California
Natural Gas Vehicle
Coalition

Testimony on Proposed Changes to the Retrofit System Certification Regulations for Gaseous Fuel Conversions

July 27, 1995
California Air Resources Board
Sacramento

Gregory E. Vlasek
Executive Director

These proposed amendments to the retrofit system certification regulations for gaseous fuel conversions represent the culmination of eighteen months of fact-finding, vehicle testing, and close cooperation between retrofit system manufacturers, conversion facilities and staff. I am pleased to be able to speak in strong support of these amendments and to thank the ARB staff for their extraordinary diligence and patience in bringing these regulations before you today.

The conversion industry has come a long way since the spring of 1992 when the 1994 and later model year retrofit regulations were adopted. Today, gaseous fuel retrofit technology is in most respects equal to OEM technology. The open loop, carburetted systems that created the initial cause for concern by ARB about retrofit emissions and durability have given way to closed loop, electronically controlled and fuel injected systems with far greater reliability and potential for long-term emissions benefits. Affecting this change was -- I believe -- the underlying goal of the Board's action in 1992, and today it has been largely accomplished.

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What the amendments proposed today will do is recognize the needs and constraints of the retrofit manufacturing and vehicle conversion industries for what they are: technically competent, small volume manufacturers. Because it produces thousands -- not millions -- of units, the industry lacks the sophisticated in-house emissions laboratories and mileage accumulation test tracks that OEMs use, and has far fewer sales over which to spread certification costs. There are three key areas in which the amendments will reduce the cost of the certification process substantially without appreciably increasing the risk to air quality benefits that the 1992 regulation was designed to ensure.

First, discretionary employment of assigned deterioration factors and emissions data carry-across are a widely accepted practices for OEM certification, and it is reasonable to extend these practices to small volume retrofit certification. The alternative test plan provision of the amendments will allow this, when technically warranted.

Second, the provision to reduce the number of BAR inspections required for identical fleet vehicle conversions is needed and welcome. It will save time and money, but only for those installers who demonstrate competency with specified conversion systems. Although many early start-up problems with the BAR inspection program have been resolved, the requirement that every conversion be driven to a BAR referee station for inspection is unnecessarily burdensome for a conversion industry operating on slim margins.

Finally, the amendments allow additional time for manufacturers to complete full durability testing of engine families for which it is required. This is very important to retrofit system manufacturers because they require additional time to reverse engineer their systems from OEM products, a process that is becoming more, not less

complicated. And again, the high cost of durability vehicle testing is a constraint that precludes the relatively quick track testing typically performed by OEMs.

Under the new regulations, manufacturers will have more latitude to market their conversion systems sooner and for a greater variety of vehicles. However, they will still need to prove their products and choose their markets carefully, because with the greater market opportunity that the new certification procedures affords comes substantially greater responsibility and liability for in-use performance. Nothing in the proposed changes weakens warranty, in-use compliance or recall provisions for these vehicles.

In conclusion, let me again thank the staff for their continuing cooperation and assistance in enabling this industry make the contributions to California's air quality and economy that it very much wants to make.

Thank you.

WSPA
Western States Petroleum Association

95-8-1
7/27/95

State of California
Air Resources Board
Received 7/25/95
by Board Secretary

cc: Board Members
JDD TAC
JB Legal
MSD

Gina Grey
Managing Coordinator

July 24, 1995

Board Members
California Air Resources Board
c/o Board Secretary
P.O. Box 2815
Sacramento, CA 95812

Subject: **Proposed Amendments to the Certification Procedures for all On-Road Motor Vehicle Retrofits and Proposed Optional Retrofit Emission Standards for Heavy-Duty Engines and Vehicles (95-8-1)**

Dear Board Members,

The Western States Petroleum Association (WSPA) submits the following comments pertaining to the above referenced document. At this time, WSPA would like to comment on the following aspects of the amendments:

- the basis for emission reduction credits earned by retrofitting heavy-duty engines,
- the proposed changes to certification procedures for vehicle retrofits,
- the treatment of bi-fuel retrofits.

Emission Reduction Credits Earned By Retrofitting Heavy-Duty Engines

The proposed standards for retrofitting heavy-duty engines and the basis for determining emission reduction credits are sound. They ensure that the emissions benefits expected from retrofitting heavy-duty engines to tighter emissions standards actually occur. The ARB proposals will encourage innovation and new technology to reduce emissions from the existing heavy-duty vehicle fleet. **WSPA endorses both the fuel-neutral basis and the equal-credit-for-equal-emissions-reduction basis for credits proposed by the ARB** These aspects allow fleet operators the flexibility to generate credits using the most cost-effective technology for their specific fleets.

Certification Procedures For Vehicle Retrofits

WSPA recognizes the need to modify the current procedures for certifying alternative fuel retrofit kits for 1994 and later model year vehicles to make them more useable, however this must be done without compromising air quality. We have the following concerns about the proposed amendments to the standards:

- Kit makers are given an inordinately long time for durability testing. Under the ARB proposal, a kit maker can begin selling kits at the beginning of one model year, say September 1996, and not complete durability testing until August 1998. **WSPA recommends that obligations incurred in a given model year be met in that model year.**
- The proposed phase-in schedule allows a substantial portion of retrofits to be certified under the older and less stringent retrofit certification procedures. Air quality is compromised if

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the required number of retrofits under the more stringent procedures are not completed. **WSPA recommends that obligations to provide 55% of the model year 1995 and 1996 retrofits under the 1994 and subsequent model year retrofit procedures be met strictly within each model year.**

- There is no meaningful enforcement if a kitmaker fails to meet the durability standards. This places air quality at risk. Lack of durability was the principal reason the Air Resources Board strengthened their retrofit procedures in March 1993. Retrofits should face the same obligations as the original equipment manufacturers with whom they compete. **WSPA recommends that vehicles converted using a kit that fails its durability test be recalled and that any benefits or emission reduction credits associated with uncorrected retrofits be disallowed.**

The Treatment Of Bi-Fuel Retrofits

A Tier 1 gasoline vehicle converted to a bi-fuel TLEV vehicle meets TLEV standards on the alternative fuel but need only meet Tier 1 standards on gasoline. The conversion provides no environmental benefit relative to Tier 1 when it is fueled with gasoline. To the extent that the converted vehicle is fueled with gasoline it is not a TLEV and it is not an alternative fuel vehicle. **WSPA recommends that a bi-fuel vehicle operated on gasoline not count either as a TLEV or an alternative fuel vehicle and that such vehicles not receive full emission reduction credits or financial incentives.**

WSPA appreciates the opportunity to discuss the above concerns. Please direct any questions to Aeron Arlin with WSPA at (818) 543-5333 or John Freel with Chevron at (510) 242-4080.

Sincerely,

cc: Susan Huscroft - CARB
Bill Lovelace - CARB

The Gas Company®

Lauren S. Dunlap
External Affairs Manager
Environment & Safety

95-8-1
7/27/95

STATE OF CALIFORNIA
AIR RESOURCES BOARD
RECEIVED 7/24/95
BY BOARD SECRETARY
Board Members
JDD TAC
JDB Legal
MSD

July 20, 1995

Dr. Eugene A. Boston
Board Member
California Air Resources Board
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Dear Dr. Boston:

Southern California Gas Company ("The Gas Company") appreciates the opportunity to provide comments regarding the California Air Resources Board's ("ARB") proposed amendments to the Alternate Fuel Retrofit Certification/Installation Regulations (July 27th agenda item 95-8-1). The staff proposal reflects significant cooperative efforts over several months between ARB staff, retrofit kit manufacturers/ installers and fuel providers to develop regulatory amendments that provide much needed flexibility to make natural gas vehicle conversions a viable air quality improvement technology.

Specific amendments supported by The Gas Company include the extended phase-in schedule that allows more time for manufacturers to meet regulatory requirements, alternate referee inspection schedule provisions, allowance of derived deterioration factors for all vehicle classes to support certification followed by validation of the derived factors within two years and incorporation of a methodology to facilitate emission credit generation for approved low-emission vehicle conversions.

Adoption of these amendments at the July 27, 1995 hearing is critical to the success of the natural gas vehicle conversion industry and provides an opportunity for the ARB to reaffirm its commitment to successful implementation of low-emission technology to support air quality improvement goals. Thank you again for your continued support.

