Federal Advisory Committee Act
Clean Air Act Advisory Committee

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

March 1, 2017
U.S. EPA Office of Transportation & Air Quality
2000 Traverwood Drive
Ann Arbor, MI 48105

Welcome and Opening Remarks

Ms. Megan Beardsley welcomed the Clean Air Act Advisory Committee (CAAAC) MOVES Review Work Group to the 3rd meeting and presented the meeting agenda (see Table 1). Ms. Beardsley requested that participants, when signing into the meeting, include both their name and affiliation.

Table 1. MOVES Review Work Group Meeting Agenda: March 1, 2017

Time	Topic
1:00-1:15	Welcome and Opening Remarks
1:15-1:45	Vehicle Idle Activity in MOVES
1:45-2:30	Model Evaluation
2:30-2:45	Break
2:45-3:15	Light-Duty PM Emission Rate Update
3:15-4:00	Discussion of Preliminary Recommendations to MSTRS/Closing Remarks

A full list of participants is provided as an attachment to this summary. Copies of the presentation topics for this meeting will be available at https://www.epa.gov/moves/moves-model-review-work-group.

Presentation: Vehicle Idle Activity in MOVES

Mr. David Brzezinski provided an overview of how idling is accounted for in MOVES. Based on recent data, a more up-to-date assessment of idle time in MOVES is needed. He noted that the total default idle time derived by MOVES driving schedules is too low and that there is a need to include idling that occurs in parking lots, driveways, or during "workday" truck operations at distribution centers, loading freight, etc.

Mr. Brzezinski reported that the EPA obtained data from Verizon (Illinois data) about total idle time for light-duty cars and trucks. When comparing MOVES data to the Illinois data, MOVES consistently underestimates the idle fraction. Based on analyses, the EPA concludes that much of the increase in idle time seen from the Illinois data is likely due to idle time off roadways. The

EPA said that, for idling that does occur on roadways, they do not know how much idling needs to be added to each driving schedule or how changing average speeds affect this.

To address/include off roadway idling emissions, the EPA proposes to add a new "off-network idle" output, and options for user input. Emission calculations would use the same emission rate for the idling operating mode as that used for idling in drive schedules. The results could be reported as both mass per hour and mass per vehicle. The Verizon data can be used to link the idle fraction to the total hours of vehicle operation/distance. On-network idle time would continue to be determined based on the amount of idle in the driving schedules during run-time, which will depend on average speed and road type. The EPA said that their proposal stays true to data sources, is flexible, and reconciles differences between on-network idle hours estimated currently in MOVES and the idle time measured from the Illinois data.

In a case study conducted to evaluate how the proposed off-network idle would be impacted by changing average speed distributions, an increase in speed reduced on-network idle hours. This also resulted in a slight reduction of off-network idle hours because the total hours operating decreased, and thus, the total idle hours also decreased, in this case, more than the decrease seen in the drive-cycle hours.

The EPA has purchased additional Verizon data for California, Colorado, Georgia and New Jersey. EPA also plans to examine the FLEET DNA activity and the CE-CERT/ARB heavy-duty databases. EPA will use this data to: 1) inform default idle fractions, and 2) evaluate regional and temporal differences by source type. The EPA is also considering options to allow users to calibrate idle hours to match local information.

Mr. Brzezinski requested input from meeting participants on the EPA's proposal.

Discussion

Mr. Matt Barth inquired about the quality of the Verizon data, the vehicles covered, and whether any bias was evident. Mr. Brzezinski responded that the data is a large data set and that their initial look at the Illinois data indicates a greater representation of newer models than older models. The EPA reported that they would be discussing this data in greater detail at the next meeting.

Mr. Dale Wells commented that he believed there is more data available on distance travelled and speed from the Verizon data and other data that could be used.

Mr. John German requested clarification of what "off-network" means. The EPA responded that "off-network" is any activity that is not captured by a drive-cycle (e.g., starts, evaporative emissions when parked).

Mr. German asked how MOVES addresses a scenario when someone drives from Illinois to California (i.e., travelling across State lines/across the country). The EPA responded that they do not have information on where vehicles are driven, only where they are registered.

