

Federal Advisory Committee Act
Clean Air Act Advisory Committee

**Mobile Sources Technical Review Subcommittee (MSTRS)
MOVES Review Work Group: Meeting Summary**

October 14, 2020 and October 22, 2020
U.S. EPA Office of Transportation & Air Quality
Meeting Via Microsoft Teams

Introduction

This meeting was held in two parts over two days, as shown in Tables 1 and 2. This meeting summary reflects both dates of the meeting.

**Table 1. MOVES Review Work Group Meeting Agenda:
October 14, 2020 (1 pm to 4 pm)**

Presenter	Presentation Topic
Matthew Barth and Megan Beardsley, co-chairs	Welcome
James Warila, EPA	Planned Updates to Light-Duty Gaseous Emission Rates and Base Fuels in MOVES3
Tiffany Mo, EPA	Updates to Energy & CO ₂ Rates for Light-Duty Vehicles with SAFE Rule
Darrell Sonntag, EPA	Crankcase Emissions for MY2007+ Heavy-Duty Diesel Trucks
Megan Beardsley, EPA	MOVES Plans & Status
Matthew Barth and Megan Beardsley	Wrap-Up

**Table 2. MOVES Review Work Group Meeting Agenda:
October 22, 2020 (2 pm to 3 pm)**

Presenter	Presentation Topic
Aron Butler	Fuels Supply Update

Welcome from the Chairs

On October 14th, Dr. Sarah Roberts opened the meeting. Dr. Matthew Barth and Ms. Megan Beardsley welcomed the Clean Air Act Advisory Committee (CAAAC), Mobile Sources Technical Review Subcommittee (MSTRS) MOVES Review Work Group to the meeting. Ms. Beardsley presented the meeting agenda (see Table 1). Similarly, on October 22nd, Dr. Roberts opened the meeting, reviewed the agenda for the meeting (see Table 2), and Ms. Beardsley welcomed attendees to the meeting.

Member Roll Call

Each day, Dr. Roberts conducted a Work Group member roll call. A list of Work Group members and others in attendance is presented in an attachment to these meeting minutes.

General Announcements

Each day of the meeting, Dr. Roberts made general announcements regarding meeting procedures, including how participants should signal when they had questions (i.e., by using the raised hand feature in Microsoft Teams). Dr. Roberts stated that the meeting minutes will be submitted to the Work Group members for review before posting to the website and that any additional questions about the technical content of today's presentations should be sent to her at her e-mail address: Roberts.sarah@epa.gov.

Presentation: Planned Updates to Light Duty Gaseous Emission Rates and Base Fuels in MOVES3 – Presented by James Warila, U.S. EPA

Mr. Warila began by providing background information regarding the light-duty gaseous emission rates in MOVES, noting that some studies have suggested that MOVES overestimates NO_x emissions. As a result, the EPA has been evaluating NO_x emission rates and planning updates to MOVES to address the areas that may contribute to the overestimates. The EPA's updates include revisions to emissions deterioration and to base fuel. He stated that accounting for emissions deterioration remains a challenge, as deep, broad datasets are necessary to account for changes in average emissions with model year and age. The EPA has observed that deterioration follows logarithmic patterns by standard (i.e., Tier 1 and Tier 2) and model year. The EPA's approach is to modify MOVES by making adjustments to emission rates in young vehicles (4 years: ages 0 – 3) and making adjustments for deterioration in older vehicles by vehicle age groups. They have used analyses of running emissions to inform start emissions adjustments. The EPA evaluated IM240 test cycle data from Denver, Colorado for NO_x and total hydrocarbons (THC) and remote sensing data from the Colorado Department of Public Health and Environment for carbon monoxide (CO). The EPA then fit statistical models to the deterioration observed in these data sets and compared the predictions to results obtained using simulated IM240 results developed from existing MOVES rates. Next, comparing the results, the EPA developed deterioration ratios, or adjustment factors, for the running process. For start emissions, the EPA used in-use verification program (IUV) data from vehicle manufacturers to