Sincerely,

for LSD

cc: Jim Boyd, ARB
Tom Cackette, ARB
Rose Castro, ARB
Robert Cross, ARB
Rod Summerfield, ARB
Greg Vlasek, CNGVC

(4)

Testimony of California Trucking Association
Proposed Amendments to the Certification Procedures for All On-Road Motor Retrofits and Optional Standards
July 27, 1995

My name is Stephanie Williams and I'm employed by the California Trucking Association as Manager of Research and Environmental Policy. The California Trucking Association is a non-profit trade organization representing over 2400 for-hire trucking companies, private carriers and suppliers operating into and within California. Our members include both intra and interstate motor carriers.

The trucking industry is working diligently to develop truck policy that can accomodate both the environment and the economy. California registered vehicles must be allowed, by their own state, to compete for freight in California. Without a level playing field for California based carriers, environmental regulations do not achieve the forecasted benefits and will actually have a negative impact on both the air and the economy in our state.

We've had limited opportunity to review the report and recommendations, however our preliminary review indicates that this proposed regulation will obstruct work under development with the CTA's SIP Task Force. This task force includes the environmental community, the local air districts, the engine manufacturers and the trucking industry. We are working towards a plan that will provide both air quality benefits and economic stability in California.

We are near completion of the planning stage and our subcommittees on Replacement, Retrofit and Export/Scrappage will meet in mid-September to finalize the plan which will then be presented to the ARB. As the flow chart depicts, we are addressing both used and new vehicles. Because retrofit has so much potential, we ask that the adoption of any formal (new or changed regulation dealing with retrofitting of heavy-duty vehicles be delayed until the industry plan has been submitted to and considered by the board.

We believe some introduction of low emission vehicles in combination with retrofit, scrappage and export of existing vehicles is necessary for SIP compliance. Alternatively fueled heavy-duty vehicles are not commercially available. In other words, you cannot go to a dealer and order an alternatively fueled heavy-duty vehicle off the assembly line. A few member companies have inquired about alternative fuel vehicles, the related infrastructure and associated costs. In response to these inquiries, CTA members companies are demonstrating heavy-duty vehicles (80,000 weight rating) using liquified natural gas and compressed natural gas (12,000-26,000 weight rating). We are cost sharing projects in the South Coast and Sacramento Air Districts.

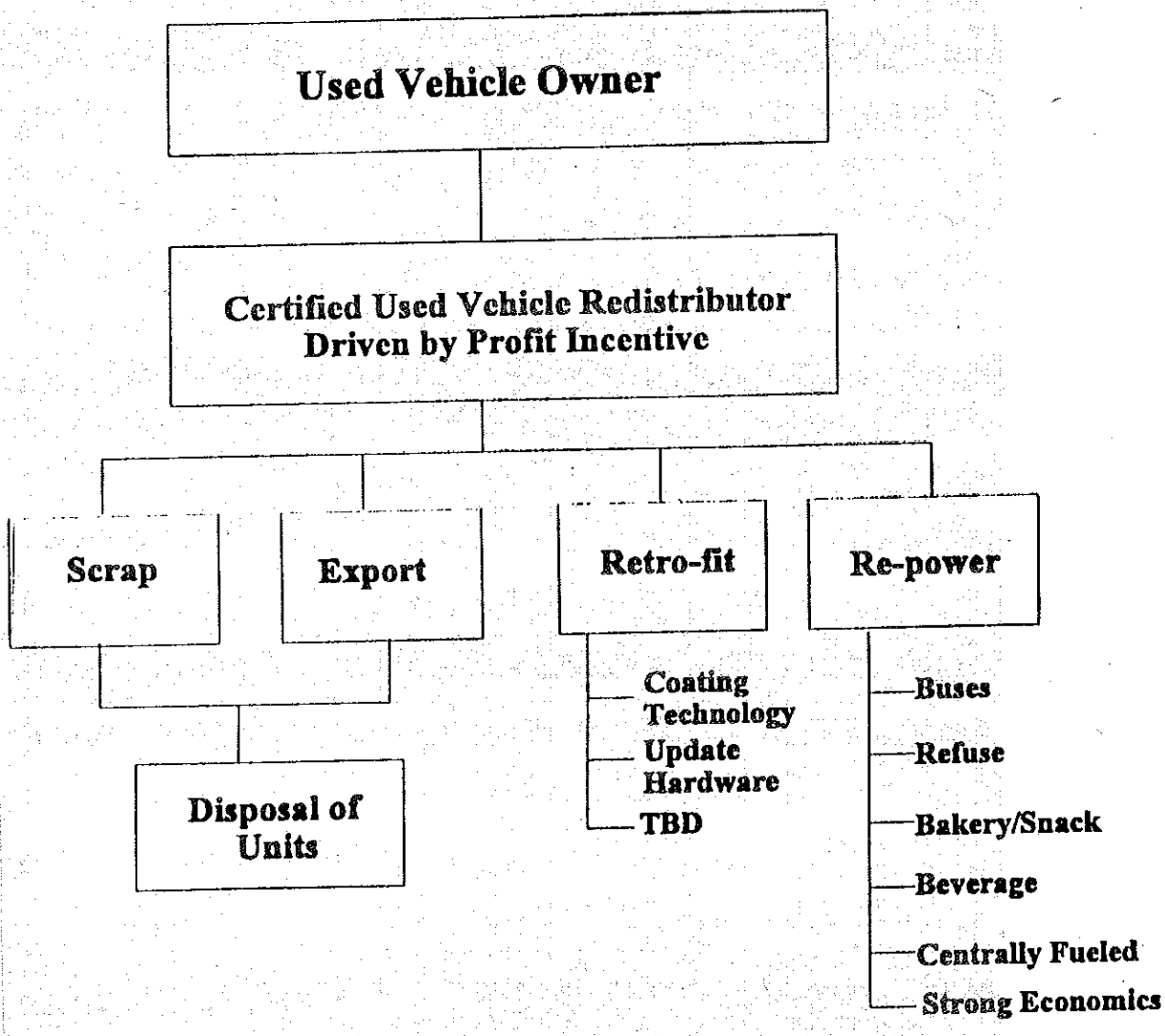
To purchase vehicles for natural gas demonstrations, we have had to jump through hoops. A company can purchase an engine that operates with natural gas but that engine will not come in a truck body or chassis. The chassis and fueling system must

be modified by a third party and no warranty is provided. The cost of modifying a heavy-duty vehicle to run on natural gas is close to the cost of purchasing a new diesel truck. Without research grants or cofunding, demonstrating these vehicles would be cost prohibitive. On the other hand, without demonstration of these new technologies, cleaner technologies may never be discovered.

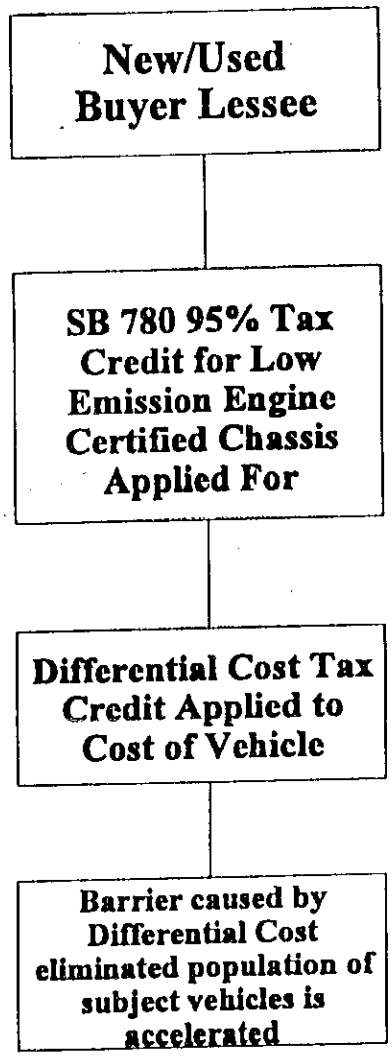
A key component of the industry plan under consideration involves retrofitting older diesel engines with new diesel technology. We are informed by the manufacturers of these systems that a substantial reduction in emissions can be obtained from retrofit technology. It is unclear to us at this time what effect this regulation would have on the opportunity offered by retrofit technology. We desire to pursue this opportunity with both the board and its staff.