Ms. Julie McDill inquired why the EPA did not think that idling emissions would be occurring off roadways. She also asked why idling would be less in rural areas. The EPA responded that they knew idling emissions were occurring but that the data did not indicate if this was on or off

roadways. The EPA stated that their proposal would result in MOVES being able to better estimate total idling emissions.

Mr. Joseph Jakuta asked whether States could more clearly take credit for idling restrictions based on the EPA's proposal. The EPA responded that States could use differing idling fractions for differing vehicles (e.g., delivery trucks). The EPA stated that, because of the complexity required to add this capability to MOVES, it might be better to deal with this outside of MOVES.

Mr. Chris Kite questioned whether this would create a separate emissions "process" in MOVES, as done for hotelling hours. The EPA stated that given that the emission rates will be the same as for idling that occurs during the driving cycle, it made sense to include off-network idling in MOVES as part of the existing "running exhaust" process, but the roadtype distinction will allow it to have separate outputs.

Mr. Jeremy Heiken reported that he had seen some data last year where the percent idling time was higher in vehicles equipped with remote start equipment.

Mr. John German requested that the EPA consider making it easier to address idling emissions by developing idling emission factors based on recent data. He further requested that any added off-network feature be well-defined/clarified and that the EPA consider preparing guidance.

Mr. Matthew Barth asked what the EPA plans to include in the next version of MOVES. The EPA reported that they hope they have time to include both updated data and user interface ease with the next MOVES version. It was explained that the user-input option (i.e., creating import tables for user input) is more complicated than updating the data.

Presentation: Model Evaluation

Mr. David Choi, Darrel Sonntag and James Warila presented the MOVES Model Evaluation presentation. The presentation included the background on MOVES model evaluation, the current model evaluation, and the MOVES 2014a comparisons to inspection/maintenance (I/M), remote sensing data (RSD), and tunnel studies.

After presenting the background for the MOVES Model Evaluation, the EPA stated that recent studies have shown differences between air quality model estimates and monitored values for NOx, suggesting that air quality models appear to be overestimating NOx emissions. It was noted that MOVES is one part of the complex modeling system that is being evaluated to discern why.

The EPA compared running exhaust emissions from light-duty gasoline passenger cars and trucks to Denver I/M compliance data. The EPA indicated that the data is highly variable, but that the MOVES NOx emission rates appear to be lower than corresponding Denver I/M results for Tier 2 cars and higher than corresponding Denver I/M results for Tier 1 cars. The EPA reported that it plans to look at larger data sets, fuel properties, temperature effects, altitude (e.g., for Denver), and potential bias due to "clean screen."

The EPA presented comparisons to the University of Denver RSD for light-duty trucks and passenger cars. The analysis showed that MOVES 2014a estimated lower NOx emissions for Tier 2 vehicles and was within the variability of the data for Tier 1 vehicles for RSD for calendar

years 2013-2015. The analysis also showed that MOVES2014a estimated lower NOx emissions, or within the variability of the data, for Tier 2 vehicles and higher NOx emissions for Tier 1 vehicles for CY2005. The EPA reported that it plans to analyze other available RSD data sets and fuel consumption in MOVES.

Lastly, the EPA presented a comparison of MOVES2014a to Caldecott Tunnel study data. In the case of the Caldecott Tunnel, using MOVES2014a national defaults estimated higher NOx emission rates than using project-level inputs. Key sources of uncertainty for project-level runs include age distributions and LEV inputs and driving cycles. The EPA indicated that limitations of this comparison include that the data is for only one tunnel, the Caldecott tunnel information measures CA fuels/vehicles, and Caldecott gasoline measurements have tended to be lower than other remote sensing studies.

In conclusion, the EPA reported that they plan to continue to work on refining their comparison of MOVES2014a to I/M, RSD, and tunnel measurements, and to work exploring other aspects of the air quality modeling system. The EPA proceeded to acknowledge people outside the Agency who have provided on-going support to their efforts and solicited feedback from participants.

Discussion

Mr. Matthew Barth inquired whether any uncertainty analyses were done for the MOVES emission estimates. Ms. Megan Beardsley stated that some uncertainty work had been done in the emission rate table but that it was more difficult to do with activity data, so they decided not to include it.