determine whether and to what extent there is deterioration for starts. The EPA found that there is deterioration for starts, and they developed deterioration ratios for NO_x, THC and CO based on the relative sensitivity of start to running deterioration found in the IUVP data. The EPA also is updating the base fuel included in the model. The major changes to the fuel characteristics include lowering the sulfur level from 90/30 ppm to 30/10 ppm, increasing the ethanol content from 0% to 10%, and increasing the Reid vapor pressure (RVP) from 6.9 to 8.8. The results of the changes are that: the running emission rates in high-power modes are reduced relative to corresponding values in MOVES2014, emission rates for young vehicles are increased, deterioration is decreased and deterioration is higher for trucks than cars. For start emissions, hot and warm start emissions increased for THC and NO_x, and deterioration was substantially reduced. Mr. Warila mentioned that these updates to MOVES have been peer reviewed by two reviewers; both considered the data selection and approaches reasonable and appropriate.

Discussion

Mr. Tom Darlington asked why IM240 data was not used for CO. Mr. Warila replied that they originally planned to use that data for CO, but they were getting some strange results with it, so they are analyzing the data to see what the issues are. He noted that with large datasets, sometimes the data measurement processes change over time, which can cause issues.

Mr. Dale Wells asked why the ‘young vehicle’ adjustments for THC are near 1.0 in 2000 and then peak sharply in 2001. Mr. Warila responded that it was because the trends in predicted and simulated IM240 emissions converge in 2000 and diverge immediately following.

Mr. Chris Dresser asked about the impact of the NO_x updates. Mr. Warila responded that he thinks they will see small emissions reductions initially, with larger reductions in the future. He noted that in developing the updates, the EPA has taken time to evaluate different data sets for NO_x emissions, and have found that, on the whole, the comparison is pretty good. He also noted that there are differences are in steepness among the trends. He noted that one site had lower emissions (for younger vehicles) but steeper deterioration.

Mr. Sam Pournazeri asked whether the EPA examined the IUVP data for deterioration between different emission standard bins. He also asked if the difference in bins is accounted for in MOVES, with its fleet average of 30. Mr. Pournazeri also mentioned that he was surprised to see a six-fold increase in THC emissions from new vehicles. Mr. Warila replied that the IUVP data was used in two ways, one was that cold-start emission rates were based directly on the IUVP data. The other was that running emissions used Tier 1 rates as a reference level, and then the IUVP data was used to weight that data. On THC, Mr. Warila agreed that they were also surprised at the difference in new vehicle emissions, and he opined that one possible explanation for this result is that the IUVP data may not be representative of the fleet average.

Presentation: Updates to Energy and CO₂ Rates for Light-Duty Vehicles with SAFE Rule – Presented by Tiffany Mo, U.S. EPA

Dr. Mo presented background information about the Safer Affordable Fuel-Efficient (SAFE) rule, in which she noted that with One National Program, the EPA withdrew the CAA

preemption waiver for light-duty vehicles it previously granted to California. The SAFE rule, finalized in March of 2020, set revised CO₂ reduction requirements, reducing the previously required ~5% reduction per year to ~1.5% per year. Dr. Mo noted that MOVES uses “real-world” CO₂ rates, which differ from the SAFE rule “fleet target” rates. In order to reflect the SAFE standards in MOVES, the EPA needed to develop a way to convert the fleet target rates into real-world rates. To do this, the EPA developed adjustment ratios, which vary for MY2017 to 2026; the MY2026 ratios are applied to MY2027 and later. The results of applying the SAFE rule to MOVES through these adjustment factors are that energy use and certain emissions are expected to increase. Looking at calendar years 2035 and 2050, MOVES results show a total energy and CO₂ and SO₂ emissions increase of 11% and 15.5% for years 2035 and 2050, respectively for the light-duty fleet; and a VOC emissions increase of 0.7% and 1% for years 2035 and 2050, respectively for the light-duty fleet. These differences are as expected from the change in the standard.

Discussion

In response to a question from Mr. Michael Hartrick regarding off-cycle credits, Dr. Mo clarified that off-cycle credits were not included in the adjustment factors and she reviewed the calculation included in the presentation.

