U.S. EPA Response to CRC Project No. E-101, Review of EPA's MOVES2014 Model

United States Environmental Protection Agency

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Assessment and Standards Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency

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Introduction

The EPA's Motor Vehicle Emission Simulator (MOVES) is a state-of-the-science emission modeling system that estimates emissions for mobile sources at the national, county, and project level for criteria air pollutants, greenhouse gases, and air toxics.[1] The Coordinating Research Council, a non-profit corporation supported by the petroleum and automotive industries, recently completed a detailed evaluation of the MOVES2014 model.[2]

The review (CRC project E-101) is a detailed evaluation of the MOVES2014 model as released on October 23, 2014. The project scope included three distinct task elements: (1) a critical evaluation of modeling methods, (2) inventory analyses applied to three locations, and (3) a validation of the latest fuel methodology using independent data sources.

The critical evaluation covered ten areas:

1. Heavy-Duty Diesel Emission Rates
2. Light-Duty Gasoline Exhaust Rates
3. Light-Duty Gasoline Evaporative Rates
4. Gasoline Parameter Modeling on Exhaust
5. Fuel Formulation Data & Fuel Wizard
6. Activity Data
7. Temperature Corrections[a]
8. Chemical Speciation
9. I/M Programs
10. Operating Mode Functionality

In each of these areas, the CRC report made recommendations for future updates to the MOVES model. EPA works continually to improve our models and the detailed independent CRC review provides a useful perspective on this work. Thus, we have prepared these responses to the CRC recommendations and findings. The remainder of this report briefly summarizes each of the recommendations within these areas and responds to each recommendation.

[a] No recommendations were made in the temperature correction section

1 Heavy-Duty Diesel Emission Rates

1.1 Recommendation: Account for NOx exhaust emissions at start-up and low exhaust temperature operation modes from vehicles equipped with selective catalytic reduction (SCR)

CRC recommends that EPA explicitly account for NOx exhaust emissions from vehicles with SCR at start and during low exhaust temperature operation modes. They cite data that suggests that SCR-equipped vehicles have higher NOx emissions when exhaust temperatures are cool.

EPA Response: We are currently analyzing real-world NOx emissions from model year 2010 and later heavy-duty vehicles equipped with selective catalytic reduction (SCR) systems from the Heavy-duty In-Use (HDIU) program[3]. The HDIU program requires each manufacturer of heavy-duty highway diesel engines to assess the in-use exhaust emissions from their engines using onboard, portable emissions measurement systems (PEMS) during routine operation. An analysis of 2010 and later model trucks within the HDIU program shows elevated NOx emissions when the SCR catalyst temperature is below the temperature where the SCR system is fully operational. We plan to update the NOx running emission rates in MOVES with these data (accounting for low exhaust temperature operation) in our next major release. In addition, we plan to validate these updated NOx running emission rates with data collected by other in-use test programs on SCR-equipped diesel trucks.

Furthermore, we have recently analyzed extended idle emissions from SCR-equipped diesel trucks[4]. We plan to include these new rates in the next MOVES release.

However, since the test programs listed above do not include start-up measurement, we will not be able to update heavy-duty NOx rates during start-up in the same time frame. We will need to evaluate other test programs that have captured start-up emissions from heavy-duty vehicles equipped with SCR for potential incorporation into future MOVES releases.

1.2 Recommendation: "Improve the modeling of SCR control effectiveness to address the variation in effectiveness by operation mode or roadway type"

The E-101 report recommends that the SCR control effectiveness should vary with operating conditions, and that data should be used to improve on the current assumption that SCR effectiveness is uniform across all engine operating modes.

EPA Response: As discussed in our previous response, we plan to update our NOx running emission rates for SCR-equipped trucks in the next version of MOVES by using second-by-second data from the HDIU program. Preliminary analysis of this data supports the E-101 suggestion that the SCR-effectiveness varies by operating condition. The new rates will replace the current emission rates, which were estimated from data on 2003-2006 model year vehicles scaled to the 2010 standards.

