

FEDERAL ADVISORY COMMITTEE ACT  
CLEAN AIR ACT ADVISORY COMMITTEE  
**MOBILE SOURCES TECHNICAL REVIEW SUBCOMMITTEE**

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CO-CHAIRS: MICHAEL WALSH AND ROBERT SAWYER

DESIGNATED FEDERAL OFFICIAL: GREGORY GREEN

**Draft Minutes from the Quarterly Meeting of October 13, 1999**

*Holiday Inn - Washington on the Hill*

*Washington, DC*

**Introductions and Opening Remarks**

Michael Walsh, Co-Chair, opened the meeting and welcomed attendees. Mr. Walsh introduced and welcomed Michael Kulakowski, Equiva, as a new member of the MSTRS. MSTRS members, other participants and observers introduced themselves. (A list of individuals attending the meeting is attached at the end of this document.)

There were no suggested changes from the meeting minutes from the July 14 MSTRS meeting. The notes were accepted as written.

**General Comments and Discussion of Reorganization and New Leadership within the Office of Mobile Sources - Margo Oge, OMS**

Ms. Oge provided an overview of recent activities at OMS:

- EPA received many comments on the proposed Tier 2 rule. EPA hopes to make decisions about any changes to the proposed rule in the next few weeks and intends to publish a final rule by the end of the year.
- EPA plans to link heavy-duty engine standards with diesel and gasoline fuel requirements, and intends to create a packaged proposed rule to the Office of Management and Budget (OMB) by end of year. It is working to get clean diesel fuel in the market as soon as possible.
- EPA is working to implement the recommendations of the Blue Ribbon Panel on MTBE.
- The Office of Mobile Sources (OMS) has developed a new organizational structure. Two new senior executive service (SES) recruits have joined OMS from states and a third was promoted from within OMS. Merrylin Zaw-Mon and Gregory Green have joined the office from positions with the States of Maryland and Oregon, respectively. A third senior executive, Chester France, moved into his position from within OMS. Ms. Zaw-Mon will direct the Transportation and Regional Programs Division, Mr. Green will direct the Certification and Compliance Division, and Mr. France will direct the Assessment and Standards Division. In addition to his other responsibilities, Mr. Green has been

designated as the Designated Federal Officer for the MSTRS. Ms. Oge commented that the new organizational structure encourages teamwork and increased stakeholder participation. EPA will finalize the new organizational structure within a few weeks.

### **Administrative Announcements - John T. White, OMS**

Mr. White described the contents of the meeting packets. The handouts included in the packet describe current OMS, NRC, CE-CERT, NCHRP, and other projects. One newly funded project will be the collection of information on different testing programs and posting of the information on the web. The effort is funded by a cooperative agreement with the Colorado School of Mines.

Debbie Wood is making a presentation to the CAAAC today on EPA's Phase 2 Reformulated Gasoline (RFG) program.

### **Toxicity of Exhaust from Diesel Engines - Dan Greenbaum, Health Effects Institute (HEI)**

Mr. Greenbaum gave a presentation focused on the lung cancer and non-cancer health risks from diesel exhaust. Particulate matter (PM), a component of diesel exhaust, has been a focus of several human health studies. Diesel contributes to PM emissions in two ways: 1) direct emissions of ultra-fine particles, and 2) emission of precursors to secondary PM, primarily NOx.

While the use of diesel fuel results in high vehicle efficiency and lower emissions of some pollutants, diesel exhaust raises concerns about cancer and other health effects. Diesel contributes to ambient air pollution and has been investigated for its contributions to lung cancer and some non-cancer health risks.

#### **Diesel and Lung Cancer Effects**

A study conducted on rats shows increased lung tumors from exposure to diesel. This result probably occurs due to lung overload and is probably not relevant to humans at the "street" level.

Mr. Greenbaum presented a review, including the strengths and weaknesses, of several studies that have been conducted to estimate the correlation between PM emissions and health. Most studies find a positive correlation between the factors. The largest studies show a statistically significant relationship between PM emissions and cancer, which suggests a hazard. The association is positive at the 1.2 to 1.4 level (1.2 -1.4 times the standard), but considered "weak" in epidemiological terms because the relative risks are small (less than 2.0).

Mr. Walsh, Consultant and Subcommittee Co-Chair, asked if Mr. Greenbaum could name some "good" studies that do not find a positive association between diesel exhaust and cancer.