We look forward to working with you to develop new truck rules that are good for the environment and the economy.

Used Vehicle Re-Distribution
(No connection to new vehicle lower N0x Aquision)



Lower N0x Vehicle Aquisition



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To RENEE KEMENA	From ROSE CASTRO
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25th July 1995

Ms Rose Castro
California Air Resources Board
Mobile Source Division
9528 Telstar Ave
El Monte, California 91731

Dear Rose,

GFI Control Systems has followed the activities of CARB with respect to proposed ammendments to the certification procedures for all on-road motor vehicle retrofits and optional retrofit emission standards for heavy duty engines and vehicles.

GFI strongly endorses the efforts of CARB in this regard, and supports the proposed ammendments to procedures and standards in all respects, which will assist the introduction of clean fueled vehicles into the State of California. GFI has provided durability data and other input in support of the CARB initiative, and we have appreciated this team approach, working with CARB to resolve issues, and arrive at ammendments which will greatly assist the commercial introduction of clean fuel technologies in California. Based on these ammendments, GFI will continue to sell and support its products in California.

A public hearing is being held on July 27th 1995 for the Board to consider adoption of these ammendments. GFI supports the ammendments, and considers it important that the Board adopt them in all respects as soon as possible.

Yours truly,

Alex Lawson, Ph.D.
Director of Engineering

Manufacturers of Emission Controls Association
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July 26, 1995

Chairman John Dunlap III
California Environmental Protection Agency
Air Resources Board
2020 L St.
Sacramento, CA 95814

Re: Proposed Amendments to the Certification Procedures for All On-Road Motor Vehicle Retrofits and Proposed Optional Retrofit Emission Standards for Heavy-Duty Engines and Vehicles

Dear Chairman Dunlap:

MECA would like to take this opportunity to provide additional comments to those previously submitted July 24, 1995 regarding the above referenced amendments to the certification procedures for on-road motor vehicle retrofits. Our comments today relate to a new and emerging control strategy -- retrofit of emission control upgrades on pre-1990 gasoline-fueled light-duty vehicles.

Several of our members are devoting considerable resources into developing retrofit systems to upgrade the emission control systems of pre-1990 gasoline-fueled light-duty vehicles. A copy of a technical report entitled ***Emission Control System Upgrades for Gasoline Powered Vehicles: An Available Option for Reducing ROG and NOx Emissions*** is attached. We believe that the concept of emission control system upgrade can provide the State of California with significant air quality benefits.

The above-referenced proposed amendments do not expressly include procedures for credit generation for upgrading emission control systems on pre-1990 gasoline-powered light duty vehicles. Consequently, we would welcome the opportunity to mutually explore with the Air Resources Board developing procedures to cover this class of retrofits, addressing such issues as the appropriate methods to determine the emission credits that would result from such a program, cost effective certification procedures, and other issues surrounding the concept of emission control upgrade.

In an emission control system upgrade program for pre-1990 gasoline-fueled light-duty vehicles, we believe that emission credits should reflect the actual in-use benefits afforded by such a program. This would involve developing a certification procedure which measured the reductions achieved with a given emission control upgrade package compared to the actual in-use emission levels. We also believe that because many of these vehicles are well beyond their statutory useful life, but may still be on the road for a number of years, that the credits should be based on the projected mileage the vehicle with the upgrade package can be expected to be operated. Insuring that credits are given for the actual in-use benefit an emission control system upgrade provides will generate the incentive required for such a program to be successful and allow the State of California to realize the full air quality benefits an emission control system upgrade program can provide.

We hope our comments are helpful to the Board in its continued efforts to develop and implement an effective retrofit program for all on-road motor vehicles. Should you have any questions regarding the above comments, please do not hesitate to contact us.

Sincerely,

Dale L. McKinnon
Technical Director

Emission Control System Upgrades for Gasoline-Powered Light-Duty Vehicles:

An Available Option for Reducing ROG and NOx Emissions

Manufacturers of Emissions Controls Association

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May 1995

0.0 EXECUTIVE SUMMARY

Emissions from existing gasoline powered passenger cars and light trucks are a significant source of ROG (also referred to as hydrocarbons (HC) in this study), NOx and CO emissions, and they must be addressed if California is to meet its clean air objectives. This preliminary report reviews a relatively new concept --emission control upgrades -- which used in combination with other in-use strategies such as vehicle scrappage and Inspection/ Maintenance has the potential for achieving significant emission reductions. The analysis and other information discussed in this preliminary report are continuing to be evaluated and a final report will be issued in the near future.

The report provides an introduction to the emission control upgrade concept and discusses the issues and opportunities. Various upgrade strategies are identified and several illustrations of the potential reductions possible are provided. The report is does not attempt to comprehensively quantify the emission reductions possible or to provide a detailed assessment of all the technological and policy issues presented. To enable such an analysis to occur, this study recommends that the public and private sectors cooperate in conducting a comprehensive pilot program to evaluate the concept of emission control upgrades.

1.0 INTRODUCTION

1.1 Premise

Even with increasingly tighter control requirements on new on- and off-road vehicles and additional reductions from stationary sources as well as consumer products, significant additional Reactive Organic Gas (ROG) and Oxides of Nitrogen (NOx) reductions will be necessary to meet the ozone standard. Reducing emissions from existing gasoline-powered vehicles remains an attractive option. Current efforts to enhance California's I/M program and vehicle scrappage will play an important role. Upgrading the emission control systems of older vehicles offers another attractive option for reducing the emissions of existing vehicles.

1.2 Concept

Vehicles which exhibit high emissions even after remedial repairs, but which are not suitable for scrappage, would be candidates for installing emission control system upgrades. A combined strategy of scrappage, remedial repairs and control upgrades together could be an extremely effective approach to reduce in use vehicle emissions.

Motor vehicle emission control technology has continued to advance in the 20 years since catalytic converters were first introduced, and opportunities exist to utilize the technology of the 1990s to reduce emissions from the vehicles sold in the 1970s and 1980s.

Possible emission control upgrade strategies include:

- Install a three-way converter with auxiliary controls on a two-way converter equipped vehicle;
- Replace the existing three-way converter on an older vehicle with a current, advanced design three-way converter;
- Add a light-off or "pre-converter";
- Install a hydrocarbon adsorber; and
- Upgrade the evaporative emission canister.

Funding for upgrades would come, at least in part, from third-party sources and not be borne entirely by the consumer. Possible concepts to promote and/or help cover the cost of upgrades might include:

- Employer pays for upgrade as means of meeting employee trip reduction obligations;
- Rebates on registration/vehicle tax;
- Emission credit generation and sale; and
- Upgrade program incorporated into the California SIP scrappage program which contemplates nearly $1 billion in public/private funding over a 10 year period.

1.3 Issues to be Addressed

To implement a successful emission control upgrade program three critical issues must be addressed: 1) technical feasibility and cost; 2) program structure and administration; and 3) the source of funding.

2.0 BACKGROUND

2.1 The California Fleet

California's motor vehicle fleet approaches 25 million vehicles traveling over 700 million miles a day. Over 40 million gallons of fuel (diesel and gasoline) are consumed daily in California.

Gasoline-powered light-duty vehicles account for 86 percent of the California fleet and account for over 600 million vehicle miles traveled (VMT), with passenger cars

responsible for over 80 percent of the VMT. The light-duty vehicle population in California can be broken down as follows:

Passenger Cars	17.9 million
Light-Duty Trucks	4.0 million

Only one percent of the passenger cars and two percent of the light-duty trucks are diesel-powered.

2.1.1 Emission Control Systems on the California Fleet

Oxidation catalysts (controlling only HC and CO) were first installed on vehicles beginning with the 1975 model year; by the 1980 model year almost all new cars were equipped with oxidation catalysts. Currently, there are approximately 1.2 million passenger cars and 0.2 million light-duty trucks which are not catalyst-equipped in California. Approximately 1.5 million passenger cars and 0.18 million light-duty trucks are equipped with oxidation catalysts. Beginning with the 1980 model year, cars began to be equipped with three-way converters (controlling HC, CO, and NOx) and by 1981, all cars sold in California were equipped with three-way converters. Table 1 outlines the light-duty passenger car population in California by model year from 1975 onwards.

