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Assessment of Institutional Barriers to the Use of Natural Gas in Automotive Vehicle Fleets

Jan Jablonski, Linda Lent,
and Michael Lawrence
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and

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Safety Sciences, Inc

August 1983



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Prepared for
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U.S. DEPARTMENT OF ENERGY
Conservation and Renewable Energy
Office of Vehicle and Energy R&D

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Office of Vehicle and Energy R&D
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FOREWORD

The study presented in this report was performed under Contract No. DEN3-295 with the National Aeronautics and Space Administration (NASA), and funded by the Department of Energy under Interagency Agreement DE-A101-81CS50006. The work was performed by Jack Faucett Associates, with subcontractual assistance from Safety Sciences, Inc. NASA responsibilities were carried out by Fred Simon of the Aerothermodynamics and Fuels Division at NASA-Lewis Research Center, Cleveland, Ohio. DOE responsibilities were carried out by Dr. Ralph Fleming of DOE's Office of Vehicle and Engine R&D.

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EXECUTIVE SUMMARY

In this study, institutional barriers to the use of natural gas as a fuel for motor vehicle fleets were identified and assessed. Recommendations for barrier removal were then developed. The research technique was a combination of literature review and interviews of knowledgeable persons in government and industry, including fleet operators and marketers of natural gas vehicles and systems.

Institutional barriers, as defined by this study, were barriers resulting from the action or inaction of a government agency at the federal, state, or local level. The study also included and investigated as potential institutional barriers, manufacturer warranties and insurance agreements for vehicles converted to natural gas.

Exhibit S-1 presents a tabular summary of the study's findings. Eight barriers, or categories of barriers, are included, listed in order of their magnitude of impact on natural gas vehicle use. The barriers, their effects, and recommendations for their removal are summarized below.

There are two safety-related barriers to the use of natural gas vehicles:

- 1) lack of a national safety standard for the safe design and use of natural gas vehicles and refueling stations, and
- 2) excessively conservative state and local regulations including:
 - bridge and tunnel restrictions;
 - restriction on types of vehicles that may be converted;
 - zoning regulations that prevent installation of natural gas refueling stations;
 - application of LPG standards to LNG;
 - parking restrictions for natural gas vehicles;
 - unintentionally unsafe vehicle or refueling station requirements.

The effects of the first are uncertainty about what constitutes acceptable design and use criteria for natural gas vehicles, and the numerous and varied safety regulations at the state and local levels that must be identified and complied with on a case-by-case basis.

**EXHIBIT S-1:
SUMMARY OF FINDINGS**

BARRIER	EFFECTS	RECOMMENDATIONS
Lack of a national safety standard	<ul style="list-style-type: none"> ● Uncertainty about acceptable design and use criteria ● Many and varied regulations at the state and local levels 	<ul style="list-style-type: none"> ● Adoption of NFPA or other appropriate standards by federal, state, and local agencies, after resolving possible conflicts with existing federal regulations ● Development of a parallel standard for LNG
<p>Excessively conservative or misapplied state and local regulations, including:</p> <ul style="list-style-type: none"> ● bridge and tunnel restrictions ● restrictions on types of vehicles that may be converted ● zoning regulations that effectively prevent natural gas refueling station installations ● application of LPG standards to LNG ● parking restrictions ● unsafe vehicle or refueling station requirements 	<ul style="list-style-type: none"> ● Unsafe installations ● Unnecessarily expensive installations ● Inconvenience to users and potential users ● Requirements to educate local authorities ● Problems must sometimes be taken before city councils or courts for resolution 	<ul style="list-style-type: none"> ● Adoption of NFPA or other appropriate standards by federal, state, and local agencies, after resolving possible conflicts with existing federal regulations. ● Development of a parallel standard for LNG.
Need for clarification of EPA's tampering enforcement policy	<ul style="list-style-type: none"> ● Marketers of natural gas vehicles systems, and potential users, may not know whether natural gas vehicles violate EPA requirements ● Marketers of natural gas vehicles are not aware of all alternatives for satisfying EPA requirements 	Update the EPA policy to reflect all alternatives for meeting EPA requirements and to eliminate ambiguity
The U.S. EPA vehicle standard for hydrocarbons	If tested outside of California, natural gas vehicles, though generally emitting less reactive hydrocarbons than gasoline vehicles, have difficulty meeting hydrocarbon standards because of their relatively large emissions of nonreactive hydrocarbons	Develop and implement a nonmethane hydrocarbon standard for use as an alternative to the current standard
Uncertainty concerning state utility commission jurisdiction	Potential refueling station operators do not know whether they will be regulated by state utility commissions as public utilities	Systematic effort to identify states where public refueling stations would be subject to state regulation, and modification of appropriate state laws
Sale-for-resale prohibitions at the state level	Potential nonutility refueling station operators may be prevented from installing a refueling station when the fuel is to be resold to fleet operators or the public	Systematic effort to remove state regulations and clauses in utility contracts that would prohibit customers from establishing refueling stations
Ambiguities in manufacturer warranties leave open the question of whether or not warranties on converted vehicles will be honored	While not a barrier to the many fleet operators who perform their own warranty work, this can be a barrier to operators of small fleets who are left uncertain about what repairs will not be honored	Accumulation of experience in working with natural gas vehicles at both the dealer and manufacturer levels. Manufacturers should also consider issuing more definitive statements on types of repairs that would not be covered by their warranty
Road use taxes in South Dakota result in substantially higher fees for CNG users than for gasoline users in some cases	Users of CNG vehicles may pay higher road use taxes than gasoline vehicle users; and potential users of CNG vehicles may be discouraged by the higher fees	Replacement of the current fee system for CNG with one that taxes CNG vehicles at rates more similar to those for gasoline vehicles
State road use tax regulations often do not provide a factor for converting natural gas to gasoline equivalent units	Potential users of natural gas are uncertain about what amount of tax they will pay	Research is needed to develop an appropriate natural gas to gasoline conversions factor to be used by the states

The effects of the second include unsafe and unnecessarily expensive installations, inconvenience to users and potential users, and the necessity for marketers of natural gas systems and fleet operators to educate local authorities.

Both safety-related barriers can be removed through development and implementation of a national standard. The National Fire Protection Association (NFPA) standard for compressed natural gas vehicles currently under development and scheduled for publication in early 1984 will be a major step forward toward eliminating this barrier. A similar standard should be developed by the NFPA or another organization for liquefied natural gas vehicles. Both should be adopted, or adapted, for use in federal, state, and local regulations.

The third and fourth institutional barriers are barriers associated with Environmental Protection Agency (EPA) policies. One is the need for clarification of EPA's policy for the enforcement of the anti-tampering requirements under the Clean Air Act as contained in EPA Mobile Source Enforcement Memorandum 1A. This vaguely worded and outdated memorandum renders marketers and potential users of natural gas vehicles uncertain about whether the vehicles violate EPA requirements. Furthermore, one EPA alternative for satisfying its requirements, discovered through discussions with EPA officials, is not written policy included in Memorandum 1A or supporting letters or documents. Not all marketers are aware of it and may choose a less attractive or more costly option. The EPA policy should be updated to reflect all alternatives and to eliminate ambiguity.

A second barrier associated with EPA policies is the U.S. EPA vehicle standard for hydrocarbons. In comparison to gasoline vehicles, natural gas vehicles generally emit large quantities of methane (nonreactive) hydrocarbons relative to their emission of nonmethane (reactive) hydrocarbons, and may tend to emit greater total amounts of hydrocarbons. The current U.S. standard, a total hydrocarbon standard, may be difficult for natural gas vehicles to meet, even if their emissions of the reactive hydrocarbons are lower than those of a gasoline fueled vehicle. EPA proposed a nonmethane standard for use as an alternative to the current standard, but withdrew it after learning that more research was needed before an appropriate standard could be selected. This research, an analysis of vehicle emissions of nonmethane hydrocarbons, should be performed and a new nonmethane hydrocarbon standard be proposed and implemented at the earliest possible date.

The fifth barrier identified is uncertainty concerning state utility commission jurisdiction. Definitions of public utilities in some states could be interpreted as extending to natural gas refueling stations. This leaves potential refueling stations operators concerned about undertaking investment in this industry, even though state utility commissions have indicated that it is not their intention to regulate natural gas refueling stations. A systematic effort possibly coordinated by the National Association of Regulatory Utility Commissions, to identify states where public refueling stations would be considered public utilities subject to state regulations, and modification of appropriate state laws, is needed.

The sixth barrier is sale-for-resale prohibitions at the state or natural gas utility level. These prohibitions, which limit the ability of a natural gas customer to resell gas, were developed originally as a means of preventing landlords, for example, from reselling gas to their tenants at higher rates than those charged by the utility. The prohibitions may be contained either in state regulations or in natural gas utility company contracts. Where they occur, only the natural gas utility may operate a refueling station if the fuel is to be resold to fleet operators or the public. A systematic effort should be undertaken, again possibly coordinated by the National Association of Regulatory Utility Commissions, to remove state regulations and clauses in natural gas utility company contracts that would prevent customers from reselling gas for the purpose of operating natural gas vehicle refueling stations.

Another area of investigation, manufacturer warranties, revealed that some manufacturers have issued verbal or written statements that they will honor warranties on vehicles converted to natural gas. However, these statements add that for the warranty to be valid, the problem must not have been caused by the natural gas conversion equipment. Uncertainty about what problems the manufacturer will view as having been caused by the conversion to natural gas is a barrier to the use of the fuel, particularly by small fleet operators who do not perform their own warranty work. Accumulation of experience and sophistication in working with natural gas vehicles will largely remove this barrier. Also manufacturers should consider issuing more definitive statements on types of repairs that would not be covered by their warranties.

Finally, investigation of state road use taxes showed that most states provide natural gas vehicle users equal or favorable tax treatment in comparison to gasoline vehicle users. However, one state recently enacted a fee system for CNG vehicles that results

in some cases in those vehicles paying substantially higher taxes than gasoline vehicles. The law will remain effect until 1985 when the state legislature meets again. The law will probably be rescinded at that time and replaced by one that gives more equitable treatment to CNG vehicles. A second barrier associated with state road use taxes is caused by the omission in the regulations of many states of factors for converting natural gas to gasoline equivalent units. The effect is that fleet operators are uncertain about what amount of tax they will pay if they convert to natural gas fuel. Research is needed to develop a natural gas to gasoline conversion factor for use by the states.

The authors appreciate the advisory support for this study provided by Fred Simon, of NASA, and Dr. Ralph Fleming, of the Department of Energy. Significant contributions were also made by fleet operators and marketers of natural gas conversion equipment who participated in telephone interviews and site visits, Tom Moskitis of the American Gas Association, Steven Hoover and Al Mannato of the Environmental Protection Agency, Richard Bechtold of Mueller Associates, and many others.

Secretarial effort for the project was coordinated by Leila Snyder.

CHAPTER 1

INTRODUCTION

Though natural gas fueled vehicles have been in operation worldwide since the early part of the twentieth century, it is only in the past twenty years that interest in this technology has been generated in the United States. In Southern California in the 1960's concern about air pollution led to efforts to experiment with and promote natural gas as an alternative to gasoline. The growth in the number of U.S. vehicles operating on natural gas lost momentum; however, in the 1970's when there were natural gas supply problems. In 1978, natural gas began to become attractive again when the supply outlook was improved by the passage of the Natural Gas Policy Act of 1978 and when gasoline was expensive and in short supply.

The market for natural gas vehicles is primarily fleet operators. Fleet vehicles, of which there were in 1980 about 17 million in the U.S. (travelling over 360 billion miles in an average year), are particularly appropriate for fueling with natural gas powering because many are fueled at a common point and are readily accessible for maintenance by specially trained mechanics. At present, there are about 25,000 to 30,000 vehicles on the road in the U.S. operating on LNG or CNG.^{1,2(1-1)}

The growth of this industry and the importance of the search for alternatives to gasoline as a fuel for motor vehicles, has led the Department of Energy and NASA to initiate a series of studies of gaseous fueled vehicles, of which this effort is a part.³ This study, sponsored by NASA's Lewis Research Center, identifies, describes, and evaluates institutional barriers to the widespread use of natural gas as a fuel for motor vehicle fleets. The study was undertaken in two tasks, barrier identification and barrier

¹*The technology is not presently viable for widespread use by private citizens because of the lack of infrastructures such as public natural gas refueling stations.*

²*Lowell Elder, Columbia Gas Service Systems, Report to the Gaseous Fueled Vehicles Contractor Coordination Meeting, Albany, New York, April 18, 1983.*

³*Other studies include two investigations of on-board storage systems for natural gas fuel, sponsored by NASA and performed by the Institute of Gas Technology and the Gulf Research Development Company; a study by Los Alamos National Laboratory under the sponsorship of the Department of Energy that is evaluating the safety characteristics of natural gas fuels; and Southwest Research Institute's study of the performance characteristics of engines fueled by natural gas.*

assessment. Included in the barrier identification task was the development of a set of criteria for identifying institutional barriers, collection of information on potential barriers, application of the identification criteria to the list of possible barriers, and preparation of a list of institutional barriers. In the barrier assessment task, the background and origin of each barrier was identified, its effects were analyzed, regional and other patterns were determined, the magnitude of impact was evaluated, and alternatives for reducing or removing the barriers were considered. In terms of barrier removal or reduction, where appropriate the analysis also considered specific technical advances that would be required before a barrier could be removed, identified areas where test data were needed, and evaluated the public health and safety implications of removing the barrier.

The study focuses on existing barriers, but also includes analysis of potential barriers that will become apparent if there is a substantial increase in the number of natural gas vehicle fleets, if a vehicles manufactured for and dedicated to natural gas begin to be used, or if certain pending legislation is passed. The study therefore should be of interest to government agencies, Congress, marketers, and fleet operators both now and in the future.

RESEARCH METHODOLOGY

Information Sources

The study consisted of two tasks, barrier identification and barrier assessment. The barrier identification task was accomplished primarily through interviews of marketers and users of natural gas vehicles. Most marketers of conversion equipment, one original equipment manufacturer, and twenty users were contacted. Among the latter were two operating LNG fleets, one operating both LNG and CNG fleets, and seventeen CNG fleet operators.¹

The second task, barrier assessment, was an analytical task. Information sources for the task included the interviews with marketers and users conducted as part of the barrier identification, supplemented by information from government agencies, industry

¹***All users operated dual fueled vehicles.***

associations (particularly the American Gas Association), research organizations, literature review, and six site visits to marketers and users. Of the six site visits, two were to CNG marketers, one to an LNG marketer, two to CNG fleet operators, and one to a fleet operator using both LNG and CNG. A partial listing of organizations contacted in the course of the study is included as Appendix A.

Scope of the Study

The barriers identified and assessed in this study are institutional barriers to the widespread use of natural gas as a fleet vehicle fuel that have been or may in the future be encountered by marketers or users of natural gas vehicles. The following paragraphs further define the concerns of this research by explaining what is meant by an "institutional" barrier and describing the criteria for identifying a "barrier."

Institutional Barriers

The barriers identified and assessed in this study were "institutional" barriers, defined as "a barrier that arises from the actions or inactions of any governmental unit at any level." This definition distinguishes institutional barriers from technological, economic, and other barriers. To help clarify this distinction, definitions of the three other categories of barriers are provided below.

- A technological barrier is a difficulty in the development, production, and/or use of natural gas fueled vehicles, natural gas as a vehicle fuel, or refueling stations that may be expected to be overcome through improvements in vehicle or refueling station design or production processes.
- An economic barrier is one that results from market conditions that are related to the cost of building, owning, or operating the vehicle. Examples would include the price of installing a natural gas refueling station, personnel training costs, and fuel price.
- Other barriers are defined here as barriers not included in any of the above three categories. Included are contractual agreements such as manufacturer warranties and insurance agreements, plus the problems of public misunderstanding, user education. Two of these "other" barriers

were included in the study, manufacturer warranties and insurance agreements.

