

**Clean Air Act Advisory Committee
Mobile Sources Technical Review Sub-committee
Double Tree Hotel - Falls Church, Virginia
January 15, 1997**

INTRODUCTION

The Mobile Sources Technical Review Sub-committee held its seventh meeting at the Double Tree Hotel in Falls Church, Virginia on January 15, 1997. The meeting was chaired by Mike Walsh, consultant, and Bob Sawyer, University of California Berkeley. Mr. Walsh opened the meeting by welcoming all attendees. Margo Oge, EPA, also welcomed everyone and asked for introductions.

The following agenda items were covered during the meeting and are summarized below:

Heavy Engine Workgroup report;

- Briefing on On-board Diagnostics technology;
- Interim recommendations of the In-use Deterioration Workgroup;
- Discussion of Executive Summary and steps for submission to the CAAAC;
- Evaluation of State I/M Programs;
- Report on activities of the Modeling Workgroup;
- Report on activities of the In-use Deterioration Workgroup;
- Report on formation of the Workgroup on the Implementation of Phase 2 RFG;
- Report on formation of the Workgroup on Ambient Effects Studies for Oxygenated Fuels;
- Meeting Wrap-up.

Mr. Walsh introduced the first speaker of the day.

HEAVY ENGINE WORKGROUP REPORT

Christine Hobbs, Cummins

Christine Hobbs presented on the activities of the Heavy-duty Engine (HDE) Workgroup. Ms. Hobbs has been participating in the Data Analysis Workgroup, a sub-group of the HDE Workgroup. The first item on the Workgroup's action plan is to review and summarize existing data pertaining to fuel effects on HDE emissions. Ms. Hobbs reported that the Workgroup originally planned to merge U.S. and European emissions data into one model. This has not worked very well because of differences in test objectives, test variables, and definitions. The Workgroup has created a table that summarizes existing studies and characterizes the various results.

The second item on the action plan is to conduct a low NO_x engine and fuel experimental study in four phases. The four phases, and the status of each are:

Phase I - Validation of a transparent test tool.

This is a very important step because the engine manufacturers want to protect the proprietary nature of their research engines. This tool will also provide a neutral test site for further testing that EPA and EMA can access. Phase I has been completed; a transparent test tool has been developed at Southwest Research. The engine is a Caterpillar 3176 with cooled, low pressure EGR capability added to a 1994 emissions configuration. The engine has high output and high injection pressure capability, and has

electronic control of both injection timing and EGR rate. Three fuels are being used for Phase I: 1) a baseline fuel that is representative of "at the pump" fuel; 2) a cetane enhanced baseline fuel; and 3) a high cetane, low aromatic fuel. Ms. Cummins presented the properties of each of the fuels used.

A total of six engine manufacturers participated in this phase, running both a transient test and an 8-mode, and results were reported as a percent difference in emissions between the enhanced fuel versus the baseline fuel. Ms. Cummins presented a slide comparing the manufacturer results. Very good comparisons were obtained with the SWRI engine using the high-cetane, low aromatic fuel. The results were less comparable using cetane-enhanced fuel. This will be further investigated in Phase II.

The conclusion of Phase I is that the magnitude of engine response to changes in fuel properties is significant, with approximately a 7.5 percent NO_x reduction with high-cetane low-aromatic fuel, and that the SWRI engine responds to fuel properties in a manner that is representative of the Workgroup's "black box" research engines. The Workgroup feels they have a valid test tool with which to proceed to Phase II.

Phase II - Fuels matrix and engine variables testing.

The Workgroup has developed a fuel matrix that examines the variables of cetane (natural and enhanced), poly and mono aromatics, and density. The engine parameters being investigated are injection timing, EGR rate and speed/load operating point. The details of this phase are still being worked out.

Phase III - Fuel effects validation.

Given the results of Phase II, the Workgroup will select fuels that engine manufacturers will run in their research engines.

Phase IV - Full report of the Workgroup's findings.

