. See Appendices A through H for copies of all responses received. The bibliography contains a list of parties contacted for comment. Appendix I contains an example of a letter sent to automobile manufacturers or associations interested in vehicles and an example of a letter sent to power companies or associations interested in the sale of electric power.

SECTION II: FEDERAL REGULATIONS APPLYING TO ALL MOTOR VEHICLES

The current regulations listed below apply to all motor vehicles whether powered by electric motors or ICEs. Authority for these regulations is, except where noted, either the National Traffic and Motor Vehicle Safety Act of 1966, or the Motor Vehicle Information and Cost Savings Act [8].

A. Safety

49 CFR 571	Federal Motor Vehicle Safety Standards (FMVSS)
see Table II-1	for complete list of standards.
49 CFR 555	Temporary exemptions from FMVSS
49 CFR 573	Defect and noncompliance reports
49 CFR 570	Vehicle in use inspection standards
49 CFR 576	Record retention
49 CFR 577	Defect and noncompliance notification
49 CFR 579	Defect responsibility

B. Emissions

40 CFR 85	Control of air pollution from motor vehicles and motor vehicle engines. Authority: Clean Air Act.

Table II-1. Federal Motor Vehicle Safety Standards Code of Federal Regulations, Revised as of October 1, 1988

Part 571 - Subpart B

571.100	Standard No. 100; Controls and displays.
571.101	Standard No. 101; Controls and displays.
571.102	Standard No. 102; Transmission shift lever sequence, starter interlock, and transmission braking effect.
571.103	Standard No. 103; Windshield defrosting and defogging systems.
571.104	Standard No. 104; Windshield wiping and washing systems.
571.105	Standard No. 105; Hydraulic brake systems.
571.106	Standard No. 106; Brake hoses.
571.107	Standard No. 107; Reflecting surfaces.
571.108	Standard No. 108; Lamps, reflective devices, and associated equipment.
571.109	Standard No 109; New pneumatic tires.
571.110	Standard No. 110; Tire selection and rims.
571.111	Standard No. 111; Rearview mirrors.
571.112	Standard No. 112; Headlamp concealment devices.
571.113	Standard No. 113; Hood latch system.
571.114	Standard No. 114; Theft protection.
571.115	Standard No. 115; Vehicle identification number -- basic requirements.
571.116	Standard No. 116; Motor vehicle brake fluids.

Table II-1. Federal Motor Vehicle Safety Standards Code of Federal Regulations, Revised as of October 1, 1988 (cont.)

Part 571 - Subpart B

571.117	Standard No. 117; Retreaded pneumatic tires.
571.118	Standard No. 118; Power-operated window systems.
571.119	Standard No. 119; New pneumatic tires for vehicles other than passenger cars.
571.120	Standard No. 120; Tire selection and rims for motor vehicles other than passenger cars.
571.121	Standard No. 121; Air Brake Systems.
571.122	Standard No. 122; Motorcycle brake systems.
571.123	Standard No. 123; Motorcycle controls and displays.
571.124	Standard No. 124; Accelerator control systems.
571.125	Standard No. 125; Warning devices.
571.126	Standard No. 126; Truck-camper loading.
571.201	Standard No. 201; Occupant protection in interior impact.
571.202	Standard No. 202; Head restraints.
571.203	Standard No. 203; Impact protection for the driver from the steering control system.
571.204	Standard No. 204; Steering control rearward displacement.
571.205	Standard No. 205; Glazing materials.
571.206	Standard No. 206; Door locks and door retention components.

Table II-1. Federal Motor Vehicle Safety Standards Code of Federal Regulations, Revised as of October 1, 1988 (cont.)

Part 571 - Subpart B

571.207	Standard No. 207; Seating systems.
571.208	Standard No. 208; Occupant crash protection.
571.209	Standard No. 209; Seat belt assemblies.
571.210	Standard No. 210; Seat belt assembly anchorages.
571.211	Standard No. 211; Wheel nuts, wheel discs, and hub caps.
571.212	Standard No. 212; Windshield mounting.
571.213	Standard No. 213; Child restraint systems.
571.214	Standard No. 214; Side door strength.
571.215	[Reserved]
571.216	Standard No. 216; Roof crush resistance-passenger cars.
571.217	Standard No. 217; Bus window retention and release.
571.218	Standard No. 218; Motorcycle helmets.
571.219	Standard No. 219; Windshield zone intrusion.
571.220	Standard No. 220; School bus rollover protection.
571.221	Standard No. 221; School bus body joint strength.
571.222	Standard No. 222; School bus passenger seating and crash protection.
571.301	Standard No. 301; Fuel system integrity.
571.302	Standard No. 302; Flammability of interior materials.

40 CFR 86	Control of air pollution from new motor vehicles and new motor vehicle engines: certification and test procedures. Authority: Clean Air Act.
49 CFR 590	Motor vehicle emissions inspections.

C. Consumer Protection and Information

1. Fuel economy

49 CFR 523	Vehicle classification.
49 CFR 525	Exemptions from average fuel economy standards
49 CFR 526	Petitions and plans for relief under the Automobile Fuel Efficiency Act of 1980
49 CFR 529	Manufacturers of multistage automobiles
49 CFR 531	Passenger automobile average fuel economy (CAFE).
49 CFR 533	Light truck fuel economy standards.
49 CFR 537	Fuel economy reporting: manufacturers submit reports to NHTSA on their efforts to improve CAFE.
40 CFR 600	Fuel economy of motor vehicles: 600.206-86 includes calculation and use of fuel economy values for gasoline-fueled, diesel, and electric vehicle configurations. Authority is

Title III of the Energy Policy and Conservation Act of 1975 and Title IV of the National Energy Conservation Policy Act of 1978.

2. Theft protection

49 CFR 541	Federal motor vehicle theft prevention standard.
49 CFR 542	Procedures for selecting lines to be covered by the theft prevention standard.
49 CFR 543	Exemption from vehicle theft prevention standard.
49 CFR 544	Insurer reporting requirements

3. Consumer protection/information

49 CFR 575	Consumer information regulations: stopping distance, truck-camper loading, uniform tire quality grading standards, utility vehicles.
49 CFR 580	Odometer disclosure requirements.
49 CFR 581	Bumper standard.
49 CFR 582	Insurance cost information regulation.
40 CFR 600	Subpart D - Fuel economy regulation for 1977 and later model year automobiles - labeling. Authority is Title III of the Energy Policy and Conservation Act of 1975 and Title IV of

the National Energy Conservation Policy Act of 1978.

16 CFR 259 Guide concerning fuel economy advertising for new automobiles. Regulated by Federal Trade Commission.

4. Other

Commerce - 15 CFR 615. Determination of bonafide motor vehicle manufacturer: has to do with US companies importing vehicles and parts from Canada. Authority: Automotive Products Trade Act of 1965.

Customs - 19 CFR 12.73 Entry of motor vehicle and motor vehicle engines under the Clean Air Act as amended - Federal motor vehicle air pollution control. 19 CFR 12.80 Motor vehicles and motor vehicle equipment manufactured on or after January 1, 1968 - Federal motor vehicle safety standards.

Energy - 10 CFR 473. Automotive propulsion research and development. Authority: Federal Energy Administration Act of 1978 - Civilian Application.

SECTION III: EXISTING FEDERAL REGULATIONS PECULIAR TO ELECTRIC/SOLAR VEHICLES

All regulations listed below were promulgated under authority of the Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1976.

A. 10 CFR 475 Electric and hybrid vehicle research, development, and demonstration project. Covers safety, emissions, and consumer protection (battery life) for EVs "purchased or leased in fulfillment of contracts entered into ... pursuant to Section 7(c) of the Act" (Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1976). These requirements would not apply to EVs purchased outside of the Act.

B. 10 CFR 474 Electric and hybrid vehicle research, development, and demonstration program; equivalent petroleum-based fuel economy calculation.

C. 10 CFR 476 Electric and hybrid vehicle research, development, and demonstration program small business planning grants.

SECTION IV: FEDERAL REGULATIONS NEEDING AMENDMENT TO STIMULATE PRODUCTION AND INTRODUCTION OF ELECTRIC/SOLAR VEHICLES

This section is a discussion of regulations, covering motor vehicles and electric power generating plants, which may need amendment to stimulate the production and introduction of EVs. All standards will need review, when practicable, simply to amend language specific to ICEs, not because EVs could not comply with the spirit of the standard; but because changes will be necessary to generalize the language to apply to EVs. An example is FMVSS 103 S4.3(a) which refers to following the manufacturer's suggested "warmup procedure." EVs do not require warmup. Any test procedure which requires the vehicle to be in neutral gear would not apply to EVs and would need alternate language to cover operation of EVs.

A. Vehicles

1. Safety - Federal Motor Vehicle Safety Standards (FMVSS) at 49 CFR Part 571. It is the consensus of most of the interested parties we have corresponded with on EVs that most of the vehicles are built from bodies of existing ICE vans and the modifications will be designed such that all FMVSS will be met. However, no data are available at this time from crash tests of present-day EVs. Some individuals did mention particular standards which they felt would be more difficult to meet than others and may have some basis for exemption in the preliminary stages of production and distribution. Below is a discussion of each standard which is

questionable in regard to EVs, how it might need to be modified to include EVs, and comments that were received on that standard with respect to EVs.

Crash Avoidance Standards (100 series)

FMVSS 102 "Transmission shift lever sequence, starter interlock, and transmission braking effect": EVs without regenerative braking would have difficulty meeting this standard; however all EVs under serious consideration for fleet use today use regenerative braking. Vehicles having regenerative braking will likely comply because motor braking augments service braking [5].

FMVSS 103 "Windshield defrosting and defogging systems": EVs would require some type of heater to accomplish defrosting since the motor could not be used as a heat source. Minor language changes are necessary in reference to warm up procedure and engine speeds in neutral gear. Some parties questioned whether it would be necessary for EVs to have defrosting systems capable of melting one-half inch of ice since the primary initial geographic area of application for EVs will be Southern California.

FMVSS 105 "Hydraulic brake systems": If, after more extensive testing of EVs is done with respect to FMVSS, it becomes evident that current EVs cannot follow the test procedure in Section 7

because they do not have the range to follow through all the steps, an alternate procedure should be developed.

FMVSS 109 "New pneumatic tires": It had been suggested in the earlier EV study that this standard for tire performance up to 85 mph should be relaxed for EVs since their top speed is significantly less than ICE vehicles. However, this would require special labeling of "low speed" tires to prevent their use on conventional vehicles [5]. With the top speed of today's EVs approaching 60 mph and expected to be over 70 mph by the year 2000, changing the standard or issuing exemptions is not necessary. None of the parties contacted discussed it.

FMVSS 111 "Rearview mirror": Specifies requirements for the performance and location of rearview mirrors. One respondent felt that the field of view required by this standard would be difficult to meet due to the height added to the vehicle (compared to the conventional van from which the EV is built) to accommodate placing the battery pack under the cargo area floor. This difficulty does not warrant exemption from the standard.

FMVSS 119 "New pneumatic tires for vehicles other than passenger cars": Same response as for Standard 109.

FMVSS 120 "Tire selection and rims for motor vehicles other than passenger cars": The weight of the battery pack would require EVs

to use tires and rims currently used by light trucks. This is not seen as a situation requiring exemption or special procedures.

FMVSS 124 "Accelerator control systems": S4.2 covers "vehicles powered by electric motors."

Crashworthiness Standards (200 series) - At least two interested parties stated that EVs should be exempt from 30 mph barrier crash standards (204, 208, 212 and 219) because EVs have a "limited" top speed and supposedly would not be exposed to 30 mph crash situations for the first generation of vehicles which are expected to be used in urban fleet operations. However, since today's EVs have top speeds approaching 60 mph and EV use on highways cannot be ruled out, exemption from the 30 mph crash standards, even for preliminary vehicles, would not be advisable. It is possible that EV models that are built from bodies of complying ICE vehicles could still have trouble with these standards due to the weight of battery pack and the extra structure required to support it. However, no data are currently available on late model EV crash tests. This problem was discussed in the earlier NHTSA study of EVs and FMVSS and the report concluded that "every effort should be made to maintain the protection provided by current crashworthiness standards... even though certain cost, performance and/or marketability penalties may result" [5]. To meet each of the following standards, the weight of the propulsion battery in an EV may require the modification of the vehicle structure to

dissipate the resulting kinetic energy in a 30 mph barrier collision.

FMVSS 204 "Steering control rearward displacement": Rearward displacement of the steering assembly toward the driver must not exceed 5 inches.

FMVSS 208 "Occupant crash protection": In a 30 mph frontal barrier impact, all portions of the (restrained) test dummy must remain inside the occupant compartment throughout the test. The Head Injury Criterion must not exceed 1,000, the chest acceleration must not exceed 60 g's, and the force on each femur must not exceed 2,250 pounds. If a Hybrid III dummy is used, the sternum deflection must not exceed 3 inches.

FMVSS 212 "Windshield mounting": The windshield mounting of the vehicle shall retain not less than 50 percent of the periphery on each side if the vehicle is equipped with passive restraints, or not less than 75 percent if the vehicle is not equipped with passive restraints.

FMVSS 219 "Windshield zone intrusion": No exterior part of the vehicle shall penetrate the proscribed portion of the windshield by more than one-quarter inch.

In addition to these 30 mph crash standards, one respondent felt that compliance with FMVSS Nos. 207 "Seating systems" and 210 "Seat belt assembly anchorages" may be difficult for EVs modified from conventional van bodies due to modifications required to stow the battery pack under the cargo floor pan. Such possible difficulty does not warrant exemption in light of the protection sought by the standards.

Fire Protection Standards (300 series) - Only one 300 series standard would apply to EVs and that is FMVSS 301 "Fuel system integrity." This would apply to EVs which use petroleum fuels (gasoline, diesel, kerosene) in an auxiliary heating system.

2. Emissions - The EPA regulations governing emissions from motor vehicles will need to be amended by the EPA to include EVs' operating and evaporative emissions from a petroleum-fueled heating system in the standards and test procedures, 40 CFR Parts 85 and 86.

3. Consumer protection - No amendments of current regulations required. Once the regulation governing the computation of miles per gallon rating for EVs is updated, those ratings should be reported on the new vehicle labels as required under 40 CFR 600 Subpart D.

4. Fuel economy - 10 CFR 474 Electric and hybrid vehicle research, development, and demonstration program; equivalent petroleum-based fuel economy calculation. Petroleum equivalency factors expired in 1987, and are currently being updated by DOE. Fuel economy test procedures and regulations at 40 CFR 600 should be reviewed for ICE-specific language (e.g., warmed-up engine) and amended to include EVs which contain petroleum-fueled accessories.

5. Other - General Services Administration Federal Acquisition Regulations need to be amended to allow vehicles to be purchased at other than the lowest initial price; life-cycle cost should be considered. The DOE has such provisions at 41 CFR 109-38.1304-50 (e), "Electric vehicles may be used advantageously for certain applications. The use of these vehicles is encouraged wherever it is feasible to use them to further the goal of fuel conservation."

B. Power Plants/Utilities

1. Emissions - Several respondents suggested that electric utility companies should be granted credits, based on their support of EVs in their service area, to "trade-off" against power plant emissions that they otherwise would be required to reduce. This would require, at least, amendment of the regulations at 40 CFR 60 "New stationary sources performance standards."

2. Business practices - The following regulations promulgated by the Department of Energy may need to be amended if their language would prevent the sale of electricity at discount prices to recharge EVs at "off-peak" times of day.

18 CFR 300	Federal power marketing administrations, confirmation and approval of rates.
10 CFR 903	Power and transmission rates, adjustments and extensions for Alaska, southeastern, southwestern, and western area power administrations, public participation
18 CFR 35	Filing rate schedules
18 CFR 294	Electric energy and capacity, interim procedures for shortages under Public Utility Regulatory Policies Act of 1978.
10 CFR 508	Electric utility conservation.
18 CFR 50	Filing of company procurement policies and practices.
18 CFR 290	Public Utility Regulatory Policies Act of 1978 retail electric service, collection of cost of service information under Section 133.

SECTION V: ADDITIONAL FEDERAL REGULATIONS NEEDED TO STIMULATE PRODUCTION AND INTRODUCTION OF ELECTRIC/SOLAR VEHICLES

Discussed in this section are additional regulations that may be considered to promote public confidence in the vehicle when a need becomes apparent and regulation becomes practicable.

Vehicle Safety

Regulations may be needed to address EV specific hazards as 49 CFR 571 addresses safety of motor vehicles in general. Safety criteria for EVs involved in the Electric and Hybrid Vehicle Research, Development, and Demonstration Program are a part of the regulations at 10 CFR 475. Section 475.11 Paragraph (o) states:

> (1) The vehicle shall comply with all applicable Federal Motor Vehicle Safety Standards as set forth in 49 CFR Part 571, unless a temporary exemption is obtained by the manufacturer from the Department of Transportation.
>
> (2) Until the Department of Transportation issues regulations which cover the same subjects, the vehicle shall also have the following performance characteristics:
>
> (i) The electric propulsion circuit shall be electrically isolated from other conductive portions of the vehicle sufficiently to

prevent personal hazards due to contacting any portion of the electric propulsion circuit while in contact with other portions of the vehicle.

(ii) The vehicle shall be capable of complying with their [sic] performance requirements of Federal Motor Vehicle Safety Standards 208 and 301 with all battery materials remaining outside the passenger compartment.

(iii) Vehicles with battery vents shall have flame barrier provisions to inhibit battery explosions.

(iv) Ventilation shall be adequate within the battery compartment to maintain the concentration of hydrogen below 4 percent by volume during vehicle operation (including charging and maintenance).

(v) The vehicle shall have a device which provides for the positive disconnection of the battery and which is operable from the normal operator position.

Incorporation of these criteria into the FMVSS may be considered by NHTSA if the need becomes apparent, the regulation becomes practicable, and test procedures are available.

SECTION VI: AIR POLLUTANT EMISSIONS FROM ELECTRIC VEHICLE USE
(Prepared by the Environmental Protection Agency)

A. Summary

Emissions associated with an electric vehicle (EV) are primarily those of the utility power plant that furnishes electricity for recharging the EV batteries. Those emissions depend on the fuel burned by the utility and its level of emission control.

Compared to conventional vehicles at their present level of emission control, the use of electric vehicles would result in

1. significantly lower emissions of carbon monoxide (CO) and volatile organic compounds (VOC),

2. significantly higher emissions of sulfur dioxide (SO_2) and particulates, and

3. slightly higher emissions of nitrogen oxides (NO_x)

on a nationwide basis, considering the current mix of coal, oil, natural gas, and nonfossil energy sources used by the U.S. electric utilities, and their current emission control levels (see Table VI-14).

The EV advantage in low utility CO and VOC emissions is essentially independent of the utility fuel, and hence should apply to any part of the U.S.

In a region whose utilities use a higher-than-average fraction of natural gas or nonfossil energy, the EV SO_2 disadvantage will be less severe; in a region whose utilities use predominantly coal or oil, the problem will be worse.

Vehicle (non-powerplant) EV emissions, particularly those associated with battery recharge and any fuel-burning onboard heater, need to be quantified experimentally. One should note that an addition of an ICE, such as in a hybrid vehicle, would not be expected to offer any emission advantage over conventional vehicles.

B. Scope and Methodology

Strictly speaking, an evaluation of the air quality impact of a potential change in mobile emission sources is usually performed by a State or local air quality management district; it begins with statistics such as the individual source emission factors (average mass per unit distance, e.g., grams per mile), travel intensity (average distance per unit time, e.g., miles per year), and includes airshed modeling accounting for the total emissions from all mobile and stationary sources within each airshed as well as

pollutants entering and leaving the airshed via transboundary migration. Aggregation of individual airshed model results into regional, nationwide, and global figures is done as necessary for reporting purposes.

The time allowed by the Act for this study did not permit an airshed modeling analysis. This chapter develops per-mile emission factors for baseline electric vehicles, and compares them to those of conventional vehicles. There is no "forecasting" of any kind: the EV baseline is current or very near-term technology; the fuel mix, overall thermal efficiency, and emission control levels of electric utilities are current; and the conventional vehicles whose emissions are compared to the derived EV-related emissions are the vehicles on the road today. It is expected that both powerplant and ICE emissions will be reduced in the future, therefore these comparisons will remain valid directionally, even though the exact numbers may change. The study also resisted the temptation to "resolve" inherent differences between EVs and conventional vehicles (performance, range) by hypothesizing "exactly comparable" versions of either or both. Finally, the study did not consider certain items because they are being treated in other work required of EPA under Section 400EE(b) of P.L. 100-494; those items include global warming and other air quality effects of the manufacturing and distribution of alternate fuels and alternate-fueled vehicles, including electrics.

Clearly, local air quality impacts can differ markedly from the national average. For a State or local air quality management district to project air quality impacts due to EV use, EPA will require that a specific analysis be performed for that locale using its own power plant emissions inventories, EV-related electrical load demand profiles based on actual test data of EVs and their battery chargers (including time-based recharging power demand projections), and specific consideration of all non-powerplant emissions attributable to EVs. The analysis will have to address the reactivity potential of all ozone precursors emitted (primarily volatile organic compounds, VOC, and oxides of nitrogen, NO_x), which depends strongly on the mix of fuels used to generate electricity within the district and the relative consumption of locally generated power versus interdistrict imported power. State and local air quality management officials will be able to incorporate EV use in their State Implementation Plans with the assistance of their EPA Regional Offices using the process now in place to generate such plans.

Several recent studies have analyzed features of current- and projected-technology EV design and operation which have direct bearing on their potential air quality impact; these analyses provide important inputs to our study, and to future work in this area [10, 12, 13, 14].

C. Analysis

Air pollutants emitted due to operation of an EV are of two general classes: electric utility power plant emissions associated with electricity used for recharging the EV batteries, and emissions of various sorts from the EV itself.

The battery recharge energy replenishes that spent for vehicle propulsion and other vehicle electrical loads; the utility power plant necessarily furnishes more energy than that, due to losses inherent in the battery recharge process and power transmission losses between the utility and the recharger.

Emissions from the EV can include volatiles from its structure and trim, particulates from tire and brake wear, gases released by the battery during recharge, ozone emissions produced by vehicle and charger electrical hardware, CFC emissions from the vehicle air conditioner, and any emissions resulting from combustion of fuel onboard the EV.