"Barriers" Versus "Incentives"

A "barrier" is defined here as an obstruction or hindrance to the use of natural gas fueled vehicles. An "incentive" is a promotional activity or motivation. It was found during the course of the research for this study that when persons were asked to identify barriers to the use of natural gas as a fuel for fleet vehicles, some issues that were raised frequently were actually related to the lack of incentives, rather than to a barrier. Incentive programs, or the lack of them, are not discussed in this report. For purposes of this study, areas in which natural gas receives less than equal treatment in comparison with gasoline are considered barriers.

"Appropriate" Versus "Inappropriate" Barriers

Another distinction required in defining barriers involved the question of whether the impediments to the widespread use of natural gas as a motor vehicle fuel were appropriate or inappropriate. For example, if natural gas cylinders used in CNG fueled vehicles are required to be tested periodically to insure safe containment of the flammable fuel which they hold, and that testing is comparable to testing required of similar vessels containing similar fuels, the requirements are appropriate. However, if natural gas vehicle cylinders were subjected to far more stringent tests than those used to test similar vessels, the testing might then be inappropriate.

Outside of the simple cases presented above for purposes of illustration, distinguishing between appropriate and inappropriate barriers is not often a straightforward process. Attempting to do so requires knowledge of the safety, environmental impact, and other aspects of the fuel that for now remain uncertain in some cases. The fact that conversion kits and refueling installations are subject to safety and environmental regulations is not in and of itself a barrier to the use of the vehicles in the study. It is when the requirements are excessive or otherwise inappropriate that they are considered barriers.

ORGANIZATION OF THE REPORT

The remainder of this report is organized to provide first the background information on the research methodology and the scope of the study that will aid the reader in interpreting its findings, then the barrier-by-barrier discussions that reflect the findings. Chapters Two through Six are barrier discussions, arranged in order of the importance of the barriers described therein to the widespread use of natural gas as a fuel for motor vehicle fleets. Chapter Two presents the safety-related barriers, focusing on the problems associated with the lack of a national standard of set of regulations for the safe design and certification of natural gas powered vehicles. Existing federal regulations that are currently or could be applied to the industry are considered, and the ad hoc nature of the many state and local regulations are discussed.

Chapter Three presents the barriers associated with the Environmental Protection Agency's regulations enforcing the Clean Air Act's prohibition of the removal of emissions control equipment instituted on automotive vehicles. It also describes potential changes in Environmental Protection Agency standards that may affect the use of natural gas as a vehicle fuel. Chapters Four and Five cover restrictions on the natural gas industry and the operation of refueling stations imposed by the Federal Energy Regulatory Commission, and state utility commissions. Chapter Six concludes the main body of the report with discussions of other barriers and potential barriers, including motor vehicle warranties, state road use taxes, state environmental protection laws, and insurance agreements.

The report contains three appendices. Appendix A lists many of the organizations contacted as part of this study. Appendix B details two safety related issues: National Highway Traffic and Safety Administration certification and safety defect responsibilities of natural gas equipment and vehicle manufacturers and installers; and testing requirements for fuel cylinders. Appendix C is a summary of California safety regulations applied to natural gas vehicles. Appendix D concludes the report with a summary of California environmental regulations and testing requirements for natural gas fueled vehicles.

References

- 1-1. Committee on Science and Technology, "Methane Transportation Research, Development, and Demonstration Act of 1980: Report," August 20, 1980.

CHAPTER 2

SAFETY RELATED INSTITUTIONAL BARRIERS

The major institutional barrier to the use of natural gas as a fuel for fleet vehicles is the lack of a national standard applicable to the design, certification, and use of natural gas vehicles and refueling stations. The direct effect of this barrier has been a growing number of state and local regulations that must be identified and complied with on a case-by-case basis. The indirect, and more important, effect has been uncertainty about what constitutes acceptable design criteria, which leaves potential users and local authorities uncertain about natural gas vehicle and refueling station safety.

A second safety barrier, closely related to the first, is that some state and local regulations of the design, operation, and use of natural gas vehicles and refueling stations are misguided or inappropriate. Fleet operators are sometimes requested by fire marshalls to install the natural gas conversion equipment in a manner the local fire officials believe is safe, but which is actually unsafe. Also included here are tunnel and road restrictions, parking restrictions, application of LPG standards to LNG prohibitions on converting certain types of vehicles; and zoning regulations that prohibit installation of refueling stations.

The remainder of this chapter begins with an overview of federal regulatory agencies, their jurisdictions, and the status of their regulations with respect to natural gas vehicles. This overview is followed by a discussion of federal, state, and local regulations identified in the course of the study, and found to be excessive misguided, or otherwise needing change. The next section, Barrier Impact, describes the effects of the existing regulatory climate on the use of natural gas vehicles by fleet operators. The chapter concludes with recommendations for changes, and suggestions on areas where test data and further research are needed.

FEDERAL REGULATION OF NATURAL GAS VEHICLES AND EQUIPMENT

With the exception of design and inspection criteria for compressed gas cylinders, there are no regulations which directly address natural gas as a motor vehicle fuel. A review of the Code of Federal Regulations for potentially applicable federal regulations

revealed considerable uncertainty in regulatory agencies as which federal regulations actually do apply to motor vehicles fueled by natural gas.

Examples of areas where regulations for the use of natural gas as a motor vehicle fuel would be expected, but are missing or uncertain, are provided below. These examples include regulations promulgated by the National Highway Traffic Safety Administration, the Materials Transportation Bureau, the Federal Highway Administration and the Occupational Safety and Health Administration. These uncertainties apply equally to organizations which manufacture new vehicles or convert new vehicles to natural gas use, as the regulations were intended to address both situations. The regulations, and attendant uncertainties, do not apply to fleet owners who modify existing fleets (which includes most existing vehicles now operating on natural gas) unless such fleet owners are regulated by the Federal Highway Administration's Bureau of Motor Carrier Safety (BMCS) as private, common or contract carriers.

National Highway Traffic Safety Administration

The National Highway Traffic Safety Administration (NHTSA) has no requirements that represent institutional barriers to the use of natural gas as a fuel for motor vehicles. The few NHTSA requirements that are applicable to conversions of vehicles to natural gas are summarized below.

Section 108: Certification and Alterations

The National Traffic and Motor Vehicle Act of 1966 (as amended in 1975):

- (1) requires new motor vehicles to comply with applicable Federal Motor Vehicle Safety Standards until they are first purchased by a person or entity for reasons other than resale (Sections 108(a)(1)(A) and (b)(1)), and
- (2) prohibits manufacturers, distributors, dealers, and motor vehicle repair businesses from knowingly removing, disconnecting, or reducing performance of equipment installed on a vehicle in accordance with applicable Federal Motor Vehicle Safety Standards (Section 108(a)(2)(A)).

In terms of conversions of new gasoline vehicles to natural gas or dual natural gas/gasoline fuel systems, Section 108(a)(1)(A) and (b)(1) of the Act require that any person who alters a vehicle prior to its delivery to the ultimate consumer in a manner that significantly affects either its configuration or purpose must recertify the entire vehicle as complying with all applicable Federal Motor Vehicle Safety Standards (FMVSS's). In practice, the only FMVSS likely to be applicable is FMVSS 301-75, a vehicle standard specifying the amount of liquid fuel permitted to escape from a fuel system after a controlled test impact.¹ The standard, however, applies only to vehicles that use a fuel with a boiling point above 32 degrees Fahrenheit. It thus does not apply to vehicles converted to operate solely on natural gas (which has a boiling point below 32 degrees Fahrenheit). It does apply to an alterer who converts a vehicle from gasoline to a dual natural gas/gasoline fuel system. In the latter case, the alterer would be required to recertify the vehicle.(2-1)

After delivery of the vehicle to the ultimate consumer, alterations to the vehicle are governed by Section 108(a)(2)(A). There is no liability under section 108(a)(2)(A) if the converter (called a "tamperer") converts a vehicle that has been delivered to its ultimate consumer into a vehicle fueled solely by natural gas. In the case of a tamperer who modifies a used gasoline vehicle so that it has a dual natural gas/gasoline system, a violation occurs only if in doing so, the tamperer knowingly reduces the performance of the original fuel system. Violators are liable for civil penalties of up to \$1,000 for each violation.(2-1)

Section 151: Safety Defects

Persons who alter new vehicles by converting gasoline fuel systems to natural gas or dual natural gas/gasoline fuel systems, as well as manufacturers and assemblers of the equipment being installed, are subject to safety defect responsibilities. Should a safety defect be discovered by NHTSA, motor vehicle and equipment manufacturers must notify owners of defective vehicles and equipment, and remedy the defects without charge. Failure to do so would result in a civil penalty of up to \$1,000 per violation.

¹Other safety standards could become applicable if in converting the vehicle the position of a seat, operation of a seatbelt, or other equipment characteristics regulated by NHTSA, were affected.

Persons who convert a gasoline system to a natural gas or dual natural gas/gasoline fuel system after its delivery to the ultimate consumer have no safety defect responsibilities, since these requirements apply only to new vehicles. Manufacturers of the equipment installed on these used vehicles would be subject to NHTSA safety defect responsibilities however.(2-1)

Appendix B-1, an issue paper prepared by the Chief Counsel of NHTSA, provides further detail on the federal implications of converting fuel systems to use natural gas.

Vehicle In Use Inspection Standards

Another set of NHTSA standards examined were the "Vehicle In Use Inspection Standards" to be used by state inspection systems to, "reduce death and injuries attributable to failure or inadequate performance of motor vehicle systems." This standard, 49 CFR Part 570, does not address either gasoline or natural gas fuel systems. While this lack of a fuel system inspection requirement may be acceptable for gasoline powered vehicles, its absence in the case of natural gas vehicles may result in safety problems in the future as the cylinders used to store compressed gas, (commonly at 2,400 PSI), should be tested periodically to ensure their integrity. While the Department of Transportation (DOT), Materials Transportation Bureau (MTB), discussed below, sets forth such test requirements for natural gas cylinders, the applicability of MTB requirements to privately owned vehicles, not in commerce, is somewhat in question. Either the MTB or NHTSA should take jurisdiction in this area, and enforce a requirement to test CNG cylinders periodically.

Materials Transportation Bureau

The Department of Transportation's Materials Transportation Bureau (MTB) has promulgated regulations to minimize the dangers to life and property incident to the transportation of hazardous materials. While natural gas is included in the materials regulated by the MTB, the regulations are directed to private, common and contract carriers and are thus not directly applicable to vehicles which are not transporting bulk natural gas or using natural gas as a fuel for freight carrying vehicles. However, every manufacturer and user contacted during this study, as well as the State of California, used the MTB compressed gas cylinder design and test regulations set forth in 49 CFR 173 as a guide to the safe use of compressed gas cylinders. MTB requirements are

generally imposed through reference in another applicable standard such as a National Fire Protection Association Standard (NFPA) adopted into a local fire code, or Occupational Safety and Health Administration (OSHA) standards.¹ Unlike the privately-owned vehicles mentioned above, almost every fleet user is subject either to the MTB or OSHA requirements relative to the design and testing of compressed gas cylinders.

One subpart of MTB's guide to the safe use of natural gas cylinders, 49 CFR 173.34, "Qualification, maintenance and use of cylinders", requires that compressed gas cylinders used in an automotive CNG system be hydrostatically tested every five years (Appendix B-2). This requirement was sometimes cited by fleet operators as a barrier. The "barrier" occurs because the cylinder must be removed from the vehicle to perform this test which results in vehicle downtime, the necessity to stock replacement cylinders, or arrangements with a supplier to exchange cylinders. This regulation however is almost universally applied, is clearly stated and is reasonable in content and should not be considered a barrier. However, the need to remove the cylinders at five year intervals can be expensive and disruptive to fleet operations. A recommendation for further research to develop alternative test methods is made later in this chapter.

Federal Highway Administration

Among the rules applicable to motor carriers promulgated by the Federal Highway Administration (FHWA) is 49 CFR Part 393, "Parts and Accessories Necessary For Safe Operation." Subpart E of this part sets forth requirements for the fuel systems of vehicles operated by regulated carriers. While the requirements in this regulation do not specifically mention CNG and LNG vehicles, there are two general fuel system requirements with which the National Fire Protection Association's Compressed Natural Gas Standard, now under development, is potentially in conflict:

- Federal Highway Administration regulation 393.65(b)(6) states that no part of the fuel system of a bus manufactured on or after January 1, 1973, is to be located within or above the passenger compartment. The proposed NFPA CNG standard permits such a location.

¹ *NFPA or OSHA standards may require that cylinders be designed and tested in accordance with the MTB requirement.*

- Federal Highway Administration regulation 393.65(f) requires that a fuel line which is not completely enclosed in a protective housing must not extend more than two inches below the fuel tank or its sump. The proposed NFPA CNG standard would permit this situation.

The proposed NFPA standard is discussed later in this chapter.

Another issue concerning how, or if, Federal Highway Administration regulations apply to natural gas derives from 49 CFR Part 393.63, which sets forth requirements for liquefied petroleum gas systems (LPG). These provisions require that such fuel systems must conform to the "Standards for the Storage and Handling of Liquefied Petroleum Gases" as published by the NFPA. Two officials within the Bureau of Motor Carrier Safety, charged with enforcing these regulations, provided conflicting interpretations as to whether or not these LPG requirements apply to vehicles fueled by LNG. While one official said that the LPG regulations would apply to LNG vehicles, the second stated that there are no federal standards applicable to LNG automotive systems.

Occupational Safety and Health Administration (OSHA)

The Occupational Safety and Health Administration (OSHA) is charged with promulgating and enforcing safety and health standards in areas which are not regulated by another regulatory agency. There are no standards directly applicable to natural gas as a motor vehicle fuel. There are two related sections, however: 29 CFR Part 1910.101, "Compressed Gases"; and Part 1910.110, "Storage and Handling of Liquefied Petroleum Gases," which are discussed below.

- Part 1910.101 - Compressed Gases. This section contains general requirements that compressed gas cylinder inspections should be conducted as prescribed by the MTB and handled in accordance with Compressed Gas Association Pamphlet P-1-1965. These are universally applicable and proven safety standards which do not constitute a barrier to the use of natural gas.
- Part 1910.110 - Storage and Handling of Liquefied Petroleum Gases. The definition section of this part defines liquid petroleum gas as "LPG and LP

Gas — any material which is composed predominantly of any of the following hydrocarbons, or mixtures of them: propane, propylene, butanes (normal butane or iso-butane) and butylenes." While natural gas does not normally fall within this definition, OSHA personnel have indicated that they would use this standard to inspect an LNG installation. Thus, as in the Bureau of Motor Carrier Safety regulations, the LPG standard may be applied to LNG operations. While there are some similarities between LNG and LPG, some requirements, such as those concerned with tank filler marking for a liquid at temperatures between 20 and 130 degrees fahrenheit, would be inappropriate since LNG would not remain a liquid at those temperatures.

STATE AND LOCAL REGULATION OF NATURAL GAS VEHICLES AND EQUIPMENT

With few exceptions, state and local regulations applicable to CNG and LNG used as motor vehicle fuels are set forth in fire codes, and enforced by local fire prevention officials. Without the guidance that most fire codes derive from National Fire Protection Association standards, or other national level standards, and without knowledge of the safety characteristics of the fuels, a series of complex, sometimes inappropriate, regulations have been developed by local governments. These must be addressed location by location, and are a barrier to any national policy or marketing strategy on use of natural gas as a motor vehicle fuel. Further, the existence of such local ordinances exposes the system to a greater degree of emotional and political influence. There are many examples of excessively conservative or misguided safety regulations at the state and local levels. Some of these are listed below.

- The State of Maryland, which does not otherwise regulate the use of CNG or LNG as a vehicle fuel, prohibits their use as fuel for school buses.
- While the NY-NJ Port Authority prohibits CNG and LNG powered vehicles from using its tunnels, some New York school districts are in the final process of purchasing CNG fueled school buses.¹

¹The New York/New Jersey Port Authority and the Baltimore Harbor Tunnel are the only localities known to have tunnel or bridge restrictions.