Mr. Dale Wells asked what the project inputs were in MOVES (e.g., VMT, speed) for the RSD analysis. Mr. Choi stated that the University of Denver RSD data included vehicle age and operating mode distribution.

Mr. Wells inquired about the duration of the tunnel study (i.e., Caldecott tunnel study) used in the comparison. Mr. Sonntag stated that the study was conducted over 8 days.

Mr. John German stated that slide 22 did not indicate a significant difference for new vehicles. Mr. Choi stated that they looked at different scales (including a log scale), which indicated that 2014 had clearly lower NOx emissions for newer vehicles.

Mr. Jeremy Heiken stated that the Denver I/M data is unique, with lax NOx cutpoints, and the EPA may not want to include it (e.g., Denver is different from Phoenix). Mr. Choi and Mr. Warila stated that the Denver data includes a sample of both passing/failing vehicles and specifies driving cycle with lower power/less aggressive driving.

Mr. Chris Kite stated that MOVES estimates larger NOx emissions for passenger trucks than for passenger cars, so what did EPA mean when they said the RSD results were similar? Choi stated that light-duty car NOx comparisons between RSD and MOVES were **consistent** with the comparisons for light-duty truck NOx emissions.

Mr. Steven Vander Griend expressed concern regarding MOVES default values. He asserted that certain areas, such as Denver, use different fuel (e.g., lower octane gas). He requested that the

EPA consider updating the fuel input defaults based on refinery information. Ms. Beardsley said EPA is working to update the fuel defaults.

Ms. Julie McDill expressed that "clean screen" could be an input bias. Mr. Warila noted that the contractor looked at what would have been exempted, and it was estimated that NOx emissions may be overestimated by 10 percent.

Mr. Wells stated that "clean screen" is not based on NOx emissions and might increase NOx emission estimates for older vehicles.

Mr. Grodzinsky requested a clarification regarding the discrepancy between sulfur and defaults within I/M. He also asked why there were higher NOx emissions based on MOVES defaults. Mr. Choi stated that that the EPA is planning on making fuel supply updates to reflect national average fuel properties provided by refineries and this information was used to create project level inputs for this analysis. He also noted that the I/M defaults used are based on the EPA's 2011 National Emissions Inventory (NEI). He stated that increased NOx emissions based on defaults could be based on one or more of several reasons (and referred to page 19 of the presentation for some of the reasons).

Presentation: Light-Duty PM Emission Rate Update

Mr. Michael Aldridge provided an overview of the base emission rates for particulate matter (PM) used in MOVES2014. MOVES2014 uses emission rates for particulate matter (PM) from the 2004/2005 Kansas City study with updates for temperature and fuel effects on PM based on more recent studies. This data did not include Tier 2 vehicles and all vehicles tested were port fuel injected (PFI). MOVES2014 Tier 1 and Tier 3 rates were projected from certification standards.

New information is available since the Kansas City study. Based on newly available data, the EPA is proposing to make emission rate updates for the next public version of MOVES. The EPA is proposing to include start and running exhaust emissions for Tier 2 and later vehicles (MY 2004+), the effect of GDI engines on elemental and non-elemental carbon PM, and temperature effects on running PM emissions (all model years).

Mr. Aldridge provided an overview of the EPA's analysis of six datasets:

- EPA Tier 2 sulfur
- EPAct Phase 1 FTP
- EPAct Phase 3
- EPAct Phase 4
- CARB GDI
- EPA CFI Program

Analyses examined test program information, vehicle information, fuel information and test data. Based on the analysis of the data and other studies, the EPA proposes to revise MOVES for the next release to address start and running exhaust PM rates for light-duty vehicles for MY 2004+ to account for new data and phase-in of GDI vehicles, non-EC ratio updates for MY 2004-2050, and to remove temperature effects for PM running emissions (all model emissions).

The EPA determined, based on their analyses, that insufficient information exists to include the following in the next MOVES release:

- Temperature effects for start emissions
- Brake and tire wear PM emissions
- Deterioration effects for both start and running emissions
- Changes in the proportion of PM emissions attributed to each MOVES operating mode.