1.3 Recommendation: Change the methodology used to estimate $PM_{2.5}$ crankcase emissions of pre-2007 model year heavy-duty diesel vehicles

The CRC report states "coupling the PM crankcase emissions to PM exhaust emissions is a problematic methodology for this model year group [pre-2007] because many of the exhaust PM adjustment factors and trends in PM exhaust (due to changes in exhaust PM certification standards) ultimately should not factor into the model's estimates for crankcase PM." In addition, the E-101 reports suggests that the start crankcase emissions should be zero, because crankcase emissions occur primarily when the engine is operating in a warmed-up condition.

EPA Response: We agree that estimating crankcase emissions as a ratio of tailpipe emissions has shortcomings, because the emission processes for exhaust PM and crankcase PM are different, and changes in PM exhaust do not necessarily relate to changes in crankcase emissions. However, making the recommended change is not a high priority for the next MOVES update for several reasons:

1) The E-101 report confirms the crankcase/tailpipe exhaust PM ratio used in MOVES is within the range of the studies cited in the MOVES technical documentation.
2) The crankcase emissions are largely allocated to the running and extended idling crankcase processes (which occur when the engine is fully warm), rather than crankcase start exhaust. For example, for a typical urban area, MOVES2014 estimates more than 99% of diesel crankcase PM is produced from running and extended idling processes, with less than 1% of diesel crankcase PM emissions produced from starts.
3) The current MOVES design is appropriate for 2007-and-later engines. As mentioned in the heavy-duty report[5], beginning with 2007 model year heavy-duty engines, all vented crankcase emissions are required to be included in the exhaust certification measurements. The measurements of the $PM_{2.5}$ exhaust speciation include both the crankcase and tailpipe exhaust for 2007 and later trucks[6]. We anticipate that future test programs will continue to measure crankcase and tailpipe exhaust together, making the distinction of the two processes difficult. Thus, in MOVES2014, we chose to estimate crankcase emissions as a fraction of the total exhaust emissions. This assures that we have the correct total, even if the allocation between crankcase and running is not precisely accurate.
4) Making the suggested change in MOVES is fairly difficult, in that it would require structural changes to both the code and database. As the pre-2007 vehicles become a smaller portion of future fleets, the benefits of such a change will continue to decrease.

Additionally, page 16 of the E-101 report states: "It was not confirmed whether specifically a crankcase retrofit device, such as a closed crankcase ventilation retrofit, can be modeled in MOVES2014." However, MOVES2014 does allow crankcase retrofit devices to be specifically modeled[7].

1.4 Recommendation: "Account for the delay in the 0.2-gram NOx standard in the NOx emission rates"

In MOVES2014, the 0.2 gram NOx standard is assumed to be fully implemented with model year 2010 heavy-duty diesel vehicles. The E-101 report correctly states that a significant portion

of heavy-duty diesel engines between 2010 and 2012 were certified above the 0.2 gram standard using certification carryover credits.

EPA Response: In the next version of MOVES, we plan to use the engine sales data to account for the delayed phase-in of the 0.2 gram standard in the heavy-duty NOx emission rates.

2 Light-Duty Gasoline Exhaust Rates

2.1 Recommendation: Update Exhaust PM Emission Rates for Gasoline Direct Injection (GDI) Engines

The CRC report recommends that PM emission rates in MOVES need to account for GDI light-duty gasoline vehicles because they have higher PM emissions than conventional fuel-injection gasoline engines and have a significant market share starting with model year 2007 vehicles and increasing into the future.

EPA Response: We agree that it is important to incorporate PM emissions data from gasoline direction injection (GDI) engines into MOVES. When MOVES2014 was being developed, there was very limited data available on emissions from GDI engines, particularly PM emissions, and because the GDI engine technology was developing rapidly, it was not clear how representative the tested engines were of current and future GDI engines.

As the CRC report mentions, the US EPA is currently conducting emission test programs to address that gap. EPA is compiling this and other data for analysis and intends to incorporate the results into MOVES when the analysis is complete.

3 Light-duty Gasoline Evaporative Rates

3.1 Recommendation: Revise Permeation Modeling for Near-Zero Evaporative Standards

The CRC report recommends that EPA "update the permeation rates for near zero (Tier 2) evaporative standards to reflect the significant differences between vehicles meeting these standards and those meeting enhanced evaporative standards."