- In addition to its numerous bridge, tunnel, and expressway restrictions, New York City requires costly and extensive fire detectors and control systems and combustible gas detector systems. Until recently, no person or private company but a utility company could install refueling stations in New York City. However, the New York City Fire Department has now published a notice of amended regulations to allow private companies to install CNG refueling stations if they are assisted by a New York City gas utility.¹
- Three of five fleets operated by utility companies and investigated in a recent study of gas fueled vehicles in the State of New York, have encountered local prohibitions against the use of gaseous fuels.²
- A Lexington, Kentucky fire marshall asked that city officials develop zoning regulations for the installation of CNG refueling stations in the city. Regulations that would severely limit the areas where refueling stations could be installed were developed and offered for public comment. In addition to being restrictive, the regulations were poorly worded. In one zone, for example, refueling stations were limited to two cylinders, without qualifying the requirement by describing the cylinder size limitations.
- The City of Los Angeles does not permit natural gas vehicles to be parked in the city government garage.

One state, California, has a comprehensive set of regulations applicable to natural gas fueled private automobiles, buses, carriers, and refueling operations. An outline of California natural gas regulations is contained in Appendix C. In contrast with most state and local governments, as well as the federal government, the California regulations are a detailed approach to each aspect of vehicle and fueling station design, test and operation. Recently, a second state, New York, also promulgated a regulation for natural gas vehicles. Such regulations can provide useful guidelines for other states and localities seeking to develop their own standards.

^{1,2} *Mueller Associates, Inc. and E. F. Technology, Inc., Report to the Gaseous Fueled Vehicle Contractor Coordination Meeting, Albany, New York, April 19, 1983.*

BARRIER IMPACT

The effect of the primary safety barrier, the lack of a national standard applicable to the design and certification of natural gas vehicles, has been a growing number of state and local regulations and ad hoc decisions by fire marshalls that must be identified and complied with on a case-by-case basis. Possibly more important has been the resulting uncertainty about what constitutes acceptable design criteria, which leaves potential users and local authorities concerned about safety.

The effects of the second type of safety barrier, the excessively conservative or misguided regulations that have appeared in some states and localities, have been to force fleet operators and marketers of conversion equipment to educate local authorities in the safe design and use of natural gas vehicles and refueling stations; to require sometimes that the fleet operator or marketer must take problems with regulations to a court or the city council; and may occasionally mean that conversion equipment and refueling stations are unsafe.

RECOMMENDATIONS

Recognizing the proliferation of locally developed, widely differing regulations of natural gas vehicles and refueling stations, the American Gas Association (AGA) in 1980 formed a committee to develop a draft standard for compressed natural gas vehicles. In late 1981, AGA asked the National Fire Protection Association (NFPA) to organize a technical committee to support this project. The NFPA Committee 52 on Compressed Natural Gas Vehicular Fuel Systems was established in July, 1982.¹

The NFPA standard, intended for use by manufacturers of natural gas system components and by installers and operators, relies heavily on established compressed gas technology and standards recommended by the Department of Transportation, ASME, the Compressed Gas Association, and others. The standard will apply to the design and installation of compressed gas engine fuel systems on vehicles of all types and to their associated fueling systems and is the only existing initiative to standardize CNG vehicle design.²

^{1,2}Lowell L. Elder, *Columbia Gas System Service Corp., Report to the Gaseous Fueled Vehicles Contractor Coordination Meeting, Albany, New York, April 18, 1983.*

The NFPA standard generally parallels the California regulations, with the exception that the California regulations are somewhat more specification oriented than those of the NFPA. When the NFPA standard is published, each government entity will review the standard for inclusion in its fire code. These authorities may adopt the standard as written, or they may amend its provisions. Publication of this NFPA standard, an estimated six months to one year away, will go far towards removing the barriers to compressed natural gas fuel use that now exist at the state and local levels.

The National Fire Protection Association standard for compressed natural gas vehicles and fuel systems is a major step toward the elimination of safety-related regulatory barriers. The standard is not a complete solution to the problems, however, as described below:

- The NFPA standard addresses only compressed natural gas vehicles and facilities. There is no comparable standard development underway for liquefied natural gas. One recommendation, therefore, is that an organization such as the NFPA develop parallel standards for LNG.
- Second, as previously explained, some provisions of the NFPA standard are potentially in conflict with existing federal standards in the areas of crash testing, fuel tank location on buses, and ground clearance of fuel system components. These conflicts should be resolved before the standard is published.
- Third, it is not sufficient for the standards to be published by NFPA. They must then be adopted, or adapted, into the codes of government agencies — with federal agencies setting the vehicle design criteria, and state and local agencies taking jurisdiction in the areas of refueling station facilities and operation.

Implementation of these three recommendations would result in the removal of many misguided regulations, eliminate much of the need for educating local officials when a new installation is being considered, help standardize local requirements, and remove much of the uncertainty surrounding the safety of the vehicles.

One other recommendation is offered here as a suggestion for research. As described earlier, the Materials Transportation Bureau of the Department of Transportation requires that cylinders for compressed gas be tested periodically, usually every five years. The current testing procedure, a hydrostatic test that requires the cylinders to be removed from the vehicle and transported to a test facility, is expensive for fleet operators. Research, sponsored either by a government agency such as the Materials Transportation Bureau or by industry organizations, should explore other tests, such as ultrasonic tests, which could be completed without removing the cylinder from the vehicle.

Reference:

- 2-1 Office of the Chief Counsel, National Highway Traffic Safety Administration, "Motor Vehicle Safety: The Federal Implications of Installing Auxiliary Fuel Tanks and of Converting Fuel Systems to Use Alternate Fuels." Undated.

CHAPTER 3

EPA TAMPERING ENFORCEMENT POLICY

The Clean Air Act prohibits the removing or rendering inoperative of any emission control device installed on a motor vehicle before or after delivery to a customer. Violators of the law are subject to fines of \$2,500 to \$10,000 per vehicle.¹ According to EPA policy, conversions of vehicles to natural gas do not violate anti-tampering laws if the converter and/or fleet operator can show that certain requirements have been met. There are two problems with the EPA policy:

- 1) The written policy, and supporting documents such as letters, do not reflect the agency's actual practices. This makes it difficult for converters and others to find out what their options are for complying with EPA requirements.
- 2) Only one of EPA's three alternatives for meeting its requirements is both economically viable and sufficiently well-defined as to allow converters to be certain they are not violating EPA requirements. A converter who chooses to use either of the other alternatives can never be sure that vehicles converted will not be subject to EPA fines.

These barriers and recommendations for their removal are detailed in the following pages. The chapter concludes with a discussion of a related EPA issue important to natural gas vehicle manufacturers and converters, EPA's hydrocarbon standard and the proposed nonmethane hydrocarbon alternative standard.

THE CLEAN AIR ACT AND ALTERNATIVE FUELS

According to EPA emission estimates, motor vehicles account for nearly three-quarters of the total carbon monoxide, over one-third of the hydrocarbons, and one-third of the

¹*Fleet operators and persons engaged in servicing, repairing, selling, leasing, or trading motor vehicles and motor vehicle engines who violate the tampering prohibition are subject to fines of \$2,500. The fine for manufacturers and dealers who violate this prohibition is \$10,000.*

nitrogen oxides emitted to the atmosphere. The emissions contribute to health problems such as anemia, heart strain, headaches, and lung and eye irritation.(3-1) EPA is thus understandably concerned about controlling motor vehicle emissions and tampering.

The Clean Air Act is EPA's primary instrument for addressing this issue. Among its many other provisions, the Clean Air Act prohibits any dealer or manufacturer of motor vehicles from removing or rendering inoperative any emission control device or element of design installed on a motor vehicle before or after delivery to the customer. The 1977 amendments to the act extended the prohibitions to fleet operators and persons engaged in servicing, repairing, selling, leasing, or trading motor vehicles and motor vehicle engines.(3-2)

An early version of the Clean Air Act (1967) provided an exemption process for conversions to alternative fuels. According to Section 203(c) of the Act, the Administrator of EPA may exempt from the Act's anti-tampering restrictions any vehicles manufactured before 1974 "for the purpose of permitting modifications to the emission control device or system" in order to use alternative fuels. The exemption would be granted if the Administrator finds, on the basis of information submitted by the applicant, that such modification will not result in the vehicle or engine's failure to comply with applicable emissions standards.(3-2)

The legislative history for Section 203 is sparse so the rationale for inserting the exemption process outlined in Section 203(c) is uncertain, as is the reason for allowing it to expire at the end of the 1973 model year. It appears, however, that the exemption process was inserted into the law in support of the Federal government's interest in promoting the use of alternative fuels. According to EPA the selection of the 1973 model year as the last model year that would be eligible for this exemption was probably due to the possibility that after that time, with changes in emissions control technology, conversions to alternative fuels might no longer be feasible. It should be noted that during the model years for which this exemption was available, conversions of vehicles to natural gas by any one other than a dealer or manufacturer would not have been considered tampering under any circumstances. The language of the Clean Air Act was not amended until 1977 to include activities by fleet operators and the conversion equipment marketers.(3-2)

EPA's Memo 1A, issued in 1974, essentially replaced the Clean Air Act's exemption procedure, for vehicles manufactured after the 1973 model year. The memo is more specific than the Clean Air Act's exemption procedure in its requirements, and also is applied to more activities than conversion to alternative fuels. The memo is discussed in detail below.(3-2)

OVERVIEW OF EPA POLICY

EPA's enforcement policy for the Clean Air Act's tampering prohibition is set forth in letters and in Mobile Source Enforcement Memorandum 1A (hereafter referred to as Memo 1A).(3-3) Memo 1A was issued in 1974, prior to the 1977 amendments to the Clean Air Act. Its provisions, however, have been interpreted by EPA as extending to the persons named in the amendments, which includes the marketers and users of vehicles converted to natural gas.

Memo 1A sets forth certain categories of acts as not constituting a violation of the Clean Air Act, if there is a reasonable basis for knowing there will be no adverse effect on emissions performance. From Memo 1A, two of these are:

1. Use of a nonoriginal equipment aftermarket part or system as an add-on, auxiliary, augmenting, or secondary part or system, if the dealer (or other persons named in the 1977 amendments) has a reasonable basis for knowing that such use will not adversely affect emissions performance; and
2. Adjustments or alterations of a particular part or system parameter, if done for purposes of maintenance or repair according to the vehicle or engine manufacturer's instructions, or if the dealer (or other persons named in the 1977 amendments) has a reasonable basis for knowing that such adjustment or alteration will not adversely affect emissions performance.

According to EPA, installation of a natural gas conversion system and any accompanying alterations or adjustments of a motor vehicle or motor vehicle engine parts or operating parameters, such as carburetor adjustments, would fall within the above two categories.(3-4) As a result, there must be a reasonable basis for knowing the conversion, adjustments, or alterations will not adversely affect emissions performance.

According to Memo 1A, this reasonable basis exists if:

- (a) The dealer (or any persons named in the 1977 amendments) knows of emissions tests which have been performed according to testing procedures prescribed in 40 CFR 85 (now 40 CFR 86) showing that the act does not cause similar vehicles or engines to fail to meet applicable emission standards for their useful lives (5 years or 50,000 miles in the case of light duty vehicles); or
- (b) the part or system manufacturer represents in writing that tests as described in (a) have been performed with similar results; or
- (c) a Federal, State or local environmental control agency expressly represents that a reasonable basis exists. (This provision is limited to the geographic area over which the State or local agency has jurisdiction.)

A literal interpretation of the first two alternatives would mean converted vehicles establishing a "reasonable basis" as set forth in (a) or (b) above would have to be subjected to the comprehensive Federal Test Procedures, a process that requires emissions testing at about every 5,000 miles for the useful life of the vehicle.(3-5) Furthermore, since new vehicle manufacturers are required to submit vehicles from every engine family for testing (there are about 250 engine families), the use of the phrase "similar vehicles or engines" in Memo 1A could be interpreted as meaning the converters must do the same. Finally, these tests would have to be repeated every model year, rendering the meeting of EPA requirements very expensive.

EPA's third alternative for establishing a "reasonable basis," is having a federal, state, or local environmental control agency expressly represent that a reasonable basis exists. Memo 1A states that this representation or certification is valid only within the geographic area where the local or state agency has jurisdiction. In practice, EPA has accepted California approval nationwide.¹

¹California is the only state known to have an emissions approval program for conversions to natural gas.

In verbal discussions, EPA has not applied a strict interpretation to Memo 1A alternatives (a) and (b). Instead of subjecting vehicles to testing at 5,000 mile intervals for 50,000 miles, the agency recommends that converters:

- 1) subject a converted vehicle to chassis dynamometer testing, as set forth in the Federal Test Procedures, after the accumulation of 4,000 miles on the vehicle, and
- 2) use the engineering judgment of the converter or the testing facility operator to determine whether durability tests (the testing of emissions at 5,000 mile intervals for 50,000 miles), and tests of each engine family and model year are needed to establish whether all vehicles to be converted will be able to meet emissions standards throughout their useful lives.¹

Since this verbal interpretation differs somewhat from a strict interpretation of Memo 1A, it is somewhat difficult for converters and others to find out what their options are for avoiding violating the Clean Air Act's tampering prohibition.

Closely related is the problem that neither the oral nor the written policy provides any means for those who choose to satisfy EPA requirements by performing chassis dynamometer testing after 4,000 miles to assure themselves that they are not violating the Clean Air Act. This second problem exists because EPA does not certify or otherwise approve vehicles. A converter who elects to use EPA's oral interpretation of options (a) or (b) (chassis dynamometer testing of a vehicle after 4,000 miles, with engineering judgment applied to determine whether the vehicle will meet emissions requirements for its 50,000 mile life, and whether vehicles from other engine families or model years will meet the EPA requirements) may submit his results of tests along with engineering findings to EPA for review, but EPA will not approve or disapprove the data. A converter who obtains California approval however, or who subjects his vehicles to the full statutory set of Federal Test Procedures, can be relatively certain that he is satisfying EPA requirements and will not be subject to fines for violating the anti-tampering law. According to an EPA letter, any marketer who has his system approved by the California Air Resources Board or has subjected his equipment to emissions tests pursuant to applicable procedures specified in 40 CFR Part 86 (the Federal Test Procedures), may represent that the installation of its fuel conversion system by parties named in the Clean Air Act would not violate the Federal tampering prohibition.(3-4)

¹Verbal discussions with Steven E. Hoover and Al Mannato, Environmental Protection Agency, December 1, 1982, and January 28, 1983.

CURRENT STATUS

Almost all marketers of conversion systems subject their equipment and converted vehicles to emissions testing, but do not necessarily use the testing equipment or procedures recommended by EPA. According to EPA, some use a nondispersive infrared (NDIR) analyzer to sample directly from the vehicle exhaust system during idle and/or steady-state cruise conditions, as a substitute for EPA recommended chassis dynamometer testing using a constant volume sampling system. The results of the former procedure have no correlation with the results of the chassis dynamometer testing.

