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

Introduction

Dr. Sarah Roberts opened the meeting by welcoming the attendees and going over the agenda, which consisted of a presentation by Ms. Megan Beardsley about the newly released MOVES3, followed by time for discussion. Dr. Roberts also noted the protocol for the meeting, asking everyone to remain muted and use either the chat function or the raise hand function if they have questions at the end. Dr. Roberts mentioned that a copy of the presentation was attached to the Outlook calendar meeting invitation and would be uploaded to the meeting chat as well as to the MOVES workgroup website, where past presentations and meeting summaries can also be found. Dr. Roberts concluded by mentioning that if anyone has questions or comments later, they can email her at roberts.sarah@epa.gov.

Member Roll Call

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.

Presentation: MOVES3 Introduction and Overview– Presented by Megan Beardsley, U.S. EPA

Ms. Beardsley provided a brief introduction to the MOVES model and then moved into the changes that have been made for the MOVES3 version of the model. She noted that this is the 3rd major MOVES release and that future major revisions will follow the same naming convention, with minor revisions designated as increments after a decimal point (e.g. MOVES3.1) and minor patches designated with an additional decimal (e.g. MOVES3.1.1). Ms. Beardsley stated that MOVES3 incorporates rules not included in the prior version of the model, includes new data on light-duty (LD) and heavy-duty (HD) emissions, improves user features and is accompanied by policy and technical guidance. She recounted some highlights of the LD updates, which include updated LD emission rates for hydrocarbons (HC), carbon monoxide (CO), nitrogen oxides (NOx), and particulate matter (PM); and fuel updates for LD, which include new fuel characteristic data, updated fuel effect calculations and incorporation of the effects of the Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule. She also recounted highlights of the HD updates, which include improved diesel running emission rates, updated diesel starts and

extended idle rates, updated gasoline and compressed natural gas (CNG) truck emission rates, and incorporation of the effects of the HD GHG Phase 2 rule. A few highlights for activity updates she mentioned include incorporation of real-world data on vehicle start and idling activity, updated vehicle miles travelled (VMT) and vehicle population defaults, and updated national onroad vehicle default fuel, regulatory class and age distributions.

Ms. Beardsley next provided comparisons of the previous version of the model (MOVES2014b) to MOVES3. She stated that compared with MOVES2014b, MOVES3 emission estimates are generally lower for most criteria pollutants and higher for GHGs in future years. However, she noted that results will vary for a given area based on local inputs. She also noted that urban areas may see increases in NOx emissions. Ms. Beardsley stated that MOVES3 also generally predicts lower exhaust $PM_{2.5}$ and volatile organic compounds (VOC) than MOVES2014b.

Ms. Beardsley presented guidance information on when MOVES3 should be used. She stated that MOVES3 must be used for state implementation plans (SIPs) when it is released, with no grace period. However, she noted that if a state has done significant work already with MOVES2014b, it may continue with that version. MOVES3 will be required to be used for transportation conformity for analyses that begin after a two-year grace period. Ms. Beardsley also mentioned that technical guidance for MOVES is available that provides information on how to use the model, provides information about the main changes in MOVES3 from MOVES2014b, discusses the tools provided within MOVES, and includes an appendix with a script to reduce the size of the nonroad output database.

Ms. Beardsley provided information on the websites available for more information on MOVES, including the MOVES webpage - https://www.epa.gov/moves; the MOVES3 webpage - https://www.epa.gov/moves/latest-version-motor-vehicle-emission-simulator-moves; MOVES GitHub sites - https://github.com/USEPA/EPA_MOVES_Model and https://github.com/USEPA/EPA_MOVES_Model/tree/master/docs; the MOVES3 guidance webpage - www.epa.gov/state-and-local-transportation/policy-and-technical-guidance-state-and-local-transportation#emission; and the MOVES listserv - : www.epa.gov/moves/forms/epa-mobilenews-listserv.

Discussion

Dr. Roberts thanked Ms. Beardsley for her presentation and explained that she would moderate the discussion portion of the meeting. She first read a question posted to the meeting chat box from Mr. Dale Wells, who asked, "Do light duty PM emissions increase with decreasing temperatures like they did in MOVES2014?" Ms. Beardsley answered affirmatively for start emissions (running emissions are no longer adjusted) and noted that for more information, people can consult the Adjustments Report, which is on the MOVES webpage.

