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September 30, 2013

Mr. Isaac Warren
ICF International
9300 Lee Hwy
Fairfax, VA 22031

RE: Peer Review of Fuel Effects, Toxics Emissions, Total Organic Gases (TOG), and Particulate Matter (PM) Speciation Analysis Report

Dear Mr. Warren:

Please find attached my comments on the documents relating "Fuel Effects, Toxics Emissions, Total Organic Gases (TOG), and Particulate Matter (PM) Speciation Analysis Report". I work as a research engineer for the University of California at Riverside, CE-CERT and have no real or perceived conflict of interest related to this evaluation. I have considerable expertise in emissions testing and have conducted a number of major emissions test programs related to the topics presented in this report. Please let me know if you would like further information or have further questions relating to my comments, or would like to discuss the comments via a conference call.

Regards,
Tom Durbin, Ph.D
Research Engineer
University of California
CE-CERT
Riverside, CA 92521

1. Data sets – Does the presentation give a description of selected data sources sufficient to allow the reader to form a general view of the quantity, quality and representativeness of data used in the development of emission rates? Are you able to recommend alternate data sources might better allow the model to estimate national or regional default values?

This particular question I will address globally for all of the reports, as many of the datasets being recommended apply to more than one report. This is also the area of my significant criticisms. The data sets selected for the MOVES2014 development are large, relatively comprehensive, representative, and generally well conducted, and as such represent a good basis in the model development for MOVES2014. These data sets focus predominantly on the EPA Kansas City study, the E-55/59 study, the ACES Phase 1 study, and the EPAct study for fuel effects.

On the other hand, EPA coverage of data is relatively narrow in terms of the larger body of literature, and in particular doesn't consider the relatively significant work being carried out in California. As the MOVES model continues to develop into future years, it is suggested that EPA broadens its coverage of data being collected around the country. Many of the California datasets are just being completed and should be available in time for the next MOVES update.

The issue with the silicone in the Kansas City study for the hot running is another point of consideration. While some corrections can be applied to species profiles that may be reasonable, it also reinforces the idea that a broader range of data sources should be considered.

Some of the areas where additional data could be particularly useful is for vehicle categories for which data is still relatively limited. In particular, gasoline direct injection engines (GDI) are rapidly expanding into the in-use fleet, have considerably different characteristics compared to more traditional gasoline vehicles, and are not included in the data sets currently being used for MOVES2014. Data for heavy-duty vehicles/engines with newer 2007+ and 2010+ are also still relatively limited. Finally, data on natural gas vehicles/engines are relatively limited.

Its difficult to determine how recent the Predictive/Complex model are. In one of the document that discusses fuel effects for sulfur its seems to rely heavily on studies conducted in the early 1990s by CRC and EPA and then goes to the EPAct Study with almost no consideration of anything done in between. CARB, on the other hand, considered a number of additional and robust dataset in its 2007 update of its predictive model.

Another important consideration is that the heavy-duty pre-2007 data does not seem to include any data from retrofit DPFs, which tend to be more passive in nature and can vary from the OEM DPFs for 2007+ engines.

For the "Gasoline Fuel Effects for Vehicles Certified to Tier-2 Standards" report, there are several other data sets should be considered for inclusion in the fuel effects part of the model as the model continues to be developed. These include the CRC-83 project, which utilizes the same vehicle fleet as the main EPAct study, but evaluated fuel olefin levels. UC Riverside is also conducted an extensive study of ethanol/butanol blends that is nearing completion. In particular, this study includes GDI vehicles that are not covered in EPAct study. This study

has some emphasis on California fuels, but should also have more general applicability for evaluated fuels at a national level.

For the "MOVES2014 Sulfate and Sulfur Dioxide Emissions Calculator" report, there are several other data sets should be considered for inclusion in the model as the model continues to be developed. There are several other datasets that are coming out that would be worth EPA considering or at least evaluating with respect to the model, especially on the diesel vehicle side. The California Air Resources Board has been looking at the toxicity of advanced technology vehicles, and some of this data has sulfate emissions that could be of relevance here. The South Coast Air Quality Management District has also conducted a study to evaluate the in-use emission rates of 2007+ technology, heavy-duty diesel and natural gas vehicles. These data will probably not be available until the first part of next year, but they could be considered for future application to the model. Phase 2 of the ACES program is another data set that could be of value for future model revisions.

For the "Calculating the Effects of Gasoline Sulfur on Exhaust Emissions" report, there are several other data sets should be considered for inclusion in the model as the model continues to be developed. Even though M6Sulf is supposed to model Tier 1, LEV, and ULEV vehicles, the majority of the datasets listed are from studies conducted in the early 1990s. Given that early 1990s technologies are not very representative of Tier 1, LEV, and ULEV vehicles, consideration should be given to incorporating more data here. Example data sets include the the CRC E-60 program.