For example, in the case of hydrocarbon emissions, the only analytic method that is suitable for measurement of vehicular exhaust is the Flame Ionization Detection (FID) method, the method recommended by EPA for emissions certification. Many fleet operators and/or natural gas equipment installers can be misled by using a nondispersive infrared (NDIR) analyzer because this particular instrument detects only 30% of the methane present in the exhaust. (The NDIR analyzer is the instrument commonly used in vehicle inspection stations and garages.) During the mid-1960's, Jackson of General Motors Research Laboratories, evaluated the NDIR analyzer using various pure hydrocarbons.(3-6) Some of the results are as follows:

<u>HYDROCARBON</u>	<u>CONCENTRATION</u>	
	<u>ACTUAL</u>	<u>AS DETECTED BY NDIR</u>
Methane	100	30
Propane	100	103
N-Hexane	100	97
Benzene	100	2
Toluene	100	13
Acetylene	100	1

In no case has EPA taken action against a marketer or fleet operator who marketed or purchased a natural gas vehicle whose emissions had not been evaluated according to the EPA procedures, however; and not all fleet operators and marketers are aware that they could be subject to EPA penalties of as much as \$2,500 per vehicle for purchasing

or marketing vehicles that have not met EPA requirements. It should be noted that some marketers have obtained California approval of their vehicles, and several others are working with California and/or EPA to try to satisfy emissions requirements. There appears to be a move towards greater awareness of EPA requirements, and toward working with the agency to satisfy them.(3-7, 3-8, 3-9)

EPA is aware of the ambiguity and confusion resulting from Memo 1A. In response to this awareness and to demands from natural gas vehicle converters and others, EPA made a step towards addressing the problem by publishing an Advance Notice of Proposed Rulemaking in January 1981, announcing its consideration of adding a subpart to the Federal Test Procedures concerning tampering enforcement regulations.(3-1) The agency received comments but did not act again until August of 1982 when a public workshop was held. Among the purposes of the workshop was to establish whether further explanation of the tampering provision was needed and whether the explanation should be in the form of regulation or a policy statement. No decisions have yet been made and the timing of EPA's plans for doing so are unknown.(3-10)

BARRIER IMPACT

EPA's tampering enforcement policy can impede conversions to CNG and LNG fuel in two ways: It can make conversions more expensive and it can leave fleet operators unwilling to convert because they are not certain that they would not be violating Federal anti-tampering law. In terms of the former, the policy can make conversions more expensive by encouraging the marketers who are uncertain whether their conversion systems satisfy EPA requirements to do more testing than necessary if EPA would rule on the marketers' findings in order to protect themselves from possible EPA fines. The latter also arises because EPA will not certify or otherwise approve a marketer's emissions tests. It is a barrier primarily to marketers rather than to users. Any fleet operator concerned about tampering policy and possible fines would probably purchase a system with California approval, assuming the fleet operator was aware that there were such systems.

No regional patterns in the impact of this barrier were observed. Sensitivity to or awareness of EPA requirements among fleet operators did not vary geographically. They also did not appear to depend on the size of the operator or on whether the conversion was to compressed or liquefied natural gas. There may be some correlation

according to type of user, however. Of the nineteen fleet operators interviewed, only two had investigated, or even considered, EPA anti-tampering restrictions before the conversion. Both of these were local government agencies.

RECOMMENDATIONS

In summarizing the important aspects EPA tampering enforcement policy in terms of its effects on the use of CNG and LNG fueled vehicles, the following facts emerge.

- 1) The primary statement of EPA tampering enforcement policy, Memo 1A, was written in very general terms to cover all types of activities that could be construed as tampering. Many elements of its wording are left open to interpretation.
- 2) Secondary sources of the EPA policy are letters the agency has prepared in response to inquiries from conversion equipment marketers and users. These are not available in an easily accessible manner.
- 3) Even with the aid of both the primary and secondary source of information, an equipment marketer who is trying to satisfy the EPA requirement will probably have to obtain additional information from the agency.
- 4) Interpretation of guidelines in Memo 1A, EPA letters interpreting Memo 1A, and verbal discussions with the Agency disagree. EPA has said in letters, for example, that California certification is accepted nationwide by the Agency. This is an amendment to policy as set forth in Memo 1A. Another example is that Memo 1A calls for the use of the Federal Test Procedures in 40 CFR 86 to test the vehicles, while in practice EPA recommends far less rigorous testing.
- 5) A converter who uses the emissions testing and engineering judgment suggested by EPA as an alternative to obtaining California approval or subjecting converted vehicles to the full battery of Federal Test Procedures cannot obtain any acknowledgment from EPA that the systems so tested are not in violation of the Clean Air Act's anti-tampering provisions.

A set of guidelines is needed that 1) specifically addresses conversions to alternative fuels 2) updates Memo 1A to reflect current interpretation of EPA policy, and 3) provides equipment marketers and converters a means of determining, when they choose to evaluate vehicle emissions using the tests and equipment described in the Federal Test Procedures to test a converted vehicle after the accumulation of 4,000 miles, that the conversion is in compliance with EPA requirements and the Clean Air Act. It is important to note that many questions concerning conversions, emissions of converted vehicles, and emissions deterioration would need to be answered before the third aspect of this recommendation could be implemented. Further research is needed in this area.

In general, alternatives for regulatory action include:

- o promulgating regulations,
- o issuing a statement of policy,
- o maintaining the status quo.

The advantages and disadvantages of each, along with options within each alternative, are discussed in the following paragraphs.

The first alternative is to promulgate regulations that would replace Memo 1A and all its subsequent interpretations. The primary advantage of promulgating a regulation is that this is probably the only alternative through which EPA could set forth procedures for actually certifying the vehicles. Certification, as used here, is an official ruling that usually requires the satisfaction of detailed technical criteria. Also, in the interest of ensuring that emissions are not adversely affected, a regulation would be legally binding on the converters and fleet operators. Equipment that did not meet EPA standards would not be marketed. The disadvantages of a regulation are serious however. The regulatory process is slow. Two years would probably pass before EPA would have regulations in place. Furthermore, if the guidelines for self-certifying aftermarket parts, issued by EPA in November, 1980, are any indication, the regulations would probably be very detailed, set up a lengthy testing process, and eliminate much of the flexibility gained through case-by-case interactions with EPA.

The second alternative is to issue an EPA Statement of Policy that would replace Memo 1A. One advantage of this alternative is that it could retain the flexibility inherent in the current policy, while eliminating the confusion caused by the current, simultaneous

use of Memo 1A, "supporting" EPA documents, and verbal discussions with the agency to determine EPA policy with respect to the conversions. Also, a statement of policy could be prepared and made available to marketers and fleet operators much more quickly than a regulation. It could also provide an official vehicle through which EPA could establish guidelines that it could apply to converters who use the combination of EPA recommended short tests and engineering judgment to test their vehicles, so that these converters could represent in their advertising that their conversions do not violate the Clean Air Act's anti-tampering provisions.

The third alternative, maintaining the status quo as represented by Memo 1A and EPA letters and practices, has the advantage of providing the most flexibility to the equipment marketers, partially through the amount of confusion it generates. There are many disadvantages to this alternative however. It would not provide EPA with grounds for eliminating the limitations on EPA's ability to acknowledge that vehicles subjected to short tests and the marketer's engineering judgment would not violate the Clean Air Act. It also would not eliminate the barrier of difficulty in finding out what EPA policy and testing requirements are. Although industry awareness, understanding of, and interest in complying with EPA policy and requirements is growing, especially in the past year, it will still be important to clarify the policy for fleet operators, especially since the equipment cannot be officially certified under Memo 1A.

The second alternative, issuing an EPA Statement of Policy, would probably be the most viable way to eliminate the barriers associated with EPA's current policy. The Statement of Policy should be one specifically addressing conversions to alternative fuels, the situation preferred by the marketers. It should update and coordinate statements in Memo 1A, EPA letters, and current EPA practices. It should describe the testing procedures EPA has prescribed for the converted vehicles in lieu of the full Federal Test Procedures or California approval, while maintaining the ability of the agency and marketers to work together on a case-by-case basis. It should provide for some form of EPA acknowledgment that marketers who pass the short tests, and use engineering judgment to show the vehicles they convert will not fail to meet applicable emissions standards, are not in violation of the Clean Air Act. This acknowledgment could be in the form of an approval, a waiver given to converters who have so tested their approvals, or the permission that California approved system marketers now have to represent that installation of their systems does not violate the Clean Air Act's anti-tampering prohibition.

RELATED ISSUES:
U.S. EPA VEHICLE STANDARD FOR HYDROCARBONS

A large portion of the hydrocarbons emitted by natural gas vehicles is nonreactive methane which does not participate in atmospheric photochemicals reactions that produce "smog" or adversely affect the earth's ozone layer. The current U.S. hydrocarbon standard is a standard for total hydrocarbons, not distinguishing between the nonreactive methane and other hydrocarbons. Recognizing that a distinction between methane and other hydrocarbon emissions was valid, EPA proposed in 1981 a nonmethane hydrocarbon standard of 0.39 grams per mile to be used in place of the current standard for total hydrocarbon emissions of 0.41 grams per mile.(3-11) (The State of California already has such a standard.) Implementation of a nonmethane hydrocarbon standard on a national scale would mean that manufacturers of equipment to convert vehicles to natural gas operation would be able to meet federal requirements more easily since typically the hydrocarbons emitted by natural gas vehicles are largely methane hydrocarbons, with only a small part being nonmethane. Hydrocarbon emissions from gasoline vehicles also contain a significant amount of methane. Although the ratio of methane to total hydrocarbon for gasoline-fueled vehicles is somewhat less than that for natural gas vehicles, the ratio of methane to total hydrocarbons for gasoline vehicles has increased since the advent of catalytic converters for emission control. The 0.39 gram per mile nonmethane hydrocarbon standard that was adopted by California was based on the ratio of methane to total hydrocarbon determined for vehicles without catalytic converters, therefore, promulgation of the proposed nonmethane standard would have the effect of relaxing the current hydrocarbon standard and could result in a net increase of reactive hydrocarbons from gasoline vehicles. EPA is still interested in pursuing a viable nonmethane hydrocarbon standard, but much test data on gasoline vehicles using modern emission control technology would be required before a realistic nonmethane hydrocarbon standard could be determined.

References

- 3-1 Environmental Protection Agency, "Tampering Enforcement Regulations," Federal Register, Vol. 46, No. 17, January 27, 1981, p. 8982.
- 3-2 The Clean Air Act, Sections 203(a)(3)(A), 203(a)(3)(B), and 203(c).
- 3-3 EPA Mobile Source Enforcement Memorandum 1A, issued June 25, 1974.
- 3-4 Letter from Steven E. Hoover, Acting Chief, In-Use Branch, Field Operations and Support Division, Environmental Protection Agency, to John J. Burke, Assistant Township Manager, Township of Middleton, Pennsylvania, April 30, 1980.
- 3-5 U.S. Department of Energy, Alternative Fuels Utilization and the Automotive Emission Certification Process, March, 1980.
- 3-6 Jackson, N.W., Journal of Air Pollution Control Association. Vol 16, p. 697, 1966.
- 3-7 Committee on Science and Technology, House of Representatives, "Report: Methane Transportation Research, Development, and Demonstration Act of 1980," August 20, 1980.
- 3-8 American Gas Association, Written Summary of Comments to EPA. Prepared for a workshop on EPA Memo 1A, August 26-27, 1982.
- 3-9 Docket No. EN-80-2, Central Docket Section, Environmental Protection Agency.
- 3-10 Summary of Views Presented at EPA Tampering Workshop, August 26-27, 1982.
- 3-11 Federal Register, December 23, 1981.

CHAPTER 4

FEDERAL ENERGY REGULATORY COMMISSION SALE-FOR-RESALE RESTRICTIONS

Several issues involving the Federal Energy Regulatory Commission's (FERC) jurisdiction over the sale of natural gas to and by refueling stations have in the past, represented potential barriers to widespread use of natural gas as a vehicle fuel. FERC regulation could limit the sale for resale of natural gas for use as vehicle fuel and thereby limit a fleet owner or refueling station's ability to purchase and/or resell natural gas. Issues that have received attention include:

- the question of whether the point of consumption of natural gas is the introduction of fuel into the vehicle or the time at which the vehicle consumes the fuel
- whether a sale of natural gas for resale to a refueling station would result in regulation by FERC where the seller was not previously subject to FERC regulation
- the regulation by FERC of sales to refueling stations made by companies that are otherwise subject to FERC regulation. (4-1, 4-2, 4-3)

Based on recent formal and informal FERC opinions, it does not appear that FERC regulation will continue to be a significant barrier to the use of natural gas as a fuel for motor vehicle fleets. Details on FERC cases in which these issues have been addressed, and on the current status of this barrier, are provided in the following paragraphs.

BACKGROUND

Historically, FERC has regulated the interstate transportation and sale of natural gas. Under Section 1(b) of the Natural Gas Act the local distribution of natural gas is not regulated by FERC, but is subject to the regulation of the appropriate state or local regulatory agency. Furthermore, a seller of natural gas whose transactions are confined within a state is exempted from FERC regulation (Section 1(c) of the Natural Gas Act, commonly referred to as the Hinshaw exemption). Under current regulation,

should the point of consumption of natural gas for vehicle use be defined as the point at which the fuel was consumed by the engine and vehicles crossed state lines before "consuming" the fuel, sale by a refueling station to a natural gas vehicle user could represent an interstate sale and subject the seller (and the seller's supplier) to FERC regulation.

CURRENT STATUS

As of the writing of this report, FERC has issued several informal opinions and one formal Declaratory Order (4-1) finding that natural gas may be considered "ultimately consumed" at the time the fuel is injected into the vehicle. A resale of natural gas to a natural gas vehicle within the state of purchase of the gas will not affect the refueling station's supplier's exemption from FERC regulation under the Natural Gas Act.(4-1) Though the formal opinion was granted to Northern Illinois Gas Company (Docket No. G-10632-004) and strictly applies only to that company, it can be expected that other suppliers with a Hinshaw exemption will be able to petition successfully for similar exemption.

Other specific questions on FERC's jurisdiction under the Natural Gas Act relevant to the sale for resale of natural gas include: (1) Can a local natural gas distribution company make a sale of natural gas (for resale) to a refueling station without coming under FERC's jurisdiction? and (2) Does a sale of natural gas by an interstate company represent a direct industrial sale or is the sale a sale for resale subject to FERC regulation under Section 1(b) of the Natural Gas Act?

Related to the sale of natural gas by a local distribution company to a refueling station, the local distribution company (prior to the sale) is not subject to FERC regulation under Section 1(b) because it is stated that "The provisions of this act ... shall not apply ... to the local distribution of natural gas...". However, in a letter from Charles A. Moore, General Counsel, FERC, on January 28, 1982 to Larry D. Hall of Kansas-Nebraska Natural Gas Company,¹ it was stated that "The sale-for-resale aspect of the

¹*Kansas-Nebraska (K-N) is an interstate natural gas company (operating pipelines and local distribution operations) that, for more than a year, has sought a decision from FERC as to whether sales made to refueling stations by its own distribution companies or by others it serves at wholesale are subject to FERC regulation under the Natural Gas Act. To date, FERC has indicated that, while sales to refueling stations by local distribution companies (qualifying for the Hinshaw exemption) will be exempt from FERC jurisdiction, sales by the distribution companies owned by an interstate company, e.g., K-N, do not qualify for the Hinshaw exemptions and their sales are therefore subject to regulation by FERC.*

transactions you propose takes them out of the category of local distribution (both for Kansas-Nebraska and the distributor companies it serves), and the local distribution exemption of Section 1(b) therefore does not apply." Nonetheless, exemption of the sale is still possible assuming that the local distribution company qualified under Section 1c for the Hinshaw exemption and "provided that the rates, services and facilities of that distributor company be subject to regulation by a state commission."

The issue of whether a sale by an interstate pipeline to a refueling station is subject to FERC regulation was also addressed in the petition filed by Kansas-Nebraska. The informal opinion (expressed in the January 28, 1982 letter to Kansas-Nebraska) was that since Kansas-Nebraska is an interstate company Kansas-Nebraska's distribution facilities were not eligible for exemption under Section 1(c). Moreover, since it was the opinion also that the sale-for-resale aspect of the transaction removed it from the definition of "local distribution" exemptions provided for in Section 1(b) (see discussion above) the transaction would be within the Commission's jurisdiction under the Natural Gas Act. Thus, if the informal opinion by General Counsel is upheld by the Commission, sales of natural gas to refueling stations for resale would be exempt for sellers qualifying as operating within a state under Section 1(c) but not for companies that are engaged in the interstate transportation of natural gas. Kansas-Nebraska continues to seek exemption for its distribution facilities.¹

BARRIER IMPACT

The uncertainty that has surrounded FERC's potential ability to regulate the sale of natural gas to natural gas refueling stations has in the past resulted in some hesitancy to invest in vehicle conversion. However, as explained above, formal and informal opinions by FERC indicate that:

- the point of consumption will be considered the point of injection into the vehicle rather than the point wherein the vehicle burns the fuel,

¹Personal communication with representatives of the Kansas-Nebraska Natural Gas Company.