Mr. Pournazeri asked about the impact of the SAFE rule on criteria pollutants and whether the EPA had investigated the impact of having less fuel-efficient vehicles on the road in the real world. He noted that he thought NO_x, hydrocarbons (HC) and particulate matter (PM) emissions might increase in the higher power bins. Dr. Mo responded that for the SAFE rule updates, they did not see any impacts on criteria pollutants, due to the way those pollutants are modeled. She noted that the MOVES team is always trying to update the model, and they will continue to investigate issues like this, as she suspects there would be impacts to those pollutants in an indirect way. Mr. Pournazeri remarked that the vehicle specific power (VSP) effects are going to change due to the SAFE rule, so it would be helpful to consider this in future model updates.

In response to a question from Ms. Jackie Ploch, Ms. Beardsley clarified that the values shown in Dr. Mo’s presentation reflect the changes in emission estimates due only to changes with the SAFE rule, and they do not reflect the impacts from other rules, notably the Heavy-Duty GHG Phase 2 rule that is also included in MOVES3. She also noted that the EPA updates the model to reflect the requirements of new and revised rules.

Presentation: Crankcase Emissions for MY2007+ Heavy-Duty Diesel Trucks—Presented by Darrell Sonntag, U.S. EPA

Dr. Sonntag began by explaining how emissions occur from crankcases and how they are regulated. He stated that open crankcase systems vent gases, which include unburned fuel, combustion products and lubricating oil. Whereas light-duty emissions regulations require closed crankcase systems, pre-2007 heavy-duty diesel engines are unregulated and 2007+ MY heavy-duty diesel engines can either have a closed crankcase system or include open crankcase emissions in exhaust certification tests. Due to other emissions reductions from heavy-duty diesel engines, crankcase emissions now represent a larger part of the total emissions from these

vehicles. In MOVES2014, limited data was available to estimate crankcase emissions. The EPA is updating MOVES to reflect recent crankcase test program data for MY2010 and later engines. The EPA performed crankcase emissions testing for two heavy-duty diesel trucks on a chassis dynamometer with a test cycle that included a start, a transient cycle, idle and two steady state speeds. The results showed fairly large differences in emissions between the two tested trucks. For NO_x, both tested trucks showed much higher emissions from the tailpipe than the crankcase. For CO, crankcase emissions were higher than tailpipe emissions for one truck for three phases of the cycle and similar to tailpipe emissions for the other cycle phase; for the other truck, the emissions from the crankcase and the tailpipe were roughly the same for three cycle phases, with tailpipe emissions much higher than crankcase emissions for the other phase. For THC, one truck showed much higher emissions from the tailpipe for all four cycle phases, whereas the other truck showed higher emissions from the crankcase in three of the four cycle phases. For MY 2007-2009, the EPA plans to update crankcase emissions by revising the ratios of crankcase to tailpipe emissions for gases and PM_{2.5} based on ACES Phase 1 emission rates, MOVES3 tailpipe exhaust rates, and the fraction of closed crankcase systems. For MY2010+, the EPA plans to update the gaseous crankcase to tailpipe emissions ratios based on the average of the two trucks from the EPA testing, MOVES3 tailpipe exhaust rates, and the fraction of closed crankcase systems (67.2% for MY2016-2018). For PM_{2.5}, the EPA plans to update the crankcase emissions rates to be based on the ACES Phase 1 emission rates, and these rates will not be modeled as a fraction of the tailpipe emissions. While results will vary with individual scenarios, compared to MOVES2014b, these updates are expected to have a small impact (less than 3%) on the total onroad inventory of CO and THC and a more significant impact on the total onroad inventory for PM_{2.5}, with an increase of 8% in 2035.

Discussion

There were no comments or questions.

Presentation: MOVES Plans and Status – Presented by Megan Beardsley, U.S. EPA

Ms. Beardsley reviewed the EPA's plans for releasing the next version of MOVES and where they are in the planned process. She noted that they have changed the naming convention for the model, and the next version will be called "MOVES3." This change will provide clarity on the version of the model, and minor updates will be designated by adding a decimal point and number, e.g., MOVES3.1, or an additional decimal point to designate minor patches, e.g., MOVES3.0.1. The EPA plans to release the new version of MOVES by the end of 2020. Since the last MOVES workgroup meeting in 2019, the EPA has updated MOVES inputs, peer reviewed inputs and analyses, updated the MOVES interface and code to correct errors and improve usability, and drafted technical reports, guidance documents and user support information. The next steps are to complete the documentation, post the model and the documentation on the web, share MOVES3 results and features with workgroup, host a public webinar on MOVES3 features, update training materials, evaluate MOVES3, and plan future updates. Ms. Beardsley reviewed the data updates included in MOVES3 for heavy-duty and light-duty vehicles and other general changes, noting the dates when these changes were discussed with the workgroup.