EPA Response: EPA reviewed the available data (CRC E-65[8], E-65-3[9], E-77[10, 11, 12, 13] and recent multi-day data[14]) which suggests that, while there are differences between the real-world permeation emissions of vehicles meeting the different standards, the creation of finer model year groups within the 1999-2015 timeframe to account for the changes in standards (Enhanced Evaporative Standards were fully phased in by 1999, Tier 2 Evaporative Standards phased in from 2004 through 2007, and the Mobile Source Air Toxics Rule (MSAT) Evaporative Standard went into full effect in 2009[b]) would have a minor impact on the total light-duty hydrocarbon inventory. Other uncertainties regarding evaporative emissions, such as the impacts of

[b] To clarify a statement made at the bottom of page 28 in the CRC report: The MSAT rule adopted the lower evaporative emissions standards to be equivalent to California's Low Emission Vehicle II (LEV II) standards, which already reflected the evaporative emission levels that were being achieved nationwide. The evaporative test parameters for fuels and temperature remained the same, therefore there is a change in stringency in the standards going from 0.95 g/test to 0.50 g/test. The manufacturers were already building the 50-State vehicles that met the lower emissions rates and therefore the rule did not claim benefits. The intent was to prevent backsliding in the future.

evaporative emission control failures—such as canister degradation that we plan to address in future studies—may have a much larger impact on total light-duty evaporative emissions.

However, we are currently providing data to CRC on a project (E-116) which will provide an independent estimate of evaporative emissions from MOVES and will examine the impact of a revised permeation estimate in more detail, including a sales-weighted analysis. The results of the E-116 project will help us better understand the impact and priority of updating the permeation estimates in MOVES in the future.

Table 1. Federal Evaporative Emissions Standards for Recent Model Years

	3 Day Diurnal + Hot Soak	Running Loss	Useful Life	Refueling	Other
Enhanced	2.0 g/test	0.05 g/mi	100K mi/10 years	0.20 g HC/gal	
Tier 2	0.95 g/test	0.05 g/mi	120 K mi/10 years	0.20 g HC/gal	
MSAT	0.50 g/test	0.05 g/mi	150 K mi/15 years	0.20 g HC/gal	
Tier 3	0.30 g/test	0.05 g/mi	150 K mi/15 years	0.20 g HC/gal	0.02 g/test Canister bleed 0.02“ Leak

Table 2. Federal Evaporative Emission Standards Phase-in for Recent Model Years

Phase-in Model Year	Enhanced	Tier 2	MSAT	Tier 3
1996	20%			
1997	40%			
1998	90%			
1999	100%			
2004		25%		
2005		50%		
2006		75%		
2007		100%		
2009			100%	
2017				40%
2018-2019				60%
2020-2021				80%
2022				100%

3.2 and 3.3 Recommendations: Update the federal regulatory implementation schedule of evaporative standards with actual sales-based estimates, and evaluate the potential presence of zero evaporative standard vehicles in the federal certification region

The CRC report recommends that MOVES incorporate more detail in the phase-in of evaporative standards by vehicle class, manufacturer, and model year. It points out that the actual phase-in of the rule differed for each manufacturer and depended on how they complied with both the California and National standard.

The report specifically recommends that the penetration of vehicles certified to zero evaporative standards be accounted for in MOVES. Zero evaporative standards refer to vehicles certified as partial zero emission vehicles (PZEVs) in California’s LEV II program. This program began

with the 2004 model year. Zero evaporative standards also refers to the Tier 3 and LEV III evaporative standards that begin in 2016 (Tier 3) and 2015 (LEV II). The CRC E-101 report recommends that the presence of California-certified PZEV vehicles in the other 49 states be accounted for in the MOVES evaporative emission estimates.

EPA Response: For states that adopt the California Zero Emission Vehicle (ZEV) program, we have provided tools and guidance on the MOVES webpage[15] to incorporate the lower permeation emissions achieved from the presence of California-certified PZEV vehicles in their state fleet.