The target date for this report is October 1997.

BRIEFING ON ON-BOARD DIAGNOSTICS TECHNOLOGY

Doug Teague, Chrysler

Doug Teague presented a broad overview of vehicle On-board Diagnostic (OBD) systems that covered the background and development of OBD, monitoring requirements, monitoring strategies, warranty and in-use reporting, and future challenges.

Background: OBD is a diagnostic system designed to perform self-evaluation and inform the driver when an emissions-related system or component malfunctions such that the vehicle's emissions exceed certain thresholds. Some manufacturers began using OBD systems as early as 1984. California required OBD I, which implemented systems for checking vehicle electrical components, beginning with model year 1988 vehicles. Beginning with model year 1994 vehicles, California required OBD II. OBD II, which is much more comprehensive than OBD I, instituted technology forcing requirements, and requirements for certification, warranty coverage, and recalls. The CAA required OBD in all states for model year 1994 and later vehicles

OBD II has turned out to be much bigger than originally expected in terms of manufacturer workload and manpower. Manufacturers have developed new, more powerful engine controllers for

vehicles, partly to implement OBD II. The retail price equivalent increase per model year 1997 vehicle due to OBD II is approximately \$150 to \$330 per vehicle.

Monitoring Requirements Per OBD II regulations, the following must be monitored: catalyst efficiency, fuel system, engine misfire, oxygen sensor, evaporative system, EGR, secondary air system, and any other component that can affect exhaust or evaporative emissions. New requirements come into effect for several vehicle model years through 2005.

Monitoring Strategies To keep costs down, manufacturers attempt to monitor engine operating characteristics using existing control sensors whenever possible. The inputs and outputs of these sensors are monitored and emissions performance is inferred from these measurements. Thus, there is no direct emissions measure. Mr. Teague presented examples of this strategy for the catalyst efficiency and the engine misfire monitors. The OBD system also performs a self-evaluation. If a fault is discovered on two successive trips, the malfunction indicator lamp (MIL) is turned on and a diagnostic trouble code is stored in the computer's memory for that fault. If the fault fails to be detected on three successive trips, the MIL is turned off. If the fault is not present for 40 to 80 successive trips, the diagnostic trouble code is erased from memory.

The OBD system is designed to test itself at a point when the vehicle is running in a predictable mode. This avoids allowing the system to interrogate itself at an inappropriate time, such as during an unusual mode like high speed/low load or before a catalyst is properly warmed up.

Warranty: The OBD II regulations require warranty coverage on OBD vehicles. For Federal vehicles, all emission-related OBD components are covered for 2 years/24,000 miles, and 8 years/80,000 miles for major emission-related components, including the catalytic converter and the powertrain control module. For California vehicles, all emission-related components are covered for 3 years/50,000 miles, and 7 years/70,000 miles if component cost is greater than a certain dollar value that increases with each model year, starting at \$300 in 1990.

In-use Reporting Manufacturers are required to report in-use defects. For Federal vehicles, manufacturers are required to explain emission effects and resolve problems when 25 specific defects are known, or when EPA asks as a result of enforcement testing. For California vehicles, manufacturers must recall a vehicle if a specific defect causes emissions failure and there is a four percent screened warranty rate, or if defects are found in enforcement testing programs.

Future Challenges Several challenges lie ahead for vehicle manufacturers in meeting OBD requirements. Some of the areas where challenges will be faced are LEV catalyst monitors, full range misfire detection, detection of 0.020" leak in evaporative system leaks, LEV/ULEV emissions thresholds, alternative fuel vehicles, system reliability and robustness, and component reliability.

Mr. Teague elaborated on each of these challenges. He presented a matrix of emission component reliability and OBD II system reliability, shown below. The goal is to be in the upper left corner, where there are no component malfunctions and no MIL illumination. This results in a satisfied customer. The lower right corner consists of a component malfunction and a MIL illumination. This represents a reliable OBD II system, but results in a dissatisfied customer. The other two matrix sections represent OBD II system failures where an alpha or beta type errors occurs. The challenge is to stay in the upper left corner of the matrix and avoid the other sections.

