

# MOVES Work Group: Meeting Summary

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December 7, 2016  
U.S. EPA Office of Transportation & Air Quality  
2000 Traverwood Drive  
Ann Arbor, MI 48105

## Welcome and Opening Remarks

Megan Beardsley welcomed the MOVES Work Group and presented the meeting agenda (see Table 1). Ms. Beardsley requested that participants, when signing into the meeting, include both their name and affiliation. She informed the Work Group that there is a new Work Group website and that minutes of the meeting will be sent out to the Work Group for review for accuracy before being posted to this website. Ms. Beardsley stated that comments on the meeting will need to be provided by January 11, 2017. She informed the group that seven people sent responses to the presentation topics from the September 14, 2016 Work Group meeting and that those individual comments and EPA's notes on those comments were sent to the Work Group, along with today's meeting presentation files, in an email.

**Table 1. MOVES Review Work Group Meeting Agenda: December 7, 2016**

<b>Time</b>	<b>Topic</b>
<b>1:00-1:15</b>	Welcome and Opening Remarks
<b>1:15-2:00</b>	Update to Running Exhaust Criteria Pollutant Emission Rates for Model Year 2010+ Heavy-Duty Vehicles
<b>2:00-2:30</b>	Updated Emission Rates for Extended Idle and Auxiliary Power Units
<b>2:30-2:45</b>	Break
<b>2:45-3:30</b>	MOVES Onroad Vehicle Population and Activity Update
<b>3:30-3:45</b>	Updating Hotelling Hours in MOVES
<b>3:45-4:00</b>	Closing Remarks

A full list of participants is provided as an attachment to this summary. Copies of the individual comments from the September 14, 2016 Work Group meeting and the presentations for this meeting are available at <https://www.epa.gov/moves/moves-model-review-work-group>.

## **Presentation: Update to Running Exhaust Criteria Pollutant Emission Rates for Model Year 2010+ Heavy-Duty Diesel Vehicles; Gurdas S. Sandhu and Darrell Sonntag (presented by Gurdas S. Sandhu)**

Mr. Gurdas Sandhu discussed the data sources in the current MOVES model. In MOVES2014a, the NO<sub>x</sub> running exhaust emissions rates for model year (MY) 2010 and beyond heavy-duty vehicles (HDV) is based on real-world data from MY 2009 and earlier vehicles scaled per the change in emissions standards. Since then, real-world data from MY 2010 and newer HDVs is available under the heavy-duty in-use (HDIU) program. He stated that the EPA is proposing emission rate updates for MY 2010+ heavy duty vehicles for nitrogen oxide (NO<sub>x</sub>), carbon monoxide (CO) and hydrocarbon (HC) emissions, and also is proposing energy use updates (which affects carbon dioxide (CO<sub>2</sub>) emissions).

Mr. Sandhu reported that manufacturer-run HDIU testing data for engines selected in calendar years 2010 to 2014 is available and included in the proposed update. This data covers MY 2010-2013 engine families. The data for engines selected in 2015 is expected to be available by January 2017 and the EPA plans to include this data in the MOVES update. The methodology EPA uses to update emission rates is to assign operating modes (OpMode) to each second of engine operation based on estimated power demand at the wheel and average the emissions from all seconds assigned the same OpMode. Emission rates are estimated by service class and grouped by NO<sub>x</sub> family emission limit (FEL) group and are then weighted using the production volume by NO<sub>x</sub> FEL group for a given MY. Mr. Sandhu noted that MOVES and real-world data show little activity in high power OpModes. Compared to MOVES 2014 where the emissions for these modes were extrapolated from the highest OpMode with sufficient data, the next version of MOVES will fold in emission rates from OpModes with sparse data into the highest power OpMode with sufficient data. This method results in total emissions equal to real-world emissions.