Mr. Greenbaum replied that they have not found such a study. All studies they have looked at find at least a small positive correlation. Mr. Greenbaum added that all studies seeking to make a hazard identification name diesel as a probable carcinogen, but few have estimated the degree of risk diesel presents to human health. The National Cancer Institute is currently studying the effects of occupational exposure to diesel exhaust in humans who work in mines.

Drew Kodjak, NESCAUM, asked if the panel looked at other chemicals, such as benzene, that might exhibit a similar downward trend related to cancer. Mr. Greenbaum responded that typically other toxic chemicals did not show the downward trend. The "healthy survivor effect" may explain why more exposure does not always lead to higher incidence of cancer.

### Diesel and Non-Cancer Effects

Mr. Greenbaum presented information suggesting a relationship between diesel exhaust and the onset of allergic reactions and childhood respiratory illness. A few experiments have been conducted to look at the possible exacerbation of allergic reactions or respiratory illness in response to diesel exposure.

### Conclusions

While newer vehicles have reduced emissions, older cars in the fleet continue to contribute to emission problems. Key issues include the extent and timing of decreases in PM, NOx, PAHs, and other organic compounds and techniques in promoting fleet turnover or upgrades to reduce the health risks associated with diesel exhaust.

### Discussion

A subcommittee member asked about the error bars associated with the different studies included in the presentation, stating that the scale used on the charts makes the data appear to show that health risks may decrease with exposure to diesel exhaust, but that the possible high-end risk is multiple times the standard. Mr. Greenbaum responded that the larger studies have narrower error bounds and tend to show more robust associations between diesel exhaust and health risk, but with lower high-end estimates.

Mr. Kulakowski, Equiva, asked if Mr. Greenbaum had any comments on California's methodology to study these issues. Mr. Greenbaum replied that HEI does not tend to make such comments.

John Kowalczyk, State of Oregon, asked if the studies differentiate between the health effects from gasoline versus diesel exhaust. Mr. Greenbaum replied that it is difficult to determine the combined effect and to attribute any one effect to a specific exposure.

Overheads from the presentation are posted on the MSTRS web site:  
<http://transaq.ce.gatech.edu/epatac/documents/greenbam.pdf>.

**Ultra-Fine Particulate Matter (PM) in the Exhaust from Diesel and Gasoline-Powered Mobile Sources - David Kittelson, University of Minnesota**

Dr. Kittelson presented an overview of studies on the diesel cycle, particle formation, the nature of particles, particle size, and measurement issues related to the measurement of exhaust particulate matter. These are important topics because health concerns exist due to correlations between fine particles and death rates, increased asthma in children living near roadways, and special concerns about ultra-fine and nano-particles.

Dr. Kittelson described the formation of particulate matter at different points along the engine cycle. Nearly all of the particles emitted by engines are in the sub-micron diameter range, where there are two principal modes, an accumulation mode in the 0.1 to 0.2 micron range where most of the mass and soot particles reside, and a nuclei mode in the sub-50 nm range where most of the number resides. The nuclei mode particles are of small mass and are highly volatile, most likely consisting of sulfuric acid and absorbed hydrocarbons. They disappear if the sample is heated. The remainder of the presentation focused on describing formation and fate for the smallest particles.

Current emission standards are all mass-based, but there is increasing interest in other measures, such as size, number, and surface (e.g., the new ambient standards on fine particles). If other measures are adopted measurement challenges will be formidable, not because of the lack of instrumentation, but because most of the nano-meter size particles are not present in the tailpipe, but form immediately behind a vehicle as the exhaust dilutes and cools. Nano-particle formation during atmospheric dilution is extremely non-linear and difficult to simulate in the laboratory. The University of Minnesota is currently studying this, the tailpipe-to-nose process, as part of the CRC E-43 project.

Dr. Kittelson indicated that as engines become cleaner, a larger and larger fraction of not only the particle number, but also particle mass is likely to be in the form of volatile or semi-volatile materials that are in the gas phase in the tailpipe and are converted to particles during exhaust dilution. Thus, mass measurements from very low emission engines will be difficult not only because it will be necessary to measure very small masses, but also because the amount of mass collected will depend on dilution conditions. He presented recommendations for making mass measurements from low-emission engines, including recommendations to standardize the process by controlling combustion and dilution air conditioning, combustion air humidity and temperature, dilution air filtration, temperature, and scrubbing. Further, the tunnel and sampling system should be conditioned to the engine undergoing testing.