Discussion

Prof. Chris Frey asked about the peer review process for MOVES and whether it is performed under the OMB bulletin for significant actions or if the EPA has used a similar process. He commented that having only two reviewers seemed “light” and also asked whether the reviewer comments and EPA responses are publicly available. Ms. Beardsley replied that they follow the EPA’s peer review guidance, and they use a contractor to select the reviewers. She noted that the 2017 peer review documentation is on the Science Inventory webpage but that the more recent reviews have not yet been posted. She anticipates those reviews to be posted by the end of the year. She also noted that for budgetary reasons, they chose to have two reviewers.

Mr. Chris Voigt asked whether the EPA had performed any sensitivity testing with the model. Ms. Beardsley replied that they had not done sensitivity testing and were not specifically planning for that.

In response to a question from Mr. Marc Corrigan, Ms. Beardsley noted that modelers switching from MOVES2014 will need to create new model run specifications and convert their input databases. The EPA plans to explain how to use the model in the next workgroup meeting and in upcoming trainings. In a follow-up question regarding whether the model would use MYSQL or MariaDB, Ms. Beardsley confirmed that MOVES3 would use MariaDB, and it will be built into the installer.

Presentation: Planned Updates to Default Fuel Supply for MOVES3 – Presented by Aron Butler, U.S. EPA

Mr. Butler first provided an outline of the topics that would be covered in his presentation and then began presenting information regarding gasoline fuel supplies. He mentioned that the EPA has a large year-by-year dataset for gasoline tracking several fuel properties through refinery batch reports. MOVES fuel supply information contains over 20 representative formulations each calendar year to cover local and regional fuel properties. For MOVES3, the updates include revised fuel supply information for Regions 7 (Alaska) and 15 (California) based on retail survey data, moving the U.S. Virgin Islands and Puerto Rico from Region 6 to Region 1 and several county-level changes to make the fuel supply more historically representative of reformulated gasoline (RFG) and volatility controls. Several gasoline formulation updates have been made for MOVES3 for 2014+, which include computing E0 properties from each year’s E10 formulation using Fuel Wizard factors, assuming E10 is 100% of market share, computing splash blends of E15 from local E10 formulations, adjusting E10 formulations based on 2016 refinery batch data for years 2014-2018 and adjusting E10 formulations for 2018+ based on Fuel Wizard sulfur effects. For Years 2013 and earlier, MOVES3 uses the MOVES2014 fuel supply, with only a few small revisions. Mr. Butler explained that the gasoline batch data used to develop the fuel supply information contains volatility data based on the percent evaporated at a certain temperature (E-number), while the emissions models in MOVES rely on inputs based on the temperature at which a certain percentage has been distilled (T-number). To effectively use the batch data, correlations between the E-number and T-number are used. For MOVES3, they have updated the correlations between E200 and T50 and between E300 and T90 based on retail

survey data for 2017-2018 regular grade E10 fuel. The EPA has also updated the ethanol blending factors used in the Fuel Wizard based on recent refinery modeling. The EPA has created default E0 and E15 blend formulations, since these blends are of interest to model users, for each fuel region for years 2014+ (although the default market share in MOVES3 is 100% E10). The default E15 fuels were created for each region based on splash blending with the local E10 fuel, and the distillation and RVP values for this fuel were determined using data from the 2010 API blending study.

For diesel, less detailed data is available than for gasoline, due to fewer fuel property reporting requirements. There are separate formulations for onroad, nonroad, and marine applications, which differ in sulfur and biodiesel levels, and for each of these applications there is a single nationwide formulation in each calendar year. We are aware of some state programs for diesel, but they do not affect properties used in MOVES emission computations. The diesel fuel supply updates for MOVES3 include reducing the onroad sulfur level to 6 ppm for 2007+, based on retail survey data, and reducing the biodiesel blend level from 5% to 3.4% for 2011+, based on the national average blend level over 2011-2019. The updates to the nonroad diesel fuel supply include setting the diesel sulfur level to 6 ppm for 2012+. No changes were made to locomotive/marine diesel sulfur levels.