For the "TOG and PM Speciation in MOVES for Air Quality Modeling" and the "Appendix: PM2.5 Speciation in MOVES" reports, there are several other data sets should be considered for inclusion in the model as the model continues to be developed. The California Air Resources Board has been looking at the toxicity of advanced technology diesel vehicles, and some of this data has sulfate emissions that could be of relevance here. The South Coast Air Quality Management District has also conducted a study to evaluate the in-use emission rates of 2007+ technology, heavy-duty diesel and natural gas vehicles. These data will probably not be available until the first part of next year, but they could be considered for future application to the model. Phase 2 of the ACES program is another data set that could be of value for future model revisions.

For CARB studies, see http://www.arb.ca.gov/research/veh-emissions/veh-emissions.htm noting that there have been some publications more recent that those listed on the website.

UC Riverside program with the South Coast Air Quality Management District (SCAQMD), "Determining the Physical & Chemical Composition & Associated Health Effects of Tailpipe PM Emissions"

UC Riverside program with the Coordinating Research Council (CRC), "Biodiesel and Renewable Diesel Characterization & Testing in Modern LD Diesel Passenger Cars & Trucks"

UC Riverside program with the South Coast Air Quality Management District (SCAQMD), "Determining the Physical & Chemical Composition & Associated Health Effects of Tailpipe PM Emissions"

UC Riverside and West Virginia University program with the SCAQMD, "In-Use Emissions Testing and Demonstration of Retrofit Technology for Control of On-Road Heavy-Duty Engines"

Durbin, T.D., Karavalakis, G., Johnson, K.C., Miller, J.W., and Hajbabaei, M. (2013) Evaluation of the Performance and Air Pollutant Emissions of Vehicles Operating on Various Natural Gas Blends – Heavy-Duty Vehicle Testing – Regulated Emissions and PM, Final Report for the California Energy Commission by the University of California at Riverside, June.

Durbin, T.D., Karavalakis, G., Miller, J.W., Hajbabaei, M., Bumiller, K., Villela, M., and Xu, K.H., 2012. Effects of Olefins Content on Exhaust Emissions: CRC Project E-83, Final report for the Coordinating Research Council by the University of California at Riverside, June.

Durbin, T.D., Miller, J.W., Johnson, K.C., Hajbabaei, M., Kado N.Y., Kobayashi, R., Liu, X., Vogel, C.F.A., Matsumura, F., Wong, P.S., and Cahill, T. (2011) Assessment of the Emissions from the Use of Biodiesel as a Motor Vehicle Fuel in California - Biodiesel Characterization and NO_x Mitigation Study, Final report for the California Air Resources Board by the University of California at Riverside, the University of California at Riverside, and Arizona State University, October.

Durbin,T.D., J.W. Miller, T. Younglove, T. Huai, and K. Cocker. 2006. Effects of Ethanol and Volatility Parameters on Exhaust Emissions: CRC Project No. E-67. Final report for Coordinating Research Council, CRC Project No. E-67, January.

Durbin, T. D., J. W. Miller, J. T. Pisano, C. Sauer, T. Younglove, S. H. Rhee, T. Huai, and G.I. MacKay. 2003. The Effect of Fuel Sulfur on NH_3 and Other Emissions from 2000-2001 Model Year Vehicles. Final report for Coordinating Research Council, CRC Project No. E-60, CE-CERT Technical Report No. 02-VE-59971-E60-04, May.

Comments on document "Gasoline Fuel Effects for Vehicles Certified to Tier-2 Standards"

The following are comments worth considering related to the "charge questions".

2. Description of analytical methods and procedures –

The description of the methods and procedures is reasonable. The following are some suggestions in this area.

Section 2.1 should have a reference to a more basic description of the "Z factor" and other elements of the discussion for those looking for a more fundamental discussion of the method.

The first example on page 6 is for aromatics, and then the examples switch to ethanol.

Tables 2 and 3 provide a good description of the different coefficients. It is worth noting that because Table 3 is in log scale it, it is not necessarily straightforward to determine the magnitude of the effects that might be seen for different in arithmetic space. It would be interesting to see what the coefficients would be when they are transformed to arithmetic space, although this is not how they are used in the model. Also, the blanks in table 3 are not explained. Tables 5 and 6 are good, especially Table 6 that goes into detail on each of the terms.

For the means in Table 2, are these based on just a mean for the fuels in the test matrix, or are they weighted based on the number of tests run on each fuel for the dataset being used.

The first example on page 6 is for aromatics, and then the example switches to the quadratic term for ethanol.

How are start and running emissions calculated? Based on bag 1 for start and bag 2 for running?

3. Appropriateness of the methods and procedures –

The equations for this report appear to trace back to methods used and reviewed previously. The current application of these methods appears to be appropriate in that context. Comments to consider on the presentation of the methods are provided above.