Mr. Aldridge solicited questions and comments from participants.

Discussion

Mr. Steven Vander Griend expressed concern over the use of the data collected using Phase IV EPAct fuel. The commenter stated that for Bag 2 (referring to page 21 of the presentation) there is a noticeable increase in emissions with temperature with that fuel. EPA staff explained that, for this analysis, only the data collected at standard temperature was used.

Mr. Giedrus Ambrozaitis asked for clarification regarding the PM emission rate comparisons on slide 19. To explain slide 19, Mr. Aldridge referred participants to slide 15 where the EPA acknowledges that data from 2 vehicles was not sufficient to adjust emission factors for light-duty trucks, so the EPA developed adjustment factors based on the effect of GDI relative to PFI on car emissions.

Presentation and Discussion: Recommendations to MSTRS/Closing Remarks

Mr. Matthew Barth (University of California Riverside (UCR)) reviewed the MOVES Workgroup (WG) Charter and the Charter's goal to provide preliminary recommendations to the Mobile Sources Technical Review Subcommittee (MSTRS) by the late May/early June meeting. He stated that the WG would provide more refined short-term and long-term recommendations to the MSTRS at a later date. Mr. Barth stated that the focus of the preliminary and follow-up recommendations to the MSTRS would cover the following four areas:

1) Evaluating data sources and analysis methods proposed for use in developing **emission rates** used in the MOVES model.

2) Evaluating data sources and analysis of methods proposed for use in developing **fleet and activity** inputs to be used in the MOVES model.

3) Evaluating data sources and analysis methods proposed for use in developing **emission adjustment factors** to be used in the MOVES model.

4) Evaluating the **format** of MOVES input and output **structures** and the usefulness of these formats in meeting the needs of modelers developing State Implementation Plans (SIPs) and transportation conformity determinations.

Mr. Barth stated that the preliminary WG suggestions would be provided to the MSTRS on 3-5 slides that focus on MOVES short-term priorities. He referred meeting participants to the "Comments Submitted to MOVES Workgroup, September 16-February 2017" handout for

comments submitted on several topics from September 2016 to February 2017. He requested that WG and non-WG (NWG) participants provide input on what they see as short-term priorities among emissions, activity data, model structure, model evaluation, etc. going forward. He stated that the WG will continue working on the long-term improvements and recommendations and directions for MOVES throughout the life of the WG and that those recommendations will be a topic for the MSTRS later.

Mr. Barth requested that WG and non-WG participants submit feedback to him (at barth@cert.ucr.edu with a cc to Sarah Roberts; Roberts.Sarah@epa.gov) on what improvements and recommendations they believe should be prioritized based on the comments included in the handout and any other areas they feel should be prioritized. He reported that he will consolidate feedback received and will prepare 3-5 slides for the MSTRS meeting in late May/early June. He requested that participants identify themselves as either a Work Group (WG) member or a non-member participant (NWG) when they submit their feedback.

Mr. Barth and Ms. Megan Beardsley then solicited initial feedback from meeting participants:

Mr. Dale Wells (WG) stated that he would like to see altitude effects addressed in the nonroad model. He also stated that an additional onroad "Emission Rate" mode guidance document is needed.

Mr. Tom Darlington (NWG) stated that he felt that more work is needed on fuel/vehicle effects on PM emissions. He reported that Growth Energy is spearheading a data effort that could assist with PM base emission rates and emission rate corrections. He stated that the data will be available in about 5 months. He also expressed concern regarding fuel correction factors to address fuel usage in differing areas.

Ms. Julie McDill (NWG) stated that she would like to see guidance that would assist users with assigning the vehicle types (source types) in MOVES. She opined that this was needed to address issues related to light-duty trucks and other vehicle types that have lower emissions than reflected in the emission factors used in MOVES. She stated, for example, that light-duty trucks generally have comparable emissions to car-level emission factors and that guidance to assist users with assigning the right vehicle type is necessary to address this issue.

Ms. McDill suggested that the EPA work with the OAQPS oil and gas group to try and mesh the on-line oil and gas tool to EPA's nonroad model.

Ms. McDill also stated that, currently, only the EPA can run the "Emission Rate" mode and that this is problematic for the Regions and States. She stated that the Regions and States need to be able to run the "Emission Rate" mode.