- FERC's historical pattern of jurisdiction limited to interstate transactions will be carried forward and sales of natural gas to refueling stations by companies that are otherwise exempt from FERC's regulation will retain their exemption, and
- FERC will continue to exercise regulatory authority over companies already subject to regulation and will therefore take jurisdiction over sales made by interstate companies for resale.

Based on these formal and informal opinions, it does not appear that, if present policies continue, FERC regulation will be a significant barrier to the use of natural gas as a motor vehicle fuel.

RECOMMENDATIONS

The basic premise that seems to emerge after a review of the formal and informal requests (4-1) made to FERC is that those companies engaged in the sale of natural gas who are not already subject to FERC's jurisdiction will not be regulated by FERC because they sell natural gas for resale as a vehicle fuel. Nor will sales by refueling stations to vehicle users fall under FERC jurisdiction. However, those companies who already are subject to FERC jurisdiction will continue to be subject to FERC's regulation in the sale for resale of natural gas as a vehicle fuel.

It is important to note that FERC has not made some of its opinions formal, and its one formal opinion with respect to the point of ultimate consumption currently only applies to a single applicant. Formalizing its informal opinions on the Kansas-Nebraska cases would help eliminate any remaining uncertainty associated with FERC's position on natural gas used as a motor vehicle fuel. It should be noted, however, that regulatory agencies such as FERC are subject to changes imposed by future elected leaders and the current regulatory environment should not be viewed as permanent.

References

- 4-1 Cases before the Federal Energy Regulatory Commission:
- Docket No. G-10632-004 Petition by Northern Illinois Gas Company.
 - Docket No. CP82-366 Petition for Declaratory Order (Kansas-Nebraska Natural Gas Co.).
 - Docket No. CP82-364 Abbreviated Application for Blanket Certificate of Public Convenience and Necessity Authorizing the Sale of Natural Gas to CNG Distributors (Kansas-Nebraska Natural Gas Co.)
 - Docket No. CP82-443 Application of El Paso Natural Gas Company for a Certificate of Public Convenience and Necessity for a Temporary Certificate.
 - Letters to and from FERC related to the above cases.
 - FERC Opinion of August 27, 1982, approving Northern Illinois' request (exempting their sale of natural gas to a service station for vehicle fuel from FERC jurisdiction).
- 4-2 T. Joyce Associates, Inc., Assessment of Research and Development Needs for Methane Fueled Engine Systems. Prepared for the Gas Research Institute, 1982.
- 4-3 American Gas Association, "Legal Analysis: What is the federal jurisdictional impact upon a gas utility company or pipeline of making sales of natural gas for ultimate use as motor vehicle fuel?" Undated.

CHAPTER 5

STATE SALE-FOR-RESALE RESTRICTIONS

Where FERC does not take jurisdiction over the sale of natural gas by or to refueling stations (see Chapter 4), the state or local regulatory authority usually has jurisdiction over the sale. Thus even if it is clearly established that FERC will not take jurisdiction over (1) the sale of natural gas to refueling stations for resale (based on Section 1(c) of the Natural Gas Act) or (2) the sale of natural gas to vehicle users for ultimate consumption (based on Section 1(b), of the Natural Gas Act and a FERC determination that the point of ultimate consumption of the fuel is the point at which the fuel is injected into the vehicle), it is necessary to examine the role that will be taken by state regulatory bodies in these sales.¹

It is easy to envision a situation wherein refueling stations, engaged in the business of selling natural gas, could fall within state regulatory definitions as a "public utility." Since classification of refueling stations as a public utility could be expected to bring a considerable regulatory burden to refueling station operators, it is unlikely that such stations would flourish as a regulated entity. To ascertain whether refueling stations would be classified as a public utility, it is necessary to examine regulatory frameworks at the state level.

BACKGROUND

As explained in Chapter 4, FERC exemption of sales-for-resale is based on Section 1(c) of the Natural Gas Act. Section 1(c) states "The matters exempted from the provisions of this Act by this subsection are hereby declared to be matters of local concern and subject to regulation by the several States. A certification from such State commission to the Federal Power Commission² that such State commission has regulatory jurisdiction over rates and service of such person and facilities and is exercising such

¹The information presented in this chapter was based on conversations with several state public utility commissions including Kansas, Illinois, New York, Maryland, Virginia, California, and the District of Columbia as well as staff of the National Association of Regulatory Utility Commissioners (NARUC). Potential problems facing the natural gas fueled vehicle industry were identified by vehicle marketers.

²The Federal Power Commission is now the Federal Energy Regulatory Commission (FERC).

jurisdiction shall constitute conclusive evidence of such regulatory power or jurisdiction." In the course of regulating the intrastate distribution and sale of natural gas, state regulatory authorities have sometimes found it necessary to restrict the back-and-forth sale of natural gas between natural gas companies. This need arises from the current regulatory environment wherein the price paid by end-users includes the price paid by distributors for the natural gas plus an additional allowance to cover operating expenses and provide a reasonable rate-of-return to distributors. If distribution companies were allowed to sell to other distribution companies for resale, end-users could face more than one markup for the service of the distribution sector.

The restrictions to resale vary from state to state and may take the form of regulations, codes, or tariffs, or be built into the contracts entered into between natural gas companies and their clients. In addition to the expected regulation with respect to safe operations, fuel quality and payment of road-use taxes, unusual restrictions may apply to the sale of natural gas by or to refueling stations. Where they do exist, the restrictions were never established with the intent of restricting the sale of natural gas as a vehicle fuel. Nevertheless, those states which do have some form of restriction built into their regulation that could be interpreted as prohibiting the sale of natural gas to refueling stations face two choices. They could do nothing, which would in effect establish the existing natural gas utility companies in a monopoly position with respect to the sale of natural gas as a vehicle fuel, or they could remove the restrictions. Of several states interviewed that did have restrictions, none felt it would be appropriate to take no action and thereby establish a monopoly position for existing gas companies. However, during the interviews it was clear that the alternative — removal of restrictions — would not necessarily be simple or straightforward. In some cases, legislative reform would be required. In others it could be necessary to review every individual contract between natural gas companies and their clients to identify and eliminate restrictions. In summary, while state regulators did not feel that restrictions were appropriately applied to sales of natural gas to refueling stations, eliminating such restrictions could prove to be a sizeable task.

On the subject of whether the operation of a refueling station would be defined within a state to fall within the regulatory definition of a public utility, the determination rests with the phraseology used to define public utility. If a state defines public utilities to include those engaged in the sale (or resale) of natural gas, refueling stations would be

subject to regulation. However, in states where the definition includes not only the act of selling the gas but also a physical distribution system, then refueling stations would not be subject to regulation. While state regulators interviewed hesitated to state conclusively that refueling stations would or would not be subject to regulation, all of those interviewed were of the opinion that regulation of the operation of a refueling station would not be an appropriate function of their agency. Nonetheless, it remains unclear whether a state-level decision not to take jurisdiction would result in a FERC decision to take jurisdiction under the Natural Gas Act.

CURRENT STATUS

A significant obstacle to defining the role of state utility commissions in the operation of refueling stations is the lack of experience of the utility commissions in this area. Since most state commissions have not been faced with the issues related to operation of a public refueling station in their state, there are no ready answers to whether the stations would be subject to regulation and if so what form the regulation would take. It was the opinion of those interviewed that their respective state commissions lacked the resources to consider regulating an operation that was similar to a gasoline station, though they cautioned that some assurances as to the safe construction and operation of such stations would be required. They indicated a further unwillingness to become involved in the regulation of the purchase of natural gas for resale, other than recognizing a need to lift any restrictions that might currently exist. It should be noted, however, that this willingness extended only so far as to accept that lifting restrictions would be necessary should a potential operator (or potential seller of natural gas to refueling stations) petition them to do so—there was no inclination to lift the restrictions unless formally requested to do so by affected parties.

A potential problem exists in the interface of state and federal regulation. If federal regulation (on either the sale-for-resale of natural gas or the operation of refueling stations) is waived in favor of state regulation, it is not clear what will happen if state commissions subsequently elect not to take jurisdiction. Some have suggested that a decision by the states not to regulate will place the activities back under federal regulation within the Natural Gas Act. Should this occur, affected parties would most likely be subject to more regulation under FERC than would have been the case had the state(s) taken jurisdiction over the activity.

RECOMMENDATIONS

Two steps could be taken to lift current or potential restrictions to the purchase of natural gas for resale by nonutility operators and to lift restrictions on the operation of refueling stations. These are:

- review of each state's regulatory framework to ascertain if and to what extent the purchase of gas by and the operation of refueling stations falls within each state's jurisdiction
- to the extent necessary, amendment of each individual state's regulations, codes, tariffs, contracts, etc., that restrict the operation of natural gas refueling stations.

The first action, review of each state's regulatory framework, would most appropriately be conducted by staff members of each State's commission, perhaps guided by the National Association of Regulatory Utility Commissioners (NARUC) or by FERC. If the individual states lack the resources to undertake a project of this nature, the effort alternatively could be undertaken by a centrally directed effort sponsored by FERC, DOE, or jointly by the states. The end result would be a state-by-state analysis of the regulatory restrictions placed upon the operations of refueling stations, including restrictions on the purchase for resale of natural gas.

The second action, elimination at the state level of restrictions on the operation of refueling stations, would follow the previous state-by-state identification of restrictions and would vary in content depending on the type of restrictions (if any) that existed within a given state. Activities would include: (1) modifying state legislation, (2) modifying regulations, codes, etc., issued by the state's commission and/or (3) modifying existing contracts and modeling future contracts to eliminate any restrictions contained therein.

In the absence of a comprehensively and centrally coordinated effort (such as that described above) to remove these restrictions, the perceived barriers that exist on a state-level basis are likely to continue until the individual efforts of entrepreneurs succeed in removing these barriers on a state-by-state or (in cases involving contract clauses) a station-by-station basis. As a further note it is worthwhile mentioning that

while many of the barriers (or potential barriers) that are discussed in this report would disappear with the mass-production of vehicles dedicated to the use of natural gas (as opposed to the current use of conversion of vehicles manufactured as gasoline-only vehicles).

CHAPTER 6

OTHER AREAS OF INVESTIGATION: STATE ENVIRONMENTAL PROTECTION LAWS, ROAD USE TAXES, INSURANCE, AND VEHICLE WARRANTIES

Among the potential sources of institutional barriers that were identified during the early stages of the research were state environmental protection regulations, state road use taxes, insurance agreements, and manufacturers' warranties on vehicles. State environmental laws or regulations were analyzed to determine whether any state had testing requirements, anti-tampering restrictions, or environmental programs that were inappropriately applied to, or otherwise restricted, use of natural gas vehicles. State road use taxes were investigated because of the possibility that natural gas fuel would be charged, intentionally or unintentionally, higher taxes than gasoline. Insurance agreements were a source of concern because of the possibility that agreements might disallow coverage of natural gas fueled vehicles. Manufacturers' warranties were researched to determine whether dealers and manufacturers would stand behind warranties on converted vehicles. State environmental laws, and insurance, proved not to be barriers. Road use tax regulations, while universally intended by the states to equal or favor natural gas vehicle users in comparison to gasoline vehicle users, contained ambiguities and uncertainties that may be a barrier. Manufacturers' warranties, though not a major barrier, also contain uncertainties that need clarification. Findings in each of these areas are summarized in the following paragraphs.

VEHICLE WARRANTIES

One potential barrier for marketers and users of natural gas vehicles investigated was vehicle warranties. One fleet operator related that on initial contact with the dealer, the dealer had indicated that warranties would not be honored. The fleet operator then questioned the manufacturer and was assured of the continued validity of the warranty. A similar situation occurred when the government of New Zealand approached dealers with this question. Though dealers were very negative, eventually the manufacturers notified the government that warranties would be honored.

One manufacturer, Ford, has issued a statement that promises the honoring of warranties on converted vehicles, as long as the problem has not been caused by the

conversion. The Chevrolet division of General Motors has issued a similar statement verbally. While these assurances go far toward eliminating potential barriers in this area, uncertainty remains because of the ambiguities that leave open the question of whether or not particular problems were caused by the conversion. Accumulation of experience in working with natural gas vehicles, at both the manufacturer and dealer levels, will probably resolve this problem.

ROAD USE TAXES

Discussions with fleet operators and equipment marketers, along with a document entitled "State Taxation of Liquefied Petroleum Gas and Compressed Natural Gas Used as Motor Fuels," prepared by the Federation of Tax Administrators (6-1), showed that in one state, South Dakota, road use taxes are substantially higher in some cases for CNG vehicles than for gasoline vehicles. The South Dakota law, enacted in March 1983, calculates annual road use taxes for CNG vehicles¹ based on the number of miles the vehicle was driven in the previous year. The fee schedule for CNG vehicles registered in South Dakota is provided in the following table.

FEES FOR ANNUAL CNG AND LPG USER PERMITS IN SOUTH DAKOTA

	Under 10,000 Miles	10,000 to 15,000 Miles	15,001 Miles & Over
Autos (Class A)	\$ 65.00	\$ 100.00	\$ 135.00
Pickups (Class B)	100.00	150.00	200.00
Trucks & Buses (Class C)	200.00	300.00	400.00
Truck tractors & Trailers (Class D)	300.00	450.00	600.00

Unlike CNG vehicles, gasoline vehicles are taxed according to the number of gallons of fuel consumed, at a rate of 13¢ per gallon. With CNG vehicle taxes based on the fee schedule in the table above, and gasoline vehicle taxes based on the number of gallons of fuel consumed, road use taxes for CNG and gasoline vehicles are rarely comparable. For example, a gasoline fueled truck tractor that travels 12,000 miles per year at 8 miles per gallon, the state gas tax, at 13¢ per gallon, would be \$195.00. As shown in the

¹The South Dakota fee schedule for CNG vehicles is also applied to LPG vehicles.

table above, the same vehicle using CNG would pay an annual tax of \$450.00. In the case of an automobile traveling 7,500 miles per year at 20 miles per gallon, the tax for a gasoline vehicle would be about \$49.00, while that for the CNG vehicle would be \$65.00. The rationale on which the CNG vehicle road use tax schedule was based is unknown. The law will be in place at least until 1985, when the South Dakota legislature is next scheduled to convene, but it appears reasonably certain that it will be rescinded at that time.(6-2)

Another problem area related to state road use taxes is that in states that tax CNG vehicles on the basis of number of gallons of fuel used, the selection of a factor for the gasoline-to-natural-gas equivalency calculation is often left up to the individual users, generating confusion and uncertainty about what equivalency factor will be selected by states if they eventually choose to enumerate one.

All but five states tax CNG that is used as a motor fuel. These five states are Hawaii, Montana, Ohio, Oklahoma, and Rhode Island. Definitions of taxable motor fuels in these states include only liquid fuels, not gases. Legislation has been proposed in Oklahoma to extend the fee system for vehicles using LPG to include vehicles using natural gas. Hawaii's exemption is reportedly due to natural gas not being available in that state.

Twenty-six states and the District of Columbia have no special tax rates or fee systems for CNG or LPG. (LPG is included here for purposes of comparison.) These are listed in Table 6-1. Nine states have enacted special lower tax rates for LPG and four apply lower rates to CNG. These are listed in Table 6-2. No state imposes a surcharge on either LPG or CNG.

STATE ENVIRONMENTAL PROTECTION LAWS

Two issues pertaining to state environmental protection laws were investigated:

- 1) whether the California approval program for natural gas powered vehicles was a barrier, and
- 2) whether any state had laws or regulations, such as anti-tampering maintenance programs, that prohibited or impeded the use of natural gas powered vehicles.

TABLE 6-1

STATES WITH NO SPECIAL TAX RATES OR FEE SYSTEMS FOR LPG OR CNG

Colorado	Maine	New York
Connecticut	Maryland	North Carolina
Delaware	Massachusetts	North Dakota
Florida	Michigan	Pennsylvania
Georgia	Minnesota	South Carolina
Illinois	Missouri	Virginia
Indiana	Nebraska	West Virginia
Iowa	Nevada	Wisconsin
Louisiana	New Hampshire	District of Columbia

TABLE 6-2

STATES WITH LOWER ROAD USE TAX RATES FOR LPG AND CNG

LPG

Arkansas
California
Hawaii
Kansas
Mississippi
New Jersey
Tennessee
Texas

CNG

Arkansas
Kansas
New Jersey
Texas

Each of these is discussed below.