Its difficult to determine how recent the Predictive/Complex model are. In another document that discusses fuel effects for sulfur its seems to rely heavily on studies conducted in the early 1990s by CRC and EPA and then goes to the EPAct Study with almost no consideration of anything done in between. CARB, on the other hand, considered a number of additional and robust dataset in its 2007 update of its predictive model.

4. Appropriateness of assumptions –

This report does not deal extensively on data sets where data is meager. On the other hand, the data set being used does not contain any GDI vehicles, which will represent a growing and important segment of the in-use fleet going into the future.

5. Appropriateness of resulting mode inputs –

The paragraph at the bottom of page 8 provides some sense of what the model outputs would be and how fuel properties would influence emission rates. Interpreting these results in terms of natural log of the emissions is not necessarily straightforward to a more casual reader.

6. General review comments –

p. 6 . The description of the LA92 should explicitly note that is has a cold start phase, since this is one of the process categories included in the modeling, and how the start emissions are obtained.

7. Grammar and other editorial things –

--- The abbreviations CO, THC, are given on page 4, instead of when they are first use in the 1st paragraph of the document.
--- There are lots of extra spaces in the text. P. 3 last paragraph 2nd sentence was -launched; p. 4 "EPAct Test Program Report" [2] and (fueltypeID = 1) .; p 8 1st sentence etOHxArom interaction
--- Superscripted numbers are used for both references and footnotes, which takes away from the presentation.
--- Introduction – 3rd sentence is very long. Suggest splitting into 3 sentences.
--- p. 4 3rd full paragraph "The analysis involved several iterations between analysis and additional physical and chemical review of data." The part about physical and chemical review of data is unclear. Same paragraph add commas ", including subsets of terms,"
--- page 5 *Emissions Process:* add evap reference.
--- page 8 1st full paragraph "while the impacts of fuel properties on running ~~is~~are dictated …1st and second part of sentence should match

Comments on document "MOVES2014 Sulfate and Sulfur Dioxide Emissions Calculator"

The following are comments worth considering related to the "charge questions".

2. Description of analytical methods and procedures –

The description of the methods and procedures is reasonable. The following are some suggestions in this area.

As equations 1 and 2 are described, it should be noted that the derivation of these formulas is provided in Appendix 1.

What are typical value for $(H_2O)_B$?

Were any measurements made of the oil sulfur levels in the Kansas City study. Can EPA provide an estimate of what the oil sulfur levels might have been in Kansas City based on typical levels in oils of the time.

Pre-2007 Vehicles section. It would be worth noting how many samples the 172 ppm is based on.

The examples in the Appendices provide a good description of how the sulfate contribution is determined for each of the different vehicle/engine categories. They are a nice contribution to the report.

3. Appropriateness of the methods and procedures –

The inclusion of both sulfur for fuel and lubricating oil is an important advancement, especially as fuel sulfur level have been reduced. Overall, the methodology appears to be reasonable based on the data available.

Data for pre-2007 heavy-duty engines/vehicles appears to be lacking. One consideration with sulfate emissions for diesel engines equipped with such DPFs is that the formation of sulfate emissions is highly nonlinear. Nucleation particles comprised of sulfate increase substantially above a certain temperature threshold (~350°C). This phenomena is likely too complex to incorporate into the current model, but is worth considering in future versions of the model.

For the light-duty gasoline vehicle, the expanded use of gasoline direct injection engine is an important consideration in model future fleets. Little data on sulfate emissions is available for these types of vehicles, but EPA should keep this in mind in the development of future versions of the model. UC Riverside is collected some data that might be of interest as part of a mixed alcohol program being funded by the California Energy Commission.

4. Appropriateness of assumptions –

Page 7 2nd paragraph – It indicates that fuel consumption data was not available for E55/59. If the CO_2, CO, and THC emissions are available using standard carbon balance equations using assumptions for the properties of typical diesel fuel.

For the CNG measurements, EPA should consider data from CARB's latest round of studies on CNG vehicles.

5. Appropriateness of resulting model inputs –

It would be useful to bring some of the information from the Appendix into the main part of the text. In particular, it would be useful to provide oil and fuel contributions in mg/mi and oil and fuel sulfate contributions for both the fuel sulfur = 0 case and for the fuel sulfur = reference level. This would immediately give the reader a feel for what the model inputs would be.

6. General review comments –

No additional comments beside those given above.