Mr. Joseph Jakuta (WG) and Mr. Mark Janssen (WG) reiterated Ms. McDill's concern that the emission rate tool cannot be run by the Regions and States. They expressed that by adding complexity to MOVES, the CPU demand is too high and that they supported efforts to reduce run times or require less computer memory/processing.

Mr. Jeremy Heiken (NWG) acknowledged the CPU demand issues associated with the emission rate tool and added a concern that MOVES cannot be configured to go back in time. He stated that in recent work with Canada, he had to use the MOBILE model.

Mr. Christopher Voigt (WG) stated that he would reiterate a comment that he provided previously, namely that EPA should place a high priority on prioritizing improvements to support project level modeling. He added that many or most of the other comments that he provided previously would fall into that general category. Among those other comments, the one that he would raise as a priority was to improve estimates for the brake and tire wear components of particulate emissions.".

Mr. Ross Patronsky (WG) stated that under the new ozone NAAQS, smaller MPOs will need to perform conformity determinations, so it's important that MOVES be easy to run.

Mr. Gil Grodzinsky (WG) stated that he agreed with Ms. McDill's suggestion regarding documentation to assist users in identifying the appropriate vehicle type so that the emissions are properly estimated (e.g., for light-duty vehicles). He also stated that he supports changes that make it easier to determine emission factors for idling vehicles, as well as stated that hoteling activity should be allocated based on VMT on both urban and rural roads He further stated that there was a SIP need for more recent data on vehicle population and age data.

Mr. Tim French (WG) stated that he would like tampering, malfunction and mal-maintenance adjustment factors improved in the model. He stated that assumptions regarding these factors are critically important and that he would e-mail details regarding this issue.

Ms. Susan Collet (WG) stated that she agreed with Mr. French. Ms. Collet also expressed concern that they had expected that NOx emissions estimated by MOVES would be decreasing and that they may be missing something and overestimating NOx emissions.

Mr. Chris Kite (WG) suggested that MOVES update light-duty diesel emissions to account for the VW settlement.

Mr. Steve Vander Griend (WG) stated that there is more data (e.g., vehicle data, evaporative emission data, fuel data) that may be able to be used to update MOVES.

Closing Remarks

In closing, Ms. Megan Beardsley thanked the meeting participants and informed them that she would forward meeting notes to them when drafted so that they could review.

Attachment – Work Group Meeting Attendance List

2016-2017 MOVES Review Work Group Members

Name	Home Organization	Representing Organization	Sector
Matthew Barth	University of California, Riverside (CE-CERT)	University of California, Riverside (CE-CERT); Work Group Co-Chair	Academia
Megan Beardsley	Environmental Protection Agency (EPA)	EPA; Work Group Co-Chair	Federal Government
Giedrius Ambrozaitis	Alliance of Automobile Manufacturers	Alliance of Automobile Manufacturers	Industry
Susan Collet	Toyota	Toyota	Industry
David D'Onofrio	Atlanta Regional Commission	Association of Metropolitan Planning Organizations (AMPO)	State/Local Government
Tim French	Engine Manufacturers Association (EMA)	EMA	Industry
Chris Frey	North Carolina State University	North Carolina State University	Academia
Mike Geller	Manufacturers of Emission Controls Association (MECA)	MECA	Industry
John German	International Council on Clean Transportation (ICCT)	ICCT	Environmental NGO
Gil Grodzinsky	Georgia Department of Natural Resources	National Association of Clean Air Agencies (NACAA)	State/Local Government
Cecilia Ho	Federal Highway Administration (FHWA)	FHWA	Federal Government
Britt Holmen	University of Vermont	University of Vermont	Academia
Joseph Jakuta	Ozone Transport Commission (OTC)	OTC	State/Local Government
Mark Janssen	Lake Michigan Air Directors Consortium (LADCO)	LADCO	State/Local Government
Chris Kite	Texas Commission on Environmental Quality	Association of Air Pollution Control Agencies (AAPCA)	State/Local Government
David Lax	American Petroleum Institute (API)	API	Industry
Ross Patronsky	Chicago Metropolitan Agency for Planning (CMAP)	CMAP	State/Local Government
Matt Solomon	Northeast States for Coordinated Air Use Management (NESCAUM)	NESCAUM	State/Local Government
Steven Vander Griend	ICM Inc.	Energy Future Coalition/Urban Air Initiative	Industry
Christopher Voigt	Virginia Department of Transportation	American Association of State Highway and Transportation Officials (AASHTO)	State/Local Government
Dale Wells	Colorado Department of Public Health and Environment	NACAA	State/Local Government
Chris Wolfe	Environmental Defense Fund (EDF)	EDF	Environmental NGO