D. EV Propulsion

Reference [10] presents a summary of the characteristics of recent and near-future EVs; among the characteristics addressed is propulsion efficiency, miles traveled per kilowatt-hour of electrical energy consumed (mi/kWh), the electric vehicle

equivalent of miles per gallon. The report shows an average propulsion efficiency of about 3.5 mi/kWh for sedans in city driving, and 2.5 mi/kWh for the ETX-II electric van [15]. To confirm the reasonableness of these figures, and to estimate EV propulsion energy in nonurban driving, analysis was performed as follows: From Table 6 of reference [10], the average weight differential between an EV and its comparable (as defined by the reference [10] authors) internal combustion engine-powered vehicle (ICEV) was combined with the average weight of equivalent model year 1989 vehicles; the results appear in Table VI-1.

Table VI-1. Estimate of Electric Vehicle Weights (Pounds)

	Sedan	Van
Avg. weight difference, EV-comparable ICEV	+120	-100
Avg. battery weight	924	1100
Avg. of 1989 ICEVs	2815 [16]	3776 [17]
Total	3859	4776

These weights, along with typical values for frontal area, drag coefficient, and rolling resistance were used as input to a computer simulation [18], yielding the results in Table VI-2.

Table VI-2. Simulation Results for EV Propulsion Efficiency (Mi/kWh)

	Sedan	Van
City	3.51	2.55
Highway	3.91	2.46
Ref.[10] City	3.48	2.50

Converting the simulation values to kWh/mile and assuming a 70/30 split between urban and nonurban driving, the EV batteries would have to supply 0.2755 kWh/mi of motive energy for the reference sedan and 0.3964 kWh/mi for the van. Since batteries do not recharge at 100 percent efficiency and battery chargers do not operate at 100 percent efficiency, the electrical energy supplied at an EV's base station will exceed the vehicle's energy usage figure. Battery and charging efficiencies reported in references [10] and [19] are shown in Table VI-3.

Table VI-3. Battery and Charger Efficiencies

	Battery	Charger	Combined
Ref.[10] Table 6, avg. 5 sedans	--	--	64%
Ref.[10] Table 6, one van	--	--	62%
Ref.[10] Table 7, Low base case	70%	90%	63%
Ref.[10] Table 7, High base case	75%	95%	71%
Ref.[19]	75%	87%	65%

Using the 65 percent figure from reference [19], the electrical energy requirement at the EV base station is therefore 0.4238 kWh/mi for the sedan and 0.6098 kWh/mi for the van.

According to reference [14], transmission losses of some 10 percent occur between electrical utility power plants and end users, in this case the EV charging station; folding this into the above, we have the total utility load required for battery recharge, per mile of EV travel, shown in Table VI-4.

Table VI-4. Electric Utility Energy Required for Electric Vehicle Propulsion

Sedan	0.471 kWh/mi
Van	0.678 kWh/mi

E. Electric Utility Emissions

Emission of air pollutants from an electric utility depends on the type of fuel it burns. These emissions can be estimated from raw data in EPA's AP-42 document [20]. To use the AP-42 data for a given fuel type, one must know, or assume, the fuel heating values, percent sulfur and ash, type of combustion equipment and, of course, level of emission control. EPA's Office of Air Quality Planning and Standards (OAQPS) collects data from State and local air pollution control agencies on all of these items and combines these data with the AP-42 raw data to develop "hard" (assumption-free) average emission factors.

Table VI-5 summarizes the OAQPS data [21] for fossil-fueled utilities for calendar year 1987. The proportioning of VOC (volatile organic compounds or hydrocarbons) between non- methane and methane is from AP-42; the formaldehyde emission factor is from reference [22].

The three parts of Table VI-5 show, respectively, emissions per ton of coal burned by coal-fired utilities, emissions per million cubic feet of natural gas burned by gas-fired utilities, and emissions per thousand gallons of fuel oil burned by oil-fired utilities, all at the levels of emission control in place in U.S. electric utilities in 1987.

Accounting for the U.S. average BTU content of these fuels [23], and the U.S. average fuel consumption per net kWh of generated electricity [24], Table VI-5 also shows grams of pollutants emitted per million BTU of fuel consumed, and per net kWh of generated electricity.

Given the overall electric utility energy required for EV propulsion from Table VI-4 and the electric utility emission factors from Table VI-5, emission rates per mile of EV travel can be determined for each utility fuel type, and weighted in accordance with the mix of fuel types in the region of interest. Electric utilities that are not fossil-fueled (hydroelectric, nuclear, wind, solar) can be assumed to emit none of the air pollutants listed in Table VI-5. For the U.S., the mix of utility fuels in 1988 [25] was as shown in Table VI-6.

Table VI-5. Emissions from Fossil-Fueled Electric Utilities (1987 Control Level)

Coal-fired:	Lb/Ton of Bituminous or Lignite Coal	Lb/Ton of Anthracite Coal	Gm per 10^6 BTU	Gm/kWh
Particulate	1.2	1.1	20.95	0.216
SO_2	39.8	23.6	694.86	7.158
NO_x	18.6	18.0	324.78	3.346
CO	0.7	0.6	12.22	0.126
Nonmeth. VOC	0.5	0.07	8.73	0.090
Methane	0.2	0.03	3.49	0.036
Formaldehyde	0.005	0.005	0.09	0.001

99.96% Bituminous/Lignite; 10,301 BTU/kWh

Gas-fired:	$Lb/10^6$ Cu.Ft. Gas	Gm per 10^6 BTU	Gm/kWh
Particulate	3.6	1.56	0.017
SO_2	0.6	0.26	0.003
NO_x	466.0	201.49	2.166
CO	46.4	20.06	0.216
Nonmeth. VOC	2.1	0.91	0.010
Methane	0.4	0.17	0.002
Formaldehyde	1.0	0.43	0.005

10,751 BTU/kWh

Oil-fired:	$Lb/10^3$ Gal Residual Oil	$Lb/10^3$ Gal Distillate Oil	Gm per 10^6 BTU	Gm/kWh
Particulate	12.9	5.2	38.17	0.401
SO_2	158.0	39.7	464.82	4.883
NO_x	55.0	69.0	168.05	1.765
CO	5.0	14.6	16.22	0.170
Nonmeth. VOC	0.6	3.1	2.10	0.022
Methane	0.2	0.8	0.67	0.007
Formaldehyde	0.6	0.6	1.82	0.019

96.26% Residual; 10,505 BTU/kWh

Using these fuel mix percentages, the fuel-weighted nationwide average emission rates per unit of electricity are as shown in Table VI-7, and the corresponding nationwide emission rates attributable to EV propulsion are shown in Table VI-8.

F. Emissions from the EV Itself

It is expected that the emissions from EVs in the area of tire wear and brake particulates, emissions of volatiles from glues, fabrics, paints, and coatings would be the same as they are from conventional vehicles.

1. Charging and Running Emissions

When EVs operate, current is modulated and switched. Ozone emissions would be expected to result, but the levels of that pollutant are unknown.

For unsealed batteries, the charging process can cause the evolution of gases into the atmosphere: for conventional lead-

Table VI-6. Mix of Electric Utility Fuels in the U.S. in 1988

Coal	55.4%
Natural Gas	9.0%
Oil	5.5%
Nonfossil (all other)	30.1%

Table VI-7. Emissions from U.S. Utility Mix

(1988 Utility Fuel Mix, 1987 Emission Control Level)

	Gm/kWh from 55.4% Coal	Gm/kWh from 9.0% Gas	Gm/kWh from 5.5% Oil	Gm/kWh from 30.1% Other	Total Gm/kWh
Particulate	0.120	0.002	0.022	0.000	0.143
SO_2	3.965	0.000	0.269	0.000	4.234
NO_x	1.853	0.195	0.097	0.000	2.145
CO	0.070	0.019	0.009	0.000	0.099
Nonmeth. VOC	0.050	0.001	0.001	0.000	0.052
Methane	0.020	0.000	0.000	0.000	0.020
Formaldehyde	0.000	0.000	0.001	0.000	0.002

Table VI-8. Electric Utility Emissions for EV Propulsion
(Milligrams per Vehicle Mile)

(1988 Utility Fuel Mix, 1987 Emission Control Level)

	Utility Gm/kWh	Sedan Mg/mi	Van Mg/mi
Particulate	0.143	67.4	97.0
SO_2	4.234	1994.3	2870.8
NO_x	2.145	1010.5	1454.6
CO	0.099	46.4	66.8
Nonmeth. VOC	0.052	24.4	35.2
Methane	0.020	9.6	13.9
Formaldehyde	0.002	0.9	1.3

acid batteries, this can include hydrogen, and sulfuric acid and hydrogen sulfide mists. Hydrogen is not regarded as a pollutant, but it may present a safety problem. The emission concern with battery gas evolution is that the gases emitted have not been characterized with modern instruments sensitive to trace levels of pollutants. Such characterization will be needed for conventional and advanced vented batteries.

Power-consuming accessories such as headlights and air conditioning have always been a problem for EVs, since the use of battery energy to meet these power demands reduces the vehicle's driving range.

2. Air Conditioning

The release of chlorofluorocarbon (CFC) emissions during an auto air conditioner's life cycle is a well-known problem, but one that is assumed to be no better or worse for EV air conditioners than for those in conventional vehicles.

Powering an EV air conditioner by a small engine without emission controls would produce very high exhaust emissions, as will be shown below. Fortunately, most EV developers now contemplate powering the air conditioner from the battery [26]. It is that

type of approach which is assumed. The emissions of concern, then, are electric utility emissions resulting from battery recharging, exactly analogous to that associated with replenishment of propulsion energy as treated above.

Air conditioner performance and power consumption estimates used herein were derived from reference [27], which describes a practical lower limit for auto air-conditioning power consumption. A DC system mated to a conventional engine via a 96 volt alternator requires from 1.9 to 3.6 engine horsepower at its design point, which maintains a 20 degrees C temperature inside a thermally efficient vehicle traveling at 40 km/hr in sunlight and 38 degrees C ambient temperature. Used in an EV, we estimate this type of system (without an alternator but with DC voltage step-up) would draw 1.324 kW from the vehicle battery when operating at the design point. This translates to 0.00171 kWh/mile at the battery per degree F of cooling or 0.00292 kWh/mile at the electrical utility per degree F of cooling.

On a nationwide basis, the VMT-weighted cooling requirement of 1,368 degree-days implies a year-round average cooling rate of 3.75 degrees F for air conditioning, or a (more realistic) 3-month summer cooling rate of 15 degrees F. Table VI-9 summarizes the electric utility emissions corresponding to the referenced air conditioner operating at these cooling levels.

Table VI-9. Electric Utility Emissions due to EV Air Conditioning
(1988 Utility Fuel Mix, 1987 Emission Control Level)

	At full Cooling Capacity	U.S. avg. conditions: 3 Summer Months	U.S. avg. conditions: 12 Months
Cooling, deg F	32.40	15.00	3.75
Duty Cycle, %	100.00	46.30	11.57
Battery kWh/mi	0.0555	0.0257	0.0064
Utility kWh/mi	0.0946	0.0438	0.0109
Utility Emissions (Milligrams/mile):			
Particulate	13.53	6.27	1.57
SO_2	400.35	185.35	46.34
NO_x	202.86	93.92	23.48
CO	9.32	4.31	1.08
Nonmeth. VOC	4.91	2.27	0.57
Methane	1.94	0.90	0.22
Formaldehyde	0.19	0.09	0.02

Estimated exhaust emissions that would result from powering this air conditioner with a small engine instead of the vehicle battery are given in Table VI-10. The emission factors used are those in AP-42 for four-stroke non-lawn/garden engines. Note that the VOC (HC) and CO levels in Table VI-10 are well above the Federal emission standards for HC and CO emissions from passenger cars; furthermore, they exceed the electric utility VOC and CO emission levels by factors of about 200 and 2,500, respectively.

Table VI-10. Emissions from Small Engine Powering EV Air Conditioner

(Milligrams/mile)

	3 Summer Months
Particulate	18.8
SO_2	16.7
NO_x	212.6
CO	10,704
Total VOC	650.8
Formaldehyde	20.1

3. Heating/Defrosting/Defogging

All motor vehicles are required to have windshield defrosting/defogging systems under Federal Motor Vehicle Safety Standard 103, although the FMVSS 103 requirement for the capability to melt one-half inch of windshield ice may not be needed for all EVs (see the recommendation in Section VII). It is assumed that all electric vehicles will, like all conventional vehicles, will have a passenger compartment heater installed. Clearly, the use of the heater will vary from one locale and time of year to another.

The VMT-weighted national average heating requirement (excluding defrosting requirements) of 4,442 degree days annually implies a year-round average heating rate of 12.2 degrees F, or a 3-month winter average of 48.7 degrees F.

Electric vehicle designs are tending toward the use of a liquid-fueled (diesel or gasoline) heater [26]. In this way, the conventional vehicle heater ducting and controls can be utilized without modification. This makes conversion of a conventional vehicle to an EV easier. Use of diesel fuel in such a burner/heater makes the fuel tank evaporative emissions concern much less than it would be for a more volatile fuel, such as gasoline: since diesel-fueled conventional vehicles do not have to meet evaporative emissions requirements, it is not likely that diesel-fueled heaters on EVs would be required to undergo evaporative emissions certification.

Our estimate of the emissions from such a heater uses the specifications from a commercially available diesel-fired heater and the particulate, SO_2, NO_x, CO, and VOC emission factors for residential furnaces burning distillate fuel oil, Table 1.3-1 of AP-42, Vol. I. The formaldehyde emission factor is the one given for oil combustion in reference [22]. The results appear in Table VI-11.

Table VI-11. Exhaust Emissions: Diesel-Fueled EV Burner/Heater

	At full Heating Capacity	U.S. avg. conditions: 3 Winter Months	U.S. avg. conditions: 12 Months
Heating, deg F	165.80	48.70	12.17
Duty Cycle, %	100.00	42.37	7.34
Heater Gal/mi	0.00237	0.00070	0.00017
Exhaust Emissions (Milligrams/mile):			
Particulate	2.69	0.79	0.20
SO_2	61.05	17.93	4.48
NO_x	19.35	5.68	1.42
CO	5.37	1.58	0.39
Nonmeth. VOC	0.77	0.23	0.06
Methane	1.91	0.56	0.14
Formaldehyde	0.51	0.15	0.04

These heater emission estimates are undoubtedly low, since they do not reflect transient operation of the burner, which is expected to produce higher emissions than those in AP-42. Emissions characterization of the actual heaters used in EVs is probably necessary to quantify the heater-related emissions.

G. Summary: Emissions Related to Electric Vehicles

Table VI-12 brings together all of the foregoing analysis. The data here are based on the reference propulsion energy and cooling and heating requirements for the electric sedan; the van

would be expected to have emissions that are higher, by roughly the van-to-sedan ratio of propulsion energy. Note that the air-conditioning figures, which correspond to the U.S. average 3-month summer cooling requirement, constitute about 9 percent of the summer case total. The incremental emissions due to heating, at the U.S. average 3-month winter level, are shown at about 1 percent of the total, but will probably be higher than the values shown when transient operation is accounted for.

Table VI-12. Total Emissions, Electric Sedan
(Propulsion at 0.276 kWh/mile at EV,
0.471 kWh/mile at Utility)

Summer:	Utility Emissions for EV Propulsion (Table VI-8)	Utility Emissions for EV Air Cond. (Table VI-9)	Total
Particulate	67.4	6.27	73.7
SO_2	1994.3	185.35	2179.6
NO_x	1010.5	93.92	1104.4
CO	46.4	4.31	50.7
Nonmeth. VOC	24.4	2.27	26.7
Methane	9.6	0.90	10.5
Formaldehyde	0.9	0.09	0.99

Winter:	Utility Emissions for EV Propulsion (Table VI-8)	Exhaust Emissions for EV Heating (Table VI-11)	Total
Particulate	67.4	0.79	68.2
SO_2	1994.3	17.93	2012.2
NO_x	1010.5	5.68	1016.2
CO	46.4	1.58	48.0
Nonmeth. VOC	24.4	0.23	24.6
Methane	9.6	0.56	10.2
Formaldehyde	0.9	0.15	1.05

H. Compared to What?

The estimated emissions associated with EVs can now be compared to the emissions of conventionally fueled vehicles. It is recognized that such a comparison is sometimes regarded as inexact because "the conventionally fueled car" and "the EV" are not comparable in all respects; they do not have the same acceleration performance, top speed or range, for example.

Emission estimates for conventional vehicles can vary widely, depending upon the assumptions used in their compilation. In the absence of data indicating that electric cars will preferentially replace a particular segment of the conventional car population, we assume here that the average light-duty vehicle is what will be replaced by EVs, and whose emissions estimates are appropriate to compare to EV-related emissions.*

A realistic emissions estimate must account for many in-use factors beyond the laboratory test results from prototype cars. Among these additional factors are vehicle age, speed, ambient temperature, altitude, cold start operation versus hot start operation, emissions deterioration, state of tune, maintenance, tampering, misfueling, and the like. The mix of such factors, along with the mix of vehicle ages and emission control

* The expectation that small sedans and small vans will predominate among EVs is just that, an expectation, not "data".

technologies, all interact to shape the "emission signature" of the on-road fleet.

Estimates for the same pollutants as were addressed for the EV are shown for conventional light duty vehicles in Table VI-13; they were derived as follows:

The values for CO and NO_x emissions from conventional vehicles were determined from runs of EPA's MOBILE4 computer program. This program is the official tool used by air quality planners to determine the emissions from motor vehicles in actual use.

The SO_2 emissions were computed using an on-road fuel economy estimate of 21.7 MPG [28] and a gasoline sulfur content of 0.029% by weight from [29]; together they yield the value of SO_2 emissions shown in the table. The particulate emissions are from [30]. The nonmethane VOC and formaldehyde emission values are from [31], and the methane value comes from [32]. These emission values are generally comparable to those presented in references [10, 12, and 13].

The HC, CO, and NO_x levels from reference [33] were included in the table as a reminder that raw, laboratory emission levels are significantly different from "all cars on road" figures that properly account for all of the applicable in-use factors discussed earlier.

Table VI-13. Emissions from Conventional Light Duty Vehicles (Grams/mile)

Source	HC	CO	NO_x	SO_2	Part
This Study: All vehicles on road in U.S. in 1989					
Non-methane VOC:	1.73				
Methane:	0.10				
Formaldehyde:	0.007				
- Total Light Duty Vehicles	1.84	7.50	0.90	0.075	0.018

Source	HC	CO	NO_x	SO_2	Part
Ref.[33]: Laboratory data, urban test, tailpipe emissions only					
- Model Yr 1989 Autos	0.17	1.51	0.28		
- Model Yr 1989 Light Trucks	0.26	2.78	0.50		
- 1989 Small vans only	0.19	2.03	0.22		

The emission factors in Table VI-13 represent the nationwide annual average for today's on-road mix of cars and light trucks.

A comparable set of emission factors for an electric car and truck fleet was constructed by: (1) annualizing the sedan data in Table VI-12 (adding two more seasons; Spring and Fall, without air

conditioning or heating); (2) constructing a set of "EV truck" emissions that are 43.9 percent higher than the annualized sedan values, based on the van-to-sedan propulsion energy ratio, 1.439 (see table VI-4); and (3) weighting the two sets in the same 70 percent/30 percent proportions as the conventional vehicles. Table VI-14 is the result.

Table VI-14. Emissions Comparison, Electric and Conventional Light Duty Vehicles
70% Cars, 30% Trucks

(Milligrams/Mile, Annual Nationwide Average)

	Total Emissions for Electric Vehicles	Total Emissions for Conventional Vehicles	EV Increase (Decrease)
Particulate	78	18	300%
SO_2	2,314	75	3,000%
NO_x	1,172	900	30%
CO	54	7,500	(99%)
Nonmeth. VOC	28	1,730	(98%)
Methane	11	100	(89%)
Formaldehyde	1	7	(86%)

SECTION VII: SUMMARY OF RECOMMENDED FEDERAL REGULATORY CHANGES

A. Vehicles

1. Amendments

Concurrent with a widespread introduction of EVs, all standards will need review simply to amend language specific to ICEs, not because EVs could not comply with the spirit of the standard, but because changes will be necessary to generalize the language to apply to EVs. Only standards which will require substantive amendment to apply to EVs are listed below.

a. Safety

49 CFR 571.103 "Windshield defrosting and defogging systems": It may be necessary to examine whether EVs can comply with the part of this standard which requires the defroster to be able to melt one-half inch of ice, if the defroster is powered by the battery.

49 CFR 571.105 "Hydraulic brake systems": It may be necessary to develop an alternate test procedure if it is found that EVs cannot sustain a charge long enough to accomplish all the steps of the present test procedure. However, the need for this change has not been demonstrated at this time.

b. Emissions

40 CFR Parts 85 and 86: The EPA standards and test procedures governing emissions from motor vehicles will need to be amended by the EPA to include operating and evaporative emissions from petroleum-fueled heating systems installed in EVs.

c. Consumer Protection/Information

No amendments necessary; all regulations apply equally to EVs and conventional vehicles.

d. Fuel economy

10 CFR 474 "Electric and hybrid vehicle research, development, and demonstration program; equivalent petroleum-based fuel economy calculation": Petroleum equivalency factors expired in 1987, and are currently being updated DOE.

40 CFR 600 "Fuel economy of motor vehicles": EPA test emissions test procedures and regulations should be amended to include EVs which contain petroleum-fueled accessories.

e. Acquisition

To allow for the purchase of EVs for Federal fleets, the General Services Administration Federal Acquisition

Regulations need to be amended to allow vehicles to be purchased at other than the lowest initial price; life-cycle cost should be considered.

2. New regulations

After some public experience with production EVs and when practicable, additions to FMVSS and test procedures may be needed for EVs to require:

(a) electric isolation of the electric propulsion circuit from other conductive portions of the vehicle,

(b) all battery materials remain outside the passenger compartment under the performance requirements of FMVSS 208 and 301,

(c) flame barrier provisions to inhibit battery explosion on vehicles with battery vents for batteries which emit combustible gases during recharging,

(d) that the concentration of hydrogen remains below 4 percent by volume within the battery compartment during vehicle operation, charging and maintenance,

(e) a device for positive disconnection of the battery operable from the normal operator position, and

(f) operation within a broad temperature range even after being parked for an extended period.

B. Power Plants/Utilities - Amendments

1. Emissions

40 CFR 60 "New stationary sources performance standards": Could be amended to provide electric utility companies credit toward satisfaction of the standard through the use of EVs.

2. Business practices

If their language would prevent the sale of electricity at discount prices to recharge EVs at "off-peak" times of day, the following would need amendment.

18 CFR 300	Federal power marketing administrations, confirmation, and approval of rates.
10 CFR 903	Power and transmission rates, adjustments and extensions for Alaska, southeastern, southwestern, and western area power administrations, public participation.
18 CFR 35	Filing rate schedules.
18 CFR 294	Electric energy and capacity, interim Utility Regulatory Policies Act of 1978.