7. Grammar and other editorial things –

--- Document needs page numbers.
--- Page 1 paragraph 1 final sentence – change "consist of" to "make up".
--- Page 2 1st paragraph - 1st sentence …shown ~~in~~ schematically in Figure 1.; 2nd sentence …~~has~~ supported~~s~~; 3rd sentence ….treated ~~that~~ the; 4th sentence ….engines decrease~~s~~
--- page 3 1st paragraph – last sentence "If included in the PM2.5 speciation profile…" is somewhat unclear.
--- Several sentences begin with a number; page 5 1st paragraph 11 ppm; Appendix 2 2nd paragraph 171; Appendix 3 3rd page 11 ppm and 172 ppm; Appendix 4 page 1 15 ppm and 11 ppm.
--- Appendix 2 2nd paragraph – mean sulfur level is significantly ~~smaller~~lower in the summer,; 2nd page of Appendix 2 last sentence – need space before last sentence; 3rd page of Appendix 2 last sentence ~~has~~have
--- Appendix 1 – 5th line – eliminate space ….reference case~~-~~. x_B

Comments on document "Calculating the Effects of Gasoline Sulfur on Exhaust Emissions"

The following are comments worth considering related to the "charge questions".

2. Description of analytical methods and procedures –

The description of the methods and procedures is reasonable. The following are some suggestions in this area.

Top of page 2. Would like to see some explanation as to why the weighting of high and normal emitters is 50/50.

There should be some discussion of why the Tier 2 Low Sulfur Model applies to 2001 and later vehicles, and how this relates to the NLEV and other phase in transitions.

Section 2.1 – This section could be improved in terms of provided an overview of the model. A table should be added defining the elements in the table structure. There should be an explanation as to why the model in the log-log form or log-linear form is applied in one case but not the other. Why is log-log used for Tier 0 and LEV+ vehicles, whereas log-linear is used for the in between Tier 1 vehicles? Beta is not defined.

Section 2.2 – This section says even less than section 2.1. Does this use the same table structure as for the short term fuel effects? What is the basis of the different factors for HC, CO, and NOx and what is the source of their derivations (maybe a couple sentences).

Section 2.3.1 – Would be useful to add a sentence on why w_{IR} is 0.425 or where it came from.

Section 2.4 – Would be useful to add a sentence on why the numerator is multiplied by 0.608 for high NOx emitters. Is this not applied for other pollutants.

Section 2.6 – Last sentence – Would the calculation be greater than 1 for 90 ppm.

It should be noted somewhere in section 2 examples of the model output are provided in section 4.

Section 3 – The coefficients in Table 2 represent the slope but not sure how to interpret them without understanding the intercept.

Section 4 – The graphs in section 4 are very informative.

3. Appropriateness of the methods and procedures –

The methods and procedures for the M6Sulf is an already developed model, with developed methods, so most of the comments in this regard are related to the presentation of the model methodology and if it is clear, as discussed under point 2.

The discussion on the Tier Low Sulfur Model is somewhat short, but appears to be sufficient based on the fact that the data sources and analysis have been reviewed as part of another report.

4. Appropriateness of assumptions –

Even though M6Sulf is supposed to model Tier 1, LEV, and ULEV vehicles, the majority of the datasets listed are from studies conducted in the early 1990s. Given that early 1990s technologies are not very representative of Tier 1, LEV, and ULEV vehicles, consideration should be given to incorporating more data here. Example data sets include the CRC E-60 program.

The assumption on page 9 under Table 1 that NLEV vehicles are more similar to upcoming Tier 2 vehicles than Tier 1 vehicles is reasonable. This detail and how it related to the 2001+ vehicles should be discussed earlier, however.

5. Appropriateness of resulting mode inputs –

The presentation of model results in section 4 provide good information on how sulfur effects are implemented in MOVES. The results appear to be reasonably representative of sulfur effects over the range of different vehicle technologies being evaluated.

6. General review comments –

No additional comments beside those given above.

7. Grammar and other editorial things –

--- The "x" in NO_x should be subscripted.
--- Page 1 paragraph 2 – impair the effectiveness of the catalyst into converting the products of combustion, leading to increases; last sentence …as though they are independent
--- Page 1 paragraph 5 – Add section number for Tier 2 gasoline vehicles
--- page 4 Section 2.3 1st paragraph – …represent the long-term.. only to target fuel sulfur levels
--- page 9 paragraph below Table 1 2nd sentence – model years as early as ..
--- there is an extra space… bottom of page 6 Equation 14; section 2.6 Equation 16; Last paragraph section 3 Equation 17; section 4 Equation 1 to Equation 16)
--- section 3 – 1st sentence greater 30 ppm, and for all vehicles older than 2001. 2nd sentence ..For sulfur contents; 2nd paragraph catalytic converter; 4th paragraph 29 ppm, the higher level was…
--- Appendix 1 – 5th line – eliminate extra space ….reference case-. x_B

Comments on document "TOG and PM Speciation in MOVES for Air Quality Modeling"

The following are comments worth considering related to the "charge questions".