However, gathering sales data and analyzing it with emissions data has been beyond our capacity with competing priorities. An examination of these issues is included in the objectives for the CRC E-116 project which EPA is supporting through sharing of data and clarifying questions. When the E-116 project is complete, we plan to review the results and possibly incorporate some of the findings into future versions of MOVES.

4 Gasoline Parameter Modeling on Exhaust

4.1 Recommendation: Refine/Restrict E15 Modeling Capability

The CRC report states "Although the use of E15 is not approved in older light-duty vehicles, heavy-duty vehicles, or motorcycles, this restriction is not reflected in MOVES2014. Therefore, structural modifications are recommended that would restrict the assumed E15 consumption to only those newer light-duty vehicles for which it is approved."

EPA Response: This is a valid recommendation. However, making the change is not a high priority for the next MOVES update. This is because the change would require a substantial structural change to the model while it has only a minor impact on the emission results. The minor impact is due to a number of factors: (a) motorcycles, heavy-duty gasoline vehicles and pre-2001 light-duty vehicles make an increasingly small contribution to the total share of emissions, (b) the difference between emissions on E15 and E10 is small[c], and (c) E15 has a relatively small share of the gasoline market.[d]

That said, for calculations where these real-world conditions are not maintained (for example, a hypothetical study of E15 emissions for calendar year 2000, or a gasoline fuel supply with a much larger fraction of E15), model users can perform multiple runs to properly estimate E15 emissions. We intend to add information explaining this limitation and instructions for using multiple runs to do more accurate estimates of E15 emissions in the next version of the MOVES user guide.

4.2 Recommendation: Address Winter Season RVP Exhaust Impact Limitations

The CRC report states that the RVP impacts on exhaust emissions during winter months are, "based on emissions data collected using fuels and test temperatures that are not representative of

[c] As demonstrated in the sensitivity analysis in the CRC report, modeling 100% E15 relative to 100% E10 (all vehicle, all model years), had less than a 5% impact on THC, NOx, and PM2.5 emission inventories, and less than a 10% impact on CO inventories in 2011 and 2022.

[d] The maximum penetration of E15 in the MOVES2014a fuel supply in any fuel region or year is 27%, which occurs in 2030, when the emissions contribution from the pre-2001 fleet is negligible.

wintertime conditions. Therefore, it is recommended that EPA either should collect and evaluate suitable data for winter season application of this exhaust emissions adjustment factor in MOVES or should restrict the adjustment to use within the range determined by the limits of the existing available data."

EPA Response: EPA agrees that extending the EPAct fuel effects for RVPs greater than the 10 psi maximum included in that study is not ideal. No recent data exists showing the impact on exhaust emissions under winter conditions of winter fuels with different RVP levels. Simply removing RVP fuel effects for the winter season would require removing all fuel effects in the winter, which is clearly inaccurate.

EPA is currently conducting a sensitivity analysis examining the magnitude of emission effects caused by including a 10 psi 'ceiling' (i.e. limiting the RVP parameter to a maximum of 10 psi) for winter fuel when used in conjunction with the EPAct fuel effects models. This analysis will help determine the priority of additional work in this area.

4.3 Recommendation: "Update the non-sulfur fuel corrections for 2001 and newer model years to incorporate the data from the follow-up CRC E-98 project specifically, and more generally to update fuel corrections on a timely basis as new data become available"

The CRC Report states that the non-sulfur fuel corrections for 2001 and later model years are based on the EPA regression models based on results from the EPAct/V2/E-89 test program, and that different results could be obtained by using different regression models and additional data. The report recommends updating the fuel effects to incorporate the results from the follow-on CRC E-98 test program, which includes additional fuels.

EPA Response: We intend to update the fuel corrections in MOVES as appropriate data becomes available. E-98 was designed as a validation study for EPAct/V2/E-89 and was conducted more than a year later, after vehicles had accumulated substantial additional mileage in another program. Therefore, we do not consider it necessarily appropriate to simply refit the statistical models incorporating the E-98 data. We plan to perform additional research on fuel effects in vehicles using current technologies over the next several years. Based on the results of this work, updates to fuel adjustments used in MOVES will be considered.