Table 1
CALIFORNIA'S LIGHT DUTY PASSENGER CAR FLEET

1975	**1976**	**1977**	**1978**	**1979**
119,530	164,214	237,983	308,629	337,447
1980	**1981**	**1982**	**1983**	**1984**
342,548	371,708	410,716	530,472	683,083
1985	**1986**	**1987**	**1988**	**1989**
842,551	993,041	1,037,004	1,128,701	1,228,222
1990	**1991**	**1992**	**1993**	**1994**
1,298,742	1,384,004	1,501,284	1,582,771	1,670,520

2.2 The Pollution Contribution of Gasoline-Powered Light-Duty Vehicles

Exhaust emissions from gasoline-powered light-duty vehicles contribute over 650 tons of reactive organic gas (ROG) and over 750 tons of NOx emissions daily in California. Gasoline-powered light-duty vehicles also contribute an additional 400 tpd of the ROG emissions as a result of evaporative losses. Total ROG emissions from gasoline-powered light-duty vehicles in California is over 1000 tpd. In total, they are responsible for over 80 percent of the ROG emissions and almost 50 percent of the NOx emissions of the total California mobile source fleet.

Table 2 outlines in-use emissions levels of light-duty vehicles in the South Coast Air basin as determined by CARB for the 1981 to 1989 model year fleet.

Table 2
AVERAGE IN-USE EMISSIONS LEVELS

YEAR	HC (g/mi)	CO (g/mi)	NOx (g/mi)
1981	0.9	12.77	1.37
1982	1.00	12.88	1.26
1983	0.84	11.69	1.19
1984	0.50	7.92	1.05
1985	0.43	6.90	0.98
1986	0.39	6.43	0.93
1987	0.36	7.14	0.90
1988	0.33	6.30	0.84
1989	0.29	5.54	0.63

Source: CARB

An emission control upgrade program would in all likelihood not be focused on vehicles emitting average emissions levels but rather, vehicles emitting excessive pollution. Sunoco studied the feasibility of using remote sensing to find gross emitting vehicles in the Philadelphia area from February 15, 1994 to April 2, 1994. A total of 3,127 vehicles were found to be emitting excessive levels of emissions by the remote sensing device. This represented approximately 4.2 percent of the total number of vehicles that had driven by the roadside installation. Of these, 300 vehicles were tested using IM 240 methods. The results of the IM 240 tests for model years 1981-1989 are shown in Table 3.

Table 3
IM 240 IN-USE EMISSIONS RESULTS

YEAR	HC (g/mi)	CO (g/mi)	NOx (g/mi)
1981	2.69	43.06	2.08
1982	4.07	48.75	2.14
1983	1.93	24.45	2.02
1984	2.24	23.18	2.03
1985	5.68	23.56	3.39
1986	2.19	30.75	1.15
1987	1.67	20.17	1.48
1988	2.81	5.97	1.53
1989	NA	NA	NA

Note: The worst vehicles were excluded from the analysis. Source: Sunoco Study

3.0 TECHNOLOGY

3.1 Technical Considerations

Before a control upgrade is installed, the vehicle should undergo any remedial repairs and the vehicle should be returned to the manufacturer's original specifications. The upgrade must be able to be integrated into the available space on the vehicle and should be designed for easy and proper installation. Also, the upgrade must achieve the desired emission reductions without adversely impacting the emission control performance of other components of the existing system. For example, when installing an additional converter, care must be taken not to adversely effect thermal management considerations as they relate to the downstream control equipment. Similarly, the upgrade must not affect vehicle performance. For example, changing converter design or installing an additional converter must not adversely affect back pressure.

3.1.2 Description of Potential Upgrade Strategies

Various approaches to control upgrades are available. Perhaps the simplest strategy is replacing an existing three-way converter on an older vehicle with a current, advanced design three-way converter to improve converter efficiency and to obtain substantial additional emissions reductions.

There are several approaches which potentially could be used to improve the cold start performance of the emission control system on existing vehicles. The addition of a small light-off or preconverter of low thermal inertia can significantly reduce CO, HC, and NOx emissions. Similarly, the addition of a hydrocarbon trap can reduce cold start HC emissions by effectively trapping the hydrocarbons (unburned fuel) until the main converter reaches its operating temperature at which point the HCs are released from the trap and are oxidized over the active catalyst.

Another strategy is converting older, existing vehicles equipped with two-way catalytic converters to accommodate three-way catalytic converters. This approach requires not only current, advanced converter technology, but also appropriate auxiliary fuel management hardware. Although slightly more complex than the above approaches, substantial reductions in emissions can be achieved. Another factor to consider in pursuing this strategy is the advanced age of the vehicles -- most will be 1980 or earlier model year vehicles.

With evaporative emissions responsible for approximately a third of California's ROG emissions from light-duty vehicles, considerable opportunity exists to reduce these emissions by upgrading evaporative emission controls on existing vehicles. For example, General Motors has suggested that a relatively simple modification to the evaporation canister could reduce evaporative emissions from existing vehicles.

4.0 EMISSION REDUCTION BENEFITS OF CONTROL UPGRADES

The various approaches to control upgrades will be characterized by varying costs and emissions reductions. A detailed analysis of the costs will be needed. However, if a market can be created for control upgrade packages, significant emission reduction appears possible.

To illustrate the emission reduction potential of upgrades, preliminary data on three control upgrade strategies are discussed below. Although preliminary in nature, the data suggests significant potential to reduce HC, CO, and NOx emissions from the existing California light-duty fleet.

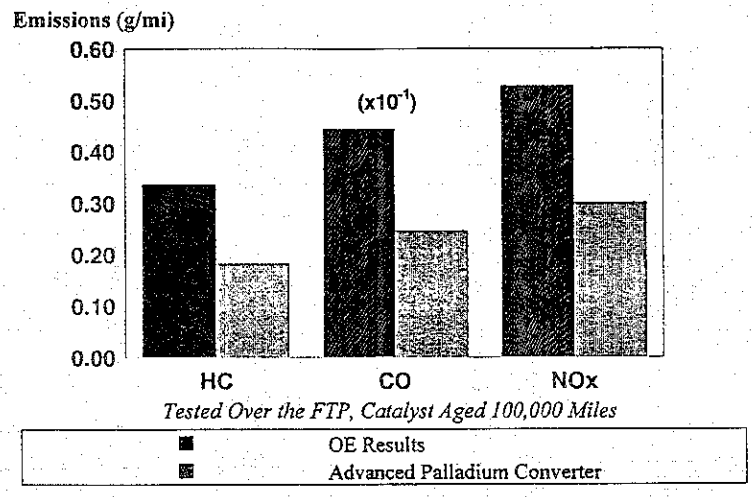
4.1 Upgrading to An Advanced Palladium Catalyst Formulation:

A simple approach to control upgrade would be to install an advanced catalyst formulation on an existing vehicle. The emissions benefits of employing such a strategy is shown below. The test was performed with a 100,000 mile simulated aged advanced catalyst formulation converter on a 1992 vehicle with a 4.6 liter, V-8 engine. The upgrade converter, although an advanced palladium formulation, used loadings similar to the OE catalyst. Hence, even better performance could be achieved with higher loadings. The installation of the advanced design converter reduced emissions by 46% for HC, 45% for CO and 43% for NOx (see Figure 1).

