Clean Air Act Advisory Committee
Mobile Sources Technical Review Subcommittee
Ramada Inn - Detroit Metropolitan Airport
Detroit, Michigan
December 1, 1995

INTRODUCTION

Margo Oge, Director of the EPA Office of Mobile Sources, opened the meeting, thanked the participants for attending (and Mike Walsh for flying through the night to attend), and introduced Chris Grandler who previously served as the Director of the Great Lakes Program and was recently named as Deputy Director of the Office of Mobile Sources. She also announced that Bob Maxwell of EPA has announced his retirement. She thanked him for his service to the Agency and wished him well in his new endeavors.

Ms. Oge briefly discussed the Heavy Duty NO_x presentations that are outlined below. A Statement of Principles (SOP) was recently signed by EPA, the State of California, and the on-road engine manufacturers. The ultimate goal of the SOP is to reduce NO_x emissions from HD on-road engines by 50 percent. The SOP is discussed in the following sections.

WORKGROUP PRESENTATIONS

Each of the three subcommittee workgroups reported on the status of their work to date, as follows:

Modeling Workgroup. The group met on November 30 and made significant progress. Specifically, three subgroups had been formed to focus on the following tasks:

Set priorities for MOBILE5 revisions so that key analyses and improvements occur;
Develop a procedure to review full revisions to the model and incremental changes to model outputs; and
Develop a statement on model validation.

EPA has developed a list of roughly 100 proposed revisions to the model that the workgroup members have ranked as high, medium, or low. Randy Guensler added that the modeling workgroup will be surveying stakeholders to identify ongoing and planned analyses as sources of data.

In-use Deterioration Workgroup. The group passed a draft charter and plans to pursue the following tasks:

Identify sources of in-use performance data;
•. Identify what mechanisms might be used to reduce emissions due to in-use deterioration; and
Review technological solutions, fuels, and owner behavior as possible remedies to the problem.

One potential problem faced by the group includes the relevance of older data to the performance of the current fleet. The group would like to look for opportunities to understand the current fleet and future fleets. The group will develop a work plan and a list of data sources with information on the current fleet that may apply to future fleets.

Certification Program. This proposed work group has not been formed as of this meeting. (See the presentation by Bob Maxwell discussed below.)

HEAVY DUTY (HD) NO_x STATEMENT OF PRINCIPLES (SOP)

Chet France, EPA, presented on the HD diesel engine initiative. The SOP commits EPA and CARB to work together on a national program for HD engine NO_x emissions with a commitment to reduce NO_x emissions by approximately 50 percent by 2004.

The SOP also commits the parties to stabilize the particulate standard at 0.1 g/bhp hr. Ultimately, the goal is to extend the useful life of engines and focus on issues surrounding rebuilt engines. The parties are committed to look at averaging / banking / trading programs to create flexibility and incentives for early introduction of technologies. EPA will re-examine the standards by 1999. There is an obligation to examine HD engine emission technology in a holistic fashion that includes the use of fuels to meet the 2.0 gram NO_x standard. A long term research program will focus on developing an engine that meets a 1.0 g/bhp hr NO_x and 0.05 g/bhp hr PM10 standard.

Expectations. The main objective is to reduce NO_x emissions. By 2020, EPA expects a NO_x reduction equivalent to reducing the number of cars by 25 million, or 900,000 tons/yr. The Agency also expects an HC reduction of 100,000 tons.

Next Steps. EPA is actively working on the NPRM. Simultaneously, EPA is developing a non-road SOP based on the on-road SOP, and expects to finalize a rule by the end of the year. EPA is also preparing for a 1999 review of the standards. The 1999 review must address a number of issues including the feasibility of 2004 standards, an assessment of the cost-effectiveness of technologies, and the emission effects. Any fuel improvements would need to be implemented prior to 2003. The charge to the subcommittee is to recommend a methodology to meet the SOP goals and provide advice on relevant issues and data gaps that need to be addressed.

Comments. A question was asked whether the time frame for fuels may limit EPA. EPA noted that Cummins will present today on engine and fuel technologies. Margo Oge emphasized that it is critical for dialogue to begin now to identify stakeholders and data needs. She stated that the goal is to look for technology changes to meet SOP goals. One of these technologies is fuels. Steve Gerritson noted that the OTAG process is looking at mobile sources. He asked whether costs for mobile source NO_x reductions have been examined so they can be compared to stationary source options. Chet France responded that costs have to be considered in any rulemaking, and Margo Oge noted that numbers are being developed and will be made available.