Dr. Roberts then read a question posted to the meeting chat box from Mr. Chris Voigt, who asked, "What is the recommended approach for modeling what was formerly done in a custom domain, now that that option has been removed from MOVES? For example, if modeling for GHGs was previously done using a custom domain with inputs representative of an entire state -

rather than modeling the state on a county by county basis - how would that be done with MOVES3? Using the new default option?" Ms. Beardsley responded that this is not a topic she knows about in detail, and she will think about it and get back to Mr. Voigt. Ms. Meg Patulski added that the existing MOVES greenhouse gas (GHG) inventory guidance is still applicable, so it is still possible to do modeling without the custom domain based on a representative county, and the MOVES GHG guidance has several options for addressing this issue. Mr. Gil Grodzinsky added that Ms. Patulski's comment aligns with his experience, as some metrics are consistent across all counties, otherwise you can do multiple runs.

Dr. Roberts then read a comment from Mr. Patrick Lentlie, who asked, "We know it is a small fraction, but is there any data or estimate of the amount of VMT from electric vehicles from Source Types 21/31/32?" Ms. Beardsley responded that one of the reasons they did not include electric vehicles (EVs) in the MOVES defaults is that the number varies significantly from county to county, so national defaults would not be very informative. However, it might be possible to obtain local information through registrations or other estimates.

The next question came from Prof. Matt Barth, who noted that MOVES3 has the SAFE rule projections included as defaults, but there may be changes when the Biden Administration takes over. Prof. Barth asked how quickly the MOVES3 team could adjust to new rules if they are introduced. Ms. Beardsley answered that even if the rule is changed relatively quickly, the process is slow, and the team could possibly be involved in doing the modeling for the rulemaking. The MOVES team is typically aware of the analysis that contributes to rulemakings, so they should be able to respond fairly quickly to a new rule. Prof. Barth followed up by asking whether, from a modeling perspective, adapting to a new rule would only require plugging in new numbers to the model. Ms. Beardsley responded that it depends on the complexity of the rule.

The next question came from Mr. Robert d'Abadie, who explained that he has been having trouble modeling localized projects because of uncertainty about how to model shuttle buses using the existing bus categories due to their size. Mr. d'Abadie asked if the EPA has any advice for how to approach this in MOVES3. Ms. Beardsley responded that the answer may depend on the specifics of the situation, but that the update includes a few new bus categories, and that they could talk more about this issue after the meeting.

Dr. Roberts then read a question from Mr. Grodzinsky, who asked, "Does Stage 2 of the [light duty (LD)] GHG rule impact criteria pollutants, or just GHGs in MOVES?" Dr. Darrell Sonntag asked whether Mr. Grodzinsky was referring to the Phase 2 heavy duty (HD) GHG rule, or the SAFE LD rule. Mr. Grodzinsky clarified that he meant the SAFE LD rule. Dr. Sonntag responded that he would defer to Dr. Tiffany Mo on this, but he thinks it only affects CO_2 fuel economy and emissions from refueling, not NOx or GHG. Dr. Mo confirmed that this is correct. Ms. Beardsley added that there is also a small SO_2 effect due to increased fuel consumption.

The next question came from Mr. Chris Kite, who stated that he is expecting to start working on a State Implementation Plan (SIP) soon and asked if there is a tentative release date for MOVES3.0.1 that corrects any bugs that have been identified so far. Ms. Beardsley answered

that there are not any bugs that seem urgent to address, and they have identified workarounds for most of them so far, so that release is likely going to happen in early 2021. However, the release date may change if something urgent comes up that needs to be rushed.