Figure 1

THE USE OF AN ADVANCED DESIGN PALLADIUM CATALYTIC CONVERTER

(8 cyl., 4.6 liter, 1992 vehicle)



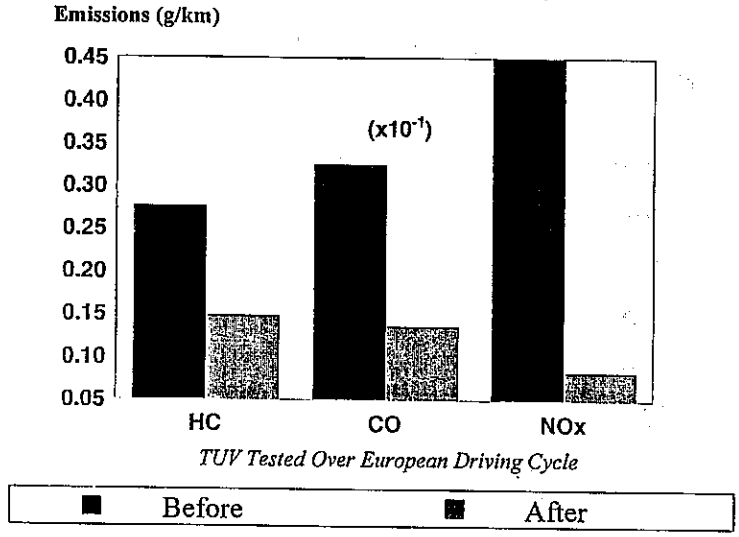
4.2 The Addition of a Light-Off Converter

A 1992 Jeep Grand Cherokee equipped with a 5.2 liter, V8 engine was tested by TUV of Germany, the country's government authorized testing facility. The vehicle had only accumulated approximately 5,000 miles at the time of the investigation and hence, the emission control system is assumed to have been performing well. The vehicle was tested over the European driving cycle as it was received and subsequently, retested with the addition of a light-off catalyst. The small (3.54 in. dia. x 2.93 in.) light-off catalyst was installed after the "Y" in the exhaust system approximately two feet from either manifold and three feet in front of the main underbody factory installed converter. The light-off converter used an advanced technology washcoat placed on a thin metal foil substrate. The results of the test are shown in Figure 2 below. As can be seen, the installation of the light-off converter on the Grand Cherokee reduced emissions by 46% for HC, 58% for CO, and 81% for NOx.

Figure 2

ADDITION OF A LIGHT-OFF CONVERTER

(8 cyl., 5.2 liter, 1992 vehicle)

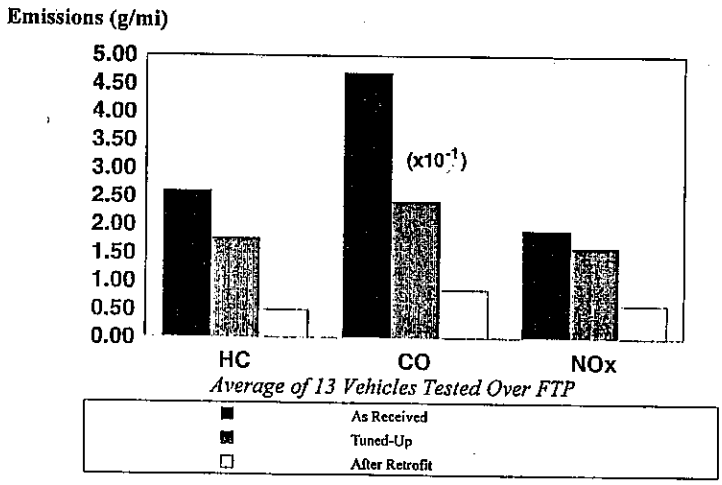


4.3 Upgrading Two-Way Systems to Three-way, Closed Loop Systems

Thirteen older (MY 1975-1979) vehicles were studied to quantify the emissions reductions which could be obtained from converting these vehicles from two-way catalyst, open-loop emission control systems to three-way, closed-loop systems, and installing a new certified aftermarket converter. The results of the investigation are shown in Figure 3.

Figure 3

COMPARISON OF THREE-WAY, CLOSED-LOOP RETROFIT TO TWO-WAY, OPEN-LOOP VEHICLES



As shown, the control upgrade reduced emissions significantly. If compared to the emissions of the vehicles after they had been tuned-up, average reductions of 72% for HC, 64% for CO, and 62% for NOx. These reductions increase to 81, 82, and 69 percent respectively if compared to the emissions of the vehicles as received.

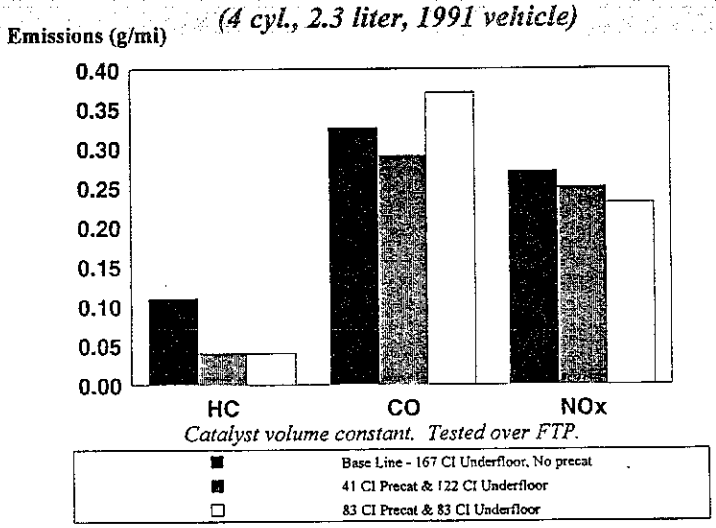
4.4 An Investigation of Catalyst Location:

A recent Society of Automotive Engineers technical paper (SAE Paper 922338) reported the results of an investigation comparing different converter configurations and volumes to emissions performance. The testing was performed on 2.3 liter 1991 vehicle and all converters were rapidly aged to a 50,000 mile equivalent. The baseline configuration included one 167 cubic inch (in^3) underbody converter. Two additional configurations tested included the addition of light-off converters. The first employed a small (41 in^3) light-off converter combined with a 28 percent smaller volume (122 in^3) under body converter, and the second employed a light-off converter combined with an underbody converter both of a 83 in^3 volume (50 percent of the baseline underbody converter). Therefore, total catalyst volume remained approximately constant for all configurations. The results are shown in Figure 4.

Figure 4

COMPARISONS OF DIFFERENT CATALYST LOCATIONS ON PERFORMANCE

(4 cyl., 2.3 liter, 1991 vehicle)



Source: SAE 922338

The tests show that significant reductions (greater than 60 percent) in HC emissions can be achieved by moving a portion of the catalyst volume close to the manifold. At the same time, a 10 to 15 percent NOx reduction is achieved. Although CO emissions increased in the instance where 50 percent of the catalyst volume was placed in a close coupled location, this result was probably the result of the particular washcoat and precious metal

compositions used. It should be emphasized that the catalysts used in this testing program were not optimized; significantly improved results could be achieved by employing thin-walled substrate, increased cell densities, and optimized washcoat and precious metal formulations.

4.5 Additional Aftermarket Converter Installation Data

Emission control upgrades are designed by definition to be OE equivalent or better. Although aftermarket converters are not manufactured to the same specifications as OE converters, data generated by an advanced formulation aftermarket converter of lower loadings and volume can be used to illustrate the potential of emissions control upgrades (see Figure 1 for results of OE equivalent upgrade).

In one investigation, both two-way and three-way aftermarket converters were installed on vehicles to quantify the emissions reductions achieved over the FTP. Once these reductions had been quantified, the converters were aged to 25,000 miles then retested to quantify deterioration. In the case of the tests of the two-way converters, two 1979 Ford F250 light-duty trucks with 40,000 and 110,000 accumulated miles were used. Both trucks had 7.5 liter engines. For the three-way tests, a 1989 3.8 liter Mercury Sable with 63,000 miles and a 1988 5.9 liter light-duty Dodge truck were used. The results of the tests are shown in Figures 5 and 6.

Again, although not completely representative of a control upgrade, the reductions achieved by the simple installation of an aftermarket converter serves to highlight the minimum reductions that can be expected with an OE or better control upgrade.