5 Fuel Formulation Data & Fuel Wizard

5.1 Recommendation: Revise Default and Historic Fuel Property Assignments for Specific Geographic Areas

The CRC Report recommends that "EPA create a historically accurate RegionCounty data table. The problem is that the existing MOVES2014 county-to-fuel-region assignment is static (identical for all calendar years). The data table is already configured to allow for calendar year assignment to fuel regions and this functionality should be utilized to ensure that the fuel region definitions actually match the historical regulatory record, as best as possible given the limitations of the fuel region definitions themselves. This table can be created and distributed to MOVES users and does not need to wait for an official model release."

EPA Response: EPA understands that the inclusion of this additional information would be helpful for conducting historical analyses.

However, creating a MOVES default database with fuel regions that change over time to reflect historical fuel properties creates issues when MOVES is used to assess the benefits of future regulations and other policy changes. For example, if the fuel regions change between analysis years, this can cause artifacts when comparing reference and control cases.

Of course, EPA will continue to update regional fuel property assignments as it is notified of changes to local programs. We will consider producing more complete 'historical non-default' fuel supplies for specific calendar years as a future update.

5.2 Recommendation: **"Increase the number of fuel regions from 22 to 24 in order to properly distinguish all possible combinations of underlying regulatory context"**

The CRC report specifically recommends that Alaska, Hawaii and U.S. territories be placed in separate fuel regions from the continental US, because they are exempt from volatility requirements. Additionally, the report recommends that Alaska and Hawaii be placed in different fuel regions since their volatility specifications are distinct.

EPA Response: The boundaries of the 22 fuel regions originally created were based on where a sufficient volume of fuel production data could be aggregated to create representing geospatial fuel properties without revealing potential CBI information. We will review the data for the two newly recommended fuel regions to determine if they meet these criteria, and may include one, or both, in future versions of the MOVES model.

5.3 Recommendation: "Return MTBE-containing gasoline to the historical data record"

For historical years, MOVES represents MTBE-containing fuels as ethanol gasoline blends, such that the EPAct ethanol fuel adjustments that apply to 2001 and later vehicles apply to MTBE fuels. The E-101 report suggests that the ethanol adjustments could be modified to be applicable to oxygen-content equivalency. The report states that the "substitution of ethanol for MTBE is problematic as the RVP, evaporative permeation, and speciation impacts are significantly distinct between MTBE-and ethanol-containing gasoline."

EPA Response: The primary purposes of MOVES are to do estimates for State Implementation Plans and conformity determinations and to assess the benefits of future regulations, but MTBE has not been used in U.S. gasoline in significant quantities since 2005.[16] Additionally, Tier 2 vehicle fuel effects in MOVES2014 are based on the EPAct test program, which did not include MTBE as a fuel parameter.[17,18] Conducting additional work to better model historical years is not a high priority for MOVES development.

5.4 Recommendation: "EPA should develop explicit guidance or a modeling tool to assist state and local agencies to regularly incorporate EIA's *Annual Energy Outlook* into market share forecasts of the various ethanol blends"

EPA Response: The AEO provides analysis on a national basis and does not provide information that would be useful for individual states or counties. Since EPA does use the AEO data and incorporates this information into the default database, states or local areas should not need to replicate this process themselves. While MOVES does provide the fuel wizard (which states can use to evaluate changes in local fuel policy) and the AVFT (which states can use to adjust the default fleet mix of fuel types to better reflect the local fleet), the AEO does not provide useful information for either of those tools, since it does not contain local information.

As with our recent MOVES releases, we intend to incorporate AEO information in future MOVES releases that is as up-to-date as possible.

5.5 Recommendation: "Incorporate data-derived sulfur content of conventional gasoline for the period from 2011 through 2016"

The E-101 report states, "For these years, the fuel input data of MOVES2014 assumes the sulfur content of conventional gasoline equal the maximum allowable average of 30 ppm sulfur. The data reviewed for this project suggest that the actual sulfur content was below 30 ppm."