Mr. Sandhu presented the preliminary emission rate results for heavy-heavy duty trucks using the EPA's proposed methodology and currently available data for MY 2010-2013 for NO<sub>x</sub>, THC and CO<sub>2</sub>. Preliminary results for NO<sub>x</sub> led to a 42% increase in cycle total NO<sub>x</sub>, a 47% decrease in cycle total THC emissions and an 8% increase in cycle total CO<sub>2</sub> emissions over MOVES2014 rates for HHD trucks. Mr. Sandhu reported that the EPA plans to complete analysis of all HDIU testing data, including data for engines selected in calendar year 2015, and compile emission rates by regulation class.

Mr. Sandhu further stated that EPA plans to look at the impact of mal-maintenance and high-emitters, conduct MOVES runs to estimate impact from updated emission rates on the national inventory, and potentially include data from other sources to fill gaps (depending on time and data availability). He acknowledged that there is need for additional MOVES improvements (e.g., updated data, model features) and listed several areas where additional work/information is needed in the future (e.g., diesel particulate filter (DPF) regeneration, deterioration and failure).

### *Discussion*

Dale Wells inquired whether the percent of time by OpMode average is based on an average of all road types or based on differing road type percentages. Mr. Sandhu responded that the OpMode average is based on an average of all road types and includes restricted and unrestricted types for rural and urban roads.

Joseph Jakuta asked if EPA looked at on-board diagnostic (OBD) programs to compare emission estimates. The EPA expressed that they hoped to do that in the future.

Matthew Barth inquired whether the fold-in method used for emission rates (gap-filling emission rate slide) are average emission rates. Mr. Sandhu responded that they are average rates based on 10 trucks. Mr. Barth asked whether error bars were created to show variation. Mr. Sandhu responded that the EPA developed error bars but that the error bars were massive for the higher operating modes because of lack of data. He further stated that they used the fold-in method to fill these data gaps and plan to use this method in MOVES updates going forward.

Mr. Barth commented on diesel particulate filter (DPF) regeneration. He reported that there are some studies on DPF regeneration being done by California. He stated that he had not seen the studies but suggested that EPA continue on-going discussions with the Air Resources Board (ARB) regarding DPF regeneration.

Tim French commented that he was disappointed to see a 42% increase in cycle total NO<sub>x</sub> over MOVES 2014 emission rates. He mentioned that the California Air Resources Board (CARB) is using different test methods and wondered whether the EPA test data could be compared to its CAL-EMFAC data. Ms. Beardsley responded that they would look into obtaining the CARB test data.

Sam Pournazeri inquired whether there are limitations regarding calculation of engine power demand, based on ECU reported torque, during low torque operation, which in turn may pose challenges to calculation and assignment of OpModes. Mr. Sandhu acknowledged the concern regarding low torque operation. He noted that the data for this class of operation does not have a large effect on total emissions and the effect is limited to low power OpModes. He further explained that the torque calculation uses engine map profiles provided by manufacturers and should be accurate at low torque.

Julie McDill stated that she was concerned that the high OpMode emission factor is based on limited and extrapolated data. She inquired whether there is any available data that can be used to ground-truth the assumptions. She further asked about the effects of fuel sulfur content. Mr. Sandhu responded that the data used is consistent with available research data for high power OpModes, so they are confident with the current approach. He explained that trucks spend very little time in the high OpModes, so the inventory is not affected much by these emissions. He also stated that trucks use the same fuel (diesel), which is low in sulfur content, and it has not been a priority to look at sulfur effects.

Susan Collet asked about differences in default emissions rates at the State level due to local truck population. Darrell Sonntag responded that emission rates don't change by state and the production volume used is the national production volume.

## **Presentation: Updated Emission Rates for Extended Idle and Auxiliary Power Units, Darrell Sonntag and David Choi (presented by Darrell Sonntag)**

### Extended Idle Activity/Emission Rates

Darrell Sonntag presented an overview of updates to the extended idling activity and MY 2007+ extended idle emission rates for diesel long-haul combination trucks as developed for the regulatory version of MOVES used in support of the final Heavy Duty Vehicle Greenhouse Gas (HD GHG) Phase 2 rulemaking. The EPA is proposing to make these same updates in the next version of MOVES.