2. Description of analytical methods and procedures –

Sections 3.1 to 3.5 – The description here is not clear. In equation 1, defines a "speciation factor". Then later on the page there is a "speciationConstant" that is not defined. Similarly, "oxySpeciation" does not appear to be defined. The equations above table 4 are also not clear. Does this mean that the speciation is defined separately for the pure gasoline as opposed to the oxygenate part of the fuel. What is the voltowtpercentoxy term?

Table 13 is useful, providing a link with other models, as our Figure 2 and Figure 3.

Section 5.1 step 1 – It would be useful to provide a one sentence explanation as to why the EC/PM2.5 ratios vary across operating modes.

Step 2 – last sentence "the nonECnonSO4PM as a whole…. (potential suggestion)

Step 4 – It would be useful to give a simple example of a basis temperature effect (effect on catalyst temp, for example).

Step 5 – For the crankcase emissions for the pre-2007 diesel, there are some important factors that are left out that would be useful in interpreting Table 14. In particular, from the MOVES2014 Heavy-duty Emissions Rate Report it indicates that "The crankcase emission factors shown in Table 51 are derived such that the crankcase $PM_{2.5}$ emissions are 20% of the PM2.5 exhaust measurements, and have an EC/PM split of 1.57%."

Top of page 28 – refers to Table 7, but this deals with VOC/NMHC not PM.

Step 8 – It seems like since there are only 7 categories that a table could actually be included with the speciation profiles used for each of the categories.

3. Appropriateness of the methods and procedures –

The methods and procedures appear to be reasonable for this document. The bigger question is probably the description of the methods and the evaluation of the data sets, as described above. One major category that is missing is pre-2007 retrofit heavy-duty diesel engines and how these are modeled. Also, GDI vehicles for future years.

4. Appropriateness of assumptions –

Again, the most critical assumption appears to be where the datasets sufficiently cover the vehicle categories that are needed for the model. Additional categories that could be added include pre-2007 retrofit heavy-duty diesel engines and GDI vehicles for future years, as well as some of the data sets described above.

5. Appropriateness of resulting mode inputs –

The resulting model inputs appear to be consistent with exhaust emissions formation and the associated literature.

6. General review comments –

No additional comments beside those given above.

7. Grammar and other editorial things –

--- extra space – page 3 1st sentence (THC) ,; page 4 elemental carbon " [5]; Page 7 last sentence [1] ." might be extra space; page 8 under table 3 (field meanbase rate –in..; page 14 section heading … for -Evaporative
--- add space – page 8 (TOG): h;
--- add comma – page 3 3rd sentence , such as; page 6 nonECPM , such as; page 28 2nd full paragraph (i.e., ;
--- page 3 sentence 4 add "to make TOG" to end of sentence.
--- page 3 last sentence first paragraph ..seems to be missing something
--- page 3 second paragraph 3rd sentence – under different measurement
--- page 4 elemental carbon – can a reference to the TOR method be provided?
--- page 4 chemical mechanism – to speed up the atmospheric…
--- page 5 integrated species – 3rd sentence CM-speciate is unclear
--- page 8 Table 4 not centered – some headings are centered but not others throughout
--- page 12 and 13 – there is an issue with the paging
--- page 14 & 15– issue with section numbering should be 3.4 and 3.5
--- page 15– section 4.1 1st sentence – MOVES2014 produces an or the output
--- page 28– 3rd full paragraph there is a reference in (EPA, 2014) and not number format
--- page 28– last paragraph "capability"

Comments on document "Appendix: PM2.5 Speciation in MOVES"

The following are comments worth considering related to either the "charge questions".

2. Description of analytical methods and procedures –

p. 3 Why was EC measured for considerably more vehicles for the KCVES than OC. What method was used for the EC?

The comparisons in Table A-8 and the associated discussion is valuable in that it ties the current estimates to earlier model estimates and data in the literature.

Under Table A-4. The discussion needs to be clarified about how OM is split into organic carbon and non-carbon organic matter using the relationship: OM = 1.2 * OC. The table seems to show that the OC is scaled down and then renamed OM, which is subsequently modified by the 1.2 factor. It seems that it would be best to start out by saying that the initial OC includes organic carbon, a positive artifact, and other non-carbon species associated with the organic carbon (such as hydrogen, oxygen, etc.).

3. Appropriateness of the methods and procedures –

Although the silicone contamination from the connecting pieces from the transfer line can be removed, is it possible that some other PM species relating the transfer line heating/burning. I see in another section that there is some compensation for other species, but it reinforces the idea that EPA should consider a broader range of data sources in its modeling.

Although the Kansas City study is one of the more recent comprehensive studies of gasoline PM, it is not obvious that fleet average composition profiles would be representative of the fleet going into the future. On page 2, it does indicate that there were differences in PM2.5 composition that between different model year groups. If there are differences between Tier 0, Tier 1, and NLEV/Tier 2 vehicles, will a fleet average profile be adequate for the fleet going into the future. Of course, future generations of the model will need to include GDI vehicles, as more information on their PM species profiles become more available. Additionally, how are light-duty diesel vehicles accounted for in the model?