Dr. Roberts then read a question from the meeting chat box from Ms. Cecilia Ho, who asked, "Did EPA conduct any comparison at the county level beyond 2028? Our analysis showed that there is a big increase in NOx emissions in 2040 (in the range of 40-140% increase). Also, is there any information on project level impacts?" Ms. Beardsley responded to the second question, replying that project level impacts depend on what each project entails, such as running emissions. Ms. Patulski added that the EPA did not conduct an analysis at the county scale beyond 2028, but they did at the national level, and asked Ms. Ho to clarify her second question. Ms. Ho explained that she has done some analysis based on typical highway projects and has seen a decrease in PM but an increase in CO. She also noted that these results were shared with the MOVES team. She added that her concern is a lack of conformity at the project and regional level of analysis when looking 20 or more years out. Ms. Patulski responded that NOx emissions may increase based on local information and changes in the distribution of different processes, such as running or extended idle. She noted one of the reasons the EPA has extended a 2-year conformity grace period is to allow time for these analyses. Ms. Patulski added that for PM, the EPA doesn't expect the trends to change from what is noted in the presentation, but they can talk more offline with Ms. Ho if she wishes. Mr. Grodzinsky added that he did some testing for 15 counties and saw PM and NOx both decreasing. He noted that many local maintenance SIP budgets are going to run out around 2030, so it will be important to know how emissions change going out farther.

Dr. Roberts then read a question from the meeting chat box from Mr. Thomas Olmstead, who asked, "Do MOVES to AERMOD scripts still work?" Ms. Beardsley answered that the EPA is planning to check, but she expects that they still do. Ms. Patulski added that some scripts definitely still work, but she is less sure about others that convert output for air quality dispersion modeling.

Dr. Roberts then read a question from the meeting chat box from Mr. Chris Porter, who asked, "Since most of the MOVES3 input tables seem to have a similar structure to MOVES2014, what are the conversion tools 'converting'?" Ms. Beardsley responded that in general, the input files are the same, but not all of them. The fuels tables in particular are different enough that the conversion tools don't work, and the user needs to update those manually. She added that users can look at the Q&A document and GitHub for more information about conversion.

Dr. Roberts then read a question from the meeting chat box from Mr. Alexis Zubrow, who asked, "Do you want us to use GitHub to report feature improvements/bugs/etc?" Ms. Beardsley answered that users can use either GitHub or the mobile@epa.gov email depending on the nature of the question and the user preference. She noted that for specific questions about details in the code, GitHub would be better.

Dr. Roberts then read a question from the meeting chat box from Ms. Ho, who asked, "What is EPA's plan on MOVES3 training?" Ms. Patulski answered that the team will be following up

early next year with another webinar, which in the past was advertised for experienced users. She noted that this training should be relevant to everyone interested in a more detailed overview of the features and changes for MOVES3. The team is also currently evaluating options for a multi-day training, including a county-scale class and a project-level training class, although there is no specific timeframe for those. Additionally, in light of COVID-19, the team is considering their options for making the best use of web-based trainings, which might be delivered live or made available for people to view on their own time.

The next question came from Mr. Andrew Eilbert, who asked about vehicle ages. He noted that they have been updated, but he wanted to know whether they account for the general trend in vehicle ages, especially LD vehicles getting older. He also asked if the team could confirm that scrappage rates are the same. Ms. Beardsley answered that the team member who did that part of the update was not present, but that he could consult the Vehicle Population and Activity Report on the MOVES webpage to find that information. Mr. Elbert then asked whether gliders have been incorporated into MOVES3. Ms. Beardsley noted that for those unfamiliar with the term, "gliders" are vehicles that use new truck bodies and old truck engines, so they emit like old vehicles but drive like new vehicles. She confirmed that they are accounted for and pointed to the same report for anyone interested in looking at the default numbers and assumptions.

Dr. Roberts then read a question from Mr. Todd Pasley, who asked, "Anecdotal evidence suggests tire wear for EVs is higher than for other vehicles. Does MOVES3 reflect this in EV tire wear PM emission rates?" Ms. Beardsley responded that it does not, but the EPA is thinking about this for the future, and the MOVES team is very interested in data on this topic.

Dr. Roberts then read a question from the meeting chat box from Mr. Zubrow, who asked, "When trying to model 'total idling' for HD, should you provide both hoteling hours and 'off-network idle' activity (assuming you have county/regional specific info)?" Ms. Beardsley answered that if the user has good data on both, then they should definitely provide it; additionally, the technical guidance documents have more information. Mr. Zubrow followed up by noting that he assumes that off-network idling is vehicle specific, so there would be two types of idling with HD long haul vehicles. Ms. Beardsley confirmed that those are mutually exclusive activity types, with hoteling referring to idling for longer than 1 hour. She added that the Vehicle Population and Activity Report would have more information.