Mr. Sonntag reported that two data sets were used to determine the extended idle CO<sub>2</sub>, CO, NO<sub>x</sub>, THC and PM<sub>2.5</sub> emission rates (Texas Transportation Institute (TTI, 2014) and California Air Resources Board (ARB, 2015)). Using these data, emission rates of each pollutant were plotted by MY, test conditions (hot or cold), and whether the truck was equipped with selective reductive catalyst (SCR). The average of the tests for each data set indicated that the TTI tests were more representative of real-world extended idle conditions (compared to the ARB tests). Therefore, the EPA weighted the TTI data more than the ARB data. Separate averages were computed by MY ranges where a trend was evident in the data. The THC and PM<sub>2.5</sub> average emission rates were adjusted for DPF deterioration. The EPA incorporated the impact of age and deterioration into a single rate for extended idle. Mr. Sonntag presented the proposed extended idle emission rates for each pollutant for each MY group.

Mr. Sonntag stated that these proposed extended idle emission rates are to be included in the next version of MOVES for diesel long-haul combination trucks (both heavy-heavy duty and medium heavy-duty long-haul diesel trucks). He reported that the EPA could also revise the analysis to include additional data sets collected on extended idling trucks (e.g., supplementing ARB data with newer data) and adjusting the methodology (weighting of data) based on new data.

### APU Emission Rates

Mr. Sonntag reported that auxiliary power unit (APU) emission rates data is limited and the current APU emission rates in MOVES come from the NONROAD model for small Tier 4 compliant nonroad diesel engines.

Two primary APU data sets (TTI (2014) and Frey and Kuo (2009)) and two secondary APU data sets were evaluated (TTI (2012) and Storey et al. (2013)) and were used in the HD GHG Phase 2 rulemaking. Data for one diesel APU system (APU ID 1) indicates that there was a large impact on particulate matter (PM) emissions with the use of DPF. In general, the results of the datasets were comparable, where fuel usage was greater under hot and cold conditions compared to ambient conditions. The EPA is proposing to use the emission rates for APUs that were used in the HD GHG Phase 2 rulemaking. Mr. Sonntag presented the proposed APU emission rates for each pollutant for each MY group.

### Conclusion

Mr. Sonntag reported that the next version of MOVES will incorporate the extended idle and APU emission rates used in the HD GHG Phase 2 rulemaking. He further stated that the EPA does not plan on conducting new analyses on the extended idle and APU emission rates in the next version of MOVES and will devote resources to address other improvements in modeling heavy-duty trucks in MOVES (e.g., incorporating start emissions from SCR-equipped trucks).

### *Discussion*

One Work Group member noted that the proposed NO<sub>x</sub> extended idle emission rates do not seem to vary between hot and cold temperatures (referred to Slide 11). The member also expressed hope that California's EMFAC and MOVES are consistent. Mr. Sonntag responded that the TTI study did show differences by temperature, but the differences were mild. He further noted that the EPA does not have data to indicate clear trend of differences between cold and hot temperatures. Another meeting attendee noted that there is a similar trend for new trucks.

Chris Frey asked whether the EPA included activity data for extended idling quantification (e.g., stop duration, time the engine is on, hours of service, etc.). He noted that sometimes both the APU and base engine of the truck are used simultaneously. Mr. Frey reported that some truckers like the sound of the engine and do not like the high whine of an APU. In addition, Mr. Frey noted that "team" drivers spend less time in extended idle. Mr. Sonntag acknowledged that these situations do occur but noted that MOVES does not account for them. He noted that this could be an area for further study.

Gil Grodzinsky stated that he could not see a trend from the NO<sub>x</sub> extended idle emission rate data presented. Mr. Sonntag stated that the lines presented represent an average, and the EPA could also do a statistical analysis (e.g., T-test). Gil Grodzinsky stated that such an analysis would be good to have for trend and policy considerations.