10 CFR 508	Electric utility conservation.
18 CFR 50	Filing of company procurement policies and practices.
18 CFR 290	Public Utility Regulatory Policies Act of 1978 retail electric service, collection of cost of service information under Section 133.

SECTION VIII: REFERENCES

[1] 12th Annual Report to Congress for FY88, Electric and Hybrid Vehicles Program, U.S. DOE, February 1989.

[2] "The Electric Vehicle Program of the U.S. Department of Energy," DOE/CH10093-27, November 1988.

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[10] "Electric Vehicles: Performance, Life-Cycle Costs, Emissions, and Recharging Requirements," M. DeLuchi, Q. Wang, and D. Sperling, University of California at Davis, Transportation Research, Vol. 23A, No.3, May 1989, page 275.

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[12] "Air Pollutant Emissions and Electric Vehicles," Q. Wang, M. DeLuchi, and D. Sperling, University of California at Davis, Research Report UCD-TRG-RR-89-1, May 1989.

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[21] Memorandum from OAQPS, W.F. Hunt to CTAB, K.H. Hellman, June 23, 1989.

[22] Air Pollution, Stern, Third Edition, Vol. IV, Academic Press, 1977.

[23] "Monthly Energy Review: 1988 Annual Summary," U.S. Department of Energy, DOE/EIA-0035(88/12). From data in Tables 2.6 and 7.3, Coal=10,462 BTU/lb, Gas=1,032 BTU/cu. ft., and Oil=150,029 BTU/gallon.

[24] op. cit. From data in Tables 2.6 and 7.1, Coal=10,301 BTU/kWh (33.1% efficiency), Gas=10,751 BTU/kWh (31.7% efficiency), and Oil=10,505 BTU/kWh (32.5% efficiency).

[25] op. cit., Table 2.6
Using these fuel mix percentages, the fuel-weighted nationwide average emission rates per unit of electricity are as shown in Table VI-7, and the corresponding nationwide emission rates attributable to EV propulsion are shown in Table VI-8.

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SECTION IX: BIBLIOGRAPHY

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Office of Technology Assessment, Congress of the United States. Catching Our Breath: Next Steps for Reducing Urban Ozone. GPO Stock No. 052-003-01159-0.

Meetings

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Chrysler Corporation. G. Allardyce, B. Bunting, R. Davis, D. Evans, G. Shishkovsky, B. Smith. Meeting in Highland Park, Michigan, 14 June 1989.

Electric Power Research Institute. L. O'Connell. Meeting in Cambridge, MA, June 20, 1989.

Environmental Protection Agency. K. Hellman and D. Murrell. Meeting at Motor Vehicle Emissions Laboratory, Ann Arbor, MI, June 13, 1989.

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To H.Gould, TSC listed alphabetically by company or association.

California Air Resources Board, El Monte, CA. K.D. Drachand, Chief Mobile Source Division. August 7, 1989.

Commonwealth Edison, Chicago, IL. Klaus Wisiol, Assistant Vice President. September 5, 1989.

Electric Vehicle Development Corporation, Cupertino, CA, Gerald Mader, President. July 18, 1989.

Ford Motor Company, Dearborn, MI. David L. Kulp, Manager, Fuel Economy Planning and Compliance. July 28, 1989.

City of Los Angeles, Department of Water and Power, Los Angeles, CA. Gerald H. Enzenauer, Electric Vehicle Program Manager. July 18, 1989.

Telephone Conversations

Contacted by Robert Church, TSC.

American Public Power Association, Washington D.C. Larry Mansueti, Staff Engineer. June 28, 1989.

Consolidated Edison Company, New York, NY. Dr. Robert Bell, Vice President. June 26, 1989.

Edison Electric Institute, Wahington D.C. Thomas Marron, Vice President, Customer Service and Marketing. June 30, 1989.

Environmental Protection Agency. Robert Brenner, Director, Office of Policy Analysis and Review (Air and Radiation). July 7, 1989.

National Association of Fleet Administrators, Iselin, NJ. David Lefever, Executive Director. June 26, 1989.

National Rural Electric Cooperative Association. John Neal, Director of Research. June 29, 1989.

National Rural Electric Cooperative Association. Kenneth Hoffman, Equipment Marketing Activities. July 5, 1989.

Pacific Gas and Electric, San Ramon, CA. Gary Wainwright, Research and Development. June 23, 1989.

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Contacted H. Gould, TSC:

Commonwealth Edison, Chicago, IL. William Patterson. June 29, 1989.

South Coast Air Quality Management District, El Monte, CA. Jonathan Leonard. June 30, 1989.

Contacted by G. Klemer of TSC

Eagle-Picher Industries, Joplin, MO. Ray Hudson. July 6, 1989.

APPENDICES

LETTERS RECEIVED FROM POTENTIAL STAKEHOLDERS

NOTE: Some letters contained lengthy appendices which are not attached here. Appendices are available on request from:

Herbert H. Gould, Chief
Vehicle Crashworthiness Division
Transportation Systems Center
U.S. Department of Transportation
Kendall Square
Cambridge, MA 02142

APPENDIX A

SOUTHERN CALIFORNIA EDISON COMPANY

LETTER AND ATTACHMENTS

Southern California Edison Company

P O BOX 800

2244 WALNUT GROVE AVENUE

ROSEMEAD, CALIFORNIA 91770

June 29, 1989

Herbert Gould, DTS - 4
U.S. Department of Transportation
Transportation Systems Center
Kendall Square
Cambridge, MA 02142

Dear Herbert:

Since our last conversation, I have received from Jerry Mader (Electric Vehicle Development Corporation) a copy of a letter that you sent to him, dated June 12th, 1989, outlining a number of questions you would like to address in your study for the Alternate Motor Fuels Act of 1988. In Attachment 1 to this letter, I have outlined Edison's responses to these question.

Many documents are cited in the responses to your questions. I would like to call your attention to two documents in particular: Attachment 2 -- A memorandum written by the law firm of Van Ness, Feldman, Sutcliffe and Curtis entitled, "Initial Survey of Federal Regulatory Provisions That Impede Commercialization of Electric Vehicle Technologies," and Attachment 3 -- A draft of a five-year, national commercialization program for Electric Vehicles that requires federal support.

Attachment 4 contains a summary description of the many reference documents that are cited, and included, in this package. I trust that these documents will enable you to better understand the issues related to Electric Vehicle development and commercialization.

One major omission from the questions you raised about the Electric Vehicle is its impact on air quality. In our service territory, the air quality improvement potential of Electric Vehicles is *far superior* to that of any other alternative clean fuel vehicle. Electric Vehicle emissions are dramatically lower than gasoline vehicle emissions: 98% for Reactive Organic Gases (ROG), 65% less for NOx and 99% less for CO. (The emissions from Electric Vehicles are based on the incremental increase in emissions from power production to recharge the Electric Vehicles. There is virtually no emission from the vehicle.)

When comparing Electric Vehicles to other alternate fuel vehicles, in terms of reducing ROG emissions, Electric Vehicles are 28 times better than methanol, 11 times better than CNG, and 33 times better than LPG. In terms of reducing CO emissions, Electric Vehicles are 273 times better than methanol, 112 times better than CNG, and 128 times better than LPG. In terms of reducing NOx emissions, Electric Vehicles are 2 times better than methanol, CNG, and LPG. (The Source for these statements is the South Coast Air Quality Management District, Southern California Association of Governments, Long Range Strategies for Improving Air Quality, September 1985 -- See Exhibit M).

The greater Los Angeles South Coast Air Quality Management District's *Air Quality Management Plan*, adopted this year, indicates that federal Clean Air Standards can *only* be attained if over one-half million electric vans and passenger cars are in operation in the South Coast alone, over the next 20 years. Delays in Electric Vehicle introduction today will only *compound* the air quality problems of the future.

Electric Vehicles are an emerging technology (versus the existing technologies for other fuels). The G-Van is only the first generation of a family of Electric Vehicles. Future generations of technologically advanced Electric Vehicles will be able to meet the driving needs of commuters and families, in addition to the fleet market.

Electric Vehicle commercialization and development is proceeding as a coordinated effort between the Electric Power Research Institute, the Electric Vehicle Development Corporation, the California Electric Vehicle Task Force, the U.S. Department of Energy, major U. S. auto manufacturers, Southern California Edison and other electric utilities. However, without financial incentives and regulatory support *today*, Electric Vehicles' technological advancements, commercial introduction and market penetration could be significantly delayed.

Edison views the major obstacles to Electric Vehicle commercialization to be the higher costs for the first generation of commercial Electric Vehicles, coupled with the need to encourage vehicle demand and vehicle supply.

We hope that the information contained in this package is useful to you. If you have any questions, please feel free to contact me at (818) 302-8295 or Mary Brazell (Theodore Barry & Associates, a management consulting firm providing assistance to Edison's Electric Vehicle commercialization efforts). I will be out of the office until July 12th.

Sincerely,

Richard N. Schweinberg

Richard N. Schweinberg
Electric Vehicle Project Manager

Enc.

ATTACHMENT 1
Answers To Questions in June 12th Letter to Jerry Mader

Edison addresses each issue outlined in your June 12th letter to Jerry Mader of EVDC, citing the documents we are providing to you for backup information (a summary description of these reference documents is provided as Attachment 4 to this letter for your convenience):

1a. *Is it reasonable to use the time period of 1989-2000 as a guideline for preparation of the report?*

Los Angeles and other major urban areas, with significant concentrations of motor vehicles and people, plan to meet air quality goals *by 2010, over the next 20 years.* The Bush Clean Air Plan proposal would bring all cities currently not meeting the health standards for ozone and carbon monoxide into attainment by 2000, *except for the most severely impacted cities.* Los Angeles, Houston and New York will be allowed until 2010 to meet attainment goals (Exhibit D, p. 5). Because these cities represent a significant portion of the United States' air quality problem, the time period of this report should be 1989 - 2010, so the report can recommend changes to or additions of federal regulations to assist these major urban areas attain clean air standards *in their allowed time-frame.*

1b. *Is it reasonable to consider only electric vehicles and not hybrid vehicles?*

Hybrid vehicles offer a solution to one of the primary barriers to electric vehicle commercialization -- their constrained range. The hybrid electric vehicle (HEV) is defined as a vehicle having the elements of more than one propulsion system type, and which can utilize externally-generated electricity for at least part of its energy needs. The hybrid electric vehicle can be designed to burn a variety of liquid fuels (including methanol, ethanol, CNG and propane clean-fuels).

Exhibit N, the EPRI report entitled "*An Assessment of Hybrid Electric Propulsion Systems for Motor Vehicles,*" includes a section of recommended R&D tasks (p. 8-1) that would help spur the development and commercialization of HEVs.

Hybrid electric vehicles should be included in your evaluation, at the minimum to consider regulations to promote the research and development of these vehicles, as the DOE hybrid vehicle program has not been funded since 1985. Hybrid electric vehicles offer a intermediate solution to the range constraints of the first generation electric vehicles, by extending vehicle range.

1c. *Is it reasonable to consider that during the period considered in preparation of the report the primary market for electric vehicles will be fleet operation in urban areas?*

It is reasonable to assume that a primary market for electric vehicles in the 1989-2010 time-frame will be fleets. However, it is not reasonable to consider only the fleet market. The G-Van is only the first generation of a family of electric vehicles. While the electric vehicle is not yet appropriate for the long-range passenger vehicle

market, future generations of technologically advanced electric vehicles will expand the market beyond fleets. Commuters and families will be able to meet their driving needs conveniently with electric vehicles.

Electric vehicles are an *emerging* technology (versus the existing technology of other fuels). The first generation of this technology (the G-Van) will undergo many changes and improvements over the next twenty years. Already, the next generation electric van (the TEVan) has been produced in prototype form and has a 120 mile range capability, making it suitable for a much broader market than fleets. With its 70 mph speed and extended 120 mile range, the TEVan can easily meet the driving needs of commuters.

The South Coast Air Quality Management District's plan[1] can *only* meet the Clean Air deadline if electric vehicles attain these penetration levels in the South Coast Air Basin:

- 3% of passenger cars (240,000 passenger cars)
- 12% of vans (292,000 vans)
- 2% of heavy duty vehicles (10,000 trucks)
- 10% of public fleets

If Los Angeles and other major urban areas in the U.S. plan to meet significant electric vehicle penetration levels that involve the passenger vehicle market in the next 20 years, it is necessary to consider amendments to, and addition of, federal regulations to assist them in meeting their goals.

Current proposed regulations in the South Coast to introduce clean fueled vehicles are aimed at fleets as *only* a small first step towards cleaning the air. It will be necessary to target other markets to make significant improvement in air quality.

Exhibits B and C are market potential studies that have projected not only a market for fleet vehicles, but a market for passenger vehicles.

1d. ***Is it reasonable to assume that vehicles in the future will not require any waivers of federal motor vehicles safety standards?***

The G-Van will meet all federal standards in crash testing. The vehicle will complete FMVSS testing shortly. Waivers of federal motor vehicle safety standards will not be required.

1e. ***Is it reasonable to assume the vehicle will meet Department of Energy standards for such vehicles, e.g., ventilation, electrical shock, electrical fire, electrolyte spillage, battery explosion, battery retention during crashes, electric ignition of fuels used for***

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[1] "Air Quality Management Plan, Appendix IV-G, Transportation Land Use & Energy Conservation Measures," by the South Coast Air Quality Management District, Draft September 1988.

auxiliary systems, etc.?

Edison is unfamiliar with the Department of Energy standards, and we suggest that you consult personnel at the Department of Energy, in the Electric and Hybrid Vehicle Program office, regarding the answers to these questions.

2. *What federal regulations require amendment (or extension) to stimulate the introduction of EVs? Please consider regulations in the areas of fuel economy, emissions and safety (crash-worthiness, crash avoidance, and other hazards including hazards during recharging and maintenance).*

See answer to question 4 below.

3. *What new federal regulations are needed to stimulate the introduction of EVs? Please consider the areas listed in paragraph 2 and any other you believe to be relevant.*

See answer to question 4 below.

4. *In your judgement, do current regulations, definitions, required measurements or practices favor other alternatives to gasoline powered vehicles over EVs?*

Attachment 2 to this letter is a memorandum written by the law firm of Van Ness, Feldman, Sutcliffe and Curtis entitled, "Initial Survey of Federal Regulatory Provisions That Impede Commercialization of Electric Vehicle Technologies." This document identifies current regulations directly affecting electric vehicles, other regulatory provisions to be reviewed and regulatory opportunities to add incentives for electric vehicles. Also covered briefly are biases towards other alternatives.

In summary, existing federal regulations do not offer effective incentives to encourage electric vehicle development to overcome technological and economic obstacles. Although there are several potential impediments to the development of electric vehicles in federal regulatory provisions, merely fine-tuning these existing regulations will not be sufficient. Appropriate and identifiable new or amended regulations to encourage electric vehicle commercialization are outlined in the Van Ness attachment. New regulations or changes to existing regulations should focus on:

- encouraging manufacturers to supply electric vehicles
- encouraging public fleets to acquire electric vehicles

California activity in the clean-fuel vehicle arena has definitely been biased away from electric (and other alternatives) towards methanol. For example, the California Energy Commission has spent many millions of dollars on methanol vehicle development and demonstration programs over the past ten years while planning to spend only about $400,000 on electric vehicle programs in the next two years.

Another indication of California's bias is the definition of a clean-fuel vehicle set by the Assembly Bill 234, which became law in October, 1987, and defines a "low-emission" vehicle in methanol and gasoline terms (see Exhibit K. page 1-2, and Exhibit N.). The law could be confusing as to which other vehicles actually qualify as "low emission" vehicles. The California Air Resources Board recently released a study in which they recommended ROG exhaust standards that alternative fuels must meet to qualify as low emission vehicles. In tests performed on an *incomplete sample* of alternate fuel vehicles, CARB found the following vehicles passed the ROG emission standards:

- FFV fueled with M85
- LPG Vehicle
- CNG Vehicle
- Dedicated Electric Vehicle
- Dual-Fuel Electric Vehicle

However, it must be stressed that the sample was *incomplete*. Too few vehicles in each category were tested -- in some categories *no vehicle* was tested. CARB's recommendation is again, confusing. CARB defined some low emission vehicles, but did not necessarily eliminate all the vehicles that did not make their list.

Exhibit J, "*Curbing Air Pollution in Southern California -- The Role of Electric Vehicles*" is a result of a project undertaken to assist policy makers in evaluating future environmental, transportation, and energy options involving the use of low-emissions highway vehicles in the Los Angeles Region. The project focused on electric vehicles and their future potential as replacements for gasoline and diesel powered vehicles. The primary purpose of the project was to assess the promise of EVs over the next 20 years as a means of curbing air pollution in the South Coast Air Basin. This document provides valuable insights that will help you meet your objectives.

5. *What technological barriers do you foresee to the introduction of electric vehicles in the time frame indicated?*

The most likely technological barrier to the introduction of electric vehicles into the general vehicle market during 1989 - 2010 is the range constraint of the current Lead-Acid (Pb-Acid) battery. However, the Pb-Acid battery is expected to be replaced by the Nickel-Iron (Ni-Fe) battery. The Nickel-Iron battery improves range significantly. Edison expects to begin introduction of the TEVan with a Ni-Fe battery (see Exhibit H, pages 2-3 and Exhibit K, pages 1-2) into the Southern California market in the near future, and efforts are currently underway to jointly build a Nickel-Iron battery pilot plant (see Exhibit O-VII). Also, research and development is underway to perfect other batteries for use in electric vehicles that would improve range even more (Exhibits E & G).

The hybrid electric vehicle is another potential solution to the range constraint problem. However, incentives are needed to spur more efforts to develop hybrid electric vehicles.

5a. *What level of performance and efficiency do you envision for EVs that may be introduced into commerce during the period 1989-2010? Please address vans, two-seaters, etc., as a function of time. Performance includes range, acceleration and top speed.*

See answer to 5C, below.

5b. *What battery systems correspond to the estimates in paragraph 5a?*

See answer to 5C, below.

5c. *What are the life-cycles of the batteries mentioned in paragraph 5b?*

Please see Exhibit A, pages 3-6, Exhibit F, pages 7 , 9 and 13, and Exhibit I, page 3, for references. Exhibit I has passenger vehicle performance projections also. The following shows electric van projections from Exhibit I:

			------ Projected ------			
	GM Griffon	G-Van	DSEP	TEVan	ETX-II	Advanced G-Van
Top Speed, mph	53	52	60+	70	60	62
Urban Range, mi	54	40	52	110+	113	136
0-30 mph acceleration, secs	11.4	12.9	—	7	—	11
0-50 mph acceleration, secs	—	—	20.5	-	20	-
Battery	Pb-Acid	Pb-Acid	Ni-Fe	Ni-Fe	Na-S	Na-S
Year of Production	1985	1989	—	1991	—	—
mi/kW City	1.66	1.2	2.22	1.66*	2.5	-
Reference	TVA	TVA	Kelledes	EPRI	Altmejd	Angelis
			---------- Projected ----------			
Battery Life-cycles (80% DOD)	800	800	1100	1100	1000	1000
Battery Life-cycles (years)	4	4	10	10	10	10

Estimate provided by Southern California Edison

See Exhibit F for an evaluation and comparison of battery performance in a real-world operating environment. Batteries tested were: Pb-Acid, Ni-Fe, Ni-Cadmium, Nickel-Zinc, Gel-Cell.

6. *What economic barriers do you foresee to the introduction of EVs in the time frame indicated?*

The primary economic barrier to the introduction of these vehicles is the price of the initial, low-production vehicles and batteries. Unless production levels increase significantly, the price of the electric vehicle and battery will remain too high. At limited production levels (3,000 - 5,000 vans) life-cycle costs fall to a level competitive with a conventional gasoline powered van. Magna International has tentative plans to build a production-volume electric vehicle plant. However, to ensure that a sophisticated production facility will be built, electric vehicle purchase subsidies (or other incentives) and regulatory "demand" will be needed. Price incentives and regulatory support may will be required during the first 3 - 5 years of electric vehicle production.

The Los Angeles Braude Initiative's objective is to stimulate market penetration of electric vehicles in Southern California by demonstrating the commercial viability of the electric vehicle. The sponsors intend to help the successful respondent(s) in marketing, servicing and subsidizing the initial 10,000 electric vehicles. However, federal regulatory support and subsidies will also be needed in order to encourage investment in electric vehicle production facilities that will enable lower cost electric vehicles to be produced.

6a. *What cost differentials to the consumer do you anticipate between EVs and conventional-fuel vehicles in the purchase, maintenance and replacement of batteries or major systems?*

SCE analyses have shown G-Van fuel and maintenance costs to be 30% less than for conventional vans. Integration of the Nickel-Iron battery into the G-Van would eliminate the need for battery replacement. Additional information on cost differentials can be found in Exhibit O (on pages 2 and 3 of Exhibit III of that document).

6b. *What lead times would be required to produce the EVs mentioned in paragraph 5? In what quantities?*

Edison's baseline forecast for electric vehicle penetration over the next twenty years for the combined SCE and LADWP service territories follows these guidelines:

- by the end of 1995, a cumulative total of 10,000 electric vehicles are forecast to be in use. This is consistent with the L.A. Initiative program target.
- by year 2000, electric vehicle sales are forecast to be 25,000 annually. This is consistent with the Southern California Association of Governments (SCAG) input to the South Coast Air Quality Management Plan (AQMP).
- by year 2010, EV sales are forecast to be 70,000 annually and the total electric vehicle fleet is forecast at 500,000 vehicles. This is also consistent with SCAG input to the AQMP.

The Claremont Graduate School study (Exhibit J) has considered several electric vehicle penetration scenarios for the SCE / LADWP service territory by the year

2010:

- 5% or about 500,000 electric vehicles, which is similar to Edison's forecast
- 25% or about 2.8 million electric vehicles, and
- 47% or about 5 million electric vehicles

In addition, transportation scenario assumptions considered during development of the AQMP by the SCAQMD have included a 20% penetration within 10 years and 40% to 100% electrification within 20 years.

See answer to question 6c, below.

6c. *In your judgement, will the national capacity exist to produce enough EVs to affect a change in air quality in the localities currently out of compliance with the Clean Air Act, assuming there will exist sufficient availability of electric power for their use?*

As discussed in Exhibit O, with sufficient regulatory support and financial incentives, a G-Van with an advanced Ni-Fe battery could be available as early as 1993. (It is expected that production of G-Vans with Pb-Acid batteries will occur before then). Production of the Chrysler TEVan, while anticipated in the near future, may well depend upon the level of regulatory support and financial incentives in place to encourage production of electric vehicles.