4. Appropriateness of assumptions –

Although the silicone contamination from the connecting pieces from the transfer line can be removed, is it possible that some other PM species relating the transfer line heating/burning.

It seems reasonable that the sample size might be too high to capture high emitters in each of the model years groups, and especially for newer model years. It would be interesting to know if the population of high emitters in the KCVES was comparable to that found in previous studies of high emitters, although many of those estimates were made in older studies.

How different is the PM2.5 composition by model year groups? As this would be an important consideration in terms of using the fleet average approach.

There are some differences between the cruise and transient OC/PM factors. How was it determined that the transient cycle is more representative than the cruise for heavy-duty vehicles. Is this based on more urban driving?

For the 2007+ heavy-duty vehicles, while it is understandable to utilize measurements that are not background corrected and the associated negative numbers. It should be noted and understood that this would likely overestimate the contributions of different individual species. Nevertheless, the breakdown in Table A-9, with a predominantly sulfate contribution and minimal contribution from minor species seems reasonable.

The discussion relating to the exclusion of sulfate-bound water provides a good basis for this assumption and is adequately described.

5. Appropriateness of resulting mode inputs –

The intercomparisons between the model inputs and the available data for the pre-2007 heavy-duty vehicles indicate that the model inputs are reasonably representative. The relatively low sulfate contribution in these profiles may not be appropriate for retrofit heavy-duty diesel vehicles, however.

6. General review comments –

p. 2. Missing high emitter study ….

7. Grammar and other editorial things –

--- page 1 2nd paragraph – updated speciation profiles changes
--- the references are numbered in the main document, but use the name/year format in the Appendix
--- add comma – page 3 (effective beginning 2006-2008),;
--- page 3 3rd paragraph. Missing period after …..161.2 ppm. Fuel sulfur….
--- page 3 2nd to last sentence. ~~in~~npute
--- page 5 The CRC E-55/59 is listed three different was ….E55/59, -55/59, E-55/59
--- page 6 first sentence – extra space 2010). [1]; and 1st full sentence begins with number; 2nd to last full sentence on page beings with a number
--- page 7 2nd paragraph “Instead we used calculated”; last sentence in paragraph impact~~ed~~ing
--- page 8 last sentence – the adjusted OC speciation factors are
--- page 5 integrated species – 3rd sentence CM-speciate is unclear
--- page 8 Table 4 not centered – some headings are centered but not others throughout
--- page 12 and 13 – there is an issue with the paging
--- page 14 & 15– issue with section numbering should be 3.4 and 3.5
--- page 15– section 4.1 1st sentence – MOVES2014 produces an or the output
--- page 28– 3rd full paragraph there is a reference in (EPA, 2014) and not number format
--- page 28– last paragraph “capability”

Comments on document "Estimation of Air-Toxic Emissions from Highway Vehicles in the Motor Vehicle Emissions Simulator (MOVES 2014)"

The following are comments worth considering related to either the "charge questions".

2. Description of analytical methods and procedures –

p. 6 – 2nd paragraph discusses pre-2001 vehicles and 2004+ vehicles, but does not address 2001-2004 vehicles. 4th paragraph – what two fuel properties are used for evaporative emissions.

p. 15 – its not clear what is meant by the phrase that "relations of air toxic emissions to changes in fuel properties has remained stable from Tier 0 to Tier 1"

p. 17 – There is a reference to modeling 2000 and earlier vehicles on E15-E20, but not discussion on factors that would be used for such fuels. It would be useful to at least reference the section where this will be discussed.

For section 2.2.1 see suggestions for the report "Gasoline Fuel Effects for Vehicles Certified to Tier-2 Standards". Then on page 32, it talks about the "full" vs. "reduced" design. The fact that the reduced design represents 5 vehicles and 11 fuels (as opposed to 5 vehicles by 27 fuels) should be discussed in the 1st paragraph, rather than the 2nd. Then the 2nd paragraph talks about Table 30 and 31 before these tables are introduced in the 3rd paragraph, so the 2nd paragraph seems out of place. It should at least be mentioned here that acrolein, benzene, and 1,3 butadiene are not modeled for hot running emissions in this section (even though it is discussed in the next section). The approach using "information parity" appears to the reasonable for NMOG and ethane.