Mr. Grodzinsky inquired about whether EPA had looked at the effect of humidity and altitude on emissions. Mr. Sonntag responded that they had looked at humidity effects for NO<sub>x</sub>, and it only had a small effect, but they had not looked at effects for altitude.

### **Presentation: MOVES Onroad Vehicle Population and Activity Update, Daniel Bizer-Cox**

Daniel Bizer-Cox reported that the EPA plans to make MOVES onroad vehicle population and activity updates.

Mr. Bizer-Cox explained how MOVES links vehicle population and activity information to emission processes and rates. The rest of the presentation focused on how MOVES estimates vehicle miles travelled (VMT), vehicle populations and vehicle age distributions. This data is distributed by calendar year, source type, regulatory class, fuel type, and age.

#### Vehicle Miles Travelled

Mr. Bizer-Cox stated that the national default VMT in MOVES reflect Highway Performance Monitoring System (HPMS) classes/groupings. The EPA is updating the historic VMT in MOVES to include data up to 2015 from the 2015 or 2014 FHWA Highway Statistics and is updating projected VMT growth to reflect Department of Energy's (DOE's) Annual Energy Outlook (AEO) 2016 or 2017 (if available) VMT growth rates. Mr. Bizer-Cox presented how AEO VMT growth data would be used in MOVES (e.g., AEO VMT growth for a light duty vehicle would be applied to motorcycle, passenger car, passenger truck, and light commercial truck MOVES source types).

### Population Data

Mr. Bizer-Cox reported that MOVES uses historic population data principally from the FHWA's Highway Statistics and calculates projected populations based on projected VMT from the AEO. The EPA is updating the next version of MOVES for both historic and projected populations to correct an error in EPA Sample Vehicle Counts, include updated 2015 Highway Statistics and National Transit Database information (if available), include AEO 2017 projections (if available), and use AEO vehicle stock growth rather than VMT projections. Mr. Bizer-Cox presented how the AEO stock growth data would be used in MOVES (i.e., mapping between the source types in the data source to the source types in MOVES).

### Age Distributions

Mr. Bizer-Cox stated that MOVES uses historic sales data from several sources to estimate age distributions of vehicles. The EPA does not have data on annual scrappage. Therefore, MOVES needs to estimate scrappage by vehicle age. The EPA is proposing to use scrappage algorithms for both historic and projected age distributions (calculated at the HPMS level and applied to each source type within HPMS class). For the next version of MOVES, EPA intends to recalculate historic age distributions using updated historic populations, the latest sales data, and an updated scrappage algorithm. The EPA intends to use an iterative approach to calculate the scrappage distribution. Additionally, the EPA intends to recalculate projected age distributions from AEO 2017 (if available) and perform calculations at the source type level instead of HPMS class (using the same AEO, HPMS, source type mapping).

### Conclusion

Mr. Bizer-Cox concluded his presentation by stating that, if there is sufficient time and resources, EPA plans to update base scrappage profiles, the EPA Sample Vehicle Counts dataset, and the Sample Vehicle Population table using IHS registration data. He also noted that they might update MOVES to include default age distributions by county.

### *Discussion*

Dale Wells commented that MOVES uses HPMS for VMT for all road types. He asked whether they had considered refining this to account for different road types. David Brzezinski responded that the EPA does not have the data and do not store information by locality. He noted, however, that user can enter this data themselves when using MOVES. He added that, for the National

Emission Inventory, the EPA uses databases provided by state and local governments (when available), and that data is generally provided at the county-level. Because of this, these MOVES defaults are not used very often.

Chris Kite asked who he should talk to regarding issues related to the IHS data. David Brzezinski stated that he is handling the work using the IHS data. Mr. Kite stated that the North Carolina onroad vehicle registration numbers are a million less than the numbers in IHS, and this might be due to a purge issue. He also noted that he is not sure how IHS classifies vehicles. Mr. Kite stated that he would follow up with Mr. Brzezinski regarding these issues.

