

**Josias Zietsman, Ph.D., P.E.**

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**WA 0-14: Peer Review of “Heavy-Duty Emissions Update”**

**To: Ira Dassa and Lindsay Kirschner**

ICF Incorporated, LLC, 9300 Lee Highway, Fairfax, VA 22031

Please find attached:

1. A completed Conflict of Interest - COI form
2. My written comments included in the Peer Review Charge

**Signed:**



**Dr. Josias Zietsman**

## WA 0-14: Peer Review of “Heavy-Duty Emissions Update”

### Peer Review Charge

#### 1. Purpose

Over 125 million Americans experience unhealthy levels of air pollution. Motor vehicle exhaust is a particularly important source of exposure to air pollutants, with more than 50 million people living, working, or going to school in close proximity to high-traffic roadways. The U.S. Environmental Protection Agency’s (EPA) Office of Transportation and Air Quality (OTAQ) is tasked with identifying policy options to reduce ozone, particulate matter (PM), and nitrogen dioxide emissions, among other pollutants, from light-duty vehicles (LDVs) in the U.S. As new policy options are brought forth, there is a need to evaluate their soundness and utility.

Models can be used to help address questions that may be too large to study directly but may yield to approximations from smaller sets of real data. These models can provide insights into how drivers will change their vehicle operating patterns in response to, for example, a required increase in fuel economy across the LDV fleet. Tools, like EPA’s MOrtor Vehicle Emission Simulator (MOVES), describe the result of various inquiries into the nature of fuel and vehicle emission interactions. Specifically, the MOVES model estimates the impact of LDV, heavy-duty vehicle, and nonroad equipment exhaust and/or evaporative emissions on air quality in the U.S.

EPA is updating the MOVES model to include information from two documents referred to collectively as, “Heavy-Duty Emissions Update,” and thereby refine the model’s ability to estimate accurately the emissions impacts of motor vehicles. The two documents describe proposed updates to MOVES data and methods.

ICF, which is under contract with OTAQ to facilitate a peer review of the aforementioned documents, has selected you as a reviewer. This charge letter provides you with a detailed scope of services for this review. It includes:

- A description of the materials for review;
- A list of both general and specific questions for your review, with instructions;
- The review schedule;
- Drafts of the two documents for review; and
- A list of materials, including a Conflict of Interest (COI) form, to be submitted to ICF at the conclusion of the review.

#### 2. Description of Peer Review Materials

EPA is seeking your review of and comments on specific sections of the following two documents:

##### 1. Exhaust Emission Rates for Heavy-Duty Onroad Vehicles in MOVES201X

- *Section 2.1 (Running Exhaust Emissions)*: this section addresses updated data sources, methods, and emission rates for gaseous pollutants from MY2010+ heavy-duty diesel vehicles. EPA has also updated the method for hole-filling missing operating modes. Within Section 2.1, for the gaseous pollutants, the following subsections have not been updated and so are excluded from this peer review: 2.1.1.3.1; 2.1.1.3.3; 2.1.1.4.2; 2.1.1.6; and 2.1.1.7. Please review all of the other subsections within Section 2.1, including those identified below.

However, for particulate matter (PM), you only need to review subsection 2.1.2.2.8 (see below for details).

- *Section 2.1.2.2.8 (Computation of Elemental Carbon and Non-Elemental Carbon Emission Factors)*: this section addresses EC/PM factors for pre-2007 vehicles based on speciation data from the E55-59 report.
- *Section 2.1.4. (Energy)*: this section addresses energy rates for MY 2010+ vehicles, including the impact of the heavy-duty Phase 2 greenhouse gas (GHG) emissions standards rulemaking.
- *Section 2.2 (Start Exhaust Emissions)*: this section addresses gaseous and PM<sub>2.5</sub> start emission rates for MY 2010+ heavy-duty diesel vehicles.
- *Section 2.3. (Extended Idling Exhaust Emissions)*: heavy-duty diesel extended idle and auxiliary power unit emission rates have been updated to reflect current data and the adoption of the heavy-duty Phase 2 GHG emissions standards.
- *Section 3.1.3 (Energy Consumption)*: heavy-duty gasoline energy rates have been updated to reflect the adoption of the heavy-duty Phase 2 GHG emissions standards.
- *Section 3.2.3 (Soak Time Adjustments)*: EPA has not made updates, but considered updating the gasoline soak time adjustments based on new data.
- *Chapter 4 (only the introductory text on pp. 154-55) and Section 4.2 (Development of Running Exhaust Emission Rates)*: this section addresses gaseous and PM<sub>2.5</sub> emission rates for MY 2007+ heavy-duty CNG vehicles, which rates apply to all heavy-duty CNG source types.