The Los Angeles Department of Water and Power, "Request for Proposal -- An Initiative to Stimulate Electric Vehicle Market Penetration in Southern California," (the Braude Initiative) anticipates that successful respondents will target introduction of 3,000 electric vehicles (range: 65 miles) by 1991, by 1993 an additional 3,000 electric vehicles (range: 100 miles), and by 1995 an additional 4,000 electric vehicles (range: 150 miles). It is anticipated that the RFP will be awarded to respondents in 1989.

Both the G-Van (GM Vandura) and the TEVan (Chrysler Plymouth Voyager and Dodge Caravan) are based on existing vehicles that are produced in mass production volumes. There clearly exists ample national capacity to make the bodies of the vehicles. Similarly, there is ample capacity of Lead-Acid batteries and power units. The only question is the national capacity for advanced batteries -- such as Nickel - Iron or Sodium Sulfur. Efforts are currently underway to stimulate the development of production - volume advanced battery plants, but additional support for battery production would help ensure that sufficient capacity would exist so that Electric Vehicles could have a major impact nationwide on air quality improvements.

7. *What institutional barriers do you foresee to the introduction of EVs in the time frame indicated? Are there any regulatory actions or incentives that would be likely to stimulate the introduction of EVs by promoting interaction among potential EV manufacturers, electric utility companies, and other interested parties?*

See answers to questions 2, 3 and 4 above, particularly Attachment 2.

8. *In reference to the calculation of the equivalent petroleum-based fuel economy value of electric vehicles (part 474, 10 CFR Ch.II see Attachment 2), are there reasons to recommend changes to the test procedures, driving cycles, cycle weighing multipliers, petroleum equivalency factors, etc.? Do you believe that other factors, such as utility power plant emissions, vehicle auxiliary systems emissions and vehicle performance, should be included in the calculation?*

Edison is unfamiliar with the referenced calculation. Measurements of fuel economy should be calculated on the basis of cents / mile, Life Cycle Costs. (See Exhibit O for in-depth discussions of Life Cycle Costs). Measurements of air quality should be calculated using grams / mile of pollutant emissions.

9. *What regulations unique to EVs do you believe should be in place prior to mass production to:*

   a. facilitate their acceptance and use by the general public
   b. prevent delays in their introduction due to the time required for the regulatory process, and
   c. reduce uncertainty on the part of manufacturers and utilities in making economic decisions?

In fiscal year 1990, Edison urges that $1 million in appropriations be included in the Department of Energy's Electric and Hybrid Vehicle Site Operators Program. Additionally, Edison urges that $3 million in appropriations be provided by the Federal government for use in a 50-50 federal / State / Local government (50%) and private sector (50%) supported cost-share program to introduce a 200 to 300 vehicle field evaluation program in fiscal year 1990.

A national electric vehicle commercialization plan -- a five-year, $50 million cost-sharing program -- is needed. A suggested version of the national commercialization plan is outlined in attachment 3.

See Attachment 2, memorandum written by the law firm of Van Ness, Feldman, Sutcliffe and Curtis entitled, "Initial Survey of Federal Regulatory Provisions That Impede Commercialization of Electric Vehicle Technologies."

ATTACHMENT 2

Van Ness, Feldman, Sutcliffe and Curtis

Memorandum

June 22, 1989

Re: Initial Survey Of Federal Regulatory Provisions That Impede Commercialization Of Electric Vehicle Technologies

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An initial survey of applicable federal regulatory provisions has revealed several potential impediments to the development of electric vehicles (EVs). Perhaps more importantly, the survey has also disclosed a number of regulatory programs that potentially could be altered in order to provide more meaningful incentives for electric vehicles. To place the following discussion of regulatory barriers/opportunities in perspective, however, a number of preliminary observations are necessary.

Most importantly, the survey suggests that, by and large, regulations cannot be said to constitute significant barriers to electric vehicle development or use. The significant barriers to widespread use of this technology are essentially economic and technological.

It should be observed, however, that existing regulations do not offer effective incentives for electric vehicle development. The current regulatory framework does not meaningfully contribute to efforts to overcome the economic and technical obstacles to electric vehicles.

Finally, areas in which new or amended regulations designed expressly to encourage electric vehicle commercialization would be appropriate can be identified. Included among these would be tax incentives, currently limited to ethanol/methanol, and federal procurement programs and procedures. However, it must be recognized that in these areas, appropriate changes in statutory authority would likely be required to effectuate regulatory changes.

The following discussion focuses principally on regulatory programs that affect electric vehicles directly. Such programs are chiefly under the auspices of the Department of Energy. Additionally, references will be provided for other programmatic regulations that may indirectly affect electric vehicles, and which should be examined through further research in conjunction with efforts to pinpoint regulatory obstacles to widespread use

of electric vehicles. Finally, opportunities for regulatory changes that could offer incentives for electric vehicles will also be described.

Regulations Affecting Electric Vehicles Directly

Only a relatively small number of current regulations apply specifically to electric vehicles. These are primarily the regulations established by the Department of Energy to implement the Electric and Hybrid Vehicle Research, Development and Demonstration program, established pursuant to the Electric and Hybrid Vehicle Research, Development and Demonstration Act of 1976, 15 U.S.C. § 2501 et seq.

In general, the DOE regulations under the Electric and Hybrid RD&D program do not appear to present barriers to EV development. Nor, however, do they offer significant incentives to commercialization. Given the limited funding available for the program, along with the sunset of the loan guarantee program initially enacted to serve as a major stimulus to EV production, the existing regulatory program has little direct impact on the obstacles facing EV commercialization.

One aspect of the regulatory program that may still play a role in electric vehicle commercialization efforts concerns the performance values for electric vehicles established as part of the program and set forth in 10 CFR Part 475. These regulations, which were applicable to the acquisition of EVs through a demonstration program created under section 7 of the 1976 Act and since terminated, were last updated in 1980. Given the technological advances since that time, it may be appropriate to review the standards in light of intervening technological developments, to assure that they are consistent with obtainable performance through the current generation of vehicles, even though there are no ongoing large-scale Federal EV acquisition programs. In connection with the establishment of any major new initiative for electric vehicles, these minimum standards should be reviewed to assure that they contribute to efforts to put the most advanced technology possible on the roads.

With respect to the automotive propulsion research and development program described in 10 CFR Part 473, the definition of "research and development" contained in 10 CFR § 473.2, could foreclose support for activities "involving technology transfer to mass production" and "evaluative testing." The automotive propulsion R & D program is authorized by the Federal Energy Administration Act of 1978 - Civilian Applications. As a practical matter, it is unlikely that substantial funding will become available for automotive R & D programs pursuant to this statutory authority. However, if funding were to become available, this regulation could disqualify those efforts that

are most needed now, i.e., efforts to establish a production capability and to evaluate the initial generation of commercially produced vehicles to produce information needed by the marketplace, from receiving funding. The regulatory restriction may also foreclose certain unsolicited proposals that might otherwise be forthcoming to DOE and that could serve to address the important barriers to widespread use of electric vehicles.

Regulations in 10 CFR Part 474 establish a mechanism for crediting automobile manufacturers subject to the corporate average fuel economy (CAFE) standards program that also produce electric vehicles. The regulations contain rather cumbersome provisions for the calculation of an "equivalent petroleum-based fuel economy value." In conjunction with the overall review and updating of the CAFE standards program, consideration should be given to reformulating the credit for electric vehicles, and perhaps stating it more simply as a credit of a specific number of miles per gallon per electric vehicle produced, in order to provide a more effective incentive.

Department of Energy regulations in 10 CFR § 475.11(c) regarding safety standards applicable to electric vehicles speak of exemptions to be granted by the Department of Transportation, as well as the prospective issuance by the Department of Transportation of specific electric vehicle safety requirements. The applicable DOT regulations, or the lack thereof, should also be reviewed as a possible barrier to EV commercialization.

Other Regulatory Provisions To Be Reviewed

With respect to the issue of safety testing of electric vehicles, EVs are currently subject to the same Federal Motor Vehicle Safety Standards as conventional automobiles. These regulations, which are set forth in 49 CFR Part 571, should be reviewed to determine whether they are adequate to address the types of safety concerns that may be associated with electric vehicles.

Another area of potential inquiry concerns the customs regulations. Given the lack of development of the domestic electric vehicle industry, importation of component parts or vehicles themselves may be a part of any large scale commercialization effort. Therefore, regulations of the Customs Service applicable to the importation of motor vehicles or parts thereof, see, e.g., 19 C.F.R. § 12.73, may need to be examined to determine if they pose any particular barrier.

With respect to programs channeling federal funds to private entities for technology development, consideration may be given to possible impediments arising from provisions of the Federal Acquisition Regulations, 41 C.F.R. 9-9, concerning rights in

patents, data and copyrights. These provisions are applicable to DOE grant awards under the DOE assistance regulations in 10 CFR Part 600, and therefore could impact on DOE assistance to electric vehicle projects.

Regulatory Opportunities To Add Incentives For Electric Vehicles

A program operated under the auspices of the Environmental Protection Agency offers one potential opportunity for the inclusion of incentives for electric vehicles. Under regulations appearing in 40 C.F.R. Part 85, each manufacturer of substantial numbers of light duty motor vehicles is required to institute a research program to develop low emission vehicles. Clearly the development of electric vehicles could and perhaps should be a primary focus of such efforts, if the program described in the regulations is still ongoing. Among the criteria for demonstration vehicles, specific references to electric vehicles could be added. See 40 CFR § 85.404(b).

Another important opportunity for creating new incentives for electric vehicles is through the federal acquisition regulations, which appear in Title 41 of the Code of Federal Regulations. The current federal acquisition regulations, as illustrated by the DOE regulations in 41 CFR Part 109-38, make no provision for the acquisition of electric vehicles. In view of the lack of a currently available production model EV, this omission is understandable. However, the regulations could be revised to include a provision permitting or even mandating the purchase of EVs when and where a production model becomes available.

In the procurement context, however, one regulatory barrier would need to be overcome. As illustrated in 41 CFR § 109-38.1204-50, concerning the selection of the type of motor vehicles to be acquired, a general requirement is imposed that mandates that the least expensive unit overall be purchased. This provision could effectively disqualify electric vehicles with high initial purchase prices, and fails to recognize the public policy importance of providing for acquisition of such vehicles by federal agencies. This and similar regulations should be amended, within permissible statutory constraints, to provide that electric vehicles may be acquired when available, and to assure that the cost of electric vehicles is considered on a life-cycle basis, rather than simply as the initial purchase price.

With respect to incentives that are available for some alternative fuels but not similarly available for electric vehicles, the Internal Revenue Code in section 48, see 26 CFR § 48.4041-19, provides exemptions from federal gasoline excise taxes for methanol and ethanol fuel. Additional incentives are

provided elsewhere in the tax code for manufacturers of these alternative fuels. However, no similar incentives are available for electric vehicles. While it would necessarily require statutory action to make such incentives available, appropriate changes in the tax code to facilitate the development of an electric vehicle manufacturing capability should figure prominently in any program of incentives to encourage electric vehicles.

Finally, a number of DOE administered energy conservation programs may also offer opportunities for providing incentives for electric vehicles. Among the specific programs that could be examined are the State Energy Conservation Program, see 10 CFR Part 420, the Energy Extension Service, see 10 CFR Part 465, and the Federal Energy Management Program, see 10 CFR Part 436. As a practical matter, the funding limitations of these programs make it unlikely that these programs would offer realistic support for EV commercialization efforts.

Conclusion

The most significant obstacles to widespread use of electric vehicles are not primarily regulatory, but appear to be economic -- the high per vehicle cost, resulting from a lack of a production capability and the lack of consumer demand resulting from the lack of a production model -- and technological -- the need to improve range and performance of the vehicles. Direct incentives to address these problems are needed; simply fine-tuning existing regulations would not make a significant improvement in the prospects for development of an electric vehicle marketplace. However, after an electric vehicle production capability is developed, a number of federal regulations, especially those concerned with procurement, will need to be revisited to assure that they offer incentives for EVs.

§ 473.22 Initial review by manager.

(a) Upon expiration of the time for filing information under these regulations, the manager shall—

(1) Review the proposed research and development to be performed under grant, under cooperative agreement, under contract, as a DOE project, or as an agency project and any other pertinent information received under these regulations or otherwise available; and

(2) Initially determine whether the research and development reviewed under paragraph (a)(1) of this section complies with the standards and criteria of § 473.30.

(b) A manager who makes a negative determination under paragraph (a)(2) of this section shall inform the applicant and any interested person who objected of the decision in writing with a brief statement of supporting reasons.

(c) A manager who initially determines that research and development reviewed under this section complies with the standards and criteria of § 473.30 shall cause an interagency review panel to be convened under § 473.23.

§ 473.23 Interagency review panel.

(a) The interagency review panel shall consist of—

(1) A head designated by the Federal agency that employs the manager;

(2) A representative of the DOE if the manager is not an employee of the DOE; and

(3) A representative of any other Federal agency deemed appropriate by the Federal agency that employs the manager.

(b) The interagency review panel shall—

(1) Review the research and development to be performed and consider the information presented by the applicant, in the case of a grant, cooperative agreement, or contract, and by any interested person who filed a statement of objection;

(2) Make a recommendation with a supporting statement of findings to the manager as to whether the research and development to be performed complies with the standards and criteria of § 473.30; and

(3) Operate by majority vote with the head of the panel casting the decisive vote in the event of a tie.

§ 473.24 Final action and certification by manager.

(a) Upon consideration of the recommendation of the interagency review panel and other pertinent information, the manager—

(1) Shall determine whether the research and development to be performed complies with the standards and criteria of § 473.30;

(2) Shall obtain the concurrence of the DOE if the manager is not an employee of the DOE;

(3) Shall, in the event of a negative determination under this section, advise the applicant, in the case of a grant, cooperative agreement, or contract, and any interested person who filed a statement of objection; and

(4) Shall, in the event of an affirmative determination under this section, prepare a certification—

(i) Explaining the determination;

(ii) Discussing any allegedly related or comparable industrial research and development considered and deemed to be an inadequate basis for not certifying the grant or contract;

(iii) Discussing issues regarding cost sharing and patent rights related to the standards and criteria of § 473.30 of these regulations; and

(iv) Discussing any other relevant issue.

(b) After complying with paragraph (a) of this section, the manager shall sign the certification and distribute copies to the applicant, if any, and any interested person who filed a statement of objections—

(1) Immediately in the case of a DOE or agency project; and

(2) After the agreement has been negotiated in the case of a grant, cooperative agreement, or contract.

§ 473.25 Reviewability of certification.

Any certification issued under these rules is—

(a) Subject to disclosure under 5 U.S.C. 552 (1970) and section 17 of the Federal Nonnuclear Energy Research and Development Act of 1974, as amended, 42 U.S.C. 5918 (1970);

(b) Subject neither to judicial review nor to the provisions of 5 U.S.C. 551-559 (1970), except as provided under paragraph (a) of this section; and

(c) Available to the Committee on Science and Technology of the House of Representatives and the Committee on Energy and Natural Resources of the Senate.

§ 473.30 Standards and criteria.

Research and development to be performed under a grant, under a cooperative agreement, under a contract, as a DOE project, or as an agency project under the Act may be certified under these regulations only if the research and development to be conducted—

(a) Supplements the automotive propulsion system research and development efforts of industry or any other private researcher;

(b) Is not duplicative of efforts previously abandoned by private researchers unless there has been an intervening technological advance, promising conceptual innovation, or justified by other special consideration;

(c) Would not be performed during the annual funding period but for the availability of the Federal funding being sought;

(d) Is likely to produce an advanced automobile propulsion system suitable for steps toward technology transfer to mass production in a shorter time period than would otherwise occur;

(e) Is not technologically the same as efforts by any person conducted previously or to be conducted during the annual funding period regarding a substantially similar advanced automobile propulsion system; and

(f) Is not likely to result in a decrease in the level of private resources expended on advanced automotive research and development by substituting Federal funds without justification.

PART 474—ELECTRIC AND HYBRID VEHICLE RESEARCH, DEVELOPMENT AND DEMONSTRATION PROGRAM: EQUIVALENT PETROLEUM-BASED FUEL ECONOMY CALCULATION

Sec.

474.1 Purpose and scope.
474.2 Definitions.
474.3 Test procedures.
474.4 Equivalent petroleum-based fuel economy calculation.

AUTHORITY: Sec. 503(a)(3), Motor Vehicle Information and Cost Savings Act, Pub. L. 94-163 (15 U.S.C. 2003(a)(3)), as added by sec. 18, Chrysler Corporation Loan Guarantee Act of 1979, Pub. L. 96-185; Department of Energy Organization Act, Pub. L. 95-91.

SOURCE: 46 FR 22753, Apr. 21, 1981, unless otherwise noted.

§ 474.1 Purpose and scope.

This part contains procedures for calculating the equivalent petroleum-based fuel economy value of electric vehicles, as required to be prescribed by the Secretary of Energy under section 503(a)(3) of the Motor Vehicle Information and Cost Savings Act (15 U.S.C. 2003(a)(3)), as added by section 18 of the Chrysler Corporation Loan Guarantee Act of 1979. The equivalent petroleum-based fuel economy value is intended to be used in calculating corporate average fuel economy pursuant to regulations promulgated by the Environmental Protection Agency at 40 CFR Part 600—Fuel Economy of Motor Vehicles.

§ 474.2 Definitions.

For purposes of this part, the term—

"Electric vehicle" means a vehicle that is powered by an electric motor drawing current from rechargeable storage batteries or other portable energy storage devices. Recharge energy shall be drawn primarily from a source off the vehicle, such as residential electric service.

"Electrical efficiency value" means the weighted average of the stop-and-go and steady-speed electrical efficiency values, as determined in accordance with § 474.4(b).

"Energy equivalent fuel economy value" means the electrical efficiency

value converted into units of miles per gallon, as determined in accordance with § 474.4(c).

"Equivalent petroleum-based fuel economy value" means a number, determined in accordance with § 474.4, which represents the average number of miles travelled by an electric vehicle per gallon of gasoline.

"Model type" means the term defined by the Environmental Protection Agency in its regulations at 40 CFR 600.002-81(19).

"Model year" means the term defined by the Environmental Protection Agency in its regulations at 40 CFR 600.002-81(6).

"Petroleum equivalency factor" means a number which represents the parameters listed in section 503(a)(3)(ii) through (iv) of the Motor Vehicle Information and Cost Savings Act (15 U.S.C. 2003(a)(3)) for purposes of calculating equivalent petroleum-based fuel economy in accordance with § 474.4.

"Petroleum-powered accessory" means a heater/defroster system or an air conditioner system which uses fuel, as defined in section 501(5) of the Motor Vehicle Information and Cost Savings Act (15 U.S.C. 2001) as its primary energy source.

"Production volume" means the term defined by the Environmental Protection Agency in its regulations at 40 CFR 600.002-81(32).

"Steady-speed electrical efficiency value" means the average number of kilowatt-hours of electrical energy required for an electric vehicle to travel 1 mile, as determined in accordance with § 474.3(c).

"Stop-and-go electrical efficiency value" means the average number of kilowatt-hours of electrical energy required for an electric vehicle to travel 1 mile, as determined in accordance with § 474.3(b).

[48 FR 22753, Apr. 21, 1981, as amended at 48 FR 28432, June 22, 1983]

§ 474.3 Test procedures.

(a) The conditions and equipment in the Electric Vehicle Test Procedure—SAE J227a of the Society of Automotive Engineers shall be used for conducting the test procedures set forth in this section.

(b) The test procedures prescribed in SAE procedure J227a, Vehicle Energy Economy, using Vehicle Test Cycle C for the driving cycle, shall be used for generation of the stop-and-go electrical efficiency value.

(c) The test procedures prescribed in SAE procedure J227a, Vehicle Energy Economy, using a driving cycle consisting of a maximum cruise speed of 54 mph, as prescribed in the SAE procedure for Range at Steady Speed, shall be used for generation of the steady-speed electrical value. For an electric vehicle model type that is incapable of maintaining a maximum cruise speed of 54 mph, this test procedure shall be conducted at the maximum cruise speed as defined in section 2.8 of the SAE procedure J227a.

§ 474.4 Equivalent petroleum-based fuel economy calculation.

(a) Calculate the equivalent petroleum-based fuel economy of an electric vehicle as follows:

(1) Determine the stop-and-go electrical efficiency value, according to § 474.3(b).

(2) Determine the steady-speed electrical efficiency value, according to § 474.3(c).

(b) Calculate the electrical efficiency value by:

(1) Multiplying the stop-and-go electrical efficiency value by 0.91;

(2) Multiplying the steady-speed electrical efficiency value by 0.09; and

(3) Adding the resulting two figures, rounding to the nearest 0.01 kWh/mile.

(c) Calculate the energy equivalent fuel economy value by dividing the electrical efficiency value into 36.66.

(d) For purposes of paragraph (e) of this section, use the appropriate Petroleum Equivalency Factor as follows:

(1) If no more than 33 percent of the production volume of the electric vehicle model type is to be equipped with any petroleum-powered accessories, use the first number listed under paragraph (e) of this section for the applicable model year.

(2) If more than 33 percent of the production volume of the electric vehicle model type is to be equipped with only one petroleum-powered accesso-

ry, use the second nu... ...der paragraph (e) of this section of the applicable model year.

(3) If more than 33 per...nt o... production volume of the electric vehicle model type is to be equipped with two petroleum-powered accessories, use the third number under § 474.4(e) for the applicable model year.

(e) Calculate the equivalent petroleum-based fuel economy value in miles per gallon by multiplying the energy equivalent fuel economy value by the appropriate petroleum equivalency factor for the model year in which the electric vehicle is manufactured.

(1) For model year 1981, the petroleum equivalency factor is:

(i) 1.9,

(ii) 1.7, or

(iii) 1.6;

(2) For model year 1982, the petroleum equivalency factor is:

(i) 2.0,

(ii) 1.8, or

(iii) 1.6;

(3) For model year 1983, the petroleum equivalency factor is:

(i) 2.0,

(ii) 1.8, or

(iii) 1.6;

(4) For model year 1984, the petroleum equivalency factor is:

(i) 2.1,

(ii) 1.9, or

(iii) 1.7;

(5) For model year 1985, the petroleum equivalency factor is:

(i) 2.3,

(ii) 2.0, or

(iii) 1.8;

(6) For model year 1986, the petroleum equivalency factor is:

(i) 2.3,

(ii) 2.0, or

(iii) 1.8; and

(7) For model year 1987, the petroleum equivalency factor is:

(i) 2.3,

(ii) 2.0, or

(iii) 1.8.