Figure 5

COMPARISON OF IN-USE EMISSIONS TO FRESH AND AGED AFTERMARKET CONVERTER EMISSIONS

(Two-way A/M Converters)

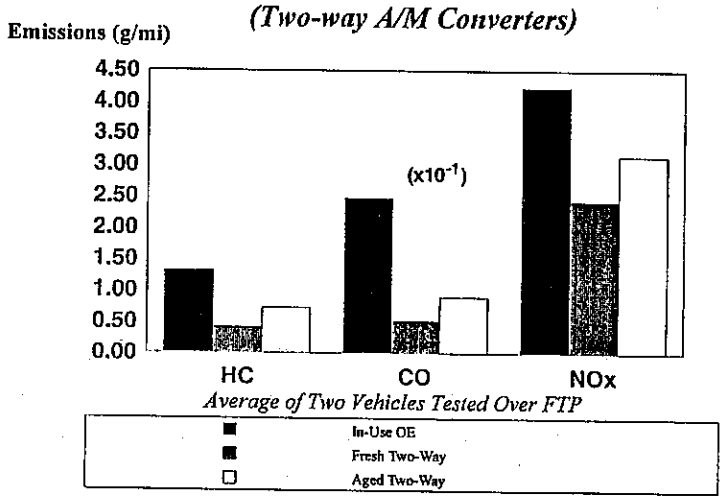
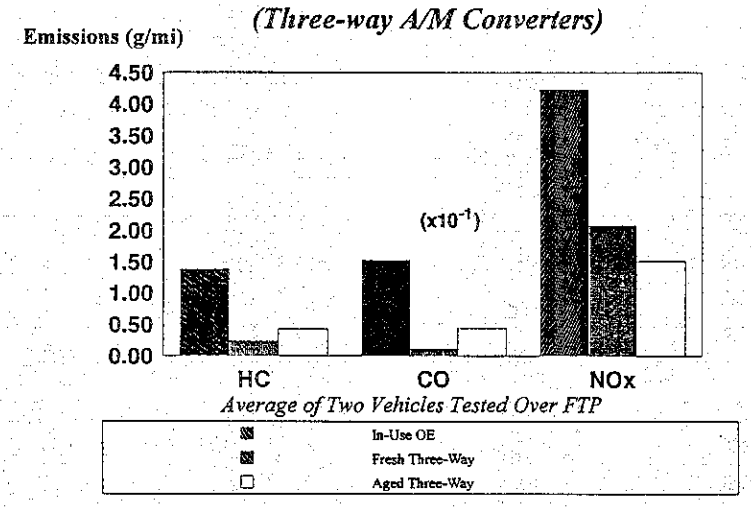


Figure 6

COMPARISON OF IN-USE EMISSIONS TO FRESH AND AGED AFTERMARKET CONVERTER EMISSIONS

(Three-way A/M Converters)



4.6 Analysis of California Air Quality Benefits:

In order to take a preliminary look at the potential air quality benefits that an emission control upgrade program could offer California, two analyses have been performed.

The first analysis uses:

- data from Section 4.2 which quantifies the emissions reductions obtained by installation of a light-off converter,
- CARB in-use emissions data (model years 1981 to 1989) summarized in Table 2,
- CARB's reported passenger car fleet data for the same model years reported in Table 1 and an average daily trip of 29 miles.

An emission control upgrade program could be designed to target relatively high emitting vehicles for maximum benefit. For this reason, a second analysis was performed. In addition to using CARB passenger car fleet and VMT data, in-use emissions data from **Sunoco Emission Systems Repair Program** performed in the Philadelphia, PA area from February 15, 1994 to April 2, 1994 was used. In this study, over 3,000 vehicles were detected as high emitters by remote sensing in this period. Of these, over 300 underwent IM 240 testing. The results of these tests were used to calculate in-use emissions levels. The number of high emitting vehicles represented 4.2 percent of those vehicles which were screened by the remote sensing station. Of these, 70 percent failed the I/M 240 test. For our analysis, the in-use emissions levels (Table 3) calculated from the Sunoco study were

applied to 2.94 percent (70 percent of 4.2 percent) of California's 1981-1989 passenger car fleet. Again, the control upgrade strategy outline in Section 4.2 (e.g. a light-off catalyst) was used to determine the emissions reductions possible.

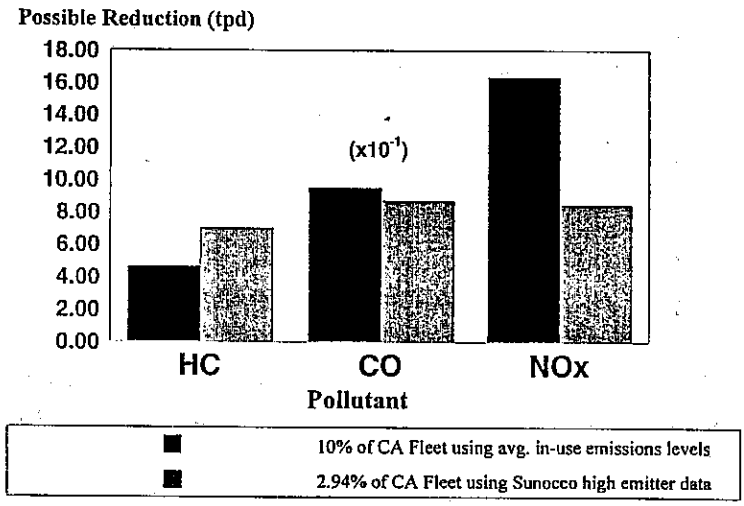
Using the first analysis and assuming 10 percent of the 1981 to 1989 California passenger car fleet was upgraded with a light-off converter as described in Section 4.2, emissions would be reduced by 4.63 tons per day (tpd) for HC, 95.04 tpd for CO, 16.35 tpd for NOx respectively as shown in Figure 7. This is equivalent to over 1650 tons of HC, 34,500 tons of CO, and almost 5,950 tons of NOx on an annual basis.

The results of the second analysis indicates that the addition of a light-off converter on 2.94 percent of California's 1981-1989 model years fleet representing the higher emitting vehicles would reduce HC emissions by 6.99 tpd, CO emissions by 86.98 tpd, and NOx by 8.44 tpd. This is equivalent more than 2,500 tons, 31,500 tons, and 3,000 tons respectively on an annual basis. A comparison of the reductions achieved for HC, CO, and NOx under the two scenarios is shown in Figure 7. The significant difference in the results found for NOx in the two instances, may be explained by the fact the remote sensing device used in the Sunoco study was designed for HC and CO, not NOx. Hence, it is quite possible that many high emitting NOx vehicles went undetected and were not included in the Sunoco study. Therefore, in reality, larger NOx reductions can be anticipated.

Figure 7

POTENTIAL DAILY EMISSIONS REDUCTIONS

2 Case Studies (avg. emission levels vs. high emitters ('81-'89))



5.0 CERTIFICATION PROGRAM DESIGN AND IMPLEMENTATION

The certification program implemented to evaluate candidate control upgrade equipment must effectively screen systems and properly quantify the emissions reduction. At the same time, the certification program should not be so burdensome as to discourage the certification and utilization of effective emission control upgrade systems. Also, a method of calculating the life-cycle benefits of a particular upgrade strategy on specific vehicles will need to be developed.

There are several emission control programs which could be drawn upon to fashion a certification program, including the California's aftermarket converter regulations, the U.S. EPA urban bus engine retrofit/rebuild program, and the California fuel conversion emission credit program.

Development of an effective and cost efficient certification process will best be developed through the cooperative efforts of California state and local air quality officials, interested private sector parties and the environmental community.

Effective enforcement will also be a critical component of a successful program. In particular, steps must be taken to insure proper pre-conditioning of the vehicle and proper installation of the upgrade kit.

5.1 Recommended Elements of Certification Program

Emission Performance Evaluation -- To maximize the flexibility and effectiveness of an upgrade program, each upgrade kit should be judged individually on its emission reduction capabilities, rather than requiring an upgrade system to meet a specific standard (e.g. such as requiring an upgrade control to enable a vehicle to meet a TLEV or LEV standard). This can be accomplished by assessing emission reduction through back-to-back emission testing on a designated "worst case" vehicle. Such an evaluation would take place after the device tested has been aged either through operation on a mileage accumulation vehicle or by an acceptable accelerated aging procedure.

6.0 CREATING A MARKET FOR EMISSION CONTROL UPGRADES

Since installation of emission control upgrades is likely to represent a cost in excess of the amount the consumer would be willing to pay, some additional incentive and/or third party source of funding will need to be developed. Possible concepts to promote and/or help cover the cost of upgrades might include:

- *Employer pays for upgrade as means of meeting employee trip reduction obligations* -- In combination with, or in lieu of employer efforts to reduce trips by its employees, an employer could fund a program under which its employee's or other's vehicles would be screened and targeted for either remedial repairs, emission control upgrade, or

scrappage. For those vehicle owners participating in the program, the employer would fund all or part of the expense.

- *Rebates on registration/vehicle tax and other incentives* -- Consumers participating in the emission control upgrade program could receive rebates for vehicle registration fees and taxes, as well as other benefits including preferential parking.