The California Emissions Approval Program

Marketers may be divided into two categories, those who sell natural gas vehicles or conversion kits for use in the State of California and those who do not. Natural gas powered vehicles that are operated in California are required to comply with "California Exhaust Emission Standards and Test Procedures for Systems Designed to Convert Motor Vehicles to Use Liquefied Petroleum Gas or Natural Gas Fuels" as adopted in April 1975 and amended in April of 1981. The emissions and test procedures are administered by the California Air Resources Board and the emissions standards are for the most part somewhat more stringent than the corresponding Federal standards. A copy of the California standards and procedures are included as Appendix D. Natural gas vehicles that are approved by the CARB are also considered to be in compliance under Federal EPA standards.

Marketers who sell conversion kits for use in the State of California object to the testing, which they state costs up to several thousand dollars per vehicle model tested. Nonetheless, it is understood by marketers familiar with California emissions programs that the testing is mandatory and no consideration has been or can be expected to be given to exempting natural gas-fueled (or any other type) vehicles from the standards and procedures. While those who choose to undergo California testing do incur additional expense, they also incur what may be perceived as a marketing advantage. The Federal government has indicated that California testing is acceptable in lieu of Federal testing to demonstrate compliance with Federal anti-tampering restrictions, and that converters whose systems have California approval may represent to the public that use of these systems does not violate the Clean Air Act.

Background

Historically, California has been a leader in reducing the level of emissions released from vehicles operated within the state. Since the enactment of the Federal Clean Air Act which allowed different emissions standards for California than for the remainder of the country, California has developed an extensive set of standards and procedures for testing and certification of vehicles purchased for use in the State. The testing of vehicles converted from gasoline to dual fuel (gasoline and natural gas) operation was

incorporated into California test procedures in 1975 and amended in 1981. California has also formulated test procedures for certification of dedicated compressed natural gas and liquefied natural gas vehicles.

California standards require that a conversion system:

- 3(a)(i) Shall not in its operation or function cause the emission into the ambient air of any noxious or toxic substance that is not emitted in the operation of such vehicle without such modification, except as specifically permitted by regulation; and
 - (ii) Shall not in its operation, function, or malfunction, result in any unsafe condition endangering the motor vehicle, its occupants, other persons, or property in close proximity to the vehicle, in accordance with the safety requirements specified for the original vehicle.
- 3(b) In the case of a dual-fuel conversion, where the vehicle may run on gasoline (or diesel) or a gaseous fuel, removal of originally required emission control systems will not be permitted. These provisions shall not apply to heated intake air systems.

The California test procedure requires two test vehicles for each carburetor-model conversion system. One vehicle shall represent the smallest engine size class and the other the largest engine size class for which approval is requested. For testing purposes, California specifies seven engine size classes. CARB reserves the right to request up to two additional test vehicles for each model. If application is made for both light and medium duty vehicles, four test vehicles are required for each carburetor-model conversion system. For 1978 or newer vehicles, a conversion system manufacturer must gain separate approval for light-duty vehicles (0-6000 lbs. GVW) and medium-duty vehicles (6001-8500 lbs. GVW). Once a vehicle is approved for a given category of vehicles, based on model year and engine size, the system may be installed by anyone without further approval provided manufacturer's instructions are followed. Testing can be performed at any laboratory properly equipped to conduct the tests. The test vehicle must remain under the control of the test laboratory or test results may be invalidated.

After receipt of the test data submitted, CARB reviews the data and makes a determination on whether the modification conforms to the test procedures. An approval for a conversion system for a given model year is accepted as approval for all previous model years unless otherwise specified. Periodically, California retests vehicles for which test results have been submitted to insure accuracy in reporting. CARB approval does not address the safety of a conversion system.

Current Status

As of August 8, 1982, California had tested conversions by three marketers of natural gas-fueled vehicles. Only one converter had 1982 model year vehicle approvals.

Marketers selling conversion kits for use on vehicles registered in California must undertake the expense of testing vehicles as required by California procedures. The cost of testing varies according to the number of retests that may be required. A minimum of two tests are required for each class of vehicles submitted for approval. In addition to receiving approval from CARB for sales in California, conversion system marketers also may sell and install the systems in other states without violating federal tampering restrictions. Since concern over violation of anti-tampering restrictions does hinder the sale of vehicles that have not been certified by California or certified by Federal test procedures, a marketing advantage may be gained by marketers that have established CARB approval.

The costs of securing approval by CARB of conversion systems is a cost that must be met by any marketer that wishes to sell conversion kits in California. It is unlikely that natural gas conversions will be exempted from this requirement in the foreseeable future. The fact that the Federal EPA has chosen to accept California approval in lieu of other means may serve to reduce the cost of federal EPA approval, given the current difficulties under present EPA policy in obtaining the same degree of approval as is now provided by California, for marketers that are able to secure approval from the State of California.

Other State Environmental Protection Regulations

The study also investigated other state laws and regulations to determine whether any state had restrictions, such as anti-tampering laws or inspection-maintenance programs, that prohibited or impeded the use of natural gas powered vehicles. Some forty states

have anti-tampering laws. No state has taken action against any marketer or user of natural gas powered vehicles for violating its requirements. Many completely exempt conversions to alternative fuels from their environmental regulations, while others exempt vehicles that comply with Federal requirements.

The State of New York, for example, exempts dedicated natural gas fueled vehicles from annual emissions certification. Dual-fuel vehicles must be tested using gasoline fuel only. An exemption from annual emissions testing for dual-fuel vehicles which seldom use gasoline as fuel in New York State can be obtained by submitting a written request. A condition for approval of the exemption is that the procedure for switching from natural gas to gasoline be difficult (more involved than a simple dashboard switch). Another condition is that a detailed description of the switching process be submitted in writing with the request for exemption.

Many states also have inspection-maintenance programs which, if they had contained improperly worded requirements, might have been interpreted as prohibiting conversions to alternative fuels. A state with visual inspection might, for example, require that all emissions equipment must be intact as originally installed. Research proved that in all cases where such problems could arise, the state specifically exempted natural gas vehicles from this literal interpretation.

INSURANCE AGREEMENTS

No marketers, users, or insurance companies contacted had any difficulties with the honoring of insurance agreements. In one case, premiums actually decreased when the vehicles were converted to natural gas. Furthermore, in many cases even if insurance companies had been found to disallow coverage, many fleet operators would not have been affected because many were self-insured.

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- Docket No. CP82-443 Application of El Paso Natural Gas Company for a Certificate of Public Convenience and Necessity for a Temporary Certificate.
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Personal communication, Office of the Director, Port Authority of New York and New Jersey, September 1982.

Personal communication, Representatives of Kansas-Nebraska Natural Gas Company, January 1983.

Personal communication, Office of the Chief Council, National Highway Traffic Safety Administration, U.S. Department of Transportation.

Personal communication, Fred Simon, NASA — Lewis Research Center.

State of South Dakota, Senate Bill #16, Introduced by the Committee on Transportation on behalf of the Interim Committee on Transportation.

Summary of Views Presented at EPA Tampering Workshop, August 26-27, 1982.

APPENDIX A

ORGANIZATIONS CONTACTED

Federal Agencies

- Environmental Protection Agency
- Department of Energy
- Federal Energy Regulatory Commission
- Department of Transportation
- National Transportation Safety Board
- Materials Transportation Board
- National Highway Traffic Safety Administration
- Occupational Safety and Health Administration
- NASA

House and Senate Committees

- House Committee on Science and Technology, Subcommittee on Transportation, Aviation, and Materials
- Senate Committee on Commerce, Science, and Transportation, Subcommittee on Science, Technology and Space
- Senate Committee on Energy and Natural Resources, Subcommittee on Energy Research and Development

State and Local Agencies

- Council of State and Local Governments
- State counterparts to the U.S. Department of Transportation, OSHA, and the Environmental Protection Agency
- State Highway Authorities
- Port Authority of New York and New Jersey
- State Public Utility Commissions

APPENDIX A

(Cont'd)

Motor Vehicle and Equipment Manufacturers

- Society of Automotive Engineers
- Ford
- Beech Aircraft
- Marketers of Conversion Equipment

Associations

- Motor Vehicle Manufacturers Association
- American Gas Association
- National Governors Association
- National Association of Regulatory Utility Commissioners
- International Bridge, Tunnel, and Thruway Association

Fleet Operators

- Operators of LNG vehicles
- Operators of CNG vehicles

Others

- American National Standards Institute
- Individuals in New Zealand informed about natural gas fuel use in that country
- Los Alamos National Laboratory

APPENDIX B-1
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
MOTOR VEHICLE SAFETY

The Federal Implication of Installing
Auxiliary Fuel Tanks and Of Converting
Fuel Systems to Use Alternate Fuels

Before getting into the legalities of these installations and conversions, I want to stress my concern about the danger which these practices may pose to the occupants of vehicles. These practices may seriously increase the risk of fire if these altered vehicles are involved in accidents. Even where there are no legal liabilities, this threat to safety may be present.

The Act^{*} authorizes the National Highway Traffic Safety Administration (NHTSA) to issue FMVSS's applicable either to entire vehicles or to equipment for installation in vehicles. The only standard relevant to this discussion, FMVSS 301-75, is a vehicle standard. It applies to vehicles which use fuel with a boiling point above 32 degrees F. and which are (1) passenger cars, or (2) multipurpose passenger vehicles, trucks, or buses with a gross vehicle weight rating (GVWR) or 10,000 pounds or less (3) schoolbuses with a GVWR greater than 10,000 pounds. If the need were found, a standard could also be issued for fuel systems designed for installation in new or used vehicles.

Under section 108(a)(1)(A) and (b)(1) of the Act, new motor vehicles must comply with the FMVSS's applicable to them until they are first purchased by someone for purposes other than resale. That purchase is completed when the vehicle is delivered to the ultimate consumer. The NHTSA regulations include two measures designed to ensure compliance with applicable FMVSS's until this delivery. First, manufacturers of new vehicles are required to affix to each vehicle they produce a label which certifies the vehicle's compliance with all applicable FMVSS's. In addition, any person who prior to the first sale, alters a certified vehicle in a manner that significantly affects either its configuration or purpose is considered to be not only an alterer but also a manufacturer and therefore, must recertify the entire vehicle as complying with all applicable FMVSS's (49 CFR 567.7 and Preamble to 37 F.P. 22800, October 25, 1972). The only alterations that a person may make prior to the first sale of a vehicle without being considered a manufacturer subject to the recertification requirements are minor

*The National Traffic and Motor Vehicle Safety Act, as amended 1974 (15 U.S.C. 1381, et. seq.)

finishing operations or the addition, substitution or removal of readily attachable components such as mirrors, tires or rim assemblies. (49. CFR 567.7).

Should a noncompliance be discovered in a recertified vehicle, as a result of an alterer's modification, the alterer would be liable for a civil penalty unless he or she could establish that he or she did not have actual knowledge of the noncompliance, and that he or she did not have reason to know in the exercise of due care that the vehicle did not comply. (Section 108(b)(2) of the Act). The civil penalty imposed could be up to \$1000 for each violation of an applicable FMVSS. (Section 109 of the Act).

With respect to FMVSS 301, the effect of the alterer provisions is that not only must the original gasoline fuel system meet the performance requirements encompassed by the standard but that any auxiliary or replacement tank added by an alterer must meet them also.

If the alterer converts the gasoline fuel system to a propane fuel system, the vehicle must still be recertified. However, FMVSS 301-75 would cease to be a factor since the standard would no longer apply to the vehicle. Propane has a boiling point below 32 degrees F. and FMVSS 301-75 applies only to vehicles using fuel with a higher boiling point. Finally, if the alterer converts a gasoline-powered vehicle so that it is both gasoline-powered and propane-powered, he must recertify the entire vehicle as complying with all applicable standards, including FMVSS 301-75.

After the first purchase of a vehicle for purposes other than resale, tampering with the vehicle is limited by section 108(a)(2)(A). That section in essence prohibits the entities and persons listed below from knowingly removing, disconnecting or reducing performance of equipment or elements of design installed on a vehicle in accordance with applicable FMVSS's. There is no prohibition against an individual person modifying his or her own vehicle. Specifically, the section provides:

No manufacturer, distributor, dealer or motor vehicle repair business shall knowingly render inoperative, in whole or part, any device or element of design installed on or in a motor vehicle or item of motor vehicle equipment in compliance with an applicable Federal motor vehicle safety standard.

A person or entity found to have violated this section would be liable for a civil penalty of up to \$1000 for each violation. (Section 109 of the Act).

If a tamperer adds an auxiliary gasoline tank to a vehicle manufactured in accordance with FMVSS 301-75, and in the process knowingly reduces the performance of the fuel system originally installed in the motor vehicle, he or she has violated section 108(a)(2)(A). (H.R. No. 1191, 93 Cong., 2d Sess. 34 (1974). Such reduction of performance could occur, for example, if gasoline from the original system (a fuel system includes the filler pipe, tank, gasoline lines, fuel pump, carburetor, and engine) could be leaked through a rupture in the auxiliary tank and fuel lines, and if the design, materials, construction, installation or location of the auxiliary tank and fuel lines made them more susceptible to rupture than the original fuel system.

If a tamperer removes the original gasoline tank and installs a replacement one, section 108(a)(2)(A) is violated unless the performance (as defined by FMVSS 301-75) of the replacement tank equals or exceeds the performance of the original tank. To determine the relative performance of the replacement tank, a number of issues would have to be examined, including the quality of the replacement tank, the connection of the tank with the filler pipe and fuel lines to the fuel pump, and the location of the tank with respect to surrounding vehicle structures. For example, if unlike the original tank, the replacement tank were sufficiently near surrounding vehicle structures so that those structures might be pushed against or into the replacement tank and cause a rupture in a collision, the performance of the fuel system would have been impermissibly reduced.

There is no liability under section 108(a)(2)(A) in connection with FMVSS 301-75 if the tamperer converts a used gasoline-powered vehicle into a propane-powered vehicle. Modifying safety systems of a vehicle being converted from one vehicle type to another would not violate section 108(a)(2)(A) so long as the modified systems complied with the FMVSS's that would have been applicable to the vehicle had it been originally manufactured as the vehicle type to which it is being converted. For example, in converting a 1978 gasoline-powered car to a propane-powered car, the converter would not be governed by FMVSS 301-75 since that standard did not apply to 1978 propane-powered cars.

The case of a tamperer who modifies a used gasoline-powered vehicle so that it has a dual gasoline/propane system would be essentially the same as that of the person who adds an auxiliary gasoline tank. If the tamperer knowingly reduces the performance of the gasoline system in adding the propane system, he or she has violated section 108(a)(2)(A). As to safety defect responsibilities under section 151 et. seq. of the Act,

persons who alter new vehicles by installing auxiliary or replacement gas tanks or by converting a gasoline fuel system to a propane fuel system as well persons who produce the equipment being installed are fully subject to those responsibilities. Sections 151 et. seq. provide that manufacturers of motor vehicles and motor vehicle equipment must notify owners of vehicles and equipment with safety-related defects and remedy those defects free of charge. As explained earlier the term "manufacturer" includes persons who alter new vehicles by doing more than simply adding, substituting, or removing readily attachable components or performing minor finishing operations. Since alterations involving installation of auxiliary replacement gas tanks or conversion of gasoline systems to propane systems are more substantial, persons who make those alterations are manufacturers.

Thus the alterer who installs auxiliary or replacement tanks or makes propane conversions is responsible for safety defects in the installation of the tanks and propane systems. Installation defects include defects in the method and location of installation.

Under 49 CFR Part 579, the auxiliary and replacement tanks and the propane systems would all be treated as "replacement equipment." Part 579 places the responsibility for safety defects in the performance, construction components, or materials, of replacement equipment on the manufacturer of such equipment. Therefore, the manufacturer who produces auxiliary or replacement tanks or propane systems, as distinct from the alterer who installs such equipment, would be subject to these responsibilities for production defects. A person who both produces such equipment and installs it in new vehicles prior to their delivery to the ultimate consumer would be subject to responsibilities for safety defects stemming from both production and installation of the equipment.

