

Comments (T.H. DeFries, August 3, 2015) on

“Speciation Profiles and Toxic Emission Factors for Nonroad Engines”
EPA-420-R-14-028
draft, March 2015

1A. In many places the report uses emission data from onroad engine measurements when nonroad emissions measurements are not available. It makes sense to me that the emissions between onroad and nonroad engines would be the same, but maybe I am just naïve. I would like to see a discussion (up front somewhere) of why the emissions of nonroad and onroad engines might be expected to be different. Is it a consequence of different emission standards, different emission controls (as a result of standard differences), and a difference in how the vehicles are used, or what?

Speciation profiles may differ between onroad and nonroad engines due to differences in operating conditions. In addition, data from 2007 and later highway diesel engines are used for Tier 4 nonroad diesels, although the former have particulate filters and nonroad diesels do not. This could result in differences. Finally, for some pollutants, data from onroad vehicles with catalysts were applied to emissions from nonroad engines without catalysts. These potential sources of differences have all been highlighted in the revised report.

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1B. In several (many) places in the report an analysis of emission factors for the sought after nonroad vehicle, fuel type, and emissions type cannot be performed because the needed data does not exist. In each instance a substitute dataset is analyzed. For example, the dioxin and furan emission factors for nonroad CNG exhaust are based on an analysis of onroad gasoline exhaust dioxin and furan data. The reasons why these substitutions might be reasonable are not given – other than the substitute data exists. To me the lack of discussion makes the substitution highly questionable. The argument that “MOVES needs something” doesn’t really cut it for me. There are those who would argue that zero is a better guess than a completely incorrect emission factor value.

So, what can be done about this? Let me suggest there be a separate discussion of the believed formation mechanism or source for each emission category. Ideally, there would be research to reference that identifies the sources. This discussion could be in the Introduction, perhaps in Subsection 1.1, which already has a presentation of each emission category. For example, one category of emissions are the PAHs. Are PAHs in the exhaust derived from PAHs in the fuel, from fuel combustion, from PAHs in the engine oil, from combustion of engine oil, or what? If the predominant source is known, it could provide a reason for choosing the substitute dataset used to determine the PAH emission factors. If none of the sources are known, then the reader at least knows that we tried to find a reasonable substitute based on some sort of logic.

We agree that the substitution of dioxin data from onroad gasoline vehicles to CNG nonroad needs additional justification. However, since onroad CNG vehicles emit compounds like PAHs, which can form dioxins and furans in the presence of chlorine, we felt it reasonable to use emission factors from highway gasoline engines rather than assume emissions were zero. Some discussion was added to the report. Other substitutions, such as use of onroad diesel speciation

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for nonroad diesels, are much more obvious substitutions and we elected not to include discussion of formation mechanisms.

2. The second paragraph of the Intro says that factors are updated using from test program data of gasoline and diesel. Are there no test programs on CNG and LPG?

We are not aware of CNG or LPG test programs for nonroad engines that include full speciation. Recent CNG highway vehicle test programs have been conducted with measurements of a subset of toxics species.

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3. The section heading for 1.1 in the text and in the TOC differ.

This has been corrected.

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4. Section 1.2, second paragraph: benzo(g,h,i)perylene.

Correct.

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5. Section 1.2, fourth paragraph, second line: “chemical mechanism species” is a term I don’t recognize.

We have added a footnote explaining this term.

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6. Section 1.3, second paragraph: Why is it “important to note”? Do you expect that emission factors would vary greatly by the factors mentioned? I guess that without any data you don’t know, but maybe you could mention that for other emission factors where data does exist as a function of the factors mentioned, the emission factors vary greatly. By inference the nonroad emission factors are also likely to vary greatly. We just don’t know by how much.

We added text pointing out there is significant variation in highway vehicles.

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7. Section 2.1, first paragraph: I don’t understand why the section starts out with “In the absence of data” when it seems that data does exist and it is used for the analysis.

We have deleted this clause.

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8. Section 2.1, first paragraph: The “single” test program apparently actually measured emissions of nonroad vehicles. Many of the sections that follow mention that nonroad data was not available so onroad data was used for the analysis. So, I think it is important to make clear for Section 2.1 that nonroad data was actually used.

Clarifying language has been added.

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9. Section 2.1, second paragraph: I am a novice when it comes to the definitions and differences among VOC, NMOG, NMHC, THC, and TOG. Then, Equation 2 throws ethane and acetone into the mix, and I am lost. I know this was explained in Section 1.2, but I need a graphic or something to make clear the differences. As it is, when I get to the two paragraphs above Table 5, I just say to myself, “if you say so...” Maybe “those in the know” don’t need anything more, and it’s OK as is for them.

We have added text to the introduction to better define VOC, NMOG, NMHC, THC and TOG.

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10. Section 2.2, first paragraph: Is OC_{2.5} the correct term, or is it a typo and should be PM_{2.5}? If it's correct, it is out of the blue for me.

OC is now defined as organic carbon in a footnote.

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11. I thought that I had understood what was going on, but when I got to Section 3.1 I began to get confused. I guess maybe this confusion may have begun in my mind with the introduction of the terms "VOC profiles" and "VOC emission profile," which are first mentioned in Section 3.1. I presume these terms mean a set of VOC fractions. But I then realized that I was not really certain what all of this work was trying to get. I think (but I'm not sure) that it's two things:

- 1) emission rates for THC, NMHC, NMOG, TOG, VOC, etc., and
- 2) the fraction of each by species that make up the VOCs.