## **2. Emission Adjustments for Temperature, Humidity, Air Conditioning, and Inspection and Maintenance for On-road Vehicles in MOVES201X**

- *Chapter 3 (Humidity Adjustments)*: This chapter has been included in this peer review because it is pertinent to the updates EPA has made to the heavy-duty diesel emission rates in the *Exhaust Emission Rates for Heavy-Duty On-road Vehicles in MOVES201X* report.

## **3. Charge Questions**

EPA is seeking your review of and comments on selected methods and underlying assumptions, their consistency with the current science as you understand it, and the clarity and completeness of the presentation. For this review, no independent data analysis is required. Rather, EPA asks that you assess whether the information provided is representative of the state of current understanding, and whether incorporating the information into the MOVES model will result in appropriate predictions and conclusions.

Although the peer review charge is limited to the sections and chapter specified above, we have provided you with the full draft reports for context. Comments made on the other sections/chapters in the draft reports are outside the scope of the peer review, and any comments made outside of the charge will be addressed at EPA's discretion. The draft reports reference other MOVES201X draft reports. We will provide these to you at your request, but we do not anticipate they will be needed for this work.

Your written comments should address, sequentially, the substantive content of the draft report that you are charged with reviewing. Comments on organization, formatting, and other minor issues are welcome, but should be provided separately.

EPA has provided the following general and specific charge questions to define the scope of your review. EPA does not expect individual responses to the general questions, but would like these questions to help guide your comments. EPA does, however, seek individual responses to the specific questions. Please note that you are welcome to identify additional topics or depart from the questions as necessary to best apply your particular area(s) of expertise. You may also include any additional comments that are not specific to the charge questions using the table provided.

In your written comments, you should distinguish between recommendations for clearly defined improvements that can be readily made based on data or literature reasonably available to EPA, and improvements that are more exploratory or dependent on information not readily available to EPA. Your comments should be sufficiently clear and detailed to allow readers to understand thoroughly their relevance to the subject report.

EPA requests that you treat all materials as confidential. Do not release or discuss with others the peer review materials or your comments. Your comments will be listed as an appendix to EPA's final published report, along with EPA's responses to them.

If you are unclear about what is required to complete this review or need additional background material, please contact Ira Dassa at ICF by telephone (443-573-0551) or email ([Ira.Dassa@icf.com](mailto:Ira.Dassa@icf.com)).

### **Charge Questions**

#### General Questions to Consider:

1. Does the presentation describe the selected data sources sufficiently to allow the reader to form a general view of the quantity, quality, and representativeness of data used in the analysis? Are you able to recommend alternate data sources that might better allow the model to estimate national or regional default values?
2. Is the description of analytic methods and procedures clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made by EPA while developing the model inputs? Are examples selected for tables and figures well-chosen and effective in improving the reader's understanding of approaches and methods?
3. Are the methods and procedures employed technically appropriate and reasonable, with respect to the relevant disciplines, including physics, chemistry, engineering, mathematics, and statistics? Are you able to suggest or recommend alternate approaches that might better achieve the goal of developing accurate and representative model inputs? In making recommendations, please distinguish between instances involving reasonable disagreement in adoption of methods as opposed to instances where you conclude that current methods involve specific technical errors.
4. Where EPA has concluded that applicable data is meager or unavailable, and consequently has made assumptions to frame approaches and arrive at solutions, do you agree that the assumptions are appropriate and reasonable? If not, and you are able to do so, please suggest alternative assumptions that might lead to more reasonable or accurate model inputs.

5. Are the resulting model inputs appropriate and, to the best of your knowledge and experience, reasonably consistent with physical and chemical processes involved in mobile source emissions, formation, and control? Are the resulting model inputs empirically consistent with the body of data and literature with which you are familiar?