PRESENTATIONS

Four presentations were given on the topic of the relationship of fuel properties and engine technologies to HD diesel engine emissions.

Presentation by Glenn Passavant and Dave Korotney, EPA

Glenn Passavant and Dave Korotney, EPA, presented current information on the effects of fuel on engine emissions. EPA believes that emission reduction technologies will include both hardware (i.e., engines) and fuels. It has been over 20 years since EPA placed standards (1974) on heavy duty vehicles. Initially, EPA developed the transient test based on gasoline technologies and a 1.3 g/bhp hr HC and 10.7 g/bhp hr NO_x standard. The NO_x standard dropped to 4.0 g/bhp hr in 1988. The PM standard dropped from 0.8 to 0.1 g/bhp hr by 1994 (0.07 g/bhp hr for buses). There is currently an effort to move to a NMHC + NO_x standard. Most of the changes required to meet these standards have been due to engine control technologies. As the technologies are phased in, in an evolutionary fashion, emission reductions occur. Electronic engine controls, fuel system upgrades, and oxidation catalysts have been the key technology changes. Today, there is a sulfur limit on diesel fuel, a cap on aromatics (35 percent), and a minimum cetane number (@40). There have also been changes in the additive packages.

Dave Korotney reviewed preliminary analyses on available data, the gaps in the data, and what is required to meet the 1999 review. He noted that there are many inferences that can be drawn, but there are numerous issues that would benefit from subcommittee input. He presented a list of reports that have analyzed fuels (but not additives). The studies cover many engines, fuels, and test cycles. EPA's analysis has relied primarily on CRC data to develop its trends analysis. EPA used specific criteria to choose data for its analysis (e.g., only transient cycle data).

Other study findings are as follows: nitrogen may effect NO_x emissions, but this is often not measured in analyses; hydrogen-to-carbon ratios may be important; raising the cetane number from 45 to 53 can result in a NO_x reduction from 1 to 4 percent (the 4 percent figure came from CRC data that were averaged across all engines); and lowering aromatics from 30 to 10 results in a 4 percent decrease in NO_x.

Regarding particulates, if cetane is increased there is a NO_x reduction. CRC found no effect from aromatics. However, EPA found an effect. Furthermore, as specific gravity is increased, particulate emissions rise.

EPA plans to use these data but is looking for better information from other engines. For example, will new engines give similar effects? Also, there is some question about comparing transient vs. steady-state testing. The Colorado School of Mines is studying sulfur effects on engines, and EPA is looking for other analyses.

Regarding technology, EPA expects to see engine redesigns and advances in fuel and air controls.

EPA is seeking to understand integrated diesel systems (for example, the relationship between fuels and engines, fuels and after-treatment, and engines and after-treatment). Understanding these relationships will enable EPA to optimize its approach to regulating these engines, fuels, and emissions.

One member cautioned that the EPA and CRC comparisons may not be as significant as the statistical evidence shows. A question was asked about in-use performance of heavy-duty diesels. EPA responded that the Agency has several small in-use studies that have found that well-maintained diesels do not deteriorate in-use. EPA only has data on light-duty vehicles for the newer technologies such as EGR. EPA believes that these new technologies, when used on diesels, may deteriorate, and they need to be examined. EPA is discussing with states how to develop in-use tests for diesels. EPA added that OBD is not being proposed for heavy-duty vehicles, but may be included by manufacturers.

Presentation by John Wall, Cummins Engine

John Wall gave a presentation titled *HD Emission Control Potential: The Diesel and its Alternatives*. Because of the sulfur content in fuels in the late 1980s, it was not technologically possible to meet particulate standards. The integration of new fuels and engine technologies will have significant effects on NO_x and particulate levels.

Why use a diesel engine? The gasoline engine is often superior in size (smaller) and noise (quieter) than a diesel engine. However, the fuel efficiency and durability of diesel engines are superior to other technologies. The high temperature of diesels is fuel efficient but causes increased NO_x emissions.