OBD II System Matrix

<p>Reliable OBD II System - Satisfied Customer</p> <p><i>No component malfunctions. No MIL illumination.</i></p>	<p>OBD II System Failure - Beta Error</p> <p><i>Component malfunction. No MIL illumination.</i></p>
<p>OBD II System Failure - Alpha Error</p> <p><i>No component malfunction. MIL illumination.</i></p>	<p>Reliable OBD II System - Dissatisfied Customer</p> <p><i>Component malfunction. MIL illumination.</i></p>

The manufacturer's experience with OBD II has not been as bad as they initially thought it could have been. With 15 million OBD vehicles in operation, there have been some problems. There has been an increase in illuminated MILs falling in each of the above matrix areas, and manufacturers have responded with recalibrations and service fixes. Some customer dissatisfaction has occurred.

Mr. Teague concluded by stating that the task of making OBD a success will continue to exert pressure on engineering resources, vehicle costs, and customer satisfaction into the foreseeable future. A lot of work will be required; manufacturers are committed to making it work.

Sam Leonard, GM, added that tight calibrations make it technically difficult to prevent OBD system errors. Given this, manufacturers will calibrate toward beta errors rather than alpha errors in order to maintain customer satisfaction.

Margo Oge stressed that it is critical for EPA, CARB, and the manufacturers to get together to leverage all of the collective resources as soon as possible to make OBD a success and overcome the challenges. Everyone is hopeful that OBD II will replace I/M programs. Mike Walsh stated that it would be useful to continue to update this group on the progress in these dialogues.

INTERIM RECOMMENDATIONS OF THE IN-USE DETERIORATION WORKGROUP

Tom Cackette, CARB

Tom Cackette began by summarizing the Workgroup's activity since the October Sub-committee meeting. At that meeting, the In-use Deterioration Workgroup presented a preliminary report that contained several recommendations. The Sub-committee suggested that the Workgroup prioritize the recommendations to give EPA a sense of what they believe to be the most important issues. The In-use Deterioration Workgroup has taken this step. The Workgroup organized their recommendations to EPA into the following five areas:

Changes to MOBILE6

- High Priority: Start implementation now
- High Priority: Start implementation within three years
- Medium Priority: Start implementation now
- Medium Priority: Start implementation within three years

Mr. Cackette then discussed the high priority recommendations, first for the Data Analysis Team and then for the New Technology/Solutions Team. For the Data Analysis Team, the high priority recommendations are listed below. Those with an asterisk indicate recommendations that EPA should implement now.

Revise the MOBILE model to:

- Reflect lower deterioration of newer models*
- .. Reflect anticipated technology improvements*
- .. Reflect current mileage accumulation rates

Analyze state IM240 data*

- Require standardized reporting*
- .. Assess multi-year data for same vehicle

Collect additional laboratory-based data that can not be obtained from IM240 programs

- Assess growing body of evaporative data*
- .. Obtain high mileage (>100K) data

Refocus EPA policies on 'performance' instead of 'credits'

- Temporary credits, revised based on performance
- .. Include behavioral response in developed policies

For the Data Analysis Team, the high priority recommendations are:

Use periodic OBDII inspections for 1996+ vehicles*

- High confidence is better than current tests
- .. Evaluate effectiveness in parallel with implementation*

Assess non-periodic inspections to reduce cost/inconvenience*

- Technology: OBDII transponders or recording medium
- .. Incentives to fix cars with warning lights illuminated

Harmonize OBDII with California's approach*

Evaluate Strategies to improve repair

- Mandatory replacement of emission critical parts on older cars
- .. Assess emission impact of replacement parts

Establish policies that get all high emitters fixed or off the road

Mr. Cackette stated that the final Workgroup product will probably be presented to the Sub-committee at the April Sub-committee meeting. The Workgroup plans to meet twice before then to finalize their report. He then presented revised wording of a recommendation regarding the potential for inspection of the OBDII system replacing the tests now used in I/M programs.