### **Discussion**

Mr. Kodjak, NESCAUM, asked which dilution conditions might be manipulated. Dr. Kittelson replied that temperature and rate are the two most critical factors to manipulate.

Dr. John Johnson, Michigan Technological University, asked how field research might develop standardized procedures for the measurement of PM formed during fuel combustion. Dr. Kittelson described research conducted at the University of Minnesota on truck-trailers that produced good results.

Overheads from the presentation are posted on: <http://transaq.ce.gatech.edu/epatac/documents/kittelsn.pdf>

### **The Future of the MSTRS - Michael Walsh, Co-Chair, MSTRS**

Mr. Walsh asked participants to think about the format of the meeting. This meeting was designed around the theme of particulate matter research, rather than the usual format of having a few presentations followed by multiple reports from the subcommittee workgroups. Members should think about what type of format they find most effective and communicate those ideas to the co-chairs or to EPA.

### **Real-World Measurements of Mobile Source Particulate Emissions - Alan Gertler, Desert Research Institute (DRI)**

DRI will conduct a study of ambient diesel emissions. The objectives of the study are to:

- Obtain chemically speciated diesel profiles for use in source apportionment studies;
- Determine the chemical species present in real-world diesel emissions;
- Measure particle number and chemically speciated size-segregated particle distributions;
- Confirm the results of recent dynamometer studies of diesel emissions;
- Determine the level of improvement in diesel exhaust particulate mass emission rates; and
- Measure particulates from light-duty gasoline vehicles.

This study will focus on tunnel measurements to capture a “snapshot” of real-world driving under a limited range of vehicle speeds and accelerations and a hot-stabilized operating

mode. The methodology includes taking measurements of concentrations at all inlets and outlets to estimate emissions. Preliminary analysis shows a large number of ultra-fine particles being emitted from both light- and heavy-duty vehicles. Fleets with a higher percentage of heavy-duty vehicles show an increase in the mean diameter of the ultra-fine emissions and higher emission factors (mg/km) than average.

In conclusion, Dr. Gertler noted that heavy-duty PM mass emission rates have decreased significantly over a 25-year period; light-duty PM emissions cannot be ignored; and both heavy- and light-duty vehicles emit significant numbers of ultra fine particles and these particles are preserved. A chemical analysis was recently completed and more analysis is underway.

### Discussion

Sam Leonard, GM, asked why the speciation data was presented only in averages. Dr. Gertler replied that these were preliminary results and more analysis would be completed shortly.

Winston Harrington, Resources for the Future, asked how sulfate relates to fuel economy. Mr. Gertler replied that sulfates are more related to the sulfur content of fuel than to fuel economy.

Richard Kassel, NRDC, asked about the health effects from emissions of iron. Mr. Gertler referred Mr. Kassel to Dan Greenbaum of HEI.

Joseph Norbeck, CE-CERT, asked why the steady-state numbers are so different from the Federal Test Procedure (FTP). Dr. Kittelson, University of Minnesota, provided a response, stating that the FTP was not designed for PM. The FTP uses both cold starts and hard accelerations. Both factors tend to underestimate PM.

Dr. Kittelson, University of Minnesota, asked if the DRI study will examine the number of particles emitted. Dr. Gertler replied that the study would address the number of particles emitted.

Dr. Johnson, Michigan Technological University, noted that with so many variables shown to be important in the dilution process, there is a lot of room for measurement error and getting low numbers will be difficult.

Overheads from this presentation are posted on:  
<http://transaq.ce.gatech.edu/epatac/documents/gertler.pdf>

**Recent Developments in Integrated Diesel Exhaust Control Technology, Dale McKinnon, Manufacturers of Emission Controls Association (MECA)**

Mr. McKinnon presented information on control technologies for PM, toxic, and NO<sub>x</sub> emissions, with a focus on diesel engine controls. Mr. McKinnon reported that while significant progress has been made in reducing emissions from diesel engines, diesel-powered vehicles remain a significant source of PM, toxic HC, and NO<sub>x</sub> emissions. Emission control technologies exist to substantially reduce emissions from diesel engines, and these technologies can be used in combination to substantially reduce all emissions.