The introduction of any technology is based on the proposed willingness of a customer to buy the engine. Cummins must develop an integrated package that customers prefer in order to introduce new technologies into the fleet. Several variables affect the creation of NO_x including limiting the peak temperature, intake manifold temperature, and injection shape. Cummins is trying to elevate the temperatures in the late stage to burn off particulates. One issue is how fuel effects can help manage temperatures and allow Cummins to work within a narrow temperature range. Cummins is currently running 2-3 gram NO_x engines in their laboratories. To achieve these results, Cummins has designed a 40 percent increase in injection pressure, 25 percent increase in cylinder pressure, and significant exhaust gas recirculation rates.

Engine redesigns can cause problems such as more frequent oil change requirements, lower fuel economy, and possible maintenance problems due to the higher loads, in addition to the higher costs of EGR. Cummins has certified engines with CNG at 1 to 1.5 g/bhp hr NO_x, but the fuel economy with this technology is not what customers currently expect for diesel.

Cummins also analyzed the effects of fuels on NO_x. Cetane and aromatics affect combustion differently. An increase in cetane number reduces the pre-mix combustion. Aromatics affect the bulk of the combustion event. Cummins examined the effects of fuels on low NO_x engines (1996 model B series TLEV with EGR). This engine is certified at 3.9 g/bhp hr NO_x + HC on California CERT fuel. Three fuels were used:

EPA 35 percent aromatics, 47 cetane
CARB 11 percent aromatics, 53 cetane
Specialty 14 percent aromatics, 64 cetane

Cummins found that the latter fuel resulted in a 0.6 g/bhp hr reduction in NO_x. They looked at the sensitivity to HC and found that the same fuel resulted in a significant reduction in HC (0.1 g/bhp hr). The combined HC + NO_x reduction is 0.7 g/bhp hr.

Mr. Wall made a note that he is not pointing to any one fuel formula. However, it is possible with low-emission engine technology to extract additional NO_x reductions with fuel modifications.

Another experiment looked at three engines: 1994 N14 (4.4 g/bhp hr NO_x + HC), the B series engine used above, and an experimental engine. Results of approximately 0.5 g/bhp hr reductions occurred across the engines.

Mr. Wall reviewed SAE, Cummins, and Navistar/AMOCO papers that similarly showed that increased cetane number caused significant NO_x reductions. He reiterated that this is not a formula for new fuels but does show that fuel modifications can achieve additional reductions. Cummins then examined introduction scenarios with emissions calculated from model runs using MOBILE5a. The slow rate of turnover in the fleet allows the fuel effect to have a significant impact.

Mr. Wall noted that there are a lot of technologies in the early research phase, including lean NO_x catalysts. Promises have been made in the literature, but many lack scientific support.

He concluded that the best overall approach will be a combination of engine and fuel technologies that will provide the most cost-effective total solution for low NO_x emissions.

Presentation by Bernard Kraus, CRC Studies

Bernard Kraus gave a presentation on the effects of cetane number, aromatics, and fuel oxygen content on HD diesel engine emissions. The CRC studies began in the mid-1980s for the purpose of identifying engines and fuels to meet upcoming standards.

Another study phase looked at the effects of fuel variables on a 1991 prototype HD engine. The test fuels separated effects of aromatics and cetane on particulates and NO_x. There were tradeoff effects found on aromatics (above the 10 percent requirement) at the expense of raising cetane number. Also examined were fuel effects on engines most like the 1994-1998 engines approaching the 4 g/bhp hr NO_x limit. The effect of cetane was also examined on a 1998 prototype engine. Cetane was varied between the low 40s to high 50s. Two additives were examined. Aromatics were varied from 10 to 30 percent. Levels of ether addition, up to 4 percent oxygen, were examined. The studies used the EPA heavy-duty transient test procedure.

Results: Demonstrated results were shown only for fuel effects on NO_x for 4 g/bhp hr engines. (Other data are available but were not presented in the interest of time.) As cetane improver is added, NO_x emissions decrease down to cetane 52 and then level out. As aromatics decrease from 28 to 11 percent, without changing cetane number, NO_x is reduced by 0.2 g/bhp hr. The combined effect is about 0.3 g/bhp hr.

Navistar engine. As cetane number increases, NO_x emissions decrease. The addition of oxygen raises NO_x emissions. The beneficial effects of cetane improver may be limited at higher levels. Particulate penalties are higher in this engine.

1998 prototype engine. As cetane number is increased with improver, NO_x is reduced. High levels of nitrogen in the cetane improver may limit the benefits of adding improver, but there are not enough data to conclusively prove this effect.