Denise Cormier asked whether the vehicle age distribution by county allows for zeros in age distribution tables. The EPA responded that the default is used where there are zeros.

Matt Solomon inquired whether they are still using the 2002 VIUS study data for the heavy-duty truck population and whether the EPA plans to obtain newer data in the near term. Mr. Bizer-Cox responded that the EPA knows the data is getting older, and they are trying to work with IHS to get better data to use in the future.

Andrew Eilbert noted that in a previous FACA meeting there was discussion about consolidating source types (e.g., removing the distinction between short-haul and long-haul trucks). He inquired whether the EPA had a timeframe for doing this. Mr. Brzezinski replied that the EPA is not going to do this for the next version of MOVES because it would be a major change. He noted, however, that it may be something they can pursue for a future version.

Andrew Eilbert stated that he had scrappage data that he could provide to the EPA. Mr. Brzezinski responded that they would be happy to have it.

Mark Janssen commented that there needs to be a solution for vehicles that are greater than thirty years old and the different certification standards for some MY vehicles. He suggested that there is a need to make VIN sub-codes that indicate actual certified make and model. He opined that it would need to go beyond VIN code or make and model. He stated that it needed to go to the certification level (e.g., 2-wheel drive, 4-wheel drive). He opined that such sub-certifications are needed to distinguish light trucks and passenger cars. Mr. Brzezinski stated that they are working on issues for vehicles that are greater than thirty years old now and IHS should have the data they need.

Mr. Wells expressed interest in the VMT for combination trucks. He stated that heavy-duty diesel trucks are often not registered where they are operated, but a surrogate for operation location could be used. Mr. Brzezinski acknowledged that the state where a truck is registered does not always correspond to where they operate. He stated that the EPA is thinking about this issue.

Chris Voigt noted that currently if there is a zero in the age distribution, MOVES will not generate an emission factor for that year for output by model year. He asked whether MOVES will be updated to generate emission factors for all years of a model year distribution, even years for which the age distribution is zero. Mr. Brzezinski responded that EPA inputs very small

numbers where there are zeros to prevent the model from ignoring the value, which does not affect the overall answer, but MOVES does not do this automatically. Mr. Voigt thanked Mr. Brzezinski and stated that using a small fraction is an acceptable workaround for the model year distribution.

### **Presentation: Updating Hotelling Hours in MOVES, David Brzezinski**

David Brzezinski presented an overview of “hotelling” in MOVES, which refers to the hours spent by drivers of long-haul trucks with their trucks parked during mandatory rest periods. He explained that MOVES accounts for engine idling and APU use during hotelling hours as separate emission processes in addition to truck operation on roadways. The fraction of time spent in each mode is a separate table in MOVES that varies by MY. MOVES and the National Emission Inventory (NEI) calculate the allocation of default hotelling hours differently. MOVES uses only rural VMT, and the NEI uses both rural and urban VMT. MOVES currently only allows users to supply hotelling hours for runs by populating the large hotelling hours table manually. Mr. Brzezinski stated that the EPA is proposing to change the design to alter the calculation of the default hotelling hours to match the methodology in the NEI and to alter the hotelling importer to use new “shaping” tables to calculate hotelling hours from smaller user input tables.

Mr. Brzezinski presented geographical VMT allocation illustrations of rural only (as it is currently) and urban additions (change), and the proposed combined (rural and urban geographical VMT hotelling allocation).

The default hotelling rate (hotelling hours per mile of travel) is calculated from the total national source hours operating as determined from the combination of VMT and default average speeds for diesel long-haul combination trucks. Rest hours are calculated based on rest hours required by Federal regulations (8 hours of sleep for every 10 hours of driving). Rest hours are distributed to locations using VMT, and the default hotelling rate is calculated from total national rest hours divided by total national restricted access VMT.