During peer review of the draft MOVES3 fuel supply data, a few substantive comments were received. These included suggestions that the EPA consider moving Alaska, Puerto Rico and U.S. Virgin Islands out of Region 6 and that RFG and other volatility programs should not be included in the 1990 fuel supply. Both of these comments have been addressed. Another comment was that a single national biodiesel blend level stepping from 0% to 5% in 2014 does not represent state/regional differences or changes over time. This comment was partially addressed by revising the 2014+ level to reflect the most recent data, but state/regional data is not available to address differences at a sub-national level.

Discussion

The first question came from Mr. Tom Darlington, who thanked Dr. Roberts and Mr. Butler and requested that Mr. Butler return to the slide titled Updated Fuel Wizard. Mr. Darlington asked what the two bottom rows of the table on that slide represent. Mr. Butler responded that those show match blending values for E15, a situation they do not believe is happening much in the market, so they recommend using the splash blends in the fuel supply. Mr. Darlington followed up with a second question about what the RVP effect was for splash blended E15. Mr. Butler answered that in the API blending study, a slight decrease in RVP was observed.

Dr. Roberts then called on Mr. Steve Vander Griend, who requested that Mr. Butler provide July and January defaults for comparison with real world observations before MOVES3 is released. Referring to information presented in Slide 15, Mr. Vander Griend said the T50 values look more reasonable than in the previous model version, but that a recent peer reviewed study on market fuel trends shows this aromatics adjustment is too small, so the model data doesn't appear to represent real-world fuel changes. Mr. Butler responded that he is familiar with the market fuel data, and noted that MOVES used refinery models rather than survey data, and that both approaches have strengths and weaknesses. Mr. Butler pointed out that there is an appendix in

the report that describes the refinery modeling cases. He said the refinery modeling results indicated that use of more alkylate would be more economically favorable than increasing aromatics to make up for octane loss, so that was the approach used for the Fuel Wizard. Mr. Butler concluded that fuel surveys could depict one thing and refinery modeling could depict another. Mr. Vander Griend responded that he had used refinery modeling in two peer reviewed studies (referring to work he was involved with), and the MOVES3 approach does not match his results nor the survey data from 2020. Mr. Vander Griend concluded his remarks by saying that the ethanol industry needs to call for another outside review of this modeling work. Mr. Butler stated that he understood.

Dr. Roberts then read a question submitted by Mr. Dale Wells, who asked, “So E15 is splash blended from E10, but the effect is calculated for splash blending E0?” Mr. Butler responded that they started with E10 data because that is what is in the market, then derived the E15 properties by splash blending through a dilution calculation. Mr. Butler continued that the E0 properties were derived from refinery modeling to make up the octane deficit that results from the market E10 not being mixed with ethanol. Mr. Butler asked if this clarified things. Mr. Wells responded that it did, then asked why the RVP goes down. Mr. Butler explained that this is due to the complex and non-linear interaction between ethanol and gasoline. Pure ethanol has low RVP, but when added to gasoline, the physical interaction between the two cause it to be higher than either component separately. This effect peaks around E5 or E10, then as more ethanol is added, the RVP will turn around and decrease. Mr. Butler concluded that this means that E15 has slightly lower RVP than E10, RVP for E30 is around the same as E0, and RVP for E85 will be quite low.

Dr. Roberts then read a question from Mr. Todd Pasley, who wrote, “2019 gasoline data has recently been published on the "Public Data on Gasoline Fuel Quality Properties" web page. It shows that sulfur levels in conventional gas only approach 10 ppm very late in 2019. Will these data be incorporated in MOVES3 before it is released? And will fuel data in MOVES3 be updated on an annual basis?” Mr. Butler answered that he does not think there are plans to update the fuel data on a regular basis and invited Ms. Megan Beardsley to add her thoughts. Ms. Beardsley agreed that the EPA does not expect to be updating the fuel data annually, although they will be keeping a close eye on it, and if it becomes very different from the defaults, they will look at correcting this difference either through a new MOVES release or instructions to users. Mr. Butler added that to answer the part about sulfur, they have 2018 data showing that sulfur is higher than 10 ppm, but they set it at 10 ppm in 2020 because gasoline will be heading to that level on average. Mr. Butler noted that it may be higher or lower as people buy credits here and there, but the total fuel supply will be around 10 ppm for sulfur.