Overall, cetane has an impact on regulated emissions for most engines. Natural cetane may give better NO_x effects than those resulting from cetane improvers.
Aromatics reduction was not as effective across all engine configurations and may increase CO.
Adding oxygen increases hydrocarbon, reduces CO and NO_x, and effects a clear reduction in particulates.
Reducing sulfur by 100 ppm reduces particulates by 3 to 5 percent.

- . Higher cetane number helped to reduce particulates.

Fuel parameter changes have significant effects, especially on older engines. However, these effects should not be extrapolated to future low NO_x engines where they may not be as large.

CRC currently is not planning additional research.

Presentation by Joanna Pedley, EPEFE.

Joanna Pedley, representing the European Programme on Emissions, Fuels, and Engine (EPEFE) Technologies reviewed the European efforts to set air quality standards, recent studies on engines and fuels, and cost-effectiveness studies to best achieve the air quality goals of the region.

Europe is looking at integrated assessments from the European Commission (EC), consultation with the European parliament, and the auto and oil industries. The scope covers air quality, emissions, options to address air quality, and cost-effectiveness. The process began in 1991 with an invitation from the EC to bring together the auto and oil industries to examine these issues. On the air quality side, they are developing estimates of emissions from mobile and stationary sources. Goals for 2010 are being developed. The groups have identified gaps between the emission estimates and the goals, and are identifying mechanisms to bridge these gaps.

The auto industry has supplied 1996 prototype engines, and the fuel manufacturers have supplied fuels that allow for controlled studies of fuel variables. Regulated and non-regulated emissions were examined (except for heavy duty vehicles). The diesel analyses were discussed here.

The objective of the diesel analysis was to look at the effects of density and polyaromatics, and cetane. The commission conducted an extensive literature search and excluded mono aromatics due to findings from this effort. Sulfur effects, which are sufficiently well understood, were not examined.

Five HD engines and 16 LD diesel engines were used. The diesel fuels (11) were blended to decorrelate the variables of interest. Parameters were varied: cetane (50 to 58), polyaromatics (1 to 7 percent), back end volatility (325 to 370), and density (830 to 855). The five engines all exceeded the 1996 regulations (7 g NO_x/kW hr, 0.15 g particulate), measured on the European steady state test.

Results. For density, NO_x benefits occur but cause increases in HC and CO. The program examined the sensitivity of each engine to the parameters. Density is the most significant parameter affecting NO_x, but engine types respond differently to density. Small benefits were shown for cetane changes. Regression equations were developed for each of the fuel parameters.

Changing density decreased power and NO_x, but increased brake-specific fuel consumption, HC, and CO. The timing and mass delivery were adjusted, and it was concluded that density effects were a function of interaction with the injection system, i.e., a physical fuel system interaction and not specific to the fuel. If injection is retarded, NO_x will reduce, but at the expense of other areas. The four parameters of the study were shown to adequately describe the emissions changes on a number of vehicles from the fuels. In the LD diesel program, some of the fuel effects were converse to those found in the HD program. This has significant importance for Europe, which has a large LD diesel fleet.

The regression equations were accepted as input into air quality models. Seven cities were examined in the analysis. The main conclusion from the modeling is that current (or planned) mobile and stationary source control measures will result in significant improvements and will allow Europe to meet their targets. Further requirements will be needed to meet NO_x requirements. In order to meet these requirements, stationary sources will also need to be considered.

A summary of the analyses ranked the technologies and fuel changes (gasoline and diesel) for cost. Using NO_x as the driver, these were ranked based on cost-effectiveness (1000ECU/tons NO_x reduced) for major European cities. Severe fuel reformulations were shown to be high-cost solutions. Ozone modeling was performed from Portugal to Finland, and found that severe fuel reformulation will have a small effect on ozone. Stationary sources must be included in any policies to meet NO_x and ozone requirements. Ninety percent of all cities can meet their NO_x targets with currently agreed average fuel quality, enhanced inspection and maintenance, and some improvements in vehicle technologies. For the remaining ten percent, mainly in southern Europe, even the most severe reformulations and other technical measures will not meet the goals. Non-technical measures (e.g., fleet turnover) must be included.

Margo Oge asked how this information will affect standard setting in Europe. Joanna Pedley stated that the EC is drafting air quality targets and fuel quality directives. These are expected by the end of the year. For more detail, much of the research is available, including the literature review (from the EC), and the SAE conference will have several presentations. Steve Gerritson asked about the cost analysis assumptions and the cost increase for fuel. Mike Walsh noted that one draft has shown a 3 to 5 percent increase.