Mr. Brzezinski stated that the EPA is updating the design of MOVES to allow user-supplied data to generate the contents of the HotellingHours core model input table. MOVES default information would be used where data is not provided. He further stated that the EPA has also added a hotelling importer feature that allows users to import all tables located in a single spreadsheet with a single selection.

### *Discussion*

Dale Wells asked whether a user could export data as well as import data. Mr. Brzezinski replied that MOVES outputs hotelling hours in the activity output (but not in rates mode).

Matt Solomon asked whether the EPA is attempting to estimate the amount of time that an air conditioner is on during idling mode (e.g., on hot days). Specifically, Mr. Solomon inquired whether the “idle” mode includes heating, cooling and true idling; whether there is a way to identify/distinguish these sub-modes; and whether there has been an attempt to capture different

emission rates to reflect activity – specifically for when the air conditioner is used. Mr. Brzezinski responded that there has not been an attempt to capture different emission rates to reflect activity, and they are just trying to capture a representative average of emission rates at this point.

Chris Frey stated that the hours of service and hoteling hours are not highly correlated. He stated that some data is available which indicates that the energy demand is temperature dependent, and more energy is used for cooling the truck cab.

Mr. Solomon asked what the magnitude of error would be from not accounting for air conditioner cooling. Megan Beardsley stated that there was insufficient time to address this and stated that this comment would be addressed outside of the meeting.

## **WRAP-Up**

Megan Beardsley stated that there was insufficient time to discuss any more questions or comments during the allotted meeting time and asked Work Group members to write questions/comments in the side bar (see below) and responses would be provided after the meeting. She further requested that attendees send additional comments and questions on today's meeting to Sarah Roberts by January 11, 2017. Ms. Beardsley announced that the next meeting is planned for March 1, 2017 and will cover light-duty truck emission rates and activity factors.

Chris Frey noted that the Transportation Research Board (TRB) meets the week of January 11, 2017 and suggested extending the due date for comments on the issues discussed at this meeting until the January 18<sup>th</sup>. Ms. Roberts acknowledged the potential conflict and stated that this will be evaluated as the comment due date (January 11, 2017) approaches.

Ms. Beardsley thanked the attendees and closed the meeting.

### Side-bar questions:

Q 1 – Gil Grodzinsky: I just had a comment. Yes, IHS does have a variety of datasets and they can go back well beyond 30 years. However, it is good that the EPA is working with IHS to assure quality assurance (QA) of any data IHS provides. Also, it is great that there are plans/attempts of matching up light-duty vehicles to current certification databases to make sure passenger cars are properly split from passenger trucks.

Q 2 – Julie McDill: I urge you to mine resources as much as possible to provide regional and county level differences. You mention several times that states could provide these for local analyses; however, this does not take into account that most states do not have resources to prepare local data. In addition, the EPA does national modeling using many defaults. Finally, regional modeling must use what is available from the national system.

I am very interested in more detailed information on the IHS VIN decoding plan.

How differentiated regionally is the EPA sample vehicle count?

Q 3 – Ms. McDill: The passenger car: passenger truck split is particularly important to get right. Information on how that is being done in the IHS data set is critical.

Q 4 – Steve Potter: How does Slide 13 expectations tie in with “shaping” tables on Slide 5? (See Presentation: Updating Hotelling Hours in MOVES)

Q 5 – Gil Grodzinsky: I support strongly the idea of hotelling being modified with smaller tables, like starts, as long as it is clearly explained to the user how it is to be done.