Diesel emissions are complex in terms of the many pollutants and variations within pollutant types. Thus, control of diesel emissions may require an integrated approach. Existing controls can greatly reduce emissions, but new engine technologies, advanced emission control technologies, and advanced fuels can achieve greater reductions needed to meet future challenges.

Mr. McKinnon described diesel oxidation catalysts, which are proven effective in removing PM. Use of these catalysts can result in a 0.05 g/bhp-hr emission rate and also achieve significant reductions in CO and HC emissions. These catalysts are more effective when used with low sulfur fuel.

Diesel particulate filters are in operation on several thousand trucks and buses in Europe, and they are part of demonstration programs elsewhere. These filters nearly eliminate PM, reducing PM below a 0.02 g/bhp-hr rate and providing significant reductions in CO and HC emissions. Ultra-fine particles are reduced in excess of 99.9 percent. These filters are, like the diesel oxidation catalysts, more effective when used with low sulfur fuel.

Mr. McKinnon then described NO<sub>x</sub> abatement strategies for diesel engines, including an active HC-DeNO<sub>x</sub> (lean NO<sub>x</sub>) system, NO<sub>x</sub> traps, and SCR applications. A plasma technology system is in the laboratory stage. Commercial availability for these various technologies ranges between 2000 and 2004.

Mr. McKinnon described examples of integrated systems that serve to maximize emission reductions. Most technologies are sensitive to the sulfur content of fuel, with the exception of non-thermal plasma and SCR with urea (but the SCR may require an oxidation catalyst due to problems with ammonia slip). It is likely that future needs for emission controls will require the use of a combination of devices.

### **Discussion**

Mr. Kodjak, NESCAUM, asked what level of diesel sulfur or NOx absorber technology would be necessary to achieve NOx reduction strategies. Mr. McKinnon answered that sulfur levels below 10ppm, near zero, would be required.

David Merrion, Detroit Diesel, noted that EPA is concerned about the development of a tamper-resistant urea-based catalyst. Mr. McKinnon replied that a demonstration project is in process.

Timothy Johnson, Corning, commented that there are technological solutions commercially available, such as a NOx sensor built by the automobile manufacturers. This would prevent tampering.

Dan Greenbaum, HEI, asked about the issues surrounding ammonia slip, including tampering or control of the catalyst. He suggested studying the experience of utilities with ammonia slip monitoring. Mr. McKinnon replied that mobile sources are more difficult to monitor, particularly because their operation is inconsistent.

Overheads from the presentation are posted on:  
<http://transaq.ce.gatech.edu/epatac/documents/mckinnon.pdf>

### **Wrap-Up**

The next meeting of the MSTRS will be held on January 12 in Washington, DC. The subcommittee may meet in a location away from Washington sometime during 2000. Members were asked for their suggestions for possible alternate locations.

Mike Walsh, Consultant and MSTRS Co-Chair, asked again for comments or thoughts on the agenda for the meeting. Randy Guensler, Georgia Tech, suggested conducting an email poll of members to solicit feedback on the topic.

John White, EPA/OMS, offered several suggestions for future meeting topics including: RFG, non-road vehicles, inspection and maintenance (I/M) programs, mechanic training, and CO studies.

Gordon Allardyce, DaimlerChrysler, asked EPA to comment on how the subcommittee can better serve its members. He also asked how the MSTRS can be the most effective in serving EPA and suggested that the MSTRS think about how to most effectively communicate their findings or recommendations to EPA.

MOBILE SOURCES TECHNICAL REVIEW SUBCOMMITTEE  
DRAFT MINUTES FROM THE MEETING OF OCTOBER 13, 1999

John White, EPA/OMS, reminded members that the topics for each meeting are determined between six weeks and a month ahead of time, and that suggestions for meeting topics should be sent to him within that timeframe.

Mike Walsh, Consultant and MSTRS Co-Chair, commented that EPA is doing a lot of work on heavy-duty vehicles right now, which may be a timely and interesting topic for the MSTRS to consider at the next meeting.

A member suggested that the MSTRS look at equipment and testing for both heavy-duty and light-duty vehicles. The member suggested that the MSTRS could hear presentations from both CARB and EPA on their testing methods.

Alan Gertler, DRI, commented that he appreciated the format of concentrating on one issue and soliciting presentations from both laboratory and on-road studies.

The meeting was adjourned.