EPA Response: EPA will continue to update 'in-use' fuel properties as data is received and quality checked. Please note that sufficient quantities of data are required to capture an accurate picture of regional fuel property variation, and that we do not consider single point fuel surveys conducted a couple times a year adequate for this purpose (due to batch-to-batch variation). We are aware that in-use sulfur has trended lower in recent years, and plan to include data through at least 2014 in the next version of MOVES.

5.6 Recommendation: "Remove the unused fields of "volToWtPercentOxy," "CetaneIndex," and "PAHContent" from the fuel formulation data table as their presence is misleading"

The MOVES fuel formulation table includes values in the field "volToWtPercentOxy", which are not used in the model. Additionally, the fuel formulation table includes two columns CetaneIndex and PAHContent, which are filled with null values. The E-101 report recommends removing these three unused variables from the fuel formulation table because it is misleading to MOVES users.

EPA Response: In MOVES2014a, the volToWtPercentOxy field in the fuel formulation table was updated to be consistent with the values that MOVES uses in the calculations and are documented in the MOVES speciation report[6]. We have added text to the MOVES fuel supply report[17] to clarify that these three fields are not used by the code. We will consider removing these fields from the fuel formulation table in a future MOVES release; however, changing table structure has the potential to create unintended consequences and we consider this a lower priority.

5.7 Recommendation: The fuel wizard should change the way in which it modifies the gasoline fuel property, T50, with changes in ethanol content

The E-101 report suggests that changes should be made to the fuel wizard "to modify the standardized relationships between E10 and E15 to include a linear change in T50, based on the T50 of the E10 gasoline to which the additional ethanol is added."

EPA Response: We are currently investigating the concerns about how the Fuel Wizard operates with respect to changes in T50. We will update the Fuel Wizard tool as needed.

6 Activity Data

6.1 Recommendation: Define mileage accumulation rates in MOVES in "absolute terms, i.e., reported in miles per year"

As described in the MOVES2014 population and activity report[19], "MOVES uses a relative mileage accumulation rate (RMAR) in combination with source type populations and age distribution to distribute the total annual miles driven by each HPMS vehicle to each source type and age group. Using this approach, the vehicle population and the total annual vehicle miles traveled (VMT) can vary from calendar year to calendar year, but the proportional travel by an individual vehicle of each age will not vary."

To improve transparency, the E-101 report recommends that the mileage accumulation rates should be input into MOVES in absolute terms, before any normalization occurs.

EPA Response: We recognize that the mileage accumulation rate could be input into MOVES in absolute terms, and MOVES could internally calculate the relative mileage accumulation rate to distribute annual miles to source type and age group. This is not a high priority to change in the next model release for the following reasons:

1. The absolute miles used to derive the relative mileage accumulation rates are documented in the MOVES2014 Population and Activity Report.
2. There are other feature changes which are higher priority than changing the current method of inputting mileage accumulation rates into MOVES.

6.2 Recommendation: "Provide guidance on recommendations and suggestions for preparing vehicle trip activity inputs in combination with vehicle soak distributions"

The E-101 report suggests that user-inputs of VMT, population and starts (including soak distributions) should be consistent with one another. In addition, the E-101 report suggests guidance should be given when developing MOVES inputs on starts using different data sources, such as instrumented vehicle studies, travel demand models, and driver surveys.

EPA Response: Even similar types of data from different sources can have differences that make combining the data into a consistent source of vehicle activity a complex task. It is not likely that any guidance document would be able to address all of the likely issues that might arise when generating activity information. Current guidance makes it clear that states should use whatever information is available to derive local vehicle activity information for their modeling, but issues and questions will need to be addressed on a case-by-case basis.

7 Temperature Corrections

The E-101 report had no recommendations in this section.

8 Chemical Speciation

8.1 Recommendation: Incorporate separate VOC profiles for "start-up and running exhaust emissions from gasoline vehicles"

The E-101 report suggests that MOVES use separate speciation profiles for start and running exhaust from light-duty gasoline vehicles. Currently, MOVES applies composite (start and running) specification profiles to estimate the chemical mechanism species from the residual total organic gases.