Dr. Roberts then read a question from Mr. Joey Huang, who asked, "How about GHG phase 2 for heavy duty?" Ms. Beardsley responded that when the EPA team modeled the HD GHG rule, it did affect criteria air pollutants, primarily because, compared to LD, the rule affects the aerodynamics of vehicles, which changes the load needed to cruise on the highway. So, requiring less load for the same activity allows the vehicle to be in a lower power bin and have less emissions. Ms. Beardsley pointed to NOx as an example of this and added that the Regulatory Impact Assessment for the HD GHG rule would have more information. Mr. David Choi added that as part of the Phase 2 GHG rule, while trucks are hoteling, they are also using more auxiliary power units, which could affect criteria air pollutants. Dr. Sonntag added that the HD GHG phase 2 rule also includes a PM standard for auxiliary power units used on heavy-duty long-haul trucks.

Dr. Roberts then read a question from the meeting chat box from Mr. Lentlie, who asked, "Can you discuss what bugs, even if minor, have been identified to date?" Ms. Beardsley listed the following:

- If a user creates a database and it requires them to input a road type distribution, they should email the team, and they will provide a workaround.
- Conducting an annual pre-aggregation for a whole year rather than a month could produce issues with E85, so the workaround is to run the months separately for now.
- There are issues when people do runs from the command line, so if a user encounters this, they should reach out to the team, and they can provide a build.xml file that will help.
- Some users have had issues with installation, which the team can help with.
- If a user attempts to do a run with only nonroad diesel, there may not be any output; the workaround for this is to select all fuels.
- The tabbed output script sometimes fails due to a merge issue, so the team has written an alternate tabbed output script that they can send to users individually, if they need it.

Ms. Beardsley added that generally, if a user runs into a problem, they should let the team know, and they will do their best to help.

Dr. Roberts then read a question from the meeting chat box from Mr. Craig Butler, who asked, "Are hybrid vehicles able to be specified in output data?" Ms. Beardsley answered that this hasn't changed from MOVES2014. Since the model relies on fleet averages, the output is for vehicle classes as a whole and hybrids are not separated out.

Dr. Roberts then read a question from the meeting chat box from Ms. Deborah Wilson, who asked, "Will EPA pull together these questions and provide a Q&A doc?" Dr. Roberts noted that meeting summaries are posted on the website. Ms. Beardsley responded that although the existing Q&A document isn't updatable, there is a FAQ document on the MOVES webpage that will be updated, depending on the questions received. They will plan to incorporate questions from this meeting, an upcoming meeting on December 15, and any emails they receive.

Dr. Roberts then read a question from the meeting chat box from Mr. David Lax, who asked, "Has EPA done a comparison between MOVES2014b and MOVES3 of the exhaust vs non-exhaust distribution of total onroad VOC through 2045?" Ms. Beardsley responded that they have not, but it is a good idea. The MOVES team is working on figuring out their priorities for additional analysis and evaluation over the next few months.

Dr. Roberts then read a question from Mr. Vivek Thimmavajjhala, who asked, "Like MOVES3 beta, does the public version also require an audit log in the input [database] to be recognized?" Ms. Beardsley answered that it does, and if a user is having problems with MOVES3 recognizing the input database, they should check to see if they included an audit log. The audit log is what MOVES3 uses to recognize an input database.

The next comment came from Mr. Wells, who noted that he saw a slight increase in 2023 for onroad emissions, but that it was compensated for by changes in off-network HD NOx due to hotelling changes.

The next question came from Mr. D'Abadie, who asked if there is a strong reason to switch to MOVES3 if you are only analyzing nonroad emissions, especially from construction. Ms. Beardsley responded that one main reason to switch would be that the new version has updated fuels that includes the best understanding of sulfur content. She added that the MOVES team had been having problems with MySQL for MOVES2014, and switched to MariaDB for MOVES3 to avoid those issues.

Dr. Roberts then read a question from the meeting chat box from Mr. Pasley, who asked, "Could you put the 'bug list' on GitHub, along with the workarounds?" Ms. Beardsley responded that that is a great idea, and the team will look into doing so.