Dr. Roberts then read a question from Prof. Britt Holmen, who asked, “Could you clarify the data inputs for the biodiesel plot in Slide 19? EIA tables show production, how is this translated to a volume percent biodiesel in the on-road fuel supply?” Mr. Butler answered that if you divide by the distillate used in transportation according to Table 3.7c, you come up with the national average blend level. Prof. Holmen asked if that was the only data used and if there were no analyses from samples at the pump. Mr. Butler confirmed that this is the case. He noted that some states have incentives for biodiesel, but it is difficult to know the amount exactly because the level of detail varies a lot across the country. The EPA has chosen to continue with this approach unless more detailed information becomes available in the future.

Dr. Roberts then read a question from Mr. Steve Vander Griend, who asked, “Why not release oil refinery modeling before releasing MOVES?” Mr. Butler responded that he was not sure, but he didn’t think they had ever released other pieces of analysis ahead of time. Ms. Beardsley added that they have given detailed presentations on the inputs, but they generally release the technical reports once the model is done because they want to make sure the reports are correct. Ms. Beardsley added that she was not sure what it would mean to release the oil refinery modeling earlier or what the feasibility of doing so would look like. Mr. Butler noted that they could look into this.

Wrap-Up

In closing each meeting day, Ms. Beardsley informed the meeting attendees that when the MOVES3 model is released, the EPA will schedule another workgroup meeting sometime this fall to provide information on the net change between the two models and provide details about the model structure. An additional meeting will be in the winter or spring to discuss the workgroup’s reactions to the MOVES3 model. During the October 22nd meeting, Dr. Barth added that for the winter/spring meeting, the EPA will ask for recommendations to be presented to the MSTRS at their spring meeting. He noted that the MSTRS is discussing transportation challenges, and modeling is a part of those discussions. During each meeting, Dr. Roberts also noted that the meeting presentations are posted online and mentioned that if anyone has questions about the presentations, they can send those to her by email.

Ms. Beardsley thanked the meeting attendees for their participation at the conclusion of both meetings.

A list of participants is provided as an attachment to this summary. This list is based on the participants who joined the meetings as noted by the participants listed in the Microsoft Teams software at the beginning of the meeting, which may not include every person who attended. Copies of the presentations given during this meeting will be available at <https://www.epa.gov/moves/moves-model-review-work-group>.

Attachment – Work Group Meeting Attendance List

October 2020 MOVES Review Work Group Attendees

Name	Home Organization	Representing Organization	Meeting Dates Attended
Matthew Barth	University of California, Riverside (CE-CERT)	University of California, Riverside (CE-CERT), Work Group Co-chair	10/14/20
Megan Beardsley	U.S. Environmental Protection Agency (EPA)	U.S. Environmental Protection Agency; Work Group Co-Chair	10/14/20, 10/22/20
Elena Craft	Environmental Defense Fund (EDF)	Environmental Defense Fund (EDF)	10/22/20
Tim French	Engine Manufacturers Association (EMA)	Engine Manufacturers Association (EMA)	10/14/20
Chris Frey	North Carolina State University	North Carolina State University	10/14/20
Mike Geller	Manufacturers of Emission Controls Association (MECA)	Manufacturers of Emission Controls Association (MECA)	10/14/20
Gil Grodzinsky	Georgia Department of Natural Resources	National Association of Clean Air Agencies (NACAA)	10/14/20, 10/22/20
Michael Hartrick	Alliance for Automotive Innovation	Alliance for Automotive Innovation	10/14/20
Cecilia Ho	Federal Highway Administration (FHWA)	Federal Highway Administration (FHWA)	10/14/20
Britt Holmen	University of Vermont	University of Vermont	10/14/20, 10/22/20
Joe Jakuta	Ozone Transport Commission (OTC)	Ozone Transport Commission (OTC)	10/14/20, 10/22/20
Chris Kite	Texas Commission on Environmental Quality	Association of Air Pollution Control Agencies (AAPCA)	10/14/20, 10/22/20
David Lax	American Petroleum Institute (API)	American Petroleum Institute (API)	10/14/20, 10/22/20
Sam Pournazeri	California Air Resources Board (CARB)	California Air Resources Board (CARB)	10/14/20
Lubna Shoaib	East-West Gateway Council of Governments	Association of Metropolitan Planning Organizations (AMPO)	10/14/20, 10/22/20
Jenny Sigelko	Volkswagen of America, Inc.	Coordinating Research Council (CRC)	10/22/20