PART 475—ELECTRIC AND HYBRID VEHICLE RESEARCH, DEVELOPMENT, AND DEMONSTRATION PROJECT

AUTHORITY: Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1976, Pub. L. 94-413, as amended by Department of Energy Act of 1978—Civilian Applications, Pub. L. 95-238; Energy Reorganization Act of 1974, Pub. L. 93-438; Department of Energy Organization Act, Pub. L. 95-91.

SOURCE: 45 FR 9544, Feb. 12, 1980, unless otherwise noted.

Subpart A—General Provisions

§ 475.1 Purpose and scope.

This part contains performance standards for electric and hybrid vehicles required to be prescribed by the Department of Energy pursuant to section 7(b)(1) of the Act.

§ 475.2 Definitions.

As used in this part:

"Act" means the Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1976 (Pub. L. 94-413, 90 Stat. 1263 et seq.), as amended by Department of Energy Act of 1978—Civilian Applications (Pub. L. 95-238; 92 Stat. 47, 91-94).

"Commercial vehicle" means a vehicle other than a personal-use vehicle.

"Electric vehicle" means a vehicle which is powered by an electric motor drawing current from rechargeable storage batteries, fuel cells, or other portable sources of electrical current, and which may include a nonelectrical source of power designed to charge batteries and components thereof.

"Hybrid vehicle" means a vehicle propelled by a combination of an electric motor and an internal combustion engine or other power source and components thereof.

"Personal-use vehicle" means a vehicle designed to carry ten persons or less, except a multipurpose passenger vehicle, motorcycle, truck, or trailer, as those terms are defined in 49 CFR 571.3.

"Vehicle" means an electric or hybid vehicle.

"Vital accessories" means headlights, taillights, windshield wipers, windshield defroster and defroster blowers. The heater blowers also shall be considered as vital accessories if the vehicle is equipped with a heater.

§ 475.3 Test conditions and procedures.

The conditions and procedures in Electric Vehicle Test Procedure—SAE J227a, as revised February 1976, of the Society of Automotive Engineers, shall be used to determine the levels of performance of vehicles for those categories for which minimum levels of performance are prescribed in Subpart B.

§ 475.4 Units.

The units and unit symbols and abbreviations used in this part are those of the International System of Units (Systeme International) or SI as established by the General Conference of Weights and Measures in 1960 and interpreted and modified for the United States pursuant to the U.S. Department of Commerce Notice on the Interpretation and Modification of the International System of Units for the United States (41 FR 54018, Dec. 10, 1976).

Subpart B—Minimum Levels of Performance

§ 475.10 Minimum levels of performance for personal-use vehicles.

The following minimum levels of performance are required with respect to any personal-use vehicle purchased or leased in fulfillment of contracts entered into following the effective date of these regulations, pursuant to section 7(c) of the Act.

(a) *Acceleration.* The time required to accelerate from rest to 50 km/h shall not exceed 13.5s.

(b) *Gradeability at speed.* The grade which can be traversed up at 25 km/h shall be at least 10 percent.

(c) *Gradeability limit.* The grade on which the vehicle can start and climb for 20s either backward or forward shall be no less than 20 percent.

(d) *Forward speed capability.* The speed which can be maintained for 5 minutes shall be 80 km/h.

(e) *Range.* The distance which the vehicle can be operated with vital accessories on or equivalent, shall be:

(1) For an electric vehicle, at least 55 km on the SAE J227 a/C cycle, and

(2) For a hybrid vehicle, at least 200 km on the SAE J227 a/C cycle.

(f) *Battery recharge time.* The vehicle shall be capable of satisfying the range requirement of paragraph (e) of this section, after being recharged for no more than 10 hours by use of an on-board charger. At the start of this recharge the vehicle shall have 80 percent discharged batteries as specified by the vehicle test conditions and procedures of § 475.3. The on-board charger shall be compatible with an electric power outlet of 110V or 220V AC, as specified by the vehicle manufacturer.

(g) *Recharge control.* The vehicle shall have an automatic recharge control which will meet the requirements of energy, life, and safety as such requirements are stated by these performance standards. This paragraph applies when on-board chargers are used and also when off-board chargers supplied by or specified by the vehicle manufacturer for recharge of the vehicle are used.

(h) *Energy consumption.* (1) For an electric vehicle, the maximum amount of nonelectrical energy consumed shall be that used for operation of the accessories only.

(2) For a hybrid vehicle, nonelectrical energy consumed shall not exceed 1.3 MJ/km and shall also not exceed 75 percent of total energy consumed for propulsion and vital accessories, based on being fully loaded on a driving schedule of 33 km on SAE J227 a/C cycle plus 33 km at 75 km/h (higher

heating value of gasoline taken as 32.7 MJ/L) and with vital accessories on.

(i) *Battery life.* (1) The vehicle shall be capable of at least 75 percent of the range specified in § 475.10(e) after 12 months or 15,000 km of normal use, whichever occurs first.

(2) The vehicle shall be capable of 100 percent of the acceleration and gradeability specified in § 475.10 (a), (b), and (c), for all test conditions and procedures specified by § 475.3, for 12 months or 15,000 km or normal use, whichever occurs first.

(3) The batteries shall, if necessary, be repaired or replaced by the vehicle manufacturer at no cost to the user of the vehicle in order to meet requirements of § 475.10(i) (1) and (2).

(j) *State-of-charge meter.* The vehicle shall have a state-of-charge meter for the propulsion battery system or other means of providing an indication of remaining range.

(k) *Odometer.* The vehicle shall have an odometer.

(l) *Passenger comfort heater.* The vehicle shall have the capability of having a passenger comfort heater installed at the option of the purchaser.

(m) *Documentation.* Adequate user manuals, maintenance (service) manual and parts lists shall be provided.

(n) *Emissions.* The vehicle shall comply with all applicable Federal emissions regulations for motor vehicles.

(o) *Safety, crashworthiness, damageability, crash avoidance and hazard.* (1) The vehicle shall comply with all applicable Federal motor vehicle safety standards as set forth in 49 CFR Part 571, unless a temporary exemption is obtained by the manufacturer from the Department of Transportation.

(2) Until the Department of Transportation issues regulations which cover the same subjects, the vehicle shall also have the following performance characteristics:

(i) The electric propulsion circuit shall be electrically isolated from other conductive portions of the vehicle sufficiently to prevent personal hazards due to contacting any portion of the electric propulsion circuit while in contact with other portions of the vehicle.

(ii) The vehicle shall be capable of complying with the performance requirements of Federal motor vehicle safety standards 208 and 301 with all battery materials remaining outside the passenger compartment.

(iii) Vehicles with battery vents shall have flame barrier provisions to inhibit battery explosions.

(iv) Ventilation shall be adequate within the battery compartment to maintain the concentration of hydrogen below 4 percent by volume during vehicle operation (including charging and maintenance).

(v) The vehicle shall have a device which provides for the positive disconnection of the battery and which is operable from the normal operator position.

(vi) The vehicle shall be capable of being parked for up to 8 hours in temperatures of −25° C. to 50° C. and subsequently operated, by moving forward under its own power, at any temperature within this temperature range without damage to the vehicle or hazard to persons.

§ 475.11 Minimum levels of performance for commercial vehicles.

The following minimum levels of performance are required with respect to any commercial vehicles purchased or leased in fulfillment of contracts entered into following the effective date of these regulations, pursuant to section 7(c) of the Act.

(a) *Acceleration.* The time required to accelerate from rest to 50 km/h shall not exceed 14s for vehicles with a payload carrying capability of less than or equal to 600 kg.

(b) *Gradeability at speed.* The grade which can be traversed up at 25 km/h shall be at least 10 percent.

(c) *Gradeability limit.* The grade which the vehicle can start and climb for 20s either backward or forward shall be no less than 20 percent.

(d) *Forward speed capability.* The speed which can be maintained for 5 minutes shall be 75 km/h.

(e) *Range.* The distance which the vehicle can be operated with vital accessories on or equivalent shall be:

(1) For an electric vehicle, at least 60 km on the SAE J227 a/B cycle, and

(2) For a hybrid vehicle, at least 200 km on the SAE J277 a/B cycle.

(f) *Battery recharge time.* The vehicle shall be capable of satisfying the range requirement of § 475.11(e) above, after being recharged for no more than 10 hours. At the start of this recharge, the vehicle shall have 80 percent discharged batteries as specified by the vehicle test conditions and procedures of § 475.3.

(g) *Recharge control.* The vehicle shall have an automatic recharge control which will meet the requirements of energy, life, and safety as such requirements are stated by these performance standards. This paragraph applies when on-board chargers are used and also when offboard chargers supplied by or specified by the vehicle manufacturer for recharge of the vehicle are used.

(h) *Energy Consumption.* (1) For an electric vehicle, the maximum amount of nonelectrical energy consumed shall be that used for operation of the accessories only.

(2) For a hybrid vehicle, nonelectrical energy consumed shall not exceed 9.8 kJ/kmkg of cargo and shall also not exceed 75 percent of total energy consumed for propulsion and vital accessories, based on being fully loaded on a driving schedule of 100 km on SAE J227 a/B cycle, the cargo not including the operator, and with vital accessories on.

(i) *Battery life.* (1) The vehicle shall be capable of at least 75 percent of the range specified in § 475.11(e) after 12 months or 15,000 km of normal use, whichever occurs first.

(2) The vehicle shall be capable of 100 percent of the acceleration and gradeability specified in paragraph (a), (b), and (c) of this section, for all test conditions and procedures specified by § 475.3 for 12 months or 15,000 km or normal use, whichever occurs first.

(3) The batteries shall, if necessary, be repaired or replaced by the vehicle manufacturer at no cost to the user of the vehicle in order to meet requirements of paragraphs (i) (1) and (2) of this section.

(j) *State-of-charge meter.* The vehicle shall have a state-of-charge meter for the propulsion battery system or other means of providing an indication of remaining range.

(k) *Odometer.* The vehicle shall have an odometer.

(l) *Passenger comfort heater.* The vehicle shall have the capability of having a passenger comfort heater installed at the option of the purchaser.

(m) *Documentation.* Adequate user manuals, maintenance (service) manuals and parts lists shall be provided.

(n) *Emissions.* The vehicle shall comply with all applicable Federal emissions regulations for motor vehicles.

(o) *Safety, crashworthiness, damageability, crash avoidance and hazards.* (1) The vehicle shall comply with all applicable Federal motor vehicle safety standards as set forth in 49 CFR Part 571, unless a temporary exemption is obtained by the manufacturer from the Department of Transportation.

(2) Until the Department of Transportation issues regulations which cover the same subjects, the vehicle shall also have the following performance characteristics:

(i) The electric propulsion circuit shall be electrically isolated from other conductive portions of the vehicle sufficiently to prevent personal hazards due to contacting any portion of the electric propulsion circuit while in contact with other portions of the vehicle.

(ii) The vehicle shall be capable of complying with ther performance requirements of Federal motor vehicle safety standards 208 and 301 with all battery materials remaining outside the passenger compartment.

(iii) Vehicles with battery vents shall have flame barrier provisions to inhibit battery explosions.

(iv) Ventilation shall be adequate within the battery compartment to maintain the concentration of hydrogen below 4 percent by volume during vehicle operation (including charging and maintenance).

(v) The vehicle shall have a device which provides for the positive disconnection of the battery and which is operable from the normal operator position.

(vi) The vehicle shall be capable of being parked for up to 8 hours in temperatures of −25° C. to 50° C. and subsequently operated, by moving forward under its own power, at any temperature within this temperature range without damage to the vehicle or hazard to persons.

PART 476—ELECTRIC AND HYBRID VEHICLE RESEARCH, DEVELOPMENT, AND DEMONSTRATION PROGRAM SMALL BUSINESS PLANNING GRANTS

Sec.

AUTHORITY: Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1976, Pub. L. 94-413, 90 Stat. 1260 *et seq.* (15 U.S.C. 2501 *et seq.*), as amended by the Department of Energy Act of 1978—Civilian Applications, Pub. L. 95-238; Department of Energy Organization Act, Pub. L. 95-91, 91 Stat. 565 *et seq.* (42 U.S.C. 7101 *et seq.*).

SOURCE: 44 FR 57370, Oct. 4, 1979, unless otherwise noted.

§ 476.1 Purpose and scope.

This part establishes a program which makes planning grants available to qualified small business concerns which require assistance in developing, submitting and entering into contracts for research, development, or demonstration of electric or hybrid vehicles pursuant to section 9(c)(2) of the Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1976, Pub. L. 94-413, 90 Stat. 1260 *et seq.* (15 U.S.C. 2501 *et seq.*), as amended.

§ 476.2 Definitions.

As used in this part—"Act" means the Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1976, Pub. L. 94-413, 90 Stat. 1260 *et seq.* (15 U.S.C. 2501 *et seq.*), as amended.

"Affiliate" means "affiliate" as defined in 13 CFR Part 121.3-2(a).

"Annual receipts" means the gross income (less returns and allowances, sales of fixed assets, and interaffiliate transactions) of a concern (and its domestic and foreign affiliates) from sales of products and services, interest, rents, fees, commissions, and/or from whatever other source derived, as entered on its regular books of account for its most recently completed fiscal year and each of the two preceding years (whether on a cash, accrual, completed contracts, percentage of completion, or other acceptable accounting basis) and, in the case of a concern subject to U.S. Federal income taxation, reported or to be reported to the U.S. Treasury Department, Internal Revenue Service for Federal income tax purposes. If a concern has been in business less than 3 years, its average annual receipts shall be computed by determining its average weekly receipts for the period in which it has been in business, and multiplying such figure by 52. If a concern has acquired an affiliate during the applicable accounting period, it is necessary in computing the applicant's annual receipts to include the affiliate's receipts during the entire applicable accounting period, rather than only its receipts during the period in which it has been an affiliate. The receipts of a former affiliate are not included even if such concern had been an affiliate during a portion of the applicable accounting period.

"Concern" means any business entity organized for profit (even if its ownership is in the hands of a nonprofit entity) with its principal place of business located in the United States. "Concern" includes, but is not limited to, an individual, partnership, corporation, joint venture, association or cooperative. For the purpose of making affiliation findings, any business entity, whether organized for profit or not, and any foreign business entity, (i.e. any entity located outside the United States) shall be included.

"DOE" means the Department of Energy.

"Electric vehicle" means a vehicle which is powered by an electric motor drawing current from rechargeable storage batteries, fuel cells, or other portable sources of electrical current.

ATTACHMENT 3

FINAL DRAFT
May 24, 1989

A National Electric Vehicle Commercialization Program

The purpose of a national electric vehicle commercialization program would be to accelerate the introduction and widespread use of electric vehicles. The Department of Energy (DOE), in consultation with the Departments of Transportation and Commerce and the Environmental Protection Agency, would be authorized to establish and undertake a five year (fiscal years 1991-1995), $50 million cost-sharing program whereby through a competitive solicitation, DOE would select two or more manufacturers to produce and sell an agreed upon number of electric vehicles. [The term "manufacturer" as used throughout this proposal is to be broadly defined to mean an entity assuming principal responsibility for producing electric vehicles.] The government would cost-share the per vehicle cost.

The program will address two major impediments to the development of electric vehicles (EVs), the high per vehicle cost of EVs and the lack of production capability. These problems are closely intertwined: until a production capability exists, EVs will be costly and, on a life cycle basis, will not achieve cost competitiveness, either with conventional gasoline-powered vehicles, or with alternatively fueled vehicles, such as methanol, ethanol, CNG or LPG powered vehicles. Further, the multi-year duration of the program will permit the integration of advanced battery technologies and other technology improvements into a commercially acceptable vehicle.

To stimulate development of a manufacturing capability, the program will require a competitive solicitation for EV manufacturers to produce one or both of the following two vehicles: a passenger vehicle and a cargo vehicle. Vehicle specifications would be developed in the manner provided under subsection 7(b) of the Electric and Hybrid Vehicle Research, Development and Demonstration Act of 1976, which requires EV performance standards to be developed taking into account the best estimates of current and future state-of-the-art technology. From responses received to the solicitation, a minimum of two manufacturers would be selected.

As an additional incentive to manufacturers, the national EV commercialization program would include a provision for revision of the Corporate Average Fuel Economy (CAFE) standards program to include EVs. Manufacturers to which the CAFE standards are applicable would receive a credit of 150/200 miles for each EV produced, to be used in the calculation of the manufacturer's fleet fuel economy standard.

The purchaser of an EV manufactured under this program would be expected to provide no less than 50% of the per vehicle cost as established by the selected manufacturer. If the manufacturer has recourse to any additional sources of cost-sharing, such as state or local government funds or other contributions, such funding must be identified in the manufacturer's proposal. The federal government would provide no more than 50% of the per

vehicle cost as proposed by the manufacturer. In addition to stating the proposed cost per vehicle, manufacturers responding to the solicitation will also be required to indicate how many vehicles would be produced under the proposal, as well as how the vehicles would be distributed and serviced.

To enhance the availability of reliable information to further stimulate the marketplace, participating purchasers would be required to collect and provide data on such issues as maintenance schedule, vehicle reliability and performance, infrastructure requirements, etc.

In recognition of one of the principal benefits of electric vehicle technology, the improvement in air quality, the program will be oriented to areas not in compliance with standards established pursuant to the Clean Air Act. The Administrator of the Environmental Protection Agency would have the responsibility for designating those non-attainment areas which would benefit most from the replacement of gasoline-powered vehicles with electric vehicles. Proposers agreeing to establish sales, distribution and service systems in non-attainment areas, and identifying committed purchasers in such areas, would have a preference in selection.

With the development of a production capability, the unit cost of electric vehicles is expected to decrease. Technological advancements occuring over the five year life of the program can also be expected to drive down the cost of electric vehicles and

incorporation of such advancements into the proposed development of the vehicles are to be included in the proposals submitted. As cost reductions are realized, the price decreases are to be recognized in proposed reductions in the level of federal cost-sharing. The program will be designed so that the cost of the EVs manufactured under this program, calculated on a life-cycle basis, will reach a parity with the life cycle cost of a gasoline powered vehicle. The experience of the national commercialization initiative will establish a record on which consumers can then judge the performance and cost-competitiveness of EVs.

ATTACHMENT 4
LIST OF REFERENCES

The following exhibits are referenced in Attachment 1:

A. "*Electric and Hybrid Vehicles, Technical Background Report for the DOE Flexible and Alternative Fuels Study*," by William Hamilton, May 26, 1988.

Examines technology projections, market penetration projections and scenarios, electricity supply impacts, infrastructure considerations, and environmental impacts.

B. National Market Potential Study by Maritz Marketing Research, Inc., February 1988.

Performed for the Electric Vehicle Development Corporation. This study estimated the national market potential for electric vans in private commercial fleets with three or more vans. The study projects a national market potential of 137,000 electric vans (61,000 with midday recharge) with a 40 mile per day range. The report projects a market potential of 283,000 electric vans with a 90 mile per day range.

C. "*Electric Vehicles in Commercial Sector Applications*," by the University of Michigan, Institute for Social Research, May 1984.

Performed for the Electric Power Research Institute. This study estimated the national market potential for light duty electric vehicles in commercial fleets. The study projects a national market for electric vehicles (all types-light duty) of 6 million vehicles.

D. "*Fact Sheet: President Bush's Clean Air Plan*," by The White House, Office of the Press Secretary, June 12, 1989.

This document provides a summary of President Bush's Clean Air Plan, announced June 15, 1989.

E. "*Electric Van Performance Projections*," by Bill Hamilton, October 31, 1988. EPRI report.

This report projects the range, energy use, and acceleration capability of four electric vans, the GM G-Van, Chrysler TEVan, Eaton DSEP Van, and Ford ETX-II van. Each van was simulated with a lead-acid battery, two different nickel-iron batteries, and three different high-temperature batteries. Results of the simulation include average efficiency of the vans and of their major powertrain components in several driving cycles.

F. "*Evaluation of Near-Term Electric Vehicle Battery Systems Through In-Vehicle Testing, Second Annual Report*," by Tennessee Valley Authority, December 1987. EPRI report.

This report documents the performance from October 1985 through September 1986 of the Tennessee Valley Authority's ongoing project to evaluate near-term electric vehicle traction batteries. The purpose of this field test activity is to provide an impartial evaluation and comparison of battery performance in a real-world operating

environment. Batteries tested were: Pb-Acid, Ni-Fe, Ni-Cadmium, Nickel-Zinc, Gel-Cell.

G. "*Electric Vehicles: Performance, Life-Cycle Costs, Emissions, and Recharging Requirements*," by Mark Deluchi, Transportation Research Group, Division of Environmental Studies, UC Davis, 1989.

This recently published paper provides an evaluation of the performance, costs, environmental impacts, and recharging requirements of electric vehicles. The report concluded that with current battery technology advances, and projected battery cost, life, and performance goals, electric passenger vehicles could be viable as second cars in multi-car households and in other markets.

H. "*Southern California Edison Testimony -- Hearing on Transportation Energy Supply and Demand Issues -- To Assist Preparation of the California Energy Commission's 1989 Fuels Report*," June 12, 1989.

This testimony was presented to the California Energy Commission in June of 1989. The testimony covers broad EV issues from status of commercialization and development to status of commercial production, including a listing of all the organizations involved with EV commercialization, development and production.

I. "*Comments of Southern California Edison Company on AB 234 Draft Report -- Cost and Availability of Low-Emission Vehicles and Fuels*." April, 1989.

This testimony was presented to the California Energy Commission by SCE in April of 1989, in response to a draft of a report the CEC was preparing for the State Legislature. The testimony addresses air quality improvement potential of electric vehicles and critiques the electric vehicle cost assumptions drafted by the Commission.

J. "*Curbing Air Pollution in Southern California -- The Role of Electric Vehicles*" by Lamont C. Hempel of the Claremont Graduate School, April, 1989.

This report is a result of the project undertaken to assist policy makers in evaluating future environmental, transportation, and energy options involving the use of low-emissions highway vehicles in the Los Angeles Region. The project focused on electric vehicles and their future potential as replacements for gasoline and diesel powered vehicles. The primary purpose of the project was to assess the promise of EVs over the next 20 years as a means of curbing air pollution in the South Coast Air Basin.

K. "*Definition of a Low-Emission Motor Vehicle in Compliance with the Mandates of Health and Safety Code Section 39037.05 (Assembly Bill 234, Leonard, 1987)*" by State of California, Mobile Sources Division, AIR RESOURCES BOARD. Date of Release: May 19, 1989.