The next comment came from Mr. Grodzinsky, who noted that for those who do inventories and vehicle populations, they should look at the MOVES3 guidance related to inspection and maintenance, since some changes have occurred in those areas compared to MOVES2014. He also agreed that it would be helpful to post a list of bugs and workarounds on GitHub.

The next question came from Mr. Thornton, who asked if there are plans for a MOVES3.1 release in the near future to address the bugs that have been identified so far. Mr. Choi responded that a release to correct small bugs would be characterized as a patch and numbered "MOVES3.0.1." He approves of the suggestion to post bugs and workarounds, and the EPA is likely looking at early 2021 for the patch release.

The next question came from Mr. D'Abadie, who noted that with COVID-19 and the current and potentially long-term changes around travel and working from home, as well as impacts to the vehicle fleet mix, analysis of 2020 and 2021 might be affected. Mr. D'Abadie asked whether this would impact conformity for those years, and what the advice is for dealing with the current uncertainty around emissions. Ms. Ho responded that this is something that FHWA will need to discuss and will need to strategize ways to adjust planning assumptions to account for these irregularities.

Dr. Roberts then read a question from the meeting chat box from Mr. Wei Zhang, who asked, "Will NEI 2020 require use of MOVES3?" Dr. Roberts responded that it would.

Dr. Roberts then read a question from the meeting chat box from Mr. Joseph Jakuta, who asked, "Back to the nonroad question, doesn't this come with improved nonroad population numbers too?" Dr. Roberts answered that MOVES3 does not reflect any changes in nonroad population and activity.

Dr. Roberts then read a question from the meeting chat box from Mr. Chris Bovee, who asked, "Do the default age distributions vary by county? Most interested in this for long-haul trucks." Dr. Mo answered that it does not. Ms. Patulski added that EPA's MOVES3 Technical Guidance has more information for selection assumptions for local regulatory analyses, as this can vary.

Ms. Patulski then addressed a question in the meeting chat box from Mr. Jim Sidebottom, which read, "Has the impact of [inspection and maintenance programs] I/M changed to include overall (non-I/M vs I/M areas), repair durability over time, and I/M test type effectiveness? If not, is there any plan in the future to review?" She answered that MOVES3 doesn't change the

evaluation of I/M programs, but that the EPA is interested in these questions for future versions of MOVES and would like to have any relevant information. Ms. Patulski added that the LD emission rates information has changed due to new information on LD information control system durability; in other words, if passenger vehicle systems don't deteriorate as quickly, that leaves them in place longer, and they can affect the calculations of I/M programs in a particular area. However, there are no changes in the how the programs themselves are characterized in MOVES3.

Ms. Patulski then addressed a question in the meeting chat box from Mr. James Spatz, who asked, "Can MOVES3 be used to look at air quality at the project level?" Ms. Patulski responded that it can; EPA has guidance on its website for applying MOVES at the project scale.

Dr. Roberts then read a question from the meeting chat box from Mr. Voigt, who asked, "Is EPA planning to conduct a project-level sensitivity study?" Ms. Beardsley responded that there are no specific plans at this point, but they are interested in doing so, among many other analyses they would like to conduct.

The next question came from Mr. Pasley, who asked - in regard to Mr. D'Abadie's earlier question about the impact of COVID-19 on 2020 data and future projections - whether the EPA plans to provide more frequent default database updates to address this. Ms. Beardsley answered that they have discussed this but haven't yet determined a course of action.

Mr. Grodzinsky then read a question from the meeting chat box from Ms. Denise Cormier, who asked, "If the light duty includes up to 14,000 lbs. is it moving H2b's back to light duty? H2b are 2 axle 6 tire." Dr. Sonntag responded that LHD2b vehicles with six tires are not classified in LD source types, and that there is more information in the Population Activity report and the HD Exhaust Technical Report on the MOVES webpage.

Seeing no more raised hands or questions in the meeting chat box, Dr. Roberts began wrapping up the meeting by reminding everyone that copies of the presentation given by Ms. Beardsley were posted in the meeting chat box and included in the meeting invitation as an attachment. She also noted that all materials would be posted soon on the MOVES workgroup website, along with the last few years of presentations about updates that went into MOVES3. Dr. Roberts also mentioned again that if anyone had more questions or comments, they should reach out to her via email at roberts.sarah@epa.gov. Prof. Barth then thanked the EPA team and meeting attendees. Ms. Beardsley also thanked everyone for attending and asking great questions. She added that there will be a meeting in the first quarter of 2021, once people are more familiar with MOVES3, to talk about recommendations and suggestions for future work on the model. Following this, Dr. Roberts adjourned the meeting.