Under section 108(a)(1)(D) and 109(a), any person who fails to provide notification of or remedy for a safety defect is liable for a civil penalty of up to \$1000 per violation.

Tamperers have no safety defect responsibilities for their tampering. As noted above, only manufacturers of motor vehicles or motor vehicle equipment are subject to section 151 et. seq. Since the term "manufacturer" is interpreted to refer to those who produce, assemble or import new vehicles or equipment and since tamperers, by definition, deal with used vehicles only, tamperers are not manufacturers.

Finally, there is the larger and more far reaching question of the liability of the alterers, tamperers, and manufacturers in tort. Whether or not these parties are liable under the Act for their actions, they may well be liable in tort. Both alterers and tamperers may be liable for the manner and location in which they install auxiliary or replacement gasoline tanks or propane systems in vehicles. Likewise, the manufacturers of these items of motor vehicle equipment may be liable for their design, materials, manufacture or performance. These persons may wish to consult a local lawyer on their liability in tort.

I hope that you will find this discussion helpful. If you have any further questions I will be happy to answer them.

Frank Berndt
Chief Counsel

APPENDIX B-2

U.S. DEPARTMENT OF TRANSPORTATION'S

CYLINDER TESTING REQUIREMENTS

Specification under which cylinder was made	Minimum retest pressure (p s i)	Retest period (years)
DOT-3 ..	3,000 p s i	5
DOT-3A, 3AA. ..	5/3 times service pressure, except noncorrosive service (see § 173 34 (e)(10))	5 or 10 (see § 173 34(e)(11), (e)(14) and (e)(15))
DOT-3AX, 3AAX	5/3 times service pressure	5
3B, 3BN	2 times service pressure (see § 173 34 (e)(10))	5 or 10 (see § 173 34(e)(14))
3C	Retest not required	
3D	5/3 times service pressure	5
3E	Retest not required	
3HT	5/3 times service pressure	3 (see § 173 34(e)(13))
3T	5/3 times service pressure	5
4	700 p s i	10
4A	5/3 times service pressure (see § 173 34(e)(10))	5 or 10 (see § 173 34(e)(14))
4AA480	2 times service pressure (see § 173 34 (e)(10))	5 or 10 (see § 173 34(e)(11))
4B 4BA, 4BW, 4B-240ET ..	2 times service pressure, except non-corrosive service (see § 173 34(e)(10))	5 or 10 (see § 173 34(e)(9) and (e)(14))
4C	Retest not required	
4D 4DA, 4DS	2 times service pressure	5
DOT-4E	2 times service pressure, except non-corrosive service (see § 173 34(e)(10))	5
4L	Retest not required	
8 8AL	Retest not required	
DOT-9	400 p s i (maximum 600 p s i.)	5
25	500 p s i	5
26 for filling at over 450 p s i	5/3 times service pressure	5
26 for filling at 450 p s i and below	2 times service pressure, except non-corrosive service (see § 173 34(e)(10))	5 or 10 (see § 173 34(e)(9))
33	800 p s i.	5
38	500 p s i.	5
Any cylinder with marked test pressure	Retest at marked test pressure	5
Foreign cylinder charged for export	As marked on the cylinder, but not less than 5/3 of any service or working pressure marking	See § 173 301(j)

Source: Code of Federal Regulations.

APPENDIX C

CALIFORNIA SAFETY REGULATIONS APPLICABLE TO CNG AND LNG MOTOR VEHICLES AND FUELING STATIONS

- **Title 8 Unfired Pressure Vessel Safety Orders address LNG and CNG tanks which may be used for storage and refueling requirements. The major requirements address:**
 - **Design and Construction of Natural Gas Tanks**
 - **Design and Construction of CNG Cylinders**
 - **Design and Construction of LNG Vaporizers**
 - **Repairs and Alterations to Tanks**
 - **Control of Products in Tanks and Cylinders and Odorization**
 - **Transfer, Operation and Maintenance**
 - **Gaging Devices for LNG Tanks**
 - **Device Approval and Certification**
 - **Location of Storage Tanks and Regulating Equipment**
 - **Installation of Above and Below Ground Tanks and Skid Tanks**
 - **Piping Standards**
 - **Piping Systems Valving and Labeling**
 - **Hose, Metallic Hose, Flexible Metal Hose and Tubing**
 - **Pressure Gages**
 - **LNG Vaporizer Installation**
 - **Safety Relief Devices**
 - **Warning Signs**
 - **Storage Transfer and Vaporization Within Buildings and**
 - **Safe Practices**

- **Title 13 California Highway Patrol (Compressed Natural Gas Requirements)**
 - **Fuel supply container fabrication, testing, pressure limitations, and identification marking**

 - **System shut-off valve location, certification, mounting requirements and marking**

APPENDIX C

(Cont'd)

- Safety relief valve location, quantity, size, type, venting and marking
- Gauge capacity, safety factors, and mounting
- Pressure reducing regulator capacity, insulation, mounting and safety factors
- Compartment venting
- Title 13 California Highway Patrol (Liquefied Natural Gas Requirements)
 - Fuel supply container fabrication, inspection, capacity, liquid level gaging device, fill limiters, mounting requirements (to withstand a 30 mph collision) and markings
 - Valve certification, shielding and mounting
 - Safety relief valve location, maximum discharge pressure, capacity and marking
 - Control valve to prevent flow with ignition off
 - Gage temperature and pressure requirements, mounting instructions,
 - Pressure regulators as required by Air Resources Board
 - Vent location and size
- Title 13 California Highway Patrol (CNG/LNG Installation Requirements)
 - Location to prevent gas from fueling, gaging or venting from releasing into driver, passenger or luggage compartments

APPENDIX C

(Cont'd)

- Fuel container mounting by either:
 - A — specifications provided, or
 - B — performance standard

- Location in front or rear frame crossmember (Author's note: certain new cars do not have frame crossmembers).

- Mounting welding and support

- Repair restrictions

- Shielding from exhaust systems and engines

- Discharge lines and outlet specification and vent locations, outlet foreign object protection, and capacity. (Also specifies option of venting via a flexible bag)

- Pipe, tubing, hose and fittings materials compatibility of involved fuel, sealants and protection

- Engine exhaust outlet restrictions

- Electrical equipment restrictions and

- Road clearance specifications

- Title 13 also requires that any school bus that has been modified to use CNG, LNG or LPG shall not be used to transport pupils until the fuel system has been inspected by the state.

APPENDIX D

STATE OF CALIFORNIA
AIR RESOURCES BOARD

**CALIFORNIA EXHAUST EMISSION STANDARDS
AND TEST PROCEDURES FOR SYSTEMS
DESIGNED TO CONVERT MOTOR VEHICLES TO USE
LIQUEFIED PETROLEUM GAS OR NATURAL GAS FUELS**

Adopted April 16, 1975

APPENDIX D

(Cont'd)

CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR SYSTEMS DESIGNED TO CONVERT MOTOR VEHICLES TO USE LIQUEFIED PETROLEUM GAS OR NATURAL GAS FUELS

The authority for these Exhaust Emission Standards and Test Procedures is found in Sections 43004 and 43006 of the California Health and Safety Code which contain the following:

43004. "--the standards applicable under this part for exhaust emissions for gasoline-powered motor vehicles shall apply to motor vehicles which have been modified or altered to use a fuel other than gasoline or diesel."

"43006. The state board may certify the fuel system of any motor vehicle powered by a fuel other than gasoline or diesel which meets the standards specified by Section 43004 and adopt test procedures for such certification."

1. General Applicability

This test procedure is applicable to any single or dual-fuel motor vehicle conversion system using liquefied petroleum gas (LPG) or natural gas (NG) in lieu of the original gasoline or diesel fuel system for emission controlled vehicles registered in the State of California.

2. Definitions

The definitions shall be the same as those in the applicable model year California exhaust emission standards and test procedures for passenger cars, light-duty trucks, and medium-duty vehicles.

All provisions of these procedures (except where specifically noted) shall apply to single fuel liquefied petroleum gas (LPG), single fuel natural gas (NG), and dual-fuel (LPG/gasoline or NG/gasoline) conversion systems.

APPENDIX D

(Cont'd)

3. General Standards

- (a) In addition to all other standards or requirements imposed, any modification of a gasoline or diesel-fueled motor vehicle to allow the use of liquefied petroleum gas or natural gas as a fuel:
 - (i) Shall not in its operation or function cause the emission into the ambient air of any noxious or toxic substance that is not emitted in the operation of such vehicle without such modification, except as specifically permitted by regulation; and
 - (ii) Shall not in its operation, function, or malfunction, result in any unsafe condition endangering the motor vehicle, its occupants, other persons, or property in close proximity to the vehicle, in accordance with the safety requirements specified for the original vehicle.
- (b) In the case of a dual-fuel conversion, where the vehicle may run on gasoline (or diesel) or a gaseous fuel, removal of originally required emission control systems will not be permitted. These provisions shall not apply to heated intake air systems.

4. Non-Applicable EPA Regulations

All requirements in the referenced California exhaust emission standards and test procedures for gasoline or diesel-powered vehicles not directly related to exhaust emission test procedures shall not be applicable to these procedures.

5. Emission Standards and Test Procedures

(a) Passenger Cars and Light-Duty Trucks.

An applicant for straight LPG, NG, and/or dual-fuel conversion systems may choose the years, makes and models of the vehicles for which the system will be applicable. The test vehicles shall be chosen from the most recent year vehicle models, and shall be designated by the Executive Officer. The applicant is encouraged to propose a test fleet for consideration by the Executive Officer.

APPENDIX D

(Cont'd)

The exhaust emission standards to be used for approval are the applicable California emission standards or typical emission levels of vehicles in good operating condition for those passenger cars and light-duty trucks selected by the Executive Officer as test vehicles. Test procedures shall be the applicable CVS-1975 California test procedures for the model year of the test vehicle. Separate approval shall be required for each engine size class. Back-to-back tests must be conducted and a significant increase in emissions from the baseline, even if the vehicle meets the applicable model-year standards, may be cause for denial. In addition, for dual-fuel systems, the Executive Officer may require CVS-72 or CVS-75 tests on gasoline with the conversion system. The durability of all systems will be determined by an engineering evaluation. For cause, and based on the engineering evaluation, the Executive Officer may require durability tests.

In comparing the emission figures, test variability will be taken into consideration. The allowable variability will be based on the previous experience of the testing facility and statistical analysis of the test data.

(b) Heavy-Duty Vehicles (Single and/or Dual Fuel Systems)

1) Vehicles over 6000 lbs. (1977 or older)

Approval of a system for passenger vehicles shall automatically qualify that system for use on 1977 or older-model vehicles over 6000 lbs. GVW with engines in the same size class and with similar emission control systems. If no passenger vehicle within a certain engine class is available for test, the Executive Officer may permit another engine class or a previous year model to be tested.

2) Vehicles Between 6,000-8500 lbs (1978 or newer, Medium Duty Vehicles)

These vehicles must be tested in accordance with the provisions of subparagraph (a).

3) Vehicles over 8500 lbs. (1978 or newer)

Approval of a system for passenger vehicles, light-duty trucks or medium-duty vehicles shall automatically qualify that system for use on vehicles over 8,500 lbs. GVW with engines in the same size class and with similar emission control systems for the same or older-model years. If an engine in a certain size class is not available, the Executive Officer may permit the substitution of another engine in a different class or a previous model-year engine.

APPENDIX D

(Cont'd)

In the alternative, the applicant may request permission from the Executive Officer to test the conversion system on an engine dynamometer. A detailed description of the test procedure and calculations must accompany such a request and must be approved by the Executive Officer prior to initial tests. Approval by this method shall only apply to systems when used on heavy-duty vehicles over 8,500 lbs GVW. A significant increase in emissions from the baseline, even if the vehicle meets the applicable heavy-duty engine emissions standards, may be cause for denial.

(c) Dual-Fuel Systems (gasoline and LPG or NG)

In addition to meeting the applicable exhaust emission standards, the vehicle's exhaust emissions may not be significantly increased above the baseline exhaust emissions when operating on gasoline with the conversion system installed. Compliance with this provision may be judged by the hot-start California CVS-1972 test procedure, or the applicable cold-start California CVS-1975 test procedure at the option of the applicant.

(d) Crankcase Emissions - None permitted

(e) Fuel Evaporative Emissions

No increase above the gasoline system baseline is permitted for dual-fuel systems.

6 Application for Approval

- (a) An application for approval of a modification to use LPG or NG in a gasoline or diesel-powered engine may be made by any engine, vehicle or conversion equipment manufacturer.
- (b) An application shall be required for each model year even though the exhaust emission standards for approval of new vehicles may be the same for consecutive model years.
- (c) The application shall be in writing, signed by an authorized representative of the manufacturer, and shall include the following:

APPENDIX D

(Cont'd)

- (i) Identification and description of the vehicles for which exemption approval is requested.
- (ii) A complete description of all modifications and additions to the engine or vehicle.
- (iii) A description of the laboratory equipment used and the exhaust emission tests performed to ascertain compliance with the General Standards.
- (iv) Emission data on such vehicles and engines tested in accordance with the applicable exhaust emission test procedures and standards.
- (v) A statement of recommended maintenance procedures, including initial installation and initial tuning, and equipment necessary to ensure that the vehicle and engine in operation conform to the regulations. If the procedures are not uniform then the specific procedures for each different make and model shall be given. A description of the program for training of personnel for such maintenance and installation.
- (vi) An agreement that upon the Executive Officer's request any one or more of the test vehicles will be supplied to the Air Resources Board (ARB) for such testing as it may require, or (by mutual consent between the ARB and applicant) will be made available at the manufacturer's facility for such testing. Provided, that in the latter case, it is further agreed that the instrumentation and equipment specified by the ARB will be made available for testing operations. Any testing conducted at a manufacturer's facility pursuant to this subparagraph will be scheduled as promptly as possible.
- (vii) An agreement that a reasonable number of vehicles will be made available to the ARB for testing for such reasonable periods as may be required. These vehicles shall be selected from time to time by the Executive Officer and shall be typical of production models available for sale to the public. They shall also be representative of the engines and transmissions offered by the vehicle manufacturers

APPENDIX D

(Cont'd)

(viii) An agreement that the modifications made in the field will be properly identified. To meet this requirement the model number shall be permanently marked on the carburetor. A permanent label covering the following for the specific installation shall be furnished for installation on the air cleaner or any other area where it may be easily read. The label shall set forth the following:

1. Manufacturer's name and address.
2. Approved by the California Air Resources Board for use on ___ model-year vehicle with engine sizes ___ in.³ to ___ in.³
3. Spark timing.
4. Idle Speed.
5. Mixture adjustment (if used) including idle, cruise and/or full throttle together with the method.
6. Type of fuel (LPG, NG, or dual-fuel).
7. Date of Installation.
8. Carburetor Model No.
9. Vaporizer Model No.
10. A statement "For vehicles over (6000) 8500 lbs. GVW only" if applicable.
11. A list of non-applicable systems (e.g.: Fuel injection, 3-way catalyst, etc.) if space permits.

(ix) For dual-fuel systems, a description of any changes to the Original Equipment Manufacturer's the evaporative emission control system.

7. Selection of Test Vehicles for the Limited Fleet.

Two test vehicles will be required for each carburetor-model conversion system. If the applicant submits additional carburetor-model conversion systems, one (but not both) of the previous test vehicles may be used. One vehicle shall represent the smallest engine size class for which approval is requested and the other the largest engine size class requested. The Executive Officer may, for cause, request up to two additional test vehicles for each carburetor model. The engine size classes are as follows:

- Class A - 0 through 140 cubic inches
- Class B - Over 140 through 200 cubic inches
- Class C - Over 200 through 250 cubic inches
- Class D - Over 250 through 300 cubic inches
- Class E - Over 300 through 375 cubic inches
- Class F - Over 375 cubic inches
- Class G - Engines which cannot be classified because of unusual design.