EPA Response: Differences in composition of VOC between start and running operation can impact spatial distribution of individual chemical compounds, such as air toxics. Thus, for 2001

and later gasoline vehicles, MOVES accounts for differences in the exhaust composition of total organic gases between start and running with separate ratios of methane/THC[20], NMOG/NMHC, VOC/NMHC[6], and separate toxic/VOC ratios for individual compounds of particular concern, such as acetaldehyde, formaldehyde, acrolein, ethanol, benzene, and 1,3-butadiene.[21]

However, MOVES applies a composite (start and running) speciation profile to estimate the other eight toxics produced by MOVES. For air quality modeling, MOVES applies the composite speciation profile to estimate the composition of the species not already identified from the toxic ratios.[6]

We agree that, ideally, MOVES should include separate speciation profiles for start and running processes. However, at present, we are not prioritizing this resource-intensive effort since, as CRC project A-85 exemplified, the difference between using composite profiles and start and running profiles for gasoline vehicles applied to residual TOG species may have very little effect on air quality modeling results. Nonetheless, we hope future test programs will provide the data needed to obtain robust speciation profiles by start and running emissions, which we could use to update MOVES in a future version.

9 Vehicle Inspection & Maintenance Programs

9.1 Recommendation: Evaluation the benefit of Inspection & Maintenance (I/M) programs on start exhaust

The deterioration of running exhaust emissions with and without I/M programs is derived from I/M program tests. In the absence of data, MOVES applies the same relative deterioration of emission rates to start exhaust. The E-101 report says that the start exhaust benefit is "not supported or validated by any real world data, and the resulting start exhaust benefit attributed to I/M is therefore uncertain."

EPA Response: We recognize the need to evaluate MOVES assumptions with real-world data; we welcome suggestions on potential data sets and methods that could be used to evaluate the deterioration effects on start exhaust, as well as the impacts of Inspection/Maintenance programs on start exhaust.

9.2 Recommendation: Correct the I/M emission rate adjustment

The CRC report states: "The model incorrectly applies additional I/M benefits to the emission rates input for a subset of light duty vehicles that already include the impacts of I/M. The recommended fix to the problem is to readjust both I/M and no-I/M emission rates input into the model. The unintended consequence for the impacted vehicles—1981 to 1995 model year passenger cars and light-duty trucks—is that the model is underestimating the exhaust emission rates for scenarios involving either the presence or absence of a local I/M program."

EPA Response: EPA plans to fix the problem in the next version of MOVES. Note, however, since this problem only impacts vehicles older than the 1996 model year, the emissions impact of the problem is small for emissions in current and future calendar years.

10 Operating Mode Functionality

10.1 Recommendation: Enable MOVES to input and output operating mode distributions, and report emissions by operating mode distributions at county and project-scales

The E-101 report requests three features of operating mode functionality to be included in MOVES:

1. "The model should include the capability to report the overall inventory operating mode distribution in the model output databases."
2. "The model should include the capability to report emissions by operating mode so that the significance of individual operating mode contributions to the overall inventory can be assessed."
3. "The model should include the ability to input a user-specified operating mode distribution so that a macro-scale inventory can be assessed using customized or standardized driving cycle."

EPA Response: The E-101 report is correct in stating that MOVES2014 does not produce output of operating mode distribution at the county-scale in a format that a typical user can use. This feature was removed in MOVES2014 in an effort to improve performance (model run time). MOVES2014 continues to report operating mode distributions in project-mode (by source type, pollutant process and link).

Updating MOVES to address this recommendation is not a high priority for the next version of MOVES for several reasons:

1. Enabling of reporting emissions by operating mode is a substantial coding task.
2. MOVES is designed in a way that this information can be obtained, but requires additional effort and expertise beyond what is required from a typical user.
3. We believe this feature would be of most use for diagnostic and academic users. There are new features that would benefit the primary users of MOVES that have a higher priority.

Conclusion

CRC's recommendations on the MOVES2014 model are a useful summary of some areas where the MOVES model could be improved. Given the limited staff and funding available for MOVES updates, we appreciate the CRC analysis and perspective on the areas most in need of improvement.

References

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