Attachment – Meeting Attendees

Presenters, Co-Chairs, and MOVES Team Members

- Sarah Roberts (EPA)
- Megan Beardsley, Co-Chair (EPA OTAQ)
- Matt Barth, Co-Chair (University of California, Riverside)
- David Choi (EPA)
- Tiffany Mo (EPA)
- Meg Patulski (EPA)
- Aron Butler (EPA)
- Darrell Sonntag (EPA)
- Jarrod Brown (EPA)
- Michael Aldridge (EPA)
- Jaehoon Han (EPA)
- Connie Hart (EPA)
- Evan Murray (EPA)
- James Warila (EPA)
- Kathryn Sargeant (EPA)
- Rich Cook (EPA)
- Ted Maciag (Contractor to EPA)
- Claudia Toro (ORISE)

Members

- Timothy French (Engine Manufacturers Association)
- Gil Grodzinsky (Association of Air Pollution Control Agencies)
- Cecilia Ho (Federal Highway Administration)
- Britt Holmen (University of Vermont)
- Mark Janssen (Lake Michigan Air Directors Consortium)
- Chris Kite (Association of Air Pollution Control Agencies)
- David Lax (American Petroleum Institute)
- Lubna Shoaib (Association of Metropolitan Planning Organizations)
- Jenny Sigelko (Coordinating Research Council)
- Matthew Thornton (National Renewable Energy Laboratory)
- Steve Vander Griend (Energy Future Coalition/Urban Air Initiative)
- Chris Voigt (American Association of State Highway and Transportation Officials)
- Dale Wells (National Association of Clean Air Agencies)
- Wei Zhang (National Association of Clean Air Agencies)

Other Attendees

- Anna Aleynick
- Carolyn Amegashie

- Gohan Bakane
- Walter Barozi
- Carla Bedenbaugh
- Marc Bennett
- Jennifer Billo
- Andrew Bollman
- Chris Bovee
- Christopher Boyd
- Ryan Buckley
- Phillip Burgoyne-Allen
- Craig Butler
- Sunghye Chang
- Ying-Tzu Chung
- Denise Cormier
- Marc Corrigan
- Louis Corsino
- Ken Craig
- Angela Cullen
- Robert d'Abadie
- Rob Dawson
- Allison DenBleyker
- Andrew Eilbert
- Alison Eyth
- Kareen Ficenec
- Dustin Fitzpatrick
- Michael Geller
- Steven Giannitti
- Jessica Goza-Tyner
- Brian Himes
- Joseph Jakuta
- Dennis Kahlbaum
- David Kall
- Katie Katrichis
- Kenneth Kelly
- Mohamed Khan
- Sandeep Kishan
- Andrew Kotz
- John Koupal
- Urszula Kukier
- Patrick Lentlie
- Kimberly Lesay

- Sonya Lewis-Cheatham
- Zheng Li
- George Lin
- Tom Malamakal
- Dominique Martinez
- Brent McDaniel
- Thomas Olmstead
- Daniel Newell
- Priyal Pandya
- Jinchul Park
- Todd Pasley
- Diamond Person
- Jackie Ploch
- Steven Potter
- Christopher Porter
- Jeff Ramsey
- Judy Raymond
- Robert Schiavone
- Jason Shank
- Jolyon Shelton
- Jim Sidebottom
- Aaron Slevin
- James Smith
- James Spatz
- Daniel Sullivan
- Vivek Thimmavajjhala
- Heather Walsh
- Peter Wasko
- Roger Wayson
- Debora Dutcher Wilson
- Evan Wright
- Tim Wood
- Ping Xi
- Fang Yang
- Chen Zhang
- Wei Zhang
- Alexis Zubrow
- Ayanna [No Last Name]
- Kimi [No Last Name]

Also present: ten unidentified phone callers.

Contractors

- Lesley Stobert (SC&A, Inc.
- Margaret Overton (SC&A, Inc.)