#### Specific Questions:

In addition to the general review, EPA requests specific responses to the following questions:

#### **Exhaust Emission Rates for Heavy-Duty Onroad Vehicles in MOVES201X**

1. [With respect to Section 2.1.1.3.2]: For a given regulatory class and NO<sub>x</sub> FEL group, EPA did not distinguish emissions rates between model years. The currently available HDIU data set is limited to data from MY 2010-2013 engines. Are there any studies that show NO<sub>x</sub> emissions of engine families, with similar NO<sub>x</sub> FEL levels, have changed significantly in recent model years due to improvements in engine management or thermal management strategies or catalyst formation?

The current approach of not distinguishing emissions rates between MYs in a regulatory class seems reasonable, however, it is clear that more in-depth testing and research needs to be done. For example, a pair of studies performed by TTI using the on-road heavy duty measurement system (OHMS) showed high levels of NO<sub>x</sub> for newer model trucks, likely linked to SCR functionality/exhaust temperature – reports available here: <http://www.nctcoq.org/trans/air/hevp/DieselIM/>. A couple of other studies also showing NO<sub>x</sub> emissions differences between vehicles of same type with slight different MYs include:

- Kotz, A.J., Kittelson, D.B., Northrop, W.F. et al. Emiss. Control Sci. Technol. (2017) 3: 153. <https://doi.org/10.1007/s40825-017-0064-4> (for buses)
- In-Use NO<sub>x</sub> Emissions from Model Year 2010 and 2011 Heavy-Duty Diesel Engines Equipped with Aftertreatment Devices, Chandan Misra, John F. Collins, Jorn D. Herner, Todd Sax, Mohan Krishnamurthy, Wayne Sobieralski, Mark Burntizki, and Don Chernich. Environmental Science & Technology 2013 47 (14), 7892-7898, DOI: <https://doi.org/10.1021/es4006288>

2. [With respect to Sections 2.1.1.2 and 2.1.1.4.1]: EPA is considering updating the fixed mass factor ( $f_{scale}$ ) values for heavy-duty vehicles (regClassID 40 through 48). The details are provided in Attachment A of this Peer Review Charge. What might be a better method to estimate an appropriate fixed mass factor for each regClassID? In addressing this question, you may find the background information on the  $f_{scale}$  discussed in Section 1.3 pertinent.

In my opinion, a focused research project collecting empirical data would be useful, to revisit the concept of a fixed mass factor, or to provide some form of benchmarking or possible linkage to physical characteristics of the vehicle and engine. Given that the fixed mass factor is a scaling constant without any physical/dimensional properties, the selection of the number can be viewed as arbitrary and open to potential scrutiny or even lawsuits. An analogy for this “revised” factor would be something like the Reynolds number.

A further point to consider is the probability of vehicles actually operating in the extreme opModes that currently do not have data in them. More empirical data collection can be used to verify this.

3. [With respect to Section 2.1.2.2.6]: For MY 2010+ PM rates, EPA initially decided not to use the HDIU data because the numbers were scarce or low, raising concerns about the quality of the data. Since the trends look fine, EPA would like feedback on whether the HDIU PM rates are of expected magnitude. Additional details are provided in Attachment B of this Peer Review Charge.

The order of magnitude of the numbers seem reasonable. The challenge is always measuring PM at such low levels, close to equipment detection limits. This is also noticed in the large error bars in the data, and there is a clear need for additional data collection for newer MYs and continuing the efforts to develop more accurate testing equipment. It is also not clear if effect of regeneration is included in the data and that needs to be clarified.

4. [With respect to Section 2.3.1]: EPA generated its pre-2007 NO<sub>x</sub>, HC, and CO extended idle emissions rates assuming 33% of trucks idle at 1000 RPM or higher engine speeds during extended idle. Can you recommend better sources or techniques for estimating the prevalence of “high idle” during extended idling?

Additional driver interviews are a possibility, especially since the UC-Davis study that the 33% number came from is now dated. Further, on-board diagnostic data extracted via data loggers would be a good source. Several large fleets are likely implementing these to collect a range of data, and companies also exist to provide tracking services to fleets, such as <http://www.teletracnavman.com/>

5. [Also with respect to Section 2.3.1]: EPA assumes MHD (regClassID 46) and HHD (regClassID 47) combination long-haul trucks have the same extended idle emission rates. Do you agree? Or can you point to sources that suggest different emission rates based on engine size?