Section 2.1.3 – It should be mentioned at the start of the paragraph that metals are represented both with these metals and the metals presented in the PM2.5 emission profile. Also, "conservative" is probably too weak a term to describe using the bag 2 emission rates, since its actually more of an upper limit estimate (although this only appears to be the case for manganese).

p. 42 – A recent study by CARB/UC Riverside/UC Davis should provide some information related to biodiesel emission factors.

p. 42/43 seems like final paragraph on 42 and 1st paragraph on 43 could be combined, since the three different references to Table 39 in these paragraphs is a little confusing.

p. 46 – section 2.3.4 – It seems like dioxin emissions might be overestimated using a data set with such older vehicles. This might be worth mentioning in the text.

p. 47 – section 2.4.2 – Its not clear what the basis of the particulate to gaseous phase split is for the PAHs. If it is discussed previously, it should be reiterated here.

p. 53 – 3rd paragraph on 20% ethanol. Its unclear what fuel speciation data was used here. Was this from in-use fuels? Since the test fuels were not necessary representative of average fuels, but rather represent the extremes of in-use fuels. Table 51 is useful.

3. Appropriateness of the methods and procedures –

Overall, the complex model provides a robust framework for modeling acetaldehyde, formaldehyde, benzene, and 1-3 butadiene, especially with its recent updates.

Table 7 – the mean value for centering the sulfur at 204 ppmw is relatively high compared to current sulfur levels. Will this potentially be modified going into the future.

Tables 8 to 11 – What do the dashes in the table represent? Is that where the data show no effect or are insufficient? For example, there is no sulfur effect on formaldehyde.

For MTBE, the model applied previously in MOBILE6.2 should be adequate, especially since MTBE use is essentially historical. Similarly, in section 2.2.2.1.1, the use of Tier 1 and earlier vehicles for Tier 2 vehicles appears reasonable.

Section 2.1.2 Its not clear what samples are being used to estimate the PAHs. It talks about a set of 99 samples being used for the fractions in the second paragraph and how the fractions are determined in terms of PAH/THC and PAH/OC2.5. Then it talks about the partitioning into gaseous and particulate phases in the 3rd and 4th paragraph that appears to be based on 2 vehicles in the medium emitter category, which was selected from 4 samples collected at two temperatures. Why was the "medium emitter" sample selected? How significant were the differences between the samples collected at 20°C and 47°C? If there were big differences wouldn't that make a big difference in the partitioning for the PAH/THC and PAH/OC2.5 for the other 99 samples? Then its unclear what Table 20 represents, since it is multiplying fractions (PAH/THC and PAH/OC2.5) by fractions (Table 19) in a seemingly strange was. Where do the absolute emission rates for the individual species play in here?

Page 37 - Although benzene can be a function of fuel benzene, it can also be a function of other low weight aromatics, especially toluene. In the EPA study on benzene, how did toluene levels vary between the fuels.

Section 2.3 – Developing the air toxics factors from the E-75 database appears to be a reasonable approach. Its unclear how these factors might account for states with low levels of aromatics, such as California. Also, its unclear why the partitioning for the PAHs was made based on a medium-duty diesel engine. Maybe just one sentence to clarify this.

The ACES study provides a good data set for the development of the air toxics factors for the 2007 and new engines. p. 49 section 2.4.4 – Would be interested to see how backgrounds were dealt with in this study. At such levels backgrounds would be important in terms of not overestimating emissions.

Section 2.6 – CNG emissions – For the PAHs, is there any consideration given to how the oxidation catalyst would reduce PAHs. It appears that the estimates were based on measurements without an oxidation catalyst, but that these are applied to both technology categories. p. 51– section 2.6.3 – By using the only the data where chromium and nickel were

detected, this would presumably overestimate emissions. Were the metal rates from heavy-duty engines also considered before deciding to use the gasoline emission rates.

Section 3 – Some more details should be provided for why the hot soak and running loss algorithms from MOBILE6.2 are applied to MOVES for the non-permeation factors. The methodologies for the permeation factors appear reasonable.

Appendix A – the fleet of vehicles used for this study appears to be too heavily weighted towards older vehicles. Were the results for the different vehicles to provide a profile that was more representative of the modern fleet.

Using an average exhaust flow might tend to underestimate emissions, since often periods of higher emissions also can be periods with higher exhaust flow.

Last paragraph – by using only the first 715 seconds, would this over represent cold start emissions.

4. Appropriateness of assumptions –

p. 9 at the top The EPA assumption that metals should be independent of temperature appears reasonable. It might be useful to examine metal emissions as a function of operation mode, however, for example, comparing more vs. less aggressive driving, although perhaps not for the metals included in Table 4.

Page 16 developing regressions for ETBE and TAME from algorithms for ethanol and MTBE appears to be a reasonable assumption, especially as these fuels are not at all prevalent.

p. 37 – When modeling 1,3 butadiene as 0.0 for hot-running operation, the impact of olefins should be considered. Later on the page – CRC E-83 can be considered for olefins, although these values were near background levels as well.