## Attachment – Work Group Meeting Attendance List

<b>2016-2017 MOVES Review Work Group Members</b>			
<b>Name</b>	<b>Home Organization</b>	<b>Representing Organization</b>	<b>Sector</b>
Ken Adler (for Chris Wolfe)	Environmental Defense Fund (EDF)	EDF	Environmental NGO
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
Susan Collet	Toyota	Coordinating Research Council (CRC)	Industry
David D'Onofrio	Atlanta Regional Commission	Association of Metropolitan Planning Organizations (AMPO)	State/Local Government
Tim French	Engine Manufacturers Association (EMA)	EMA	Industry
Christopher Frey	North Carolina State University	North Carolina State University	Academia
Mike Geller	Manufacturers of Emission Controls Association (MECA)	MECA	Industry
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
Vernon Hughes	California Air Resources Board (CARB)	CARB	State/Local Government
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
Jim Kliesch	Honda	Honda	Industry
David Lax	American Petroleum Institute (API)	API	Industry
Matt Solomon	Northeast States for Coordinated Air Use Management (NESCAUM)	NESCAUM	State/Local Government
Matthew Thornton	National Renewable Energy Laboratory (NREL)	NREL	Federal Government
Chris Voigt	Virginia Department of Transportation	Amer. Assoc. of State Highway and Transportation Officials (AASHTO)	State/Local Government
Dale Wells	Colorado Department of Public Health and Environment	NACAA	State/Local Government

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

Name	Home Organization	Representing Organization	Sector
Ken Adler	EDF	EDF	Environmental NGO
Mahdi Ahmadi			
Daniel Bizer-Cox	EPA	EPA	Federal Government
Marty Boardman	Texas A&M Transportation Institute (TTI)	TTI	Academia
Christopher Boyd	Shelby County Health Department	Shelby County Health Department	State/Local Government
David Brzezinski	EPA	EPA	Federal Government
Ying-Tzu Chung	Michael Baker International	Michael Baker International	Industry
Denise E. Cormier	Maine Department of Environmental Protection	Maine Department of Environmental Protection	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
Yian Du			
Andrew Eilbert	Volpe National Transportation Systems Center	Volpe National Transportation Systems Center	Federal Government
Alison Eyth	EPA	EPA	Federal Government
David Kall	Federal Highway Administration (FHWA)	FHWA	Federal Government
Mohamed Khan	Maryland Department of the Environment	Maryland Department of the Environment	State/Local Government
James Koroniades	Vermont Department of Environmental Conservation (VT DEC)	VT DEC	State/Local Government
Dorian Kvale	Minnesota Pollution Control Agency	Minnesota Pollution Control Agency	State/Local Government
Sonya Lewis-Cheatham	Virginia Department of Environmental Quality	Virginia Department of Environmental Quality	State/Local Government
Jeff Long	CARB	CARB	State/Local Government
Deborah Liu	Shelby County Health Department	Shelby County Health Department	State/Local Government
Mike Maleski	Ohio EPA	Ohio EPA	Federal Government
Julie McDill	Mid-Atlantic Regional Air Management Association (MARAMA)	MARAMA	State/Local Government
Rick McKeague	Utah Department of Environmental Quality	Utah Department of Environmental Quality	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

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

<b>Name</b>	<b>Home Organization</b>	<b>Representing Organization</b>	<b>Sector</b>
Steven Potter	Connecticut Department of Energy and Environmental Protection	Connecticut Department of Energy and Environmental Protection	State/Local Government
Sam Pournazeri	CARB	CARB	State/Local Government
Lubna Shoaib	East-West Gateway Council of Governments	AMPO	State/Local Government
Shuang			
Darrell Sonntag	EPA	EPA	Federal Government
Lesley Stobert	EC/R Inc.	EPA Contractor Support to MOVES Work Group	EPA Contractor
Christopher Swab	Oregon Department of Environmental Quality	Oregon Department of Environmental Quality	State/Local Government
Vivek Thimmavajjhala	North Central Texas Council of Governments	North Central Texas Council of Governments	State/Local Government
Urszula Kukier	Maryland Department of the Environment	Maryland Department of the Environment	State/Local Government
Yue Shan	Michael Baker International	Michael Baker International	Industry
Wei Zhang	Idaho Department of Environmental Quality	NACAA	State/Local Government
Zhen Dai	CARB	CARB	State/Local Government

\*Full names and organization information provided where known