We are aware of at least one study (performed by TTI) which looked at idle emissions from Class 4, 6 and 8 trucks. There were differences in emissions rates, and it warrants revisiting this assumption. Report - Characterization of Exhaust Emissions from Heavy-Duty Diesel Vehicles in the HGB Area – available at <http://tti.tamu.edu/documents/O-6237-1.pdf> ; see graph on Page 48 as an example.

### **Emission Adjustments for Temperature, Humidity, Air Conditioning, and Inspection and Maintenance for On-road Vehicles in MOVES201X**

1. [With respect to Section 3.2]: Are you aware of any studies examining the effect of intake air humidity on tailpipe NO<sub>x</sub> for model year 2010 and beyond heavy-duty engines/vehicles?

I am not aware of any studies that are more recent/covering MY 2010 or later, agree as stated in Section 3.2 that this warrants investigation.

**ADDITIONAL OVERALL COMMENTS PROVIDED (NOT CHARGE QUESTION-SPECIFIC):**

The MOVES model is comprehensive and the proposed changes/updates to the HDDV on-road emission rates will result in an improvement to the current version. In general, the report does a good job of describing the data and assumptions, and did a good job in using the best available methodologies. However, there are certain areas where additional clarity can be provided and methods can be improved, as noted below and in response to the specific questions.

**ADDITIONAL COMMENTS BY SPECIFIC REPORT CHAPTER:**

- Section 2.1.1.1 – In the description of data collected through the various initiatives it is not clear which one collected data for buses even though Table 2.2 shows that some bus data was collected.
- Section 2.1.1.2 – the power loss assumptions, as noted, is not very data driven. Can some measurements be implemented (at the axle, for example) to validate the assumptions or to potentially replace the need for calculating the losses.
- Section 2.1.1.3.2 (Pg 20) – Creation of NOx FEL groups – a table will help in clarify of the information with regards to FEL groupings.
- Section 2.1.1.8 – In discussing Sample Results one wonders about the effect of alternative fuels such as CNG and biodiesel as well as electrification moving forward.
- Section 2.2.1.1 – it is mentioned that no temperature adjustments are applied to CO, PM or NOx diesel start emissions. It is warranted to state why that is the case. Likely because the effect is much greater on HC.
- Section 2.2.3.1. (Pg 73) – add explanation for why the base cold start emissions rates are zero for NOx and HC
- Section 2.2.3.2 – It is stated that the emission reduction report discusses the impact of temperature on cold start emission rates for opMode 108. Why is this effect not included?
- Section 2.3.1 (Pg 86) – why the large increase in NOx extended idle emissions rate between pre-1990 and 1990-2006 MYs?

**4. Schedule**

The schedule for this peer review is as follows:

- September 11, 2017 (4:00 PM EST - tentative): Conference call with EPA, ICF, and all reviewers to address any preliminary questions.
- September 25, 2017: Comments/review due to ICF via email (send to [Ira.Dassa@icf.com](mailto:Ira.Dassa@icf.com), with a cc to [Lindsay.Kirschner@icf.com](mailto:Lindsay.Kirschner@icf.com)).

ICF will arrange the teleconference between the reviewers, relevant EPA staff, and ICF. The purpose of this teleconference will be to answer any questions you and the other reviewer may have regarding the EPA peer review process and the particular material you are reviewing. ICF

will contact you in advance to assess the best time for you and the other reviewer to participate in the conference call.

Any questions that you have after this teleconference should be directed to ICF, which will then seek resolution from EPA. Any answer provided and the question to which it refers will be shared with the other reviewer.

## **5. Materials to Submit**

Upon completion of your review, please submit the following to ICF:

1. A cover letter that states:
  - Your name; and
  - The name and address of your organization.
2. A completed COI form (attached).
3. Your written comments.

## **6. Material for Review**

The following files are appended for your review:

- *Attachments A and B to Peer Review Charge.docx*
- *Peer review - Exhaust Emission Rates for Heavy-Duty Onroad Vehicles in M....docx*
- *Peer review - Emission Adjustments for MOVES201X.docx*

### **Additional attachment:**

- *COI Form.pdf* (please complete this and submit it with your review)