MOBILE SOURCES TECHNICAL REVIEW SUBCOMMITTEE  
DRAFT MINUTES FROM THE MEETING OF OCTOBER 13, 1999

**Mobile Sources Technical Review Subcommittee**

**List of Members or Member Alternates Attending**

Gordon Allardyce	DaimlerChrysler Corporation	(810) 576-8053
Doug Berens	Ford Motor Company	(313) 594-2915
Bruce Bertelsen	Manufacturers of Emissions Controls	(202) 296-4797
John Cabaniss	Assoc. Of Int. Auto Mfgs. Inc.	(703) 525-8817
John Elston	NJS Dept. of Env. Protection	(609) 292-6710
Jerry Gallagher	Colorado Dept. of Public Health	(303) 692-3128
Richard Gibbs	New York Dept. of Env. Conservation	(518) 485-8913
Gregory Green	EPA - Office of Mobile Sources	(734) 214-4488
Randy Guensler	Georgia Institute of Technology	(404) 894-0405
Winston Harrington	Resources for the Future	(202) 328-5122
John Johnson	Michigan Technological University	(906) 487-2576
Tim Johnson	Corning, Inc.	(607) 974-7184
Bob Jorgensen	Cummins Engine Company	(812) 377-3434
Rich Kassel	Natural Resources Defense Council	(212) 727-4454
Bob King	Sun Company	(215) 977-6599
Drew Kodjak	NESCAUM	(617) 367-8540
John Kowalczyk	Oregon Dept. of Environmental Quality	(503) 229-6459
Mike Kulakowski	Equiva Services, LLC	(310) 522-6199
Sam Leonard	General Motors Corporation	(313) 556-7711
Dave Merrion	Detroit Diesel Corporation	(313) 592-7276
Joe Norbeck	CE-CERT (UC - Riverside)	(909) 781-5778
Margo Oge	EPA-Office of Mobile Sources	(202) 260-7645
Mike Walsh	Consultant	(703) 241-1297
John White	EPA-Office of Mobile Sources	(734) 214-4353

*Mobile Sources Technical Review Subcommittee*

*Attendance List - Interested Parties*

Fern Abrams	American Trucking Association	(703) 838-1910
Andrew Beck	National Automobile Dealers Assn.	(703) 821-7040
William Bunn	Navistar International Transp. Corp	(312) 836-2301
Matthew Best	Automotive Service Association	(202) 543-1440
Carol Cole	Hart Publications	(703) 528-1483
Frederico Cura	Mobile Source Report	(703) 416-8576
Greg Dana	Alliance of Automobile Manufacturers	(202) 326-5518
Anne David	Geo-Centers, Inc.	(703) 416-1023
Ira Domsky	Arizona Dept. of Environmental Quality	(602) 207-2365
Roger Fairchild	Shutler and Low	(703) 818-1320
Susan Field	Toyota	(734) 995-2086
Steven Flint	NYS DEQ	(518) 485-8913
David Foerter	Ozone Transport Commission	(202) 508-3840
Alan Gertler	Desert Research Institute	(775) 674-7061
Daniel Greenbaum	Health Effects Institute	(617) 876-6700 x331
Eric Harthem	Office of Management and Budget	(202) 395-5870
Jeffery Hazle	National Petrochemical & Refiners Assoc.	(202) 457-0480
Marion Hoyer	EPA/OMS	(734) 214-4513
Takuya Ikeda	Nissan	(202) 659-7737
Leonard Kata	Volkswagen of America, Inc.	(248) 340-4704
Tristan Kime	Hunton & Williams	(202) 955-1583
Dave Kittleson	University of Minnesota	(612) 625-1808
Terry Levinson	Argonne National Laboratory	(202) 488-2472
Dale McKinnon	Mfgs. of Emission Controls Assn.	(202) 296-4797
Marc Meteyer	American Petroleum Institute	(202) 682-8209
Clayton Miller	Air Quality Coalition	(909) 612-5705
Claudia O'Brien	Latham & Watkins	(202) 637-2181
Jaime Pagan	EPA - OAQPS	(919) 541-5340
Jack Peckham	Hart Energy Group	(301) 340-7788
Joe Suchecki	Engine Manufacturers Association	(312) 644-6610 x3821
Thomas Snyder	Argonne National Laboratory	(202) 488-2419
Andy Vaichekaskas	Mitsubishi	(703) 525-4800 x226
Merrylin Zaw-Mon	EPA - Office of Mobile Sources	(202) 564-9403