Matthew Thornton	National Renewable Energy Laboratory (NREL)	National Renewable Energy Laboratory (NREL)	10/14/20, 10/22/20
Steven Vander Griend	ICM Inc.	Energy Future Coalition/Urban Air Initiative	10/14/20, 10/22/20
Chris Voigt	Virginia Department of Transportation	Amer. Assoc. of State Highway and Transportation Officials (AASHTO)	10/14/20, 10/22/20
Dale Wells	Colorado Department of Public Health and Environment	National Association of Clean Air Agencies (NACAA)	10/14/20, 10/22/20
Wei Zhang	Idaho Department of Environmental Quality	National Association of Clean Air Agencies (NACAA)	10/14/20, 10/22/20

October 2020 MOVES Review Non-Work Group Attendees

Name	Organization	Meeting Dates Attended
Jiayi An	U.S. Environmental Protection Agency	10/14/20, 10/22/20
Michael Aldridge	U.S. Environmental Protection Agency	10/14/20, 10/22/20
Anna Aleynick	AECOM	10/14/20, 10/22/20
Walter Barozi	(organization not specified)	10/22/20
Carla Bedenbaugh	South Carolina Dept. of Health and Environmental Control	10/22/20
Earl Berg	(organization not specified)	10/14/20
Jenn Billo	(organization not specified)	10/14/20
Daniel Bizer-Cox	U.S. Environmental Protection Agency	10/22/20
Marty Boardman	Texas A&M Transportation Institute	10/14/20
Stani Bohac	U.S. Environmental Protection Agency	10/14/20
Andrew Bollman	North Carolina Division of Air Quality	10/14/20, 10/22/20
Chris Bovee	Wisconsin Department of Natural Resources	10/14/20, 10/22/20
Chris Boyd	Shelby County Health Department	10/22/20
Jarrold Brown	Environmental Protection Agency	10/14/20, 10/22/20
Andy Burnham	Argonne National Laboratory	10/14/20
Aron Butler	U.S. Environmental Protection Agency	10/14/20, 10/22/20
David Choi	U.S. Environmental Protection Agency	10/14/20, 10/22/20
Ying-Tzu Chung	Michael Baker International	10/14/20, 10/22/20
Denise Cormier	Maine Department of Environmental Protection	10/14/20, 10/22/20
Marc Corrigan	Tennessee Department of Environment and Conservation	10/14/20, 10/22/20
Kenneth Craig	Sonoma Technology	10/14/20, 10/22/20
Angela Cullen	U.S. Environmental Protection Agency	10/14/20
Tom Darlington	Air Improvement Resource, Inc.	10/14/20, 10/22/20
Allison DenBleyker	Eastern Research Group, Inc.	10/14/20, 10/22/20
David D'Onofrio	Federal Highway Administration (FHWA)	10/14/20
Rob Dawson	Colorado Department of Public Health and Environment	10/14/20
Chris Dresser	Federal Highway Administration (FHWA)	10/14/20, 10/22/20
Andrew Eilbert	Volpe/DOT	10/22/20
Dustin Fitzpatrick	(organization not specified)	10/14/20