This recently released report presents an overview of the California Air Resources Board's recommended approach for defining a "low-emission motor vehicle" in accordance with Health and Safety Code Section 39037.05. The guidelines for defining "low-emission motor vehicles" required the definition to be based on the *impact of the various fuels on ozone*. Thus, ARB developed a new methodology to take into account the ozone forming potential of hydrocarbon emissions from vehicles

powered by specific fuels.

L. A summary of the Item P CARB report, "*Definition of a Low-Emission Vehicle in Compliance with the Mandates of Health and Safety Code Section 39037.05*", by TB&A, June 1989.

M. Charts from the "*South Coast Air Quality Management District, Southern California Association of Governments, Long Range Strategies For Improving Air Quality, September 1985.*"

These charts contain emissions data for many clean fuels.

N. "*An Assessment of Hybrid Electric Propulsion Systems for Motor Vehicles,*" by Roy A. Reiner, September 1986. EPRI Report.

This study evaluated the feasibility of hybrid electric propulsion systems, for light-duty vehicles such as passenger cars and local delivery vans. Although the technical feasibility and air quality benefits of the hybrid vehicle was demonstrated, costs were found to be too high under present circumstances. Cost cutting breakthroughs and public policy shifts will be required to make hybrids acceptable for general use, however, specialty vehicle markets exist which could benefit from hybrid electric vehicle technology. Research and development needs are identified which might hasten the day of acceptance of hybrid electric vehicles.

O. Letter from Theodore Barry & Associates to Larry O'Connell, Manager of EPRI's Transportation Program, May 26, 1989.

This letter provides a complete record of documentation provided by Southern California Edison to the California Energy Commission to assist them in preparation of the AB 234 Cost and Availability of Low-Emission Motor Vehicles and Fuels Report. The attachments cover a wide variety of topics:

Exhibit I	SCE Testimony, May 3rd AB 234 Cost Report Hearing
Exhibit II	TB&A Memo to Dick Schweinberg, May 9, with suggested electric vehicle inputs to CEC cost model
Exhibit III	TB&A Letter to CEC, May 17th, providing backup documentation requested by CEC
Exhibit IV	TB&A Letter to CEC, May 17th, providing backup documentation and suggested inputs to CEC Model
Exhbit V	Vehma International letter with limited production G-Van price projections
Exhibit VI	Chrysler Pentastar letter, May 19, recommending that the CEC include the TEVan in their Cost Analysis of alternate fuel vehicles
Exhibit VII	EPRI letter to CEC, May 19, documenting joint efforts to develop a Nickel Iron electric vehicle battery pilot plant
Exhibit VIII	EVDC letter to CEC, May 18, documenting electric vehicle commercialization efforts

APPENDIX B

ELECTRIC POWER RESEARCH INSTITUTE

LETTER

Electric Power
Research Institute

July 7, 1989

Herbert H. Gould
Chief, Vehicle Crashworthiness Division
Transportation Systems Center
U.S. Department of Transportation
Kendall Square
Cambridge, MA 02142

Dear Herb:

It was good to see you again after all these years and the subject of our meeting was again electric vehicles. There appears to be a greater incentive this time to bring them to the marketplace.

Consider this letter a follow up to our recent meeting. I will try to address specifically the issues you raised in your letter of June 13, 1989, concerning your study for the National Highway Traffic Safety Administration of federal regulatory amendments or additions needed to stimulate the commercialization of electric vehicles (EV).

The time period for your study, 1989 - 2000 appears reasonable. It will cover the first introductory phase of electric vehicles. As I told you, at our meeting, we expect the first Electric G-Vans to be in production in 1990. This will likely be the first modern production EV.

I further agree that for the foreseeable future the primary market for EV will be commercial fleets. This is probably true through 1997 as you suggested. However, there will likely be some overlap with the personal vehicle market commencing in about 1995.

All vehicles that are produced from the EPRI program will be tested and certified to meet Federal Motor Vehicle Safety Standards. However, these standards should probably be reviewed to identify those which do not apply to EV. Exceptions should be authorized for EV in such cases.

While most of EPRI's vehicle development program involves EVs, we also have been doing work on what we call the XREV for Extended Range EVs. This is a hybrid in the strickest sense. The vehicle is designed to operate as an EV most of the time, but when a longer trip is required it will be able to accommodate that need. A small on-board engine generator is activated to work in conjunction with the batteries. This allows the longer range to be achieved. No on-board charging of the

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battery is contemplated. I would suggest that this type of hybrid be considered in your study. Other types of hybrids that are designed to improve the fuel economy of gasoline vehicle, I believe, are not appropriate to consider.

One of the biggest obstacles to EV marketing is the price differential between EV and their equivalent gasoline vehicles (ICEV). This will be particularly so in the early years when production levels are low and costs high. Once EV get to full production status we expect them to be cost competitive with ICEV. It is during this interim period when federal stimulation is needed. For example, if tax rules could be modified to provide a tax credit for the purchase of EV that is equivalent to the price differential between EV and ICEV, the EV market would be greatly stimulated. As production levels of EV increase the differential will decrease until full production eliminates it altogether. Another stimulus would be to provide a tax credit for the sales tax on the cost differential.

Amendment of a number of federal regulations would be helpful in stimulating the introduction of EV. A number come to mind:

Fuel economy - provide CAFE credits for EV to auto manufacturers in determining their total fleet fuel economy average. I believe the regulations covering this are still in effect, but that some of the factors used in the calculation need to be brought up to date.

Emissions - consideration should be given to giving auto makers emission credits for EV to offset to some extent emissions from the rest of their fleet. Since such a credit would apply to other alternate fueled vehicles, each credit should be predicated on the level of effluents the vehicle type emits. Consideration should also be given to granting electric utilities emission offset credits for developing EV markets in their areas. Since EV do not emit pollutants, they also should be exempt from emission testing. States should be encouraged to follow this approach.

The primary technical barrier to EV is the relatively short range provided by current batteries. Improvements are foreseen. Until they occur, EV will be deployed in a niche market, markets that they can serve as well as ICEV. Currently this is the urban delivery market.

EV performance from 1989 - 2000 is likely to be as follows:

-1990 Large vans
Range - 60 miles urban driving
Acceleration - 0-30 mph, 12-13 sec
Max speed - 50-55 mph

-1992 Large vans
Range - 100 miles urban driving
Acceleration - 0-30 mph, 10-11 sec
Max speed - 55-60 mph

-1992 Mini vans
Range - 120 miles urban driving
Acceleration - 0-30 mph, 7 sec
Max speed - 70 mph

-1995-97 Commuter car
Range - 100 + miles
Acceleration - Comparable to ICEV
Max speed - 70 + mph

In addition, during the 1995-97 period vans and trucks with ranges between 150-200 miles and with accelerations comparable to ICEV, should be in the market. This projected progress of course, depends on successful marketing of the first vans.

The batteries likely to be used in vehicles during this time period are as follows:

1990 Lead-Acid
1993 Nickel-Iron
1995-97 Sodium-Sulfur and Lithium Iron Sulfide

While the cycle life of all these batteries is not yet known, in terms of vehicle miles, they are projected to be:

Lead-Acid	30,000 + miles
Nickel-Iron	60,000 + miles
Sodium-Sulfur	75,000 + miles
Lithium Iron Sulfide	75,000 + miles

As I mentioned earlier the initial EV will have a premium price, principally because of low volume production, with the battery an added economic burden. As the production volume increases the price differential will be reduced. A federal stimulus such as I mentioned before or some direct subsidy will accelerate vehicle production and help to reduce production costs. From an operating standpoint EV are expected to cost about one half what it costs to operate and maintain an ICEV.

With respect to the national capacity to build EVs, I believe there will be sufficient capacity to begin to effect a change in air quality in localities out of compliance. Capacity is probably not the issue. Creating the market is the issue. If there are orders for the vehicles, there will be plants to build them. If federal incentives, such as those mentioned earlier, are put in place quickly then we can beginning to improve air quality soon. However, it takes time to change out a fleet. Eleven years (1989-2000) is insufficient to make a major air quality improvement. Remember automobiles are unlikely until 1995-97. Nevertheless, we can be well on our way to improving air quality.

A question was raised about including generating plant emissions in EV emission calculations. When calculating these emissions one generally does include the generating plant effluents even though the plants are not normally in urban areas. Such is not the case, by the way, with ICEV. Usually only tail-pipe emissions are included. This inequity should be corrected. ICEV emissions should include those from processing, transportation and distribution.

I have mentioned a number of regulatory amendments or additions that the federal government can undertake to stimulate EV. I have also suggested a number of other steps that could be taken to achieve the same goal. Now that we can see a technological way to give EV competitive performance, the next step is to stimulate the market. We need to overcome the price differential barrier that will exist in the early years of low production. Steps by the government to reduce this barrier will greatly accelerate the advent of EV and improvement of our air quality.

I hope those remarks are of help to you. Good luck in your study.

Sincerely,

Lawrence G. O'Connell
Manager
Transportation Program

LGO:pjb/LG0238
cc: A. Fickett

APPENDIX C

CITY OF LOS ANGELES DEPARTMENT OF WATER AND POWER

LETTER

Department of Water and Power the City of Los Angeles

TOM BRADLEY
Mayor

Commission
RICK J. CARUSO, *President*
JACK W. LEENEY, *Vice President*
ANGEL M. ECHEVARRIA
CAROL WHEELER
WALTER A. ZELMAN
JUDITH K. DAVISON, *Secretary*

NORMAN E. NICHOLS, *General Manager and Chief Engineer*
ELDON A. COTTON, *Assistant General Manager - Power*
DUANE L. GEORGESON, *Assistant General Manager - Water*
DANIEL W. WATERS, *Assistant General Manager - External Affairs*
NORMAN J. POWERS, *Chief Financial Officer*

July 11, 1989

Mr. Herbert H. Gould, Chief
Vehicle Crashworthiness Division
United States Department of Transportation
Transportation Systems Center
Kendall Square
Cambridge, Massachusetts 02142

Dear Mr. Gould:

This is in response to your letter of June 30, 1989, asking for the Department's views on several items concerning federal regulations relative to electric vehicles (EVs).

ITEM 1 (Assumptions)

We agree with assumptions A, D, E, and F. However, with respect to EV hybrids (B), near-term market penetration is range-dependent, and it may be necessary to use hybrid vehicles to achieve acceptable range.

In addition, the perception that the market is limited to fleet users (C) may be short sighted. Current United States technology has focused on delivery vans as a result of the Griffon experience in the United Kingdom. There is potentially a significant market for short-range commuter vehicles as second cars. European companies responding to the Los Angeles EV Initiative have recognized that potential.

ITEM 2 (Regulation)

A. Trade off of power plant emissions for support of EV market penetration is by far the most cost effective means of reducing air emissions in non-attainment areas. In the South Coast Air Basin, less than 1% of air emissions are from electric generation, while 80% are from motor vehicles. Utilities are faced with substantial capital expenditures to attain very small incremental reduction in emissions despite the fact that those investments could achieve substantially higher reductions if directed toward EV market penetration.

111 North Hope Street, Los Angeles, California ☐ *Mailing address:* Box 111, Los Angeles 90051-0100
Telephone: (213) 481-4211 *Cable address:* DEWAPOLA *FAX:* (213) 481-8701

B. The Los Angeles Department of Water and Power's (DWP's) existing supply system could absorb over 250,000 EVs without requiring additional capacity. This number of vehicles would result in a reduction in emissions of almost 10,000 tons per year.

C. Since EV charging is essentially an off-peak load, power pricing would be at off-peak discounts for the near and medium term.

D. Facilities investment for EV charging requirements would be relatively modest since most home and commercial establishments are equipped with 208-220V service. Addition of circuitry to accommodate several vehicles at a single site, however, would require an investment of $500 - $1500 per connection.

ITEM 3 (Off-Peak Metering)

Technology in time-of-use (TOU) meters, required for off-peak pricing, is advancing at a rapid pace. DWP is now offering TOU meters to large residential customers, and we expect to convert most commercial/industrial customers to TOU over the next several years. This will allow us to make expeditious rate adjustments as conditions warrant.

ITEM 4 (Power Generation Barriers)

A. Current rate change forecasts for DWP are expected to be at or near the rate of inflation (± 4% per year). Since electrical supply is not dependent on offshore energy supplies, it will not be subjected to volatile price fluctuations.

B. Recharging is significantly less cumbersome and more convenient than fueling a vehicle. It requires only that the user pull up to the charger (at his home or business), plug in the vehicle, unplug it in the morning, and drive away. The "fueling" task is a significant advantage for EVs.

C. Capacity requirements relative to EV market penetration is very difficult to calculate since EV mileage (miles/kwh) is expected to increase substantially, and the future on-peak, off-peak charging mix is uncertain given the potential for "quick charge" systems. However, DWP's current resource mix could absorb between 250,000 and 300,000 units.

ITEM 5 (Vehicle Financing)

Motor vehicle financing institutions currently offer a wide variety of purchase and lease options which can be

readily adapted to EVs. DWP has already received expressions of commitment from major institutions to extend terms based on longer predicted life. Separate financing of the "fuel" supply is certainly one of the options.

ITEM 6 (Government Regulation)

A. Federal CAFE standards for vehicle manufacturers should include an EV "credit" which could be applied to the remainder of a builder's fleet; e.g., one EV sold would be worth a five-mile per gallon credit on 50 ICE units.

B. An emissions tax on ICE vehicles in non-attainment areas could be offset by an emissions credit for EVs. In addition, an emissions credit could be given to stationary sources for inclusion of EVs in their fleet.

C. There are currently procedures in place dealing with the proper handling of large battery packs (human protection, ventilation, etc). These should probably be extended to the residential sector through the Universal Building Code. Passenger safety should not be compromised or diminished under any circumstance

ITEM 7 - (Competitive Alternate Fuels)

The current federal emphasis and "infatuation" with alcohol based fuels needs to be carefully examined. Toxic emissions and infrastructure requirements present problems which are significantly more serious than for EVs.

ITEM 8 (Economic Barriers)

A. Cost differential is an issue which has yet to be determined. Some respondents to the Los Angeles EV Initiative have quoted prices (including batteries) very near to ICE vehicles. Whether those prices are achievable at relatively low volumes is questionable.

B. In calculating the emission reduction from EV usage, DWP uses 135 tons/year/1000 vehicles. SCAQMD has calculated that to achieve the EPA standard for the South Coast Basin would require virtual elimination of fossil fueled engines.

ITEM 9 (Fuel Economy Calculations)

Since emissions from EVs are 1/20th that of conventional vehicles, consideration should be given to basing the equivalent fuel economy calculation on the relative emission improvement rather than the existing factor.

ITEM 10 (Other Actions)

Tax incentives at the federal and state level would be an important tool in the successful marketing of EVs. For example, sales tax and annual registration fee forgiveness would create a "sales rebate" which would be useful in promotional activities. In addition, federal tax credits would provide fleet owners with an incentive to convert their vehicles.

We welcome the opportunity to contribute to the formation of the Department of Transportation report and look forward to continuing our efforts in commercialization of electric vehicles.

Sincerely,

GERALD H. ENZENAUER
Electric Vehicle Program Manager

GHE:ss

APPENDIX D

ELECTRIC VEHICLE DEVELOPMENT CORPORATION

LETTER

ELECTRIC
VEHICLE
DEVELOPMENT
CORPORATION

July 18, 1989

Mr. Herbert H. Gould, Chief
Vehicle Crashworthiness Division
Transportation Systems Center
Kendall Square
Cambridge, Massachusetts 02142

Dear Mr. Gould:

The following provides a summary response to the questions posed in your letter dated June 12, 1989, concerning the need to amend or add federal regulations to promote electric vehicle (EV) introduction.

1. Guidelines for preparing PL 100-494 report:

   a. I believe that the time frame should be extended to at least 2005 to allow for and facilitate the introduction of electric cars in significant numbers.

   b. Because EVs and hybrids have very different emission, energy use, and cost characteristics, hybrids--if included in your report--should be treated as a separate class of vehicle.

   c. Prior to the year 2000--in the absence of strong mandates such as those proposed by Bush that call for rapid integration of clean-fuel vehicles in urban areas with the worst air quality--I expect the primary EV market to be urban fleets. After 2000, the market will begin to shift toward the personal-use-vehicle market.

   d. Production EVs should not require waivers from FMVSS. However, such waivers would facilitate the fabrication and testing of a limited volume (less than 50) of prototype vehicles incorporating improved/advanced technologies and designs.

   e. Production EVs should also be able to meet applicable DOE venicle standards.

2. Regulations requiring amendment:

   a. Fuel economy: Maintaining the CAFE requirements for conventional vehicles and providing a substantial mpg allowance or credit for EVs would be beneficial to EVs and would serve the overall CAFE objective of reducing petroleum consumption.

b. Emissions: Vehicle emission standards provide an excellent and effective means for encouraging EV use. In computing EV emission equivalence, care needs to be taken to incorporate the following:

- Electricity generation mix (i.e., the type of fuel used to generate electricity) varies from utility to utility. The national generating mix could be used to derive a representative mix.

- As the majority of EV recharging is expected to be done at night (most utilities will provide financial/pricing incentives to do this), any computation of EV emissions should be based on the average "off-peak" generating mix.

- In computing the emission rates for conventional vehicles, petroleum refining emissions should be included along with tailpipe emissions.

Independent of the precise method used, EVs will be found to be substantially cleaner than conventional vehicles.

c. Safety: I am not aware of the need for any change in these regulations.

3. New federal regulations:

- Incorporate EVs in CAFE regulation

- Establish a policy to allow for the trade-off of mobile-source emission reductions for stationary-source emission reductions. This can be done through several means, two of which are described below:

  --a company/industry can be allowed to use the conversion of some or all of its vehicle fleet to clean-fuel vehicles as part of an overall strategy for achieving mandated stationary-source emission reductions

  --a company/industry can be allowed to contribute dollars to a "clean-air" fund in lieu of achieving some portion of a mandated stationary-source emission reduction. The fund would provide dollars to subsidize the purchase of clean-fuel vehicles.

- Implement regulations to promote the use of clean-fuel vehicles that provide differential emission-reduction credits based on each vehicle's emission characteristics (i.e., don't treat all clean-fuels as if they have the same impact on reducing urban air pollution).

- Implement regulations mandating the conversion of a sizeable proportion of the federal fleet to clean-fuel vehicles. This should be done to serve as a model for other fleets and to stimulate the demand for clean-fuel vehicles.

4. Are other alternatives favored over EVs:

Methanol vehicles are overwhelmingly favored in all references to clean-fuel vehicles. I cannot, however, state specifically which regulations are intentionally or inadvertently biased against EVs.

- The key here is to ensure that all regulations and policies pertaining to cleaner alternative-fuel vehicles include specific reference to and recognition of EVs.

5. Technological barriers:

The following tables respond to the sub-questions a., b., and c.

	1990	1995	2000	2005
Vans: Range	60 m	120 m	150 m	150 m
Energy Use	1.0 kWh/m	0.6 kWh/m	0.5 kWh/m	0.5 kWh/m
Top Speed	55 mph	65 mph	65+ mph	65+ mph
Battery Type	Pb-Acid	NiFe	NaS/LiFe	NaS/LiFe
Battery Life	32,000 m	80,000+ m	80,000 m	80,000 m

	1990	1995	2000	2005
Cars: Range	--	--	120 m	150 m
Energy Use	--	--	0.5 kWh/m	0.4 kWh m
Top Speed	--	--	70+ mph	70+ mph
Battery Type	--	--	NaS/LiFe	NaS/LiFe
Battery Life	--	--	80,000 m	80,000 m

6. Economic barriers:

a. EV costs will be a function of several factors including vehicle production volume, battery technology, vehicle type, and whether the battery is included as part of the initial cost or recovered as part of the energy cost.

Conventional vehicle costs will be affected by possible future emission reduction standards or by the application of a environmental/pollution tax.

Cost comparisons are therefore difficult to make and will need to take into account the above factors.

However, two caveats can be made:

- Fuel costs for EVs are expected to be considerably lower than those for conventional vehicles.

- Maintenance costs for EVs are expected to be about 50% of those for conventional vehicles.

b. All EVs that are based on an existing vehicle chassis and body will require a 3-5 year period for vehicle development, design, certification testing, and production planning and start-up. An entirely unique vehicle would take longer to bring to production.

Assumed availability dates are:

G-Van	1990
TEVan	1992
Improved G-Van	1994
Advanced Van	1995
Electric Car	1998

c. Sufficient EV production capacity should be available to achieve a significant impact in air quality by the 1997-2000 timeframe provided that vehicle manufacturers are given the proper incentive to start building EVs and other clean-fuel vehicles in the next 2-3 years.

7. Institutional barriers:

I can think of no other barriers than those already mentioned.

8. CAFE procedures:

The derivation of some of the factors used in computing the equivalent petroleum-based fuel economy value for EVs was unclear to me. However, I feel that the test procedures, driving cycles, and cycle weighting multipliers currently being used are appropriate.

In developing an mpg-equivalence value for EVs, I would hope that the calculations would take into account the fact that only 5% of the total electricity is generated from petroleum and virtually no petroleum is used to generate off-peak electricity.

Regarding the incorporation of emission-related factors in the calculation of petroleum-equivalency, I believe the differences in vehicle emissions should be treated in separate regulations and not be included as part of the CAFE regulations.

9. Unique EV regulations:

I don't see the need for implementing specific or unique EV regulations, but rather advocate the introduction of regulations or procedures that account for two unique EV attributes:

- Including power plant emissions, EVs generate less HC, NOx, and CO emissions than any other clean-fuel vehicle alternative.

- Because EVs use energy derived from a variety of domestic resources, they provide an excellent means for reducing petroleum consumption.

I hope this information will help you in preparing your report. Please feel free to call if you have any questions or require further information on my responses. For your reference, I am also sending a draft copy of A California Plan for the Commercialization of Electric Vehicles.

Thank you for allowing me the opportunity to contribute to your study. I look forward to seeing the results of your effort.

Sincerely,

Gerald H. Mader

APPENDIX E

CALIFORNIA ENERGY COMMISSION

LETTER

STATE OF CALIFORNIA—THE RESOURCES AGENCY

GEORGE DEUKMEJIAN Governor

CALIFORNIA ENERGY COMMISSION
1516 NINTH STREET
SACRAMENTO CA 95814-

July 24, 1989

Mr. Herbert H. Gould, Chief
Vehicle Crashworthiness Division
U. S. Department of Transportation
Kendall Square
Cambridge, MA 02142

Dear Mr. Gould:

I am enclosing a response to your June 30 letter requesting comments on electric vehicle issues that relate to the preparation of the Secretary's Report to the Congress as specified by Section 7 of P.L. 100-494, the Alternative Motor Fuels Act of 1988.