Ms. Pedley noted that transient tests were not used because they are not applicable to HD diesel engines in Europe. Dick Gibbs noted that the difference between LD and HD diesels may have been due to the transient test used for LD vehicles. Pat Raher asked about the differences in the European and US results. Ms. Pedley believes that the fuel effects found in the Cummins and CRC data are in agreement with the European data. However, the 1996 European engines are actually closer to 1994 US engines. John Wall added that the combustion event is more perturbed in the transient test. Pat Raher asked why the Cummins results were larger. John Wall speculated that it may be due to fuel blending and the European focus on polyaromatics as opposed to total aromatics. There also may be combustion diagnostics that may help define the differences. It was also noted that a number of the fuels used in the European tests were also tested at Southwest Research Institute under transient tests. Copies of the presentation will be made available to EPA and through Bob Slott.

Discussion of the Presentations

Mike Walsh opened the floor for discussion of the collection of presentations. Pat Raher reposed his quest for an explanation of the difference among the presentation data. There is a lot of information that leads to conflicting conclusions. How much of the difference is due to the test procedure? Mr. Merrion, Detroit Diesel, noted that the response to cetane was shown to be non-linear and the European data may be at the end of this curve. He also noted that the designation of HD vehicles is different between the US and Europe.

Steve Gerritson noted that there is a potential to reduce pollutants with changes in engine technology, and these reductions can be amplified by changes in fuels, or costs can be reduced by fuel changes. He asked whether the oil companies have been included in the EPA agreement. EPA replied that the oil companies initially responded that there was not a clear demonstration that NO_x reductions were required. Michael Redemer, Texaco, said that there were some problems in the SOP, specifically that the language seemed to say that fuel changes were necessary and that no emphasis is placed on stationary sources. Professor Johnson noted that both fuels and engines are required to test the whole system, especially with respect to after treatment. John Wall believes that the experiments carried out by Cummins and others show that fuel effects will carry over with future engine technologies. Mike Redemer noted that if there is no 2.0 g/bhp hr NO_x engine technology, technology problems may occur that need to be examined before looking at fuels. Bob Slott added that issues such as the use of the vehicle (e.g., speed) and tampering should also be examined.

Mike Walsh asked if there is a need to set up a workgroup to examine these data and help prepare input for the committee to recommend to EPA. Margo Oge seconded the idea because of the need for objective review of the issues. Her hope is that participation by committee members, including fuel providers, will add significantly to the discussion and EPA's progress. Mike Walsh suggested that Alan Lloyd co-chair the subgroup with John Wall. Any other volunteers should approach Mike or Katherine McMillan with their interest. Tina Vujovich suggested calling the American Trucking Association and the California Trucking Association as additional interested parties. A sign-up sheet was distributed among the sub-committee members to volunteer for this workgroup. The volunteers currently on the list are:

Alan Lloyd
John Wall
John Johnson
Bruce Bertelsen
Mike Redemer
George Lauer
Robert Gorse (for Dave Kulp)
David Merrion
John Hyde
General Motors (TBD)

Virginia McConnell asked what kind of cost estimates have been developed. The response was that the rulemaking will cover engine hardware costs and it is unclear how refinery modeling will be included. EPA is coordinating with DOE on this process.

Presentation by Bob Maxwell, EPA

Bob Maxwell briefed the sub-committee on the status of the Compliance Program Reengineering initiative. He began by stating that the compliance issue affects both HD and LD vehicles, although the presentation will focus primarily on LD. As co-chair, Tina Vujovich will ensure that HD issues are kept on the table.

The goals for reengineering are to improve in-use compliance and use the resources of all parties more effectively, and to retain the value of the program. A shift in focus from pre-production to in-use compliance will take place. No changes will occur that would require changes to the Clean Air Act. As part of the process, several industry groups have provided information to EPA. The certification issues include:

Certification timing;

- Test requirements;
- Durability and deterioration;

- Information from manufacturers;
- Fuel economy program; and
- HD vehicles.

Timing. Manufacturers must complete the certification process before manufacturing, which requires pre-production vehicles. EPA has several ideas that include self-certification, automating information, and a focus on post-production activities.