Section 2.2.2.2 – Overall, the assumptions used in this section appear to be reasonable, as E85 data are not available for some of the toxics being measured. The section does use a range of different descriptions of higher ethanol levels from E70 to E85 to 74% ethanol without clearly describing when all of these different conditions are applied. For example is the same factor used for E70 and E85? Also, on page 40, the approach that ethanol contributes no PAHs should be verified. A UC Riverside/CEC/SCAQMD study will be completed next year that will provide some data in that area.

Section 3 – For section 3.1.1, when using the fuel speciation from the EPAct study to make estimates for E15 and E20, was the volatility of the species considered? This would not necessarily be an essential change.

5. Appropriateness of resulting mode inputs –

Overall, the methodologies selected and applied for this report appear to be providing reasonable input to the MOVES model. As additional data sets become available, they should also be considered for incorporation into the model, as discussed above.

6. General review comments –

No additional comments beside those given above.

7. Grammar and other editorial things –

--- page 5 extra page
--- p. 6 2nd paragraph used to calculated toxic..; final sentence "persistent" is not a well defined word here.
--- p. 9 1st sentence – make it two sentences As Metals… emission rates. Tthese rates ; 2nd paragraph look at indentation; final paragraph look at indentation
--- page 10 1st paragraph don't capitalize Air injection; last sentence goes to next page
--- page 11 1st sentence Table 8 to Table 11.
--- page 13 last sentence 1st paragraph – last sentence signpost?
--- page 16 2nd paragraph MTBE levels using a simple regression; 3rd to last paragraph MTBE …used for TAME blends; 2nd to last paragraph end of 1st sentence; last paragraph from the National County Database;
--- page 17 3rd line 12 vol. % or more or tert.. extra space
--- page 19 3rd sentence winter, orand blends
--- page 21 PAH seems like it should be PAHs throughout page and in title; 2nd paragraph end of 1st sentence; 3rd paragraph last sentence particulates and hydrocarbons also differ… and heavy-duty vehicles, ; last sentence smallester highester e.g., dibenzo..
--- page 22 – 1st sentence table error; last sentence structure, which
--- page 23– last paragraph 1st sentence end of sentence; page 24 include reference to 2005 EPA study; 1st paragraph 2nd to last sentence … differences … are
--- page 25– end of 3rd sentence
--- page 31– last sentence VOC emissions areis
--- page 32– several table reference errors; 3rd paragraph reverse order of second sentence; 4th paragraph 1st sentence VOCs; last sentence in this context,
--- page 38– 20% ethanol, fractions; also switch the order of the last two sentences in the final paragraph. Also, eliminate "the" before Table 34 in the last sentence.
--- page 40– Table error under 2.2.3.1; last sentence …fractions are …add period at end of sentence.
--- page 42– section title should be pre-2007 or MY 2006 and earlier.
--- page 43– table reference error in last paragraph
--- page 50– 2nd sentence gasoline ofor diesel
--- page 51– 1st paragraph under section 2.6.3, end of last sentence in paragraph has extra space?
--- page 52– 1st paragraph after 3.1 (evaporative?); later <source>
--- page 55– under eq. 18 linearlyinterpolated
--- Appendix A – p. 61 2nd paragraph 1st sentence "in the raw exhaust"; p. 62 last paragraph the end of the 1st sentence is no clear, and should have a comma after power, "; p. 63 last sentence "The Eequation.."

Comments on document "Estimating Elemental Carbon Factions"

The photoacoustic instrument should provide relatively good measurements for EC over a range of concentrations. The 2.4 mg/mi differences between the TOR and the photoacoustic seems a bit high. How due these two measurements compare to the total PM mass on the filter would be a good question to address here. Also, how high are the PM mass emission rates, where the 2.4 mg/mi offset would be small considered to be a small fraction of. Seems like 2.4 mg/mi would be a big number in comparison to emission rates of typical modern vehicles.

1st sentence – extra space (PM2.5)
Final sentence in first paragraph – speciation is misspelled

Comments on document "Updates to PM2.5 Emission Rates … for light-duty vehicles"

The issue of silicone contamination is probably something that needs further consideration. I think that some rational should be given in this description as to where the 4.075 factor comes from. In fact, I looked through the referenced ES&T paper and did not find anything either, unless there was a error with the reference numbering. This issue further emphasizes points raised above that EPA probably is using too narrow a focus in the data sets that it considers.

2nd paragraph – 4th sentence – add comma ….rates**,** as documented…

Comments on document "Updates to PM2.5 Emission Rates … for heavy-duty vehicles"

It would be interesting to see how the EC fractions developed based on Kweon et al. compare to those of other should, which could be evaluated by looking at cycles such as cruise cycles, or idle, vs. transient cycles. Comparisons could be made against E-55/59 or studies by CARB.

Last paragraph on 1st page – 1st sentence add comma after i.e., ; and also the reference for Kweon is given in the author/year format, whereas the references in the back are listed by number.