2016-2017 MOVES Review – Other Non-Work Group Attendees*

Name	Home Organization	Representing Organization	Sector
Michael Aldridge	EPA OTAQ	EPA OTAQ	Federal Government
Steve Berry			
Kevin Black	Federal Highway Administration	FHWA	Federal Government
Christopher Boyd	Shelby County Health Department	Shelby County Health Department	State/Local Government
David Brzezinski	EPA OTAQ	EPA OTAQ	Federal Government
David Choi	EPA OTAQ	EPA OTAQ	Federal Government
Denise E. Cormier	Maine Department of Environmental Protection (MEDEP)	MEDEP	State/Local Government
Marc Corrigan	Tennessee Department of Environment and Conservation	Tennessee Department of Environment and Conservation	State/Local Government
Louis Corsino	Connecticut Department of Energy and Environmental Protection	Connecticut Department of Energy and Environmental Protection	State/Local Government
Zhen Dai	California Air Resources Board (CARB)	CARB	State/Local Government
Tom Darlington	Air Improvement Resource, Inc.	Air Improvement Resource, Inc.	Industry
Yuan Du	Sonoma Technology, Inc	Sonoma Technology, Inc	Industry
Alison Eyth	EPA OAQPS	EPA OAQPS	Federal Government
Greg Frost	NOAA, ESRI, Boulder Colorado	NOAA, ESRI, Boulder Colorado	Federal Government
Tom Hanf	Michigan DOT	Michigan DOT	State/Local Government
Jeremy Heiken	Oak Leaf Environmental	Oak Leaf Environmental	Industry
David Kall	Federal Highway Administration (FHWA)	FHWA	Federal Government
James Koroniades	Vermont Department of Environmental Conservation (VT DEC)	VT DEC	State/Local Government
Jin-Sheng Lin	Virginia Department of Environmental Quality	Virginia Department of Environmental Quality	State/Local Government
Jeff Long	CARB	CARB	State/Local Government
Julie McDill	Mid-Atlantic Regional Air Management Association (MARAMA)	MARAMA	State/Local Government
Dave McClard	South Carolina Dept. of Health and Environmental Control	NACAA	State/Local Government
Joanne O'Loughlin	EC/R Inc.	EPA Contractor Support to MOVES Work Group	EPA Contractor
Sally Otterson	Washington State Department of Ecology	Washington State Department of Ecology	State/Local Government
Steven Potter	Connecticut Department of Energy and Environmental Protection	Connecticut Department of Energy and Environmental Protection	State/Local Government
Sarah Roberts	EPA OTAQ	EPA OTAQ	Federal Government
Jolyon Shelton	Delaware Department of Natural Resources and Environmental Control	Delaware Department of Natural Resources and Environmental Control	State/Local Government

2016-2017 MOVES Review – Other Non-Work Group Attendees*

Name	Home Organization	Representing Organization	Sector
James Smith	Tennessee Department of Environment and Conservation	Tennessee Department of Environment and Conservation	State/Local Government
Darrell Sonntag	EPA OTAQ	EPA OTAQ	Federal Government
Sherrie Sala-Moore	CARB	CARB	State/Local Government
Vivek Thimmavajjhala	North Central Texas Council of Governments	North Central Texas Council of Governments	State/Local Government
Jeffrey Vukovich	EPA OAQPS	EPA OAQPS	Federal Government
James Warila	EPA OTAQ	EPA OTAQ	Federal Government
Wei Zhang	Idaho Department of Environmental Quality	NACAA	State/Local Government

*Full names and organization information provided where known