Margo Oge stated that it is critical for the In-use Deterioration Workgroup to set aside some time at the next Sub-committee meeting to discuss their recommendations. At the same time, EPA will come forward with its plan to address them. Ms. Oge will ask her staff to be prepared to discuss their approach to the recommendations. She also encouraged the Sub-committee members to be prepared to discuss their responses to the recommendations.

DISCUSSION OF DRAFT EXECUTIVE SUMMARY AND STEPS FOR SUBMISSION TO CLEAN AIR ACT ADVISORY COMMITTEE

Mike Walsh, Bob Sawyer

Bob Sawyer introduced the Sub-committee Executive Summary report, which reflects Workgroup activity to date. He asked Sub-committee members to review the Executive Summary and provide comments. Phil Lorang has copies of the Workgroup chapters and will make those available for review. The report will be finalized at the April 1997 meeting.

EVALUATION OF STATE I/M PROGRAMS

Jim Bagian, EPA OMS

Mr. Bagian, Deputy Director of the OMS Regional and State Programs Division, began the presentation with a background on the issue. In November of 1995 the Highway Bill was enacted and provided for states to evaluate their I/M programs with respect to test only or test and repair programs. States are now able to receive credit based on a good faith estimate of the emission reductions. The question remained on a mechanism to prove the credit claim in the good faith estimate. Final credit determination would be made after an 18 month evaluation. ECOS and STAPPA officials met in March of 1996 and a larger group of stakeholders were organized to develop an evaluation methodology. The goal was to create an equitable system that was scientifically and quantitatively based. Early in the process, the group decided that the 18 month time frame was too short to provide a valid evaluation. The group decided to perform a short-term evaluation (in 18 months) and a longer-term evaluation. The short-term evaluation is primarily qualitative. The long-term evaluation is quantitative and uses a Mass Emission Transient Test or equivalent test (currently only the IM240 test) on a random sample of 0.1 percent of the fleet.

The short-term evaluation includes eleven items, each with a point value assigned to it. A program has to contain enough of the items to generate a total of at least 11 points. For example, performing a METT before and after repair is worth 6 points. The program must also have six months of long-term data evaluation underway by the end of the 18 month period.

Programs may receive more or less credit based on the Agency decision at the end of the 18 month period. If a state underestimated or was conservative in its estimate, or can show more verifiable emission reductions, they will be given more credits.

Once the data are available, emission models (e.g., MOBILE) will be used to estimate and validate state claims. A long-term evaluation group will be created to help the Agency evaluate state data and claims. Mr. Bagian noted that the six months of quantitative data would be used to evaluate whether the programs appear to be on track.

REPORT ON ACTIVITIES OF THE MODELING WORKGROUP

Lois Platte, EPA

Lois Platte presented for the Modeling Workgroup. There are no new work products to bring before the Sub-committee at this point. The Workgroup is presently discussing the various areas of EPA involvement in modeling. The Workgroup is being provided with new information, studies, or approaches that the Agency is undertaking or considering and various members are providing comments to the Agency. The Workgroup is also evaluating other modeling approaches to provide recommendations to EPA. The Workgroup has been evaluating papers from CARB and will be preparing draft papers on how

the Agency should use (or not use) the methodologies. The last activity is to prepare a paper that reviews the uses of the MOBILE model (e.g., SIP, inventory, control strategy evaluation). Modal models or fuel consumption based models will also be evaluated. An outline has been prepared, and writing assignments will soon be given to members of the Workgroup. Future areas of work include recommending a research plan to meet the data needs raised in earlier evaluations.

Mike Walsh asked about new driving cycles. Ms. Platte responded that the Agency has created 15 driving cycles based on speed and facility type. These will be used to replace the speed-only cycles in the current model. The new cycles include higher acceleration for current technology vehicles.