If you would like to discuss any of this issues more in depth or would like additional information, you can call me at (916) 324-3534.

Sincerely,

Kenneth Koyama

Kenneth Koyama

Transportation Technology
and Fuels Office

Attachments

RESPONSE TO QUESTIONS IN JUNE 30, 1989 LETTER

1. Report Assumptions.

a. THE TIME PERIOD 1989-2000 SEEMS TOO SHORT WHEN CONSIDERING THE EXPECTED TECHNOLOGICAL DEVELOPMENTS FOR ELECTRIC VEHICLES. RECENT REPORTS CONCERNING ELECTRIC VEHICLES HAVE BEEN EXTENDING THE TIME FRAME AS FAR AS 2010 TO INCLUDE THE DEVELOPMENT OF ADVANCED BATTERIES AND OTHER IMPROVEMENTS IN ELECTRIC VEHICLE TECHNOLOGY. Other time periods that have been used in California are included for your information. The California Energy Commission's Electricity Report includes electricity forecasts for 5, 12 and 20 years. The 1989 forecast projects electricity demand through 2009. The South Coast Air Quality Management District's Plan describes electric vehicle requirements through 2007. Just this week, Southern California Edison provided us with electric vehicle projections for the years, 2000 and 2010. A 10-year projection may not be long enough to account for potential electric vehicle penetration.

b. HYBRID ELECTRIC VEHICLES SHOULD BE INCLUDED IN THE REPORT. While all-electric vehicles will have the most dramatic impact on the electricity system, hybrids are considered by some to be a likely possibility for rapid penetration in the area of passenger vehicles. Although no hybrid vehicles are commercially available at this time, it is likely that they will be within the 1989-2000 time frame. In addition, the title of Part 474 of the Alternative Motor Fuels Act includes hybrid vehicles. Also within the legislation, only auxiliary motors powered by petroleum are mentioned. Several hybrid vehicles are being designed to use alcohol fuels.

c. FLEETS WILL BE THE PRIMARY MARKET DURING THE 1989-2000 TIME PERIOD. Fleets, especially stop-and-go urban delivery fleets, may be the best use of current electric vehicle technology. Electric vehicles will not satisfy household markets with the present limitations in performance, reliability and cost. An electric vehicle with an advanced battery and the capability of overcoming these limitations, will not be available within the year 2000 time frame. Thus, fleets which have specific applications suitable for electric vehicles will likely remain the primary market.

d. SAFETY STANDARDS SHOULD NOT BE WAIVED FOR ELECTRIC VEHICLES. At this time the only commercially available electric vehicle is the G-van and it has met federal certification standards. Safety issues may emerge with the move toward more aerodynamic, lightweight bodies in electric vehicles for the purpose of increasing range. New technology batteries that

operate at very high temperatures will also challenge existing safety regulations.

e. ACCEPTABLE VEHICLES SHOULD MEET THE DEPARTMENT OF ENERGY'S DEVELOPMENTAL SAFETY STANDARDS FOR ELECTRIC VEHICLES.

f. WHEN THE PRIMARY USE OF ELECTRIC VEHICLES IS IN FLEETS, IT IS AN ACCEPTABLE ASSUMPTION THAT NINETY PERCENT OF ALL CHARGING WILL OCCUR OFF-PEAK. AS THE PERSONAL VEHICLE MARKET IS PENETRATED, THIS IS NO LONGER A SAFE ASSUMPTION. The California Energy Commission's Electric Vehicle Demonstration Program is stressing the need for time-of-use rates to favor off-peak charging. But, only with a well thought out system of incentives and disincentives should it be assumed that 90 percent of electric vehicles will be charged off-peak.

While time-of-use rates may offer an economic incentive to charge in off-peak hours, customer convenience may negate the effectiveness of that incentive. For an occasional full or partial charge, consumer convenience is likely to outweigh even the option of very low electricity rates. For example, current residential electricity prices in California average about $0.10 per kWh. Some electric utilities have proposed rates as low as $0.02 per kWh for off-peak charging as an incentive for electric vehicles. The difference between average electricity rates and proposed off-peak rates seems great, but it may not provide enough incentive for substantial off-peak charging.

In the California Energy Commission's Assembly Bill 234 REPORT "Cost and Availability of Low-Emission Motor Vehicles and Fuels", the fuel economy used for a small (personal use) car is 0.25 kWh/mile. Assuming that this vehicle travels 40 miles in one day, the required charge would be 10 kWh. At $0.20 or $1.00 or even $2.50 per charge, convenience may outweigh the benefits of low-cost charging. Although the convenience factor may not apply to fleets with their own in-house regulations, it could apply to individual use. A USEFUL ANALYSIS WOULD INCLUDE SCENARIOS WITH INCREASINGLY HIGHER PERCENTAGES OF VEHICLES BEING CHARGED ON PEAK.

2. Federal, State or Local Regulation Changes

a. THE DEPARTMENT OF TRANSPORTATION SHOULD CAREFULLY EVALUATE TRADE-OFFS OF MOBILE SOURCES TO POINT SOURCES. Electric vehicles could substantially improve air quality in California's most severely impacted regions. Since in-basin generation in all of California's urban areas is natural gas, many with best-available control technology, the additional electricity demand

for electric vehicles should produce sizable reductions in tons of emissions. Despite this benefit, trade-offs of mobile source emissions need to be analyzed to determine the true reductions. Currently, California regulatory agencies do not allow these trade-offs.

b. and c. THE PENETRATION OF A SIGNIFICANT NUMBER OF ELECTRIC VEHICLES WOULD UNDOUBTEDLY IMPACT CURRENT FORECAST (CALIFORNIA ENERGY COMMISSION) AND RATE-MAKING (PUBLIC UTILITIES COMMISSION) RULES AND PROCEDURES. In California, utilities are required to have energy available to meet their projected peak with a reserve available at all times. If a significant number of electric vehicles recharged during peak periods, the utilities could face severe supply problems.

d. WITHIN THE TIME FRAME 1989-2000, WE DO NOT SEE THE NEED FOR NEW FACILITIES INVESTMENT DUE TO THE INTRODUCTION OF ELECTRIC VEHICLES.

3. IT IS POSSIBLE TO METER OFF-PEAK ELECTRICITY USE. Utilities are looking at sub-metering devices for their electric vehicle demonstration programs. These sub-meters track vehicle charging only and will be used for the purpose of offering special low electricity rates to electric vehicle users on a temporary basis until a formal rate-structuring process can be established. California does have a rate structure that allows special time-of-use rates in the commercial and industrial sectors.

4. THERE ARE NO PRESENT POWER GENERATION BARRIERS TO THE INTRODUCTION OF ELECTRIC VEHICLES IN CALIFORNIA.

a. INCREASES IN THE COST OF ELECTRICITY WILL OCCUR WITH THE NEED FOR INCREASED CAPACITY AND THE RESULTING CAPITAL INVESTMENT IN NEW FACILITIES. HOWEVER, ELECTRIC VEHICLES HAVE A HIGHER INITIAL COST THAT WILL FAR OUTWEIGH ELECTRICITY RATES WHEN GAUGING CONSUMER ACCEPTANCE.

b. WE BELIEVE THAT ELECTRIC VEHICLES FACE CONSIDERABLE BARRIERS INCLUDING INFRASTRUCTURE DEVELOPMENT. The California Electric Vehicle Task Force, which is comprised of 13 public and private organizations including utilities, the Energy Commission, and air quality regulatory agencies, has identified several barriers: (See Attachment 1, "A California Plan for the Commercialization of Electric Vehicles", Volume I: The Plan, July 11, 1989.)

(1) High near-term electric vehicle cost due to low sales volumes in the early development stages.

(2) Inadequate battery performance to meet the needs of a broad market. The power, reliability and life of batteries need further improvement.
(3) Limited EV travel range between charges. There is a need for lighter weight, higher capacity batteries and more efficient drivetrains.
(4) Lack of an infrastructure tailored to electric vehicles. Systems for distribution, sales, service, charging, parts, warranties, resale markets, etc. are needed.
(5) Lack of effective market forces reflecting public policy. There is a need for temporary incentives and, under some critical situations, mandates for potential EV suppliers and users.
(6) There is a lack of vehicle choices to meet the needs of a broad market beyond that served by commercial vans.
(7) Uncertainties in technological development especially in the likelihood of the success and the timeliness needed for the completion of advanced batteries.
(8) Lack of public experience with modern EV technology. There is a need for ways of demonstrating the advantages of EVs and overcoming consumer resistance to change.

c. FOR BOTH THE ELECTRICITY FORECAST YEARS 1993 AND 2000, THE POTENTIAL OFF-PEAK ELECTRICITY SUPPLY IS 25,000 MEGAWATTS FOR THE 3 MAJOR CALIFORNIA UTILITY SERVICE AREAS. THIS LEVEL COULD SUPPLY OVER 5 MILLION ELECTRIC VEHICLES. Assuming that all charging is off-peak, preliminary estimates indicate that a penetration of more than 2 million electric vehicles in the Southern California Edison will create a need for additional electricity supply. In evaluating the potential magnitude of off-peak electricity supply available to potential electric vehicle users, the difference between the utility's resource capacity and its minimum electricity demand level was determined. The difference was then used as the capacity available for electric vehicle charging during off-peak hours. (See "Costs and Fuel Availability Study", page I-11.)

California has a surplus of electricity generating capacity at this time. Within the time period considered however, some utility planning areas will be required to increase their capacity even without the introduction of electric vehicles. The impact of electric vehicles on the acceleration of this need will vary from area to area depending on utility available electricity supply and the number of vehicles in the utility service area. For a further discussion of this subject please see Attachment 1,

"Preliminary Estimate of Impacts of Electric Vehicles" by Michael Jaske.

5. BATTERY LEASING. IT IS REASONABLE, FEASIBLE AND A GOOD IDEA TO HAVE THE BATTERY MANUFACTURER, LOCAL CAR SALES OR LEASING AGENCY OR THE COMPANY/UTILITY WHICH PROVIDES THE ELECTRICITY FOR ELECTRIC VEHICLES OFFER THE OPTION OF LEASING BATTERIES IN ORDER TO OFFSET SOME OF THE INITIAL VEHICLE COST. In California, Southern California Edison and Vehma (G-van manufacturer) will be establishing a commercial infrastructure for the 200-300 G-vans expected in 1990. They are approaching existing car dealers, leasers, lenders and insurers to create an infrastructure that is as much like a conventional-fueled vehicle as possible. They have not indicated that they would be in the battery leasing business at this time, but we will explore this option with them.

6. Amendments or initiatives to federal, state or local regulations to stimulate the introduction of EVs.

a. IN THE AREA OF FUEL ECONOMY, ELECTRIC VEHICLES SHOULD BE INCLUDED ALONG WITH OTHER ALTERNATIVE FUELS IN ANY FUEL ECONOMY CREDIT SYSTEM WITH VEHICLE MANUFACTURERS.

b. STRINGENT EMISSIONS STANDARDS ON ALL MOBILE SOURCES ACT AS AN INCENTIVE TO ELECTRIC VEHICLES. Several proposed regulations will require fleets to incorporate low-emission vehicles into their pool of vehicles. These low-emission vehicles have been variously defined, but in general, they must meet one half the standard for all the vehicles. Although there are conventional vehicles that can meet the recently adopted standards, meeting one half the standards will eliminate several vehicles from fleets. Electric vehicles of course, will have no problems with these more stringent standards. President Bush's proposal to tighten the hydrocarbon standard on gasoline-powered cars from 0.41 grams per mile to 0.25 gpm and the California Air Resources Board's recent cut in the State's carbon monoxide standard from 7.0 gpm to 3.4 gpm as well as their doubling of the mandatory warranty on a car's emission control system to 100,000 miles, act as indirect incentives to electric vehicles, to the extent that other vehicles cannot meet these new standards.

c. ELECTRIC VEHICLE SHOULD HAVE STANDARDS THAT PROMOTE SAFETY. ELECTRIC VEHICLES THAT DO NOT MEET SAFETY STANDARDS SHOULD NOT BE SUPPORTED.

7. CURRENT REGULATIONS, DEFINITIONS, REQUIRED MEASUREMENTS AND PRACTICES FOCUS ON OTHER ALTERNATIVES TO GASOLINE-POWERED VEHICLES AT THIS TIME. Because alcohol fuels have a more advanced technology and have demonstrated their commercial viability, current regulations have been forthcoming. The assessment or measurement of alternatives to gasoline-powered ice's should focus on the emissions (both mobile and stationery source) and the fuel economy of all alternatives.

8. Economic Barriers to the introduction of electric vehicles. See comments under 4. b.

a. PURCHASE COST DIFFERENTIALS WILL VARY WITH EACH VEHICLE TYPE, THE STAGE OF THE TECHNOLOGY, THE PRODUCTION VOLUME AND CONSUMER DEMAND. With present technology, electric vehicles are not an economic purchase. But with technological improvements, electric vehicles could become cost competitive within the next 10 to 20 years. For example, the per vehicle price for a G-van from an initial production run of 500, is projected to be $30,000. to $35,000., making the differential about $15-20,000. A production run of 10,000 could bring the price down to $21,000 and a run of 50,000 could bring the price down to $18,100. For a full discussion of costs, please see Attachment 3 from the draft version of the "Cost and Availability Study," pages IV-123 to IV-135.

b. Currently there are 3 separate studies being conducted that compare power plant emissions with displaced gasoline emissions. The studies are being conducted by Claremont College, the Electric Power Research Institute (EPRI) and the California Air Resources Board. The results of these studies should provide some estimate of the electric vehicle market penetration needed to make substantial progress in meeting California's air quality goals.

9. FUEL ECONOMY CALCULATIONS FOR ELECTRIC VEHICLES SHOULD BE BASED UPON THE SAME FACTORS AS THOSE ESTABLISHED FOR ALCOHOL AND NATURAL GAS FUELS AS SPECIFIED IN THE ALTERNATIVE MOTOR FUELS ACT OF 1988. Since the purpose of the adjustments to the Corporate Average Fuel Economy standards is to provide incentives to manufacturers to produce and sell alternative vehicles, adding other factors to the calculations does not seem germane to the Alternative Motor Fuels Act. WHEN CALCULATING EMISSIONS FACTORS, OTHER FACTORS, SUCH AS UTILITY POWER PLANT EMISSIONS AND VEHICLE AUXILIARY SYSTEMS EMISSIONS, SHOULD BE INCLUDED.

10. For institutional barriers to the introduction of electric vehicles, see comments under 4. b.

THE ENERGY COMMISSION SUPPORTS PUBLIC PRIVATE PARTNERSHIPS AS A MEANS TO MOVE TOWARD THE COMMERCIALIZATION OF NEW FUELS AND VEHICLE TECHNOLOGIES. Working with the utilities, the Energy Commission can support a very broad demonstration program to fully test these vehicles. Selected local government fleets will be offered a reimbursement for the cost differential between a conventional and an electric vehicle as a demand-side incentive. This demonstration program is part of the Electric Vehicle Task Force's coordinated effort to commercialize electric vehicles. Additional funding to subsidize fleet purchases will make a statement to manufacturers, dealers and other infrastructure providers that a serious effort is being made to introduce electric vehicles. Incentives at the federal, state and local levels could offer temporary tax relief on the cost differential for anyone purchasing electric or other clean-fueled vehicles.

APPENDIX F

FORD MOTOR COMPANY

LETTER

Environmental and Safety
Engineering Staff
Ford Motor Company

The American Road
Dearborn, Michigan 48121

July 28, 1989

Mr. Herbert H. Gould, Chief
Vehicle Crashworthiness Division
U.S. Department of Transportation
Research and Special Programs Administration
Transportation Systems Center
Kendall Square
Cambridge, Massachusetts 02142

Dear Mr. Gould:

The attached information is provided in response to your June 9, 1989 letter regarding federal regulations for electric vehicles. We have numbered our responses to correspond with the questions in your letter. These comments represent the preliminary thoughts of interested parties within Ford Motor Company. We have not had an opportunity to fully review the question asked and completely analyze all of the factors. As such, these comments should not be considered as Ford's position on these issues, but only preliminary observations and thoughts. Moreover, while the attached responses are provided to highlight possible incentives to promote electric vehicles, implementation of such incentives is by no means an assurance that electric vehicles could be produced to satisfy market expectations.

As you know, Ford remains active in electric vehicle research programs. Although there is reason to be optimistic as to the potential of electric vehicles, realistically it will be difficult to gain customer acceptance of these vehicles, particularly in light of the anticipated, severe driving range limitations and relatively high vehicle cost. While progress has been made in improving driving range and vehicle acceleration, we are still searching for significant breakthroughs in battery technology to achieve levels that will meet market expectations.

We look forward to discussion of any incentives that may be considered to promote the introduction of commercial electric vehicles.

Sincerely,

David L. Kulp
Manager, Fuel Economy
Planning & Compliance

Attachment

THE DEPARTMENT OF TRANSPORTATION
RESEARCH AND SPECIAL PROGRAMS ADMINISTRATION'S
QUESTIONS REGARDING ELECTRIC VEHICLES

1. Reasonable Guidelines for the Report

a. 1989-2000?

Assuming market interest, the technology is available in the 1989-2000 time frame to provide the commercial sector with an electric vehicle (EV) with limited performance characteristics. Based on normal lead times for introduction of major new technologies, a time frame extending from 2005 to 2010 would be more reasonable. For the 1989 to 2000 time period, it is expected that driving range will not exceed 50 to 100 miles.

b. EVs versus Hybrids

Any EV market, it is estimated, would be best accommodated by a standard electric. Hybrids cannot be ruled out and both series (range extenders) and parallel (the vehicle can run on either powerplant) are being developed at other companies (e.g., Volkswagen is planning a test fleet of parallel hybrids). Thus, hybrids should be considered in developing your report.

c. Primary Market

Government fleets may be the primary market for any early introduction phases. However, we are unaware of any fleets, rural or urban, that consistently travel less than 100 miles per day.

As an alternative, if selected functional/technological/price barriers could be overcome, EVs might be attractive to retail customers as second or third vehicles which could be used primarily for local errands or commuting to/from work.

d. Waivers of Federal Motor Vehicle Safety Standards; and,
e. Department of Energy Standards

All Ford Motor Company vehicles will be designed to meet applicable safety standards. Since EVs will be used for more limited applications than internal combustion engine vehicles and, in particular, will probably have limited top speed, it might be reasonable to look at the various standards and determine whether changes could be made without compromising occupant safety. EVs are particularly sensitive to weight. For example, in the case of the electric Aerostar, a 40-pound savings gives either a 1% increase in range or 1% savings on first costs (estimated at $50 for the battery). If substituted for the golf carts in use as road vehicles in some communities today, a legitimately road-worthy EV could provide a significant improvement in safety, even with substantially revised safety standards. However, it is not possible to suggest specific changes to applicable safety requirements without first developing more specific definition of the future EV.

2. Do Federal Regulations Require Amendment for:

a. Fuel Economy?

Existing CAFE credits are an important incentive. However, CAFE credits are not sufficient to encourage production of a vehicle which will not satisfy market needs. Other incentives (as in 3 and 7) should be considered. However, if EVs are included in the determination of capability for purposes of establishing a standard, the incentive is eliminated. Fuel economy labels should be developed which will be simple and provide meaningful, comparable information.

b. Emissions?

Emissions are not an issue, because standard EVs give off no emissions during federal urban drive schedule (FUDS) testing. It is important, however, that electrical source/demand considerations must be thoroughly evaluated if substantial production scenarios are to be considered.

c. Safety?

See also expanded comments under 1. d. & e. above. It is unclear, given the level of development, whether any regulations should be amended.

3. Federal Regulations -- New

- Some form of incentives for government/commercial fleets to utilize EVs may be appropriate.

- Excise or sales tax relief, income tax credits, waived license and toll fees, etc. in the private sector may be a way to simulate sales.

4. Do Current Regulations/Definitions/Measurements/Practices Favor Other Alternatives?

- Current and pending regulations and legislation appear to favor those alternative fuels and engines that show the most promise -- this would appear to be an appropriate focus. However, incentives or related regulations appear to provide some form of encouragement to all alternatives.

5. Technological Barriers

a. Level of Performance -- 1989-2000

With current technology, there are some major barriers to widespread acceptance of EVs:

- Driving range is limited to between 50 and 100 miles
- Lengthy time required to recharge batteries (e.g., overnight) versus minutes to refill a gasoline or methanol tank
- Extremely slow acceleration; i.e., 0-60 mpg performance of 20+ seconds
- significant purchase price and operating cost penalties versus gasoline or methanol powered vehicles

The urban cycle driveability/performance of commercially viable EVs will have to match conventional internal combustion engine vehicles. Thus, it is likely that top speed considerations will be compromised, with top speeds being held to 70 mpg. EVs are particularly efficient in slow, stop-and-go driving and will be very economical to operate in congested urban areas. EVs have a major shortcoming in range between recharge. Projection of range and performance levels meeting customer needs without unacceptably compromising other factors impacting customer satisfaction, and projection of timing to achieve these levels, is difficult. However, it is clear that there are tradeoffs involved which, in the current climate for customer satisfaction, involve very high financial risks for manufacturers if introduction is to be achieved in the 1989-2000 time frame. For the 1989-2000 time frame, 50 to 100 miles in FUDS-like driving patterns is all that should be expected, barring an unexpected breakthrough.

b. Battary Systems

Lead-acid, nickel-iron, zinc-bromine and sodium-sulfur are the technologies that are most likely to be available in the time frame. These were assumed in the estimates for 5.a.

c. Battery Life Cycles

While several technologies have the potential for "life-of-the-vehicle" application, current technologies would indicate that early batteries should be expected to have only three to five year life cycles.

6. Economic Barriers

a. Cost Differentials

In high-volume production, EVs should be cost competitive. However in any early introduction years, with only limited production volumes, vehicle costs will be high and some form of economic incentives would be helpful if sufficient market interest exists.

To successfully market EVs, it will be necessary, at a minimum, to obtain technology breakthroughs that will provide lower overall operational costs in some of today's gasoline vehicle applications. EVs should be very reliable and require very little maintenance expense.

Batteries are expected to be particularly expensive. It could be anticipated that leasing programs could spread the "fueling cost" (including the battery and its replacement) over time and make the high cost of the battery more transparent to the user.