APPENDIX D

(Cont'd)

If the application is for both light and medium duty vehicles, then a total of four test vehicles will be required for each carburetor-model conversion system.

8. Vehicle Testing

- (a) Each test vehicle shall be a California certified version having been driven a minimum of 4000 miles as required for new vehicle certification. In the event that a manufacturer acquires a vehicle with less than 4,000 miles, the vehicle mileage must be brought to 4,000 miles by driving the vehicle on the road, or by accumulating mileage on a chassis dynamometer utilizing the CVS-75 urban cycle. The Executive Officer may allow test vehicles with less mileage if the applicant demonstrates emission stability.

Each test vehicle must also be subjected to a thorough examination prior to the baseline test to detect and correct possible defects and deviations from manufacturer's specification in emissions-related parts. The baseline emissions of the test vehicle should be typical

for that particular make and model year. Typical vehicle emissions will be determined by using the vehicle surveillance test data, supplemented by assembly line test and certification test data as required and appropriate.

If a vehicle exceeds typical emission values, the applicant may make a full diagnostic evaluation of the vehicle, make any necessary repairs, and retest the vehicle. If no abnormal conditions of the engine or the emission controls are noted, the vehicle will be accepted as a test vehicle and its emissions data will be used for comparison with conversion system test results. The applicant may forego the above and select another test vehicle from the given list of alternative vehicles.

Testing may be performed at any laboratory properly equipped to conduct the tests. The test vehicle shall be under the control of the laboratory for the entire test period. Return of the test vehicle to the applicant during the test period may invalidate prior test results.

After the baseline test has been run, prior approval must be obtained from the Executive Officer before any servicing, maintenance or parts replacements are made, except those that are in accordance with the written instructions provided with the applicant. The same fuel shall be used for the back-to-back tests using gasoline or diesel. There should be sufficient fuel in the fuel tank to permit the baseline and with conversion system tests. The laboratory shall record all the above information and include it as part of the report. The laboratory's report must be submitted directly to the Executive Officer and contain all related information, including failed test data. Tests performed for research and development purposes before the application is submitted need not be reported. The applicant may not edit the laboratory report but may submit additional clarifying comments or information.

APPENDIX D

b. Test Sequence (Cont'd)

- i) Straight liquefied petroleum or natural gas conversions.
 - 1. Adjust vehicle to vehicle manufacturer's specification.
 - 2. Run Baseline Test (Cold-start CVS-75).
 - 3. Install conversion system in accordance with conversion system manufacturer's installation instructions.
 - 4. Run cold start CVS-75 test using gaseous fuel.

ii) Dual-Fuel Systems

- 1. Adjust vehicle to vehicle manufacturer's specifications.
- 2. Run two baseline tests. One is a cold-start CVS-75 and the other is a hot-start CVS-72.
- 3. Install conversion system in accordance with the conversion system manufacturer's installation instructions.
- 4. Repeat cold-start CVS-75 test using gaseous fuel and the hot-start CVS-72 test using gasoline or diesel as the fuel.
- 5. As an alternative, the applicant may delete the two hot-start CVS-72 tests and in their places run a cold-start CVS-75 test with conversion system using gasoline or diesel fuel.

Each vehicle tested for each carburetor (mixer) model must meet the requirements of this procedure.

9. Data to be Recorded:

Vehicle:

Make and Model	Model year
Vehicle Identification Number	License Number
Odometer Reading	
Engine Displacement	

Fuel System:

Nominal Fuel Tank Capacity:	Gasoline or Diesel
	LPG/NG
Fuel Tank Location	
Model of Carburetor	
Number of Carburetor Barrels	
Model of Vaporizer and/or Regulator	

Tuning Specifications:

- Idle RPM
- Ignition Timing
- Carburetor Setting (Method used)
- Other

APPENDIX D

(Cont'd)

Dynamometer Setting Specifications:

Inertia Loading
Curb Weight
Road Load Horsepower at 50 mph
Drive Wheel Tire Pressure

Note: All maintenance (repairs and/or adjustments) are to be recorded

10. Calculation Procedures

The following calculation procedures are based on the Federal CVS-1975 Test Procedure. The final reported test results shall be computed by use of the following formulas:

Meaning of Symbols

PC - Passenger cars
LDT - Light-duty trucks
MDV - Medium-duty vehicles (over 6000-8500 lbs. GVW)
HDV - Heavy-duty vehicles (those vehicles over 8500 lbs. GVW)

CO_{conc} = Carbon monoxide concentration of the dilute exhaust sample corrected for background, water vapor, and CO_2 extraction, in ppm.

CO_{dm} = Carbon monoxide concentration of the dilution air sample as measured, in ppm.

CO_d = Carbon monoxide concentration of the dilution air corrected for water vapor extraction, in ppm.

CO_e = Carbon monoxide concentrations of the dilute exhaust sample volume corrected for water vapor and carbon dioxide extraction, in ppm. The calculation assumes the carbon to hydrogen ratio of the fuel to be 1:3.802 for natural gas and 1:2.656 for LPG.

CO_{em} = Carbon monoxide concentration of the dilute exhaust sample as measured, in ppm.

CO_{mass} = Carbon monoxide emissions, in grams per test phase.

CO_{2conc} = Carbon dioxide concentration of the dilute exhaust sample corrected for background and water vapor, in percent.

APPENDIX D

(Cont'd)

NOx_d = Oxides of nitrogen concentration of the dilute air as measured, in ppm.

NOx_e = Oxides of nitrogen concentration of the dilute exhaust sample as measured, in ppm.

NOx_{mass} = Oxides of nitrogen emissions, in grams per test phase.

P_B = Barometric pressure, in mm. Hg.

P_d = Saturated vapor pressure, in mm. Hg at ambient dry bulb temp.

P_i = Pressure depression below atmospheric measured at the inlet to the positive displacement pump.

T_p = Average temperature of dilute exhaust entering positive displacement pump during test while samples are being collected, in degrees Rankine.

R_a = Relative humidity of the ambient air, in per cent.

V_{mix} = Total dilute exhaust volume in cubic feet per test phase corrected to standard conditions (528°R and 760 mm. Hg)

V_o = Volume of gas pumped by the positive displacement pump, in cubic feet per revolution. This volume is dependent on the pressure differential across the positive displacement pump.

Y_{ct} = Mass emissions as calculated from the "transient" phase of the cold start test, in grams per test phase.

Y_{ht} = Mass emissions as calculated from the "transient" phase of the hot start test, in grams per test phase.

Y_s = Mass emissions as calculated from the "stabilized" phase of the cold start test, in grams per test phase.

Y_{wm} = Weighted mass emissions of each pollutant, i.e., HC, CO, or NOx, in grams per vehicle mile.

For passenger cars, light duty trucks, and medium duty vehicles:

APPENDIX D

(Cont'd)

(a) The mass emissions of each pollutant in grams per mile is

$$Y_{wm} = (0.43Y_{ct} + 0.57 Y_{ht} + Y_s)/7.5$$

(b) The mass of each pollutant for each phase of both the cold start test and the hot start test is determined from the following:

(1) Hydrocarbon mass:

$$HC_{mass} = V_{mix} \times \text{Density}_{HC} \times (HC_{conc}/1,000,000)$$

(2) Oxides of nitrogen mass:

$$NOx_{mass} = V_{mix} \times \text{Density}_{NO_2} \times K_H \times (NOx_{conc}/1,000,000)$$

K_H = humidity correction factor

(3) Carbon monoxide mass:

$$CO_{mass} = V_{mix} \times \text{Density}_{CO} \times (CO_{conc}/1,000,000)$$

(4) Carbon dioxide mass:

$$CO_{2_{mass}} = V_{mix} \times \text{Density}_{CO_2} \times (CO_{2_{conc}}/100)$$

$$V_{mix} = \frac{V_o \times N \times (P_b - P_i) \times 528}{(760)(T_p)}$$

$$HC_{conc} = HC_e - HC_d (1-1/DF)$$

$$NOx_{conc} = NOx_e - NOx_d (1-1/DF)$$

$$CO_{conc} = CO_e - CO_d (1-1/DF)$$

$$CO_e = (1-0.02901 CO_{2_e} - 0.000323 R_a) CO_{em} \text{ for natural gas}$$

$$CO_e = (1-0.02328 CO_{2_e} - 0.000323 R_a) CO_{em} \text{ for LPG}$$

$$CO_d = (1-0.000323 R_a) CO_{dm}$$

$$KH = \frac{1}{1-0.0047(H-75)}$$

APPENDIX D

(Cont'd)

$$H = \frac{(13.4/BR_a)(Pd)}{P_B - Pd \times R_a} \times 100$$

$$DF = \frac{9.77}{CO_{2e} + (HC_e + CO_e) \times 10^{-4}} \quad \text{for natural gas}$$

$$DF = \frac{11.7}{CO_{2e} + (HC_e + CO_e) \times 10^{-4}} \quad \text{for LPG}$$

For Hydrocarbons the Y_{wm} value must be multiplied by the methane content correction factor (MCCF).

$$HC_{wm} = Y_{wm} \times MCCF$$

HC_{wm} = weighted mean HC mass in gms per vehicle mile after correction for methane content

For 1981 and earlier model vehicles, the MCCF values as determined by the vehicle manufacturer and approved by the ARB during certification shall be used. In the absence of such values, the following shall apply:

Gasoline = PC = 0.89 (catalyst only)
PC = 1.0 (non catalyst cars)
LDT = 1.0
MDV = 1.0
HDV = 1.0
Natural Gas = 0.5 (all vehicle categories)
LPG = 0.75 (all vehicle categories)

In the alternative, the applicant may choose to determine the actual MCCF by using the "California Non-Methane Hydrocarbon Test Procedures" adopted May 24, 1978.

For 1982 and later model vehicles, non-methane hydrocarbons must be determined using non-methane instrumentation. In the alternative, the applicant may measure only total hydrocarbons during all testing. However, in such event no methane credit will be given either gasoline or gaseous fuels.

Sample calculation:

(i) For the "transient" phase of the cold-start test assume

$$V_o = 0.29344 \text{ cu ft per revolution; } N=10,485;$$

$$R_a = 48.2\%; P_B = 762 \text{ mm Hg; } P_d = 22.225 \text{ mm Hg; } P_i = 70 \text{ mm Hg,}$$

APPENDIX D

(Cont'd)

$$T_p = 570^{\circ}\text{R}; \text{HC}_e = 105.8 \text{ ppm carbon equivalent}; \text{NOx}_e = 11.2 \text{ ppm};$$
$$\text{CO}_{em} = 306.6 \text{ ppm}; \text{CO}_{2e} = 1.43\%; \text{HC}_d = 12.1 \text{ ppm};$$

$$\text{NOx}_d = 0.8 \text{ ppm}; \text{CO}_{dm} = 15.3 \text{ ppm}.$$

Then, for an LPG fueled vehicle:

$$V_{mix} = \frac{(0.29344)(10,485)(762-70)(528)}{(760)(570)} = 2595.0 \text{ cu ft per test phase}$$

$$H = \frac{(43.478)(48.2)(22.225)}{762 - (22.225 \times 48.2/100)} = 62 \text{ grains of water/pound dry air}$$

$$K_H = \frac{1}{1 - 0.0047(62-75)} = 0.9424$$

$$\text{CO}_e = (1 - 0.02328(1.43) - 0.000323(48.2))306.6 = 291.6 \text{ ppm}$$

$$\text{CO}_d = (1 - 0.000323(48.2))15.3 = 15.1 \text{ ppm}$$

$$\text{DF} = \frac{11.7}{1.43 + (105.8 + 291.6) \times 10^{-4}} = 7.961$$

$$\text{HC}_{conc} = 105.8 - 12.1(1 - 1/7.961) = 95.22 \text{ ppm}$$

$$\text{HC}_{mass} = (2595)(17.28)(95.22/1,000,000) = 4.270 \text{ grams per test phase}$$

$$\text{NOx}_{conc} = 11.2 - 0.8(1 - 1/7.961) = 10.50 \text{ ppm}$$

$$\text{NOx}_{mass} = (2595)(54.16)(10.50/1,000,000)(0.9424) = 1.391 \text{ grams per test phase}$$

$$\text{CO}_{conc} = (291.6) - 15.1(1 - 1/7.961) = 278.4 \text{ ppm}$$

$$\text{CO}_{mass} = (2595)(32.97)(278.4/1,000,000) = 23.82 \text{ grams per test phase}$$

- (ii) For the "stabilized" portion of the cold-start test assume that similar calculations resulted in $\text{HC}_{mass} = 0.62$ grams per test phase; $\text{NOx}_{mass} = 1.27$ grams per test phase; and $\text{CO}_{mass} = 5.98$ grams per test phase.

APPENDIX D

(Cont'd)

- (iii) For the "transient" portion of the hot-start test assume that similar calculations resulted in $HC_{\text{mass}} = 0.51$ grams per test phase; $NOx_{\text{mass}} = 1.38$ grams per test phase; and $CO_{\text{mass}} = 5.01$ grams per test phase.

- (iv) For an LPG fueled vehicle:

$$HC_{\text{wm}} = \left(\frac{(0.43)(4.27) + (0.57)(0.51) + 0.62}{7.50} \right) \times 0.75 = 0.275 \text{ grams per vehicle mile}$$

$$CO_{\text{wm}} = \frac{(0.43)(23.82) + (0.57)(5.01) + 5.98}{7.50} = 2.54 \text{ grams per vehicle mile}$$

$$NOx_{\text{wm}} = \frac{(0.43)(1.391) + (0.57)(1.38) + 1.27}{7.50} = 0.354 \text{ grams per vehicle mile}$$

11. Approval

- (a) If, after a review of the data and other information submitted by the manufacturer, the Executive Officer determines that a modification to use LPG or NG conforms to ~~the regulations~~ these procedures, he or she will issue an Executive Order of approval for such modifications.
- (b) Such Executive Order may be issued upon such terms as the Executive Officer deems necessary to ensure that any modifications to use LPG or NG will meet the requirements of these regulations procedures.
- (c) Approval for a conversion system for a given model year is deemed as approval for all previous model years unless specifically limited in the Executive Order. Approval for subsequent model years may be given, after request by the applicant, if further evaluation and/or testing demonstrates that the system will meet the standards for the applicable model year and engine size class.

12. Changes to Conversion System After Approval

All changes made to the conversion system, including installation changes, must be submitted to the Executive Officer. The Executive Officer may require additional testing prior to approval.

13. Non-conventional Systems

The Executive Officer may deviate from these procedures for non-conventional systems, such as diesel fuel used in conjunction with LPG, in the event that such systems cannot be tested using these procedures. Such deviations shall be limited to those necessary for the proper testing and evaluation of such systems.

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16 Abstract In this study, institutional barriers to the use of natural gas as a fuel for motor vehicle fleets were identified and assessed. Recommendations for barrier removal were then developed. The research technique was a combination of literature review and interviews of knowledgeable persons in government and industry, including fleet operators and marketers of natural gas vehicles and systems. Eight types of institutional barriers were identified and assessed. The most important were two safety-related barriers: (1) lack of a national standard for the safe design and certification of natural gas vehicles and refueling stations, and (2) excessively conservative or misapplied state and local regulations, including bridge and tunnel restrictions, restrictions on types of vehicles that may be fueled by natural gas, zoning regulations that prohibit operation of refueling stations, parking restrictions, application of LPG standards to LNG vehicles, and unintentionally unsafe vehicle or refueling station requirements. Other barriers addressed include (3) need for clarification of EPA's tampering enforcement policy; (4) the U.S. hydrocarbon standard; (5) uncertainty concerning state utility commission jurisdiction; (6) sale-for-resale prohibitions imposed by natural gas utility companies or state utility commissions, (7) uncertainty of the effects of conversions to natural gas on vehicle manufactures warranties; and (8) need for a natural gas to gasoline-equivalent-units conversion factor for use in calculation of state road use taxes. Insurance on natural gas vehicles, and state emissions and anti-tampering regulations were also investigated as part of the research but were not found to be barriers.					
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