October 2020 MOVES Review Non-Work Group Attendees

Name	Organization	Meeting Dates Attended
Steven Giannitti	(organization not specified)	10/14/20
Janice Godfrey	U.S. Environmental Protection Agency	10/14/20, 10/22/20
John Gorgol	New Jersey Department of Environmental Protection	10/14/20
Jessica Goza-Tyner	(organization not specified)	10/14/20
Jaehoon Han	U.S. Environmental Protection Agency	10/14/20, 10/22/20
Connie Hart	U.S. Environmental Protection Agency	10/14/20
Ryan Hatch	Pima Association of Governments	10/14/20
Jinhyok Heo	California Air Resources Board	10/14/20
Joey Huang	North Carolina Department of Environmental Quality	10/22/20
Noh Hyunsoo	Pima Association of Governments	10/14/20
Dennis Kahlbaum	Air, Inc.	10/14/20, 10/22/20
David Kall	Federal Highway Administration (FHWA)	10/14/20
Katie Katrichis	(organization not specified)	10/14/20
Miles Kemp	Georgia Department of Transportation	10/14/20
Sandeep Kishan	Eastern Research Group	10/14/20
John Koupal	Eastern Research Group	10/14/20
Andrea Kramer	(organization not specified)	10/14/20
Sonya Lewis-Cheatham	Virginia Department of Environmental Quality	10/14/20, 10/22/20
Marie Limage	(organization not specified)	10/14/20
George Lin	Caterpillar	10/22/20
Jeff Long	California Air Resources Board (CARB)	10/14/20
Paul Machiele	U.S. Environmental Protection Agency	10/14/20, 10/22/20
Ted Maciag	U.S. Environmental Protection Agency	10/14/20, 10/22/20
Angelica Marchi	U.S. Environmental Protection Agency/ORISE	10/14/20, 10/22/20
Tiffany Mo	U.S. Environmental Protection Agency	10/14/20
Paola Moncada	(organization not specified)	10/14/20
Greg Mortensen	Utah Department of Environmental Quality	10/22/20
Evan Murray	U.S. Environmental Protection Agency	10/14/20, 10/22/20
Michael Olechiw	U.S. Environmental Protection Agency	10/14/20

October 2020 MOVES Review Non-Work Group Attendees

Name	Organization	Meeting Dates Attended
Margaret Overton	SC&A, Inc. (EPA contractor support for the meeting)	10/22/20
Jinchul Park	Metropolitan Washington Council of Governments	10/14/20, 10/22/20
Todd Pasley	North Carolina Division of Air Quality	10/14/20, 10/22/20
Meg Patulski	U.S. Environmental Protection Agency	10/14/20
Jackie Ploch	Texas Department of Transportation	10/14/20
Jane Posey	Metropolitan Washington Council of Governments	10/14/20, 10/22/20
Steven Potter	Connecticut Department of Energy and Environmental Protection	10/22/20
Jeff Ramsey	(organization not specified)	10/14/20
Sarah Roberts	U.S. Environmental Protection Agency	10/14/20, 10/22/20
Satya Sardar	(organization not specified)	10/14/20
Kathryn Sargeant	U.S. Environmental Protection Agency	10/14/20, 10/22/20
Jolyon Shelton	Delaware Dept. of Natural Resources and Environmental Control	10/22/20
Todd Sherwood	U.S. Environmental Protection Agency	10/14/20
Kira Shonkwiler	Colorado Department of Public Health and Environment	10/14/20, 10/22/20
Jim Sidebottom	(organization not specified)	10/14/20
James Smith	Tennessee Department of Environment and Conservation	10/22/20
Darrell Sonntag	U.S. Environmental Protection Agency	10/14/20, 10/22/20
Lesley Stobert	SC&A, Inc. (EPA contractor support for the meeting)	10/14/20
Collin Smythe	Vermont Department of Environmental Conservation	10/14/20
Brian Sullins	Alabama Department of Environmental Management	10/22/20
Dan Sullivan	Minnesota Pollution Control Agency	10/14/20
Naima Swisz-Hall	U.S. Environmental Protection Agency	10/14/20
Claudia Toro	U.S. Environmental Protection Agency/ORISE	10/14/20, 10/22/20
Vivek Thimmavajhala	North Central Texas Council of Governments	10/14/20, 10/22/20
Jiao Wan	California Air Resources Board	10/14/20
James Warila	U.S. Environmental Protection Agency	10/14/20, 10/22/20
Roger Wayson	AECOM	10/14/20

October 2020 MOVES Review Non-Work Group Attendees

Name	Organization	Meeting Dates Attended
Debbie Wilson	Mid-Atlantic Air Management Association (MARAMA)	10/14/20
Tim Wood	(organization not specified)	10/14/20
Fang Yang	AECOM	10/14/20, 10/22/20
Ping Yi	Utah Department of Environmental Quality	10/22/20
Lei Zhou	California Air Resources Board	10/14/20