Some method of assuring competitive electricity rates could be considered. Since very few customers can shop competitively for electricity, it will be hard for "normal" market forces to assure competitive rates, absent external influence.

b. Production Lead Times

Conventional auto industry lead times are five or more years for the normal evolution of "conventional" technology. Major technological developments, such as new engines or transmissions, frequently take longer, with many examples available of projects that took 10 to 15 years to move from research to full production.

c. Production Capacity to Achieve Air Quality Benefits

Assuming appropriate technology breakthroughs, vehicle production capacity should be available to meet customer demands. Battery production capacity and distribution/availability could be limiting factors. Further studies, including electric generation for EVs, will be required to determine effect on air quality.

7. Institutional Barriers and Regulatory Actions/Incentives

- To overcome technological barriers, the formation of an industry-wide research consortium might be considered. This organization could also address the likely market reaction as the technology becomes more viable.

- Federally-funded demonstration fleet programs could provide a real test environment to measure vehicle durability, operating cost and customer acceptance. The programs should include meeting only regulations critical to the demonstration, rather than stringent application of all regulations which will be applicable to production two or three years later. This could achieve key objectives and avoid unnecessary strain on available technology resources.

- An equivalent petroleum-based fuel economy credit for EVs will not be sufficient to promote EV commercialization. Additional action to stimulate customer acceptance of EVs will be required. For example:

  - An incentive could be the use of "the diamond lane" by EVs.

  - Incentives for federal fleets to utilize EVs may be appropriate.

  - Excise or sales tax relief, income tax credits, waived license and toll fees, etc., in the private sector may be ways to stimulate sales.

8. Calculation of Equivalent Petroleum-Based Fuel Economy Value of EVs

Current calculations are complex and carry uncertainty. We believe that it is premature to comment on changes to the published test and petroleum equivalent fuel economy calculation procedures. Comments on such procedures should be reserved until the technology that could be used to produce a commercial vehicle is available and should take into consideration the then existing energy costs.

072489-1.jfb

APPENDIX G

CALIFORNIA AIR RESOURCES BOARD

LETTER

STATE OF CALIFORNIA—THE RESOURCES AGENCY GEORGE DEUKMEJIAN Gover

AIR RESOURCES BOARD
HAAGEN-SMIT LABORATORY
9528 TELSTAR AVENUE
EL MONTE, CA 91731-2990
PHONE: (818) 575-6800

AUG 7 1989

Reference No. E-89-022

Mr. Herbert H. Gould, Chief
Vehicle Crashworthiness Division
U.S. Department of Transportation
Research and Special Programs Administration
Transportation Systems Center
Kendall Square
Cambridge, Massachusetts 02142

Dear Mr. Gould:

This letter is in response to your correspondence of July 18, 1989, soliciting comments from ARB regarding the need to amend present federal regulations or add new regulations in order to promote electric vehicle commercialization. We understand that your recommendations would be contained in the Secretary of Transportation Report to the Congress as specified in the Alternative Motor Fuels Act of 1988.

Many of your questions have been addressed in a report which is being prepared by the California Electric Vehicle Task Force (EVTF). The EVTF is an organization comprised of representatives of various public and private agencies, and electric utility organizations for the purpose of promoting the development and commercialization of electric vehicles in California. This report, entitled "A California Plan for the Commercialization of Electric Vehicles", explores issues relating to electric vehicle commercialization and identifies opportunities and barriers facing electric vehicle introduction. This report also identifies specific elements of the commercialization process which require further development. A draft copy of this report is being forwarded to you for your information. Your questions concerning the guidelines for your report (question 1), technological institutional barriers for the introduction of electric vehicles (questions 5 and 9), and regulations to promote electric vehicle acceptance by consumers (question 8) are addressed in the EVTF report.

In addition to the EVTF analysis, electric vehicle technology will be addressed in a study by Bevilacqua Knight, Inc. (BKI) which is currently being conducted for ARB and Southern California Edison. Other issues which will be addressed by the BKI study include an analysis of the air quality impact of electric vehicle use and an economics analysis of

life-cycle cost forecasts associated with current and future electric vehicle technologies. This study, which will be completed in March, 1990, will address your questions regarding these issues (questions 6, 7, 11). We will forward a copy of the final report to you at that time.

The remainder of your questions concerning the amendment or initiation of federal regulations to stimulate the introduction of electric vehicles have not been addressed in reports available to the ARB. The ARB appreciates the opportunity to provide input for consideration in your report to Congress. If you require additional information, please contact Sarah Santoro, Air Resources Engineer, at (818) 575-6841.

Sincerely,

Bob Cross for

K. D. Drachand, Chief
Mobile Source Division

Enclosures

APPENDIX H

COMMONWEALTH EDISON

LETTER

Commonwealth Edison
One First National Plaza, Chicago, Illinois
Address Reply to: Post Office Box 767
Chicago, Illinois 60690 - 0767

September 5, 1989

Mr. Herbert H. Gould
Chief
Vehicle Crashworthiness Division
U.S. Department of Transportation
Kendall Square
Cambridge, MA 02142

Dear Mr. Gould:

Enclosed is Commonwealth Edison Company's response to your June 26 letter to Mr. John Viera regarding electric vehicles.

Sincerely,

Klaus Wisiol

Klaus Wisiol (mo)
Assistant Vice President

Enclosure

Question 1.

1. Are the following assumptions reasonable to employ for the preparation of the report:

   a. the time period 1989-2000,
   b. during the above period the primary market will be fleet operations in urban areas, and
   c. ninety percent of the EVs will be recharged at night, i.e., off-peak.

Answer

(a) The 1989-2000 time period is reasonable given current and near-term technology. Commonwealth Edison offers three points which suggest that the commercial sector may be the electric vehicle (EV) market most conducive to initial market penetration. First, the only EV technologically available for commercial operation is the large van. Within the next few years a mini-van may be ready for commercial production. Second, current battery technology allows for an average of 40 driving miles per charge, with the hope of increasing this to 90-120 miles/charge by the mid to late 1990's. With this limitation, it appears that the most viable market for commercial consideration at this time is the van market for fleet operators. Until battery technology leads to batteries that permit a travel distance per charge considered acceptable by consumers in the personal car market, successful penetration into the personal car market may not be possible.

Third, the infrastructure of the industry may require the next ten years or so to establish itself in support of the EV van market in urban areas. The infrastructure necessary to support other markets may not be developed, or fully developed, within this time period. Vehicle and battery manufacturers are not currently prepared to tap markets greater than the van market, and the distribution and service networks have not been established nor identified.

(b) This assumption is reasonable. Commonwealth Edison cited some support for this assumption above. Further, it may be reasonable to assume that initial market penetration efforts of EV vans should focus on the large fleet operator market in urban areas, and later penetration efforts should focus on the rest of the fleet operator market. Some reasons why large fleet operators (as opposed to small fleet operators) may be more receptive to initial market penetration efforts are as follows:

--they can take more risks since their conventional vans would be available in emergencies,
--they can designate EV vans for shorter and more predictable routes,

--they are better able to perform more sophisticated life-cycle cost analyses (as opposed to comparing only first costs) demonstrating the potential cost-effectiveness of EVs,
--their higher public profile may enable them to realize the intangible benefits of EVs (such as, promoter of clean air),
--they are more likely to benefit from time-of-day electric rates,
--they may already have in-house maintenance personnel to do the necessary service and maintenance on the vehicles, and
--they are more likely to have a central garage with the necessary tools, ventilation and space required to properly care for the EVs.

In addition, slow infrastructure development (i.e. dealers and service centers may initially establish only in the major cities) and current limitations in battery technology may restrict the geographic market to urban areas.

(c) On the surface, this assumption appears to be reasonable. The reasonableness of this assumption would be enhanced over time as battery reliability and miles/charge improve over time. Assuming these improvements are made during the 1989-2000 time period, the amount of recharging done off-peak will likely increase. In addition, the larger fleet operators who can benefit from the time-of-day rates (if available) will likely do their recharging during off-peak hours. However, ninety percent may be too high for the following reasons:

--If the fleet operator cannot take advantage of time-of-day rates, he will do his recharging whenever it is most convenient (i.e. at the end of the business day, around 3:00-5:00 p.m.).
--If operators cannot afford to keep a van off the road because of a discharged battery, they will recharge it as soon as possible in order to get it back on the road.
--Because the battery still suffers from low performance during cold weather and when nearing the end of its useful life, operators will have to recharge it during the day in order for an EV to complete its route.

Question 2.

2. What regulations (federal, state or local) require amendment or initiation to stimulate the introduction of EVs, specifically in the areas of

a. power plant emissions trade-offs,
b. electric power generating capacity,
c. power pricing, and
d. facilities investment

to insure availability of power for EVs at predictable prices without overall detrimental air quality effects?

Answer

Commonwealth Edison is not aware of any regulations applicable to its service territory that would require amendment or initiation to stimulate the introduction of EVs while insuring the availability of power for EVs at predictable prices without overall detrimental air quality effects. However, the Illinois Commerce Commission initiated a rulemaking to implement certain provisions of the Illinois Public Utilities Act from which the Commission derives its principal authority to determine the precise form, scope and intent of utility-specific "least-cost" energy plans. The future energy resource planning function of Commonwealth Edison will be to examine a range of energy resource options, including both supply-side and demand-side alternatives. Although Commonwealth Edison cannot currently predict exactly what demand-side management options will be addressed in its electric energy plans to be filed biennially with the Commission, Commonwealth Edison will likely assess EVs in the future as an alternative to be considered within this context. Further, Commonwealth Edison's electric energy plans will address environmental considerations, generating capacity needs, future electricity rates and rate trends, and investment in facilities.

Question 3.

3. Is it feasible, and at what cost, to meter off-peak electricity use separately from daytime use? Do regulatory barriers exist to prevent discounted rates for off-peak electricity use? If not, are they, in your judgement, likely to develop in our time frame?

Answer

Commonwealth Edison presently has a time-of-day rate for commercial and industrial customers. This is technically feasible with the use of time-of-day meters which are capable of recording off-peak energy consumption separately from on-peak energy consumption. The additional cost of time-of-day meters is recovered by Edison through a monthly customer charge higher than the standard charge.

A discounted rate for off-peak electricity use may not be the ideal solution for a couple of reasons. First, in order to offer a lower energy charge for off-peak electricity use, a higher energy charge is required for on-peak electricity use. The implications of this may not be so obvious. Under existing Commonwealth Edison commercial rates, a customer on the standard rate pays an "average" price for all energy use. If the customer elects to be billed under the time-of-day rate, the energy used during on-peak hours would cost more than the "average" price, while the energy used during off-peak hours would cost less than the "average" price. Unless the dollar amount the customer saves on off-peak energy use more than offsets the increased cost of on-peak energy use, the customer would not benefit from the time-of-day rate. Therefore, it is possible that those fleet operators who are predominantly daytime operators will not benefit by switching over to a time-of-day rate. As a result, these fleet operators will not benefit by waiting for the off-peak period to recharge the battery.

Second, as a utility's load factor rises, a discounted off-peak rate could send the wrong price signal to the marketplace. Theoretically, when the system load factor approaches 100%, all energy would have the same marginal cost. This suggests, therefore, that the utility must price the discounted off-peak rate as the full rate.

On the other hand, an off-peak cost-based rate, as opposed to a rate discounted from average costs, could mitigate the two concerns noted above. An off-peak cost-based rate could offer a lower energy charge for off-peak electricity use while sending an appropriate price signal to the marketplace. Commonwealth Edison does not anticipate a regulatory barrier in its service territory with the proposal of such a rate.

Question 4

4. One major financial barrier to market acceptance of EVs mentioned in the literature is the high initial cost of the EV compared to a conventional vehicle. Most of this higher cost is attributed to the high cost of the battery pack. One suggested remedy to this problem has been that the company which provides the electricity to recharge the EV own the battery packs and include the lease of the battery in the electric bill for recharging. Is this suggestion reasonable and feasible?

Answer

This suggestion may not be reasonable nor feasible. Electric utilities traditionally expect to recover their expenses, plus a fair rate of return on investment, through rates. This suggestion implies that electric utilities would not only purchase large quantities of battery packs for lease to the commercial sector, but would also assume some responsibility for the storage, maintenance, warranty and final disposition of the battery packs. A utility would expect to recover all of these expenditures through its rates. If all of the expenditures are recovered through a rate available to EV operators only, then the rate may be too high for market acceptance. If the expenditures are recovered through existing rates, the increase in rates would likely be negligible; in this case, the rate may not prohibit market acceptance but could introduce a question of equity since all customers would be required to subsidize EV operators. There may be regulatory barriers to adopting such a rate.

Question 5.

5. In reference to power generation, what barriers do you foresee to the introduction of EVs in the time frame indicated?

a. Do you expect future increases in the costs of generating electricity or changes in the demand patterns of electricity usage to have a significant impact on the cost to consumers of operating EVs relative to conventional-fuel vehicles?

b. In your judgement, will the need to provide recharging and other services for EVs constitute a significant barrier to their introduction?

c. At what level of EV use will generating capacity be a problem in your market?

Answer

For the 1989-2000 time period, Commonwealth Edison does not foresee any definitive barriers to the introduction of EVs to the commercial sector with respect to power generation. Assuming most EVs will be recharged during off-peak hours, Commonwealth Edison anticipates having an adequate, reliable supply of electricity through the year 2000 even with the introduction of EVs.

(a) No.

(b) The need to recharge EVs may not be a significant barrier provided that the recharging is done off-peak, but the need to provide other services for EVs to the commercial sector would likely present a barrier to EV introduction. This barrier would likely be more significant for small fleet operators than for large fleet operators who are more likely to have in-house maintenance facilities and service personnel. A pre-established network of service centers could minimize the effect this barrier would have on the introduction of EVs.

(c) Assuming most EVs will be recharged during off-peak hours, Commonwealth Edison expects to have sufficient generating capacity through the year 2000 even with a significant market penetration of EVs into the commercial sector. There will likely not be a capacity concern for those electric utilities with excess capacity. In fact, the introduction of EVs will likely improve the system load factor for utilities.

Question 6.

6. What institutional barriers do you foresee to the introduction of EVs in the time frame indicated? Are there any regulatory actions or incentives that would be likely to stimulate the introduction of EVs by promoting interaction among potential EV manufacturers, electric utility companies, vehicle fleet buyers, and other interested parties?

Answer

The following is a list of institutional barriers to the introduction of EVs in the time frame discussed:

1. Electric utilities typically see their roles to be the production, transmission and distribution of power. Other roles such as providing capital for EV research and development, promoting EVs or leasing EVs must be cost-effective. Utilities compromise shareholder and/or ratepayer interests by promoting or funding programs which are not cost-effective.

2. The large automakers may not be able to leverage their economies of scale in manufacturing and distribution. Therefore, they place a low priority in producing and promoting EVs, which appear to have a limited market in this time frame.

3. The oil companies have a significant vested interest in conventional fueled vehicles and will likely lobby to limit any federal or state regulations mandating or promoting the use of EVs.

4. GM and Chrysler manufacture electric vans but do not manufacture batteries. Similarly, battery researchers and manufacturers do not manufacture EVs.

5. Funding for battery research has been low. Battery research requires extensive capital, capital often provided by the government and electric utilities. The limited amount of funds may be hindering the development of batteries that could provide longer mileage cycles.

6. Battery manufacturers may not be willing to invest the necessary capital to construct a plant, since the initial cost is high and the potential market uncertain.

It is feasible that incentives or regulatory action of some sort could stimulate the introduction of EVs by promoting interaction among the automakers, battery manufacturers, electric utilities, and fleet operators. A test program in which large fleet operators in urban areas would test EVs for a period of time may be a good place to start. Government-sponsored incentives could stimulate the various parties to promote and participate in such a test program.

Multiple objectives are realized by running a government-sponsored test program. First, the government could avoid the potential for alienating certain interested parties if it mandated the use of electric vehicles. Second, government would permit EV technology and the necessary supporting infrastructure to develop under tested conditions for study. Third, all participants would have a better chance to evaluate the cost-effectiveness of EVs and the impact of EVs on their industry.

Also, the government is a large owner and operator of vehicles and could sponsor such a test program by purchasing EVs for its own fleets. A government-sponsored program could demonstrate clean air support and capture valuable operating data that could be shared for future study.

APPENDIX I

EXAMPLE OF LETTERS TO POTENTIAL STAKEHOLDERS

EXAMPLE OF LETTER TO AN AUTOMOBILE CONCERN

As discussed during our recent telephone conversation, this Center was requested by the National Highway Traffic Safety Administration to prepare the Secretary's Report to the Congress as specified by Section 7 of P.L. 100-494. The main thrust of this section is the assessment of the need to amend present federal regulations, or the addition of new regulations, that would promote the introduction of electric vehicles in the commercial sector (please see Attachment 1). We are soliciting the views of potential stakeholders on this subject. We shall welcome your organization's comments on all issues as these may relate to the objectives of Section 7 of P.L. 100-494. We should particularly appreciate your comments on the following:

1. Is it reasonable to employ for the preparation of the report the following guidelines:

   a. the time period 1989-2000,
   b. consideration of electric vehicles (EV) only, not hybrids,
   c. assumption that during the above period the primary market will be for fleet operation in urban areas, and
   d. the vehicles to be introduced commercially in the future will not require any waivers of federal motor vehicle safety standards or of standards defined by developers of EVs unique to such vehicles, e.g., electrical shock, electrical fire, electrolyte spillage, battery explosion, battery retention during crashes, electric ignition of fuels used for auxiliary systems, etc.?

2. What federal regulations require amendment (or extension) to stimulate the introduction of EVs? Please consider regulations in the areas of:

   a. fuel economy,
   b. emissions, and
   c. safety (crashworthiness, crash avoidance, and other hazards including hazards during recharging and maintenance).

3. What new federal regulations are needed to stimulate the introduction of EVs? Please consider the areas listed in para. 2 and any other you believe to be relevant.

4. In your judgement, do current regulations, definitions, required measurements or practices favor other alternatives to gasoline powered vehicles over EVs?

5. What technological barriers do you foresee to the introduction of EVs in the time frame indicated?

   a. What level of performance and efficiency do you envision for EVs that may be introduced into commerce during the period 1989-2000? Please address vans, two-seaters, etc., as a function of time. Performance includes range, acceleration and top speed.

   b. What battery systems correspond to the estimates in para. 5a.?

   c. What are the life-cycles of the batteries mentioned in para. 5b.?

6. What economic barriers do you foresee to the introduction of EVs in the time frame indicated?

   a. What cost differentials to the consumer do you anticipate between EVs and conventional-fuel vehicles in the purchase, maintenance, and replacement of batteries or major systems?

   b. What lead times would be required to produce the EVs mentioned in para. 5? In what quantities?

   c. In your judgement, will the national capacity exist to produce enough EVs to affect a change in air quality in the localities currently out of compliance with the Clean Air Act, assuming there will exist sufficient availability of electric power for their use?

7. What institutional barriers do you foresee to the introduction of EVs in the time frame indicated? Are there any regulatory actions or incentives that would be likely to stimulate the introduction of EVs by promoting interaction among potential EV manufacturers, electric utility companies, and other interested parties?

8. In reference to the calculation of the equivalent petroleum-based fuel economy value of electric vehicles (Part 474, 10 CFR Ch. II), are there reasons to recommend changes to the test procedures, driving cycles, cycle weighing multipliers, petroleum equivalency factors, etc.? Do you believe that other factors, such as utility power

plant emissions, vehicle auxiliary systems emissions and vehicle performance, should be included in the calculation?

We understand that not all of these questions can be answered in detail at this time, but the outlined subject areas may serve as a means of communication on the important issues and the preparation of a report that may be used for policy formulation. We appreciate your interest and help.

Sincerely yours,

Herbert H. Gould, Chief
Vehicle Crashworthiness Division

Attachment

EXAMPLE OF LETTER TO AN ELECTRIC POWER CONCERN

As discussed during your recent telephone conversation with Dr. Robert Church of our staff, this Center has been requested by the National Highway Traffic Safety Administration to prepare the Secretary's Report to the Congress as specified by Section 7 of P.L. 100-494, the Alternative Motor Fuels Act of 1988 (please see Attachment). The main thrust of this section is the requirement for the assessment of the need to amend present federal regulations, or the addition of new regulations, that would promote the introduction of electric vehicles in the commercial sector. We are soliciting the views of potential stakeholders on this subject. Stakeholders include providers of electric power, vehicle manufacturers and fleet operators. We shall welcome your organization's comments on all issues as these may relate to the objectives of Section 7 of P.L. 100-494 and your industry. We should particularly appreciate any comments you may have on the following questions:

1. Are the following assumptions reasonable to employ for the preparation of the report:

   a. the time period 1989-2000,
   b. during the above period the primary market will be fleet operations in urban areas, and
   c. ninety percent of the EVs will be recharged at night, i.e., off-peak.

2. What regulations (federal, state or local) require amendment or initiation to stimulate the introduction of EVs, specifically in the areas of

   a. power plant emissions trade-offs,
   b. electric power generating capacity,
   c. power pricing, and
   d. facilities investment

to insure availability of power for EVs at predictable prices without overall detrimental air quality effects?

3. Is it feasible, and at what cost, to meter off-peak electricity use separately from daytime use? Do regulatory barriers exist to prevent discounted rates for off-peak electricity use? If not, are they, in your judgement, likely to develop in our time frame?

4. One major financial barrier to market acceptance of EVs mentioned in the literature is the high initial cost of the EV compared to a conventional vehicle. Most of this higher cost is attributed to the high cost of the battery pack. One suggested remedy to this problem has been that the company which provides

the electricity to recharge the EV own the battery packs and include the lease of the battery in the electric bill for recharging. Is this suggestion reasonable and feasible?

5. In reference to power generation, what barriers do you foresee to the introduction of EVs in the time frame indicated?

a. Do you expect future increases in the costs of generating electricity or changes in the demand patterns of electricity usage to have a significant impact on the cost to consumers of operating EVs relative to conventional-fuel vehicles?

b. In your judgement, will the need to provide recharging and other services for EVs constitute a significant barrier to their introduction?

c. At what level of EV use will generating capacity be a problem in your market?

6. What institutional barriers do you foresee to the introduction of EVs in the time frame indicated? Are there any regulatory actions or incentives that would be likely to stimulate the introduction of EVs by promoting interaction among potential EV manufacturers, electric utility companies, vehicle fleet buyers, and other interested parties?

We understand that not all of these questions can be answered in detail at this time, but the outlined subject areas may serve as a means of communication on the important issues and the preparation of a report that may be used for policy formulation. We appreciate your interest and help.

Sincerely yours,

Herbert H. Gould, Chief
Vehicle Crashworthiness Division

Attachment

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