- *Emission credit generation and sale* -- The emission control upgrade program could be folded into existing emission credit trading programs.

- *Upgrade program incorporated into the California SIP scrappage program which contemplates nearly $1 billion in public/private funding over a 10 year period* -- A key component of California SIP is a multi-vehicle scrappage program. That program could be expanded to include emission control upgrades. As vehicles are scrapped, the per-vehicle cost is expected to increase as the supply of vehicles available for scrappage decreases. At some point, incorporating an upgrade component into the program could prove very cost effective.

7.0 PILOT PROGRAM

To assess the potential benefits of an emission control upgrade program for gasoline-powered light-duty vehicles, a multi-vehicle pilot program evaluating several upgrade strategies should be implemented. The program could be developed through the cooperative efforts of CARB, interested local air quality districts, private sector companies and emission control manufacturers. MECA would be interested in participating in such a program and MECA member companies would be willing to provide emission control technology hardware and technical support.

8.0 CONCLUSION

Even with further emission reductions from new on- and off-road vehicles and engines, consumer products, and stationary sources, additional reductions of pollutants will be necessary to enable California to meet its goal of clean air by 2010. Reducing emissions from existing passenger cars and light trucks is an available strategy. Emission control upgrades, used in combination with other strategies for reducing emissions from existing vehicles, has the potential for providing significant emission reductions of ROG, NOx and CO.

A number of technical and program implementation issues exist; perhaps the must challenging is identifying sources of funding and/or incentives to underwrite the costs of such a program. We believe these challenges can be overcome and would welcome the opportunity to work with air quality officials and private industry in California to further evaluate the potential of the emission control upgrade concept.

Statement
of the
Manufacturers of Emission Controls Association
on the
Air Resources Board's
Proposed Amendments to the Certification Procedures for all On-Road Motor Vehicle Retrofits and Proposed Optional Retrofit Emission Standards for Heavy-Duty Engines and Vehicles

July 24, 1994

The Manufacturers of Emission Controls Association (MECA) is pleased to present written testimony in support of the Air Resources Board's proposed revisions to its regulations covering retrofits. We wish to commend the Board and staff for their continuing efforts to develop and implement an effective retrofit program and for expanding the program to include conventional fuel retrofits. We concur with ARB's view that including the opportunity to certify such exhaust aftertreatment devices as catalytic converters and diesel particulate traps or filters will provide significant additional emission control opportunities.

MECA is a non-profit association of companies that manufacture various motor vehicle emission controls. Our membership includes companies with extensive experience in developing and manufacturing control technology such as the catalytic converter and diesel particulate filters. Currently, these companies are developing and producing control technologies for a variety of on- and off-road vehicles and engines.

In proposing these regulatory revisions, ARB has demonstrated a willingness to modify its requirements to ease the administrative burdens of certification while preserving the integrity of the program. ARB's efforts will no doubt facilitate operator participation in the fuel conversion/conventional fuel retrofit program. We hope that ARB will continue to show this flexibility should additional certification and durability demonstration issues arise as more experience is gained with the new procedures.

We would like to offer the following specific comments on the proposed revisions:

- Under Section 1) e, non-credit generating alternative fuel retrofit systems for model years 1994 and earlier vehicle and engines are given the option to certify under the proposed procedures. We believe that including conventional fuel retrofits, including heavy-duty vehicles and engines, under the provision would provide substantial additional control opportunities. A number of our members have been providing heavy-duty retrofit aftertreatment control systems to the off-road market for over 25 years with over 100,000 systems having been installed. These technologies are readily adapted to heavy-duty on-road vehicles and could provide substantial air quality benefits. More recently, MECA member companies have been demonstrating technologies to be certified under EPA's urban bus rebuild/retrofit program. In fact, one system has already received certification. Other

MECA members have performed considerable development and continue their efforts in the area of conventional fuel retrofits for pre-1994 light-duty vehicles. Hence, we believe that a broad spectrum of technologies will be available for certification under ARB's retrofit program and that by including conventional fuel retrofits for vehicles and engines manufactured before 1994 would provide significant additional control opportunities in the State of California.

Further, we believe that including both pre-1994 conventional fuel and alternative fuel retrofits for credit generation under the proposed revisions would give operators incentive to use retrofit technology developed for these vehicles and further provide considerable and quality benefits for the State of California.

- MECA concurs with ARB's proposal to allow carry-over and carry-across emission test data as a part of the certification procedures. This will allow manufacturers to certify products for a wider range of vehicles and engines and will provide additional air quality benefits. It is our understanding that ARB would allow certification data carry-over in a manner similar to the light-duty aftermarket converter procedures where worst case vehicles can be used or in the case of heavy-duty vehicles and engines, procedures similar to those of EPA's urban bus rebuild/retrofit program.

We hope our comments are helpful to the Board in its consideration of the proposed revisions to the certification procedures for all on-road motor vehicle retrofits and proposed optional retrofit emission standards for heavy-duty engines and vehicles.

GOLDEN STATE NATURAL GAS SYSTEMS
C.L.I. Authorized Distributor

95-8-1
7/27/95

JDD TAC
JB Legal
MSD

July 27, 1995

Chairman Air Resources Board
and Board Members

Dear Members;

Topic:
ARB Hearing, July 27, 1995
Heavy Duty Engine Certification Procedure
and Emissions Reductions.

Certain issues have caught my attention that I would like to have the board address. The focus of todays hearings are related to Heavy Duty Engines and Vehicles.

The following first two pages contain what was to be my original outline for public comment. Pages three and four represent a partial list of issues I would like the ARB Board to address. Pages five, six and seven demonstrate the ability of GSNGS and CLI in addressing air quality issues. The KG-5000D series equipment has been proven world wide to be reliable, cost effective and energy efficient.

Thank you for the opportunity to present our concerns and opinions.

Sincerely,

Kevin Weddle, President

1747 Live Oak Blvd., Suite J • Yuba City, CA 95991 • (916) 696-2234 • Fax (916) 673-3561

OUTLINE OF TOPICS TO BE DISCUSSED

Presented to: California Air Resources Board

I. California Energy Policy, California Legislative bills.

II. Federal Energy Policy and Clean Air Act.

III. Various Demonstration and R&D progress.

IV. Value of Program Results related to cost, environmental & Energy Security and the taxpaying citizens of California & USA.

V. International perspective, direction and accomplishments.

VI. Brief review of GSNGS and CLI.

VII. Further describe CLI technology.

VIII. Projects, Testing & Certification on a state, federal and International level.

IX. Results of various KG-5000D projects.

X. Insufficient data for support & evaluation at the state & federal level.

XI. Relationships between policymakers, regulators, Utility Co.s, Consultants, California Institute of energy Efficiency and other involvements between said company.

XII. What we propose.

XIII. ARB's decision: To do what is right and be an innovative leader for fair cost, effective clean air products. Or, capitalize on past accomplishments and recognition for gains where clean air and the environment are only to promote other serving interests for larger personal gain at the expense of the people and technology such as myself and my company.

Thank you for your time.

ENERGY AND THE ECONOMY
(CEC 1994)

THE CALIFORNIA & GOVERNORS ENERGY POLICY:

*Fundamental change, reshaping industry.
*California leading the nation.
*Insure energy related businesses and their companies investments with appropriate government support.
*Important to selectively maintain those that have helped previously.
*Certain closely related groups i.e. GRI, Southwest Research, Acurex Environmental, CEC, ARB, Cal-Trans, University of Riverside, West Virginia University, NREL, DOE and Ex-personnel.
*Aggressively promote export of Energy Technology pioneered here in California.
*Maintain leading edge based on past accomplishments which creates an economic benefit along with jobs.
*Work with states energy industry to develop R&D and new technologies. Also work with states Aerospace and high technology companies.
*Our efficiency is embraced Nation wide and by all states.
*The nation has followed our lead.
*CRITICALLY IMPORTANT-LISTEN TO THOSE EFFECTED BY POLICY. THOSE REPRESENTING CALIFORNIA STATE GOVERNMENT MUST INSURE OPEN ACCESS TO ENERGY REGULATORY DECISION MAKING FOR PROVIDERS AND ALL CONSUMERS.
*Support programs that create jobs.
*Streamline regulator progress.
*Promote marketing and technology.
*Balance energy, economic and environmental gains.
*Aggressively pursue alternative transportation fuels and technology.
*Implement policy to achieve COST EFFECTIVENESS.
*California or The Policy in revitalizing the economy the state's energy industries can create new high tech. jobs and reduce cost through efficiency gains, while providing ENVIRONMENTAL BENEFITS.
*California is the leader in alternative fuel technology development and exporting.
*THEREFORE CALIFORNIA CAN CAPITALIZE ON IT'S INTERNATIONAL RECOGNITION AND SELL EXPERTISE ABROAD.
*And also CAPITALIZE ON IMPORTANT ENERGY & ENVIRONMENTAL POLICY WITH INDUSTRY & JOBS.
*Coordination is needed to continue between ENERGY, TRANSPORTATION AND ENVIRONMENTAL AGENCIES TO INCREASE STATES ECONOMIC BASE.