Testing. How many tests should be run per engine family and how many families should be tested? Tests are not always completely adequate for CARB certification. EPA and CARB have tried to coordinate in order to alleviate any remaining differences. Options include broadening the definition of engine family, allowing use of development vehicles, and harmonizing with CARB.

Durability. The current program has a lack of positive assurance that manufacturers estimates will meet real-world durability. The revised concept lets manufacturers develop their own aging techniques and run their own reality program where vehicles are tested in-use and the data are provided to EPA. The goal is to obtain better in-use data.

Information. There are many non-standard forms and a good deal of incomplete information. Letters and special requests must be stored by EPA and manufacturers. Ideas include a standard application, electronic applications, e-mail, a storage format, and harmonizing with CARB.

Fuel Economy. This program is separate from certification and needs to be coordinated with any certification changes. Accuracy is very important because each 0.1 mpg change can have significant implications. Ideas include reducing testing without losing accuracy and using analytical techniques.

Bob Maxwell discussed outreach programs that may be developed to improve in-use compliance. Outreach may solve problems that are not due to how the cars are built, but instead are due to owner maintenance or driving habits. The Statement of Principles is being developed by EPA, the auto associations, and the manufacturers. Many versions have been passed back and forth and immediately revised for further review. The Statement of Principles do not currently contain elements that focus on HD vehicles. CARB is reviewing the document internally to decide on their willingness to sign on to it. They have also been working on ways to streamline their process. Many of the automakers agree to the document in principle but believe that some of the language needs to be revised. They must each pass the document through their various review systems. One recommendation noted that the document should not presume to have solutions to the problem. The Statement of Principles should be more open-ended to allow for new information and novel solutions.

Bob Maxwell emphasized that the charge to the subgroup is to help EPA review the ideas that have been and will be proposed, and to coordinate the information into a coherent proposal. The charge to the subgroup asks that they help create a “living” process that includes a way for information to feed back into the system so that the compliance program evolves with changes in technology and policy.

Margo Oge added that EPA will bring together all of the proposals and will have the workgroup review and coordinate them. She noted that an in-use testing program will need to be developed and should be coordinated with the in-use deterioration group. Mike Walsh suggested that a better use of resources - on the part of both EPA and the manufacturers - will ultimately result in a better outcome. It was noted that the technology may be such that the cars are much better, and the in-use deterioration workgroup should add to this understanding. Tom Cackette hopes that the net resources will be less at the end of this process, so long as the approach is systematic and causes appropriate responses by industry (e.g., building more durable cars). Kelly Brown, Ford, added that they will be supplying data showing that significant improvements have been made. Greg Dana, AIAM, suggested that the automakers may, if given more flexibility, do more to ensure compliance because the Agency has removed many of the intermediate check points. Tom Cackette added that CARB is interested in the lifetime of the automobile, which is well beyond the 100,000 mile point, at least in California.

The meeting was then adjourned.

List of Attendees
Members or Member Alternates
Mobile Sources Technical Review Subcommittee
December 1, 1995

Bruce Bertelsen	Manufacturers of Emissions Controls		(202) 296-4797
Kelly Brown	Ford Motor Company		(313) 322-0033
Tom Cackette	California Air Resources Board		(916) 322-2892
Joe Colucci	General Motors		(810) 986-2526
Gregory Dana	Assoc. of International Automobile Manufacturers		(703) 525-7788
Lauren Dunlap	The Gas Company		(213) 244-5580
Stephen Gerritson	Lake Michigan Air Directors Consortium		(708) 296-2181
Richard Gibbs	New York Dept. of Environmental Conservation		(518) 485-8913
Randall Guensler	Georgia Institute of Technology		(404) 894-0405
John Johnson	Michigan Technological University		(906) 487-2576
John Kowalczyk	Oregon Dept. of Environmental Quality		(503) 229-6459
George Lauer	ARCo	(fax)	(231) 486-3006
Alan Lloyd	South Coast Air Quality Management District		(909) 396-3245
Virginia McConnell	Resources for the Future		(202) 328-5122
David Merrion	Detroit Diesel		(313) 592-7276
Margo Oge	EPA Office of Mobile Sources		(202) 260-7645
Patrick Raher	Hogan and Hartson		(202) 637-5600
Mike Redemer	Texaco		(914) 253-7909
Tina Vujovich	Cummins		(812) 377-3101
Michael Walsh	Self		(202) 783-7800