REPORT ON ACTIVITIES OF THE IN-USE DETERIORATION WORKGROUP

Bob Slott, Shell

Mr. Slott presented for the In-use Deterioration Workgroup. The Workgroup has prioritized the recommendations presented at the last Sub-committee meeting and clarified the wording of their OBD II recommendation, as discussed previously by Tom Cackette. The Workgroup met the previous day and heard presentations on fuel sulfur content issues from:

- John Kowalczyk, Oregon, on sulfur and gasoline;
- Larry Bredeson, Shell, on refining issues;
- John Kreeel, Chevron, on published literature;
- Jack Benson, GM, on sulfur effects on LEVs; and
- Bob Gorse, Ford, also on sulfur effects on LEVs.

The Workgroup will consider the information gleaned from these presentations and revisit the issue to decide on a possible fuel sulfur recommendation to the Sub-committee.

Mr. Slott discussed additional issues being addressed by the Workgroup, including further data analysis efforts. The Workgroup would like to learn more about state IM240 data analyses and the Georgia Tech remote sensing efforts underway. The Workgroup expects to hear a presentation on evaporative emission research efforts underway by EPA and CRC at an April meeting. CRC is also planning a study on running loss emissions.

The Workgroup is examining partnerships that may assist the Agency in implementing some of the recommendations from the Workgroup (e.g., early evaluation of OBD II). The Workgroup also recognized that they have not spent significant time on incentive issues, and believe that there are further opportunities to use incentives in some of the recommended policy pursuits. The Sub-committee chairs will be contacted to aid in identifying an appropriate forum to conduct these discussions.

REPORT ON FORMATION OF THE WORKGROUP ON THE IMPLEMENTATION OF PHASE 2 RFG

Chuck Freed, EPA

Mr. Freed presented a status of the new Workgroup on Phase II reformulated gasoline. Don Theiler has accepted the co-chair position on the Workgroup. Many of the auto manufacturers, oil companies, and associations have expressed interest in the Workgroup and the Agency is identifying additional members from the public and environmental communities. The Workgroup is planning to examine vehicle testing and related issues along with education and outreach. One suggestion includes conducting tests in different geographic areas to obtain information on effects in specific local areas.

REPORT ON FORMATION OF THE WORKGROUP ON AMBIENT EFFECTS STUDIES FOR OXYGENATED FUELS

Phil Lorang, EPA

Mr. Lorang presented a status of the new Workgroup on effects of oxygenated fuels. The White House Office of Science and Technology Policy (OSTP) will be receiving a recommendation from the National Academy of Sciences recommending that EPA perform a new study. OSTP convened a group of experts, reviewed the current literature, and prepared a report to address some of the issues raised by EPA's winter oxygenated fuel program. The National Research Council peer reviewed the report and provided comments to OSTP. The preliminary OSTP finding is that the program provides a CO benefit of approximately a 10 percent reduction, but each of the studies used to make this finding could be improved. The final OSTP report is not complete and the Agency is waiting for the final document before convening the new Workgroup. No meetings are scheduled and the roster of Workgroup members is not complete. The Workgroup will review the research issues and potential effects of both winter oxygenated and reformulated fuels, but any future study will most likely cover oxygenated fuel effects only.

MEETING WRAP-UP

The next Sub-committee meeting is scheduled for April 16, 1997 in Washington, DC. Tentative meeting dates are also scheduled for July 16, October 15, and January 13, 1998 in undetermined locations.

Bob Sawyer adjourned the meeting.

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List of Members or Member Alternates Attending

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Bruce Bertelsen	Manufacturers of Emissions Controls	(202) 296-4797
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John Fisher	Detroit Diesel	(313) 592-7276
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John Johnson	Michigan Technological University	(906) 487-2576
Alan Lloyd	Desert Research Institute	(702) 677-3107
Sam Leonard	General Motors	(313) 556-7710
Virginia McConnell	Resources for the Future	(202) 328-5122
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