THE FEDERAL GOVERNMENT HAS SPENT 61 MILLION DOLLARS CALIFORNIA WANTS TO INCREASE TAXES $2.77 BILLION DOLLARS

Dr. Herbert Flores PH.D.
Heavy-Duty, CEC
10 years experience, manager
Radian Corp. CEC & Veracruz International University

To promote the research, development, demonstration of vehicle engines and fuel technologies that are more energy efficient, less polluting and less dependent upon petroleum fuels than current technology.

*Design program-address market needs/opportunity.
*Secure funds (state and federal).
*Prepare requests for proposals.
*Review proposals and competitively award funds.
*Help insure program execution/success.
*Gather & analyze data.
*Summarize & Disseminate to public & private sectors.
*Assist in developing energy policies based on program results.

*PARTNERS:
Local, state/Energy & Air Pollution Agencies.
Vehicle/Engine Manufacturers
Energy Utility Companies
Fleet managers.

*RESULTS TO DATE:
AFT in Heavy-duty can work (technically/feasibly)
Reduce NOx emissions 50% or more (to 0).

*NEEDS:
Provide durability and reliability.
Market incentives for economic viability.

*MEDIUM DUTY CNG DEMONSTRATION:
Using the most advanced retrofit kit.
Dedicated engine repower & OEM Technology.
3 years of data.

Paul Wuebben:
Oversees development & commercialization activity.
*Chairman of Technical review committee under AB 2297.
*Alternate fuels representative to California Assembly.
*Consultant to Nomura Research Institute.

GOLDEN STATE NATURAL GAS SYSTEMS
C.L.I. Authorized Distributor

GOLDEN STATE NATURAL GAS SYSTEMS

PROVIDING CLEAN AIR AND COST EFFECTIVE SOLUTIONS

FOR

THE STATE OF CALIFORNIA

A. CLEAN AIR SOLUTIONS FOR AIR QUALITY MANAGEMENT DISTRICTS.

1. Golden State Natural Gas Systems is working toward the solution of Clean Air Quality Issues.
2. Golden State Natural Gas Systems is a Small Minority Business submitting Projects to clean the air by way of a California Air Resources Board Certified Dual/Fuel Retrofit Conversion Equipment (the KG5000-D) manufactured by Carburetion Labs Int. Inc. of Miami, Flordia. This Equipment has been used on various Medium Duty and Heavy Duty Vehicles, along with Stationary and Locomotive Applications.

B. TESTING OF EMISSIONS:

1. Golden State Natural Gas Systems has proved that the KG5000-D Conversion Kit performs consistantly and at the same time reduces emissions in a cost-effective manner. With the use of the Enerac 3000 measuring the amount of pollutants, NOx emissions can be tested and verified in-field and on-sight when needed.

C. TECHNOLOGY:

1. The KG5000-D Conversion Kit has proved emissions reduction capable through testing for Certification by the California Air Resources Board, MTA for private clients, on locomotives utilizing in-field Testing Procedures, under UMTA random emission checks, and for the Japanese Government.

1747 Live Oak Blvd., Suite J • Yuba City, CA 95991 • (916) 696-2234 • Fax (916) 673-3561

D. WHY THE KG5000-D CONVERSION KIT?

1. The KG5000-D Conversion Kit is a Cost-Effective means to Alternative Fuels and Emission Reductions. The Kit allows the Fleet Manager to utilize his existing equipment while maintaining the original characteristics of the diesel engine to reduce operational costs, increase the performance of his Fleet, reduce emissions, and eliminating the possibility of equipment down time due to interruption of fuel supply.

E. RESOURCES AVAILABLE:

1. Golden State Natural Gas Systems has established a unique relationship with a "Diverse Association" of Companies with expertise in a wide array of service areas. What we refer to as "The Team Approach" in satisfying the customer's needs.

*REFERENCES AND INFORMATION SUPPLIED UPON REQUEST.

GREATER SACRAMENTO REGIONAL
CLEAN AIR COALITION

MEMBER: GOLDEN STATE NATURAL GAS SYSTEMS, INC.

Golden State Natural Gas Systems is the California Distributor for Carburetion Labs International, Inc. of Miami, Florida. Carburetion Labs is the manufacturer of the KG-5000D diesel/ natural gas conversion system. This retrofit conversion system enables any existing diesel engine to be converted to run on a mixture of diesel and natural gas. The process is known as fumigation, which enables the OEM intake design fo the engine to be utilized. The existing characteristics of the diesel engine are maintained allowing for a cost effective means to convert a diesel engine to an alternative fuel--Natural Gas.

For the past six (6) years, Golden State has been involved with the California Air Resources Board (CARB) certification process for the KG-5000D equipment, product evaluation by the three (3) major California Utility companies, establishing a california dealer network by working with various ARB and local AQMD agency personnel, the implementation of a training and certification program for qualified dealers and implementation of installation facilities throughout california.

Demonstration and evaluation programs have been conducted at numerous locations such as the city of Long Beach fleet services Bureau, (see attached) San Diego Gas & Electric, Pacific Gas & Electric and also the Californian Energy Commission under the CEC's medium duty vehicle program. These programs are done to evaluate the driveability and durability of the equipment, ease and cost of conversion, fuel consumption ratios (%), cost associated with the operation of the vehicles, and market acceptance potential by the diesel fleet operators.

Training and certification programs have been conducted at various locations in California since June of 1993. Currently thirty eight (38) individuals have been certified through our training programs. (See attached #2 and #3).

Equipment evaluation, research and development and emission testing are a continuous on going event coordinated by the Manufacturer, Carburetion Labs, with input from Golden State and various installers and end users. Our main interest at Golden State Natural Gas Systems is to work with various public and private entities so we are able to offer the diesel fleet user a cost effective means to switch to an alternative fuel, specifically Natural gas, while maintaining compliance with local, state and Federal emission regulations.

Sincerely,

Kevin Weddle

Carburetion Labs International Inc.
515 N.E. 190 Street
Miami, FL 33179
Phone 305/651-2220
Fax 305/651-9360

July 26, 1995

Mr. Kevin Weddle
Golden State Natural Gas Systems
1747 Live Oak Blvd.
Suite J
Yuba City, CA. 95991

Dear Kevin:

Thank you for the data which you provided us on the Cummins L-10 emissions test which was conducted at Valley Detroit Diesel. As you know, these tests were conducted with the use of the ENERAC 3000 emissions analyzer and provided data on NO, NO2, NOX and CO.

The results of this preliminary test show promising results for our TLEV program from the standpoint of emissions reductions as well as the feasibility of administering the test in a timely, efficient and cost effective manner. Although this preliminary test did not incorporate the full TLEV test schedule, it certainly demonstrated the viability of the concept.

The NOX results produced during this test series are encouraging. The baseline 100% diesel NOX concentrations were approximately 698 ppm on average. In comparison, the dual-fuel NOX results were approximately 426 ppm. Thus, we were achieving approximately a 38% reduction in NOX production with the engine operating in the dual-fuel, CNG/Diesel mode.

I find these results very promising considering that the conversion kit which was installed on the Cummins L-10 does not incorporate our most recent kit improvements of which you are aware. This includes our upgraded catalyst, new Diesel FCV (Flow control valve) or our new Diesel/Gas EGR system which we are now using in Japan.

We look forward to working with GSNGS in the implementation of the TLEV program in the near future. As always, if you have any questions, please feel free to call.

Sincerely,

Jason Green
Vice President