So, for example, for Item 1, Table 5 says that for 2-stroke, E0 the VOC emission rate is 35586 mg/mi. And for Item 2, Table 6 gives the fractions of the 35586 mg/mi that it attributed to 1,3-butadiene (0.00214), etc. Multiplying, that would mean that the 1,3-butadiene emission rate is 76 mg/mi (=35586*0.00214). Is that what the report is trying to figure? That is what is stated at the beginning of the second paragraph of Section 2.1 "In the MOVES model, individual VOC fractions are multiplied by total VOC emissions to obtain emission factors."

It seems that the toxic fractions (as in Table 6) apply only to VOCs. So, then why are THC, NMHC, NMOG, TOG, and CH₄ shown in Table 5? So, it's not clear to me the distinction between 1) how MOVES will do a calculation and 2) how the literature data is being used to come up with emissions numbers to put into MOVES.

I think this could be solved by adding another subsection to the Introduction. It would tell what MOVES needs to do the calculations, that is, what this report is trying to figure out. Section 1.1 starts out by listing the species, but doesn't complete the idea by telling how calculations are done in MOVES. Section 1.2 talks about the operational definitions of THC, NMOG, etc., what previous MOVES versions lacked, ... Section 1.3 talks about what literature was used to calculate the numbers in this report. But what is missing is what quantities we are trying to calculate.

The idea would be that for each type of fuel/emission (gasoline exhaust, diesel exhaust, CNG exhaust, LPG exhaust, evaporative emissions, and crankcase running exhaust emissions) we want to calculate X, Y, Z for use in MOVES. Basically the section needs to say: "MOVES needs the following information: X, Y, Z. So, we're going to estimate these quantities from literature studies." This could be perhaps most clearly portrayed using a table with blank cells. Please tell me in the Introduction. I think that this new subsection could go between Speciation and Methods, and it might be called something like Emission Factors to be Determined. Then, in the later sections, if the report used the same tabular layout, but now with the numbers for the fuel type, the clarity would be much better.

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Somewhere around where you tell what you are going to calculate, you could include Equations 1, 2, 3, 4. It looks to me like they may apply to more fuels than just gasoline exhaust, so putting them early in the report and explaining them may be more appropriate for the Introduction.

We agreed that the text was unclear and added a section to the introduction explaining that the report presents estimates for organic gas aggregations and then defining them.

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12. Section 3.1, fourth paragraph: Why are you talking about MY 2007 all of a sudden?

The paragraph was restructures for improved clarity.

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13. Section 3.1, fifth paragraph, fourth line: Better to say “diesel #2 C:H molar ratio of”. At first I thought it was a weight ratio.

This change has been made.

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14. Section 3.4, second paragraph: What’s a congener?

We have defined the term.

15. Table 14: Is it possible to tell what the detection limits are so that we know what the emission factors with ND are less than? I don’t mind that in MOVES NDs will be set to zero, but I think that you should tell in this document what the ND values are.

Detection limits varied among compounds, but we have added a range to the document.

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16. Section 4.1, first paragraph: What does “conservative” mean? “Conservative” from the environmentalist’s point of view or from the engine manufacturer’s point of view? Does it mean that the real emissions, which we have no data for, are expected to be less or more than the emissions that the existing data provides? Let me say that “conservative” is always a poor term for use in a technical report.

We concur and the language has been revised.

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17. Section 4.1, first paragraph: It strikes me that a transit bus is quite different from a nonroad vehicle. Can you say anything that might make us think that the CNG transit bus is a reasonable surrogate for a CNG nonroad engine? Are even the overall (i.e., non-speciated) emissions similar?

We added language indicating that since these two types of engines are much different, the quality of the surrogate is unclear.

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18. Section 4.2, first paragraph, first sentence: Does “in a manner similar” mean using Equations 3 and 4? If that’s it, say so. My suggestion, as I have stated earlier, is that the technique may best be covered in a new subsection in the Introduction. Then, here, you could just refer to the Introduction.

We added text referring to equations 3 and 4.

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19. Table 17: Is it possible to tell what the detection limits are so that we know what the emission factors with ND are less than? I don't mind that in MOVES NDs will be set to zero, but I think that you should tell in this document what the ND values are.

Unfortunately, the source reference did not provide detection limits for PAHs.

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20. Table 18. To follow along with Equation 5, shouldn't the title for Column 2 be Onroad CNG Emission Factor (g/mi) and the title for Column 3 be Nonroad CNG Emission Factor (g/gal)? I think that would make the table clearer. So, I am assuming that Column 3 has the values that we need for nonroad vehicles, and Column 2 just shows the onroad values that they are derived from.

This change has been made.

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21. Section 4.4: Boy, this is a stretch! CNG dioxins and furans from onroad gasoline engines! All we can do is convert the units using Equation 5? Can you mention ANY reason that these guesses are at all reasonable (see comment 1B)?

Please see response to comment 1B

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22. Table 19. To follow along with Equation 5, shouldn't the title for Column 2 be Onroad CNG Emission Rate TEQ (g/mi) and the title for Column 3 be Nonroad CNG Emission Factor TEQ (g/gal)? I think that would make the table clearer. So, I am assuming that Column 3 has the values that we need for nonroad vehicles, and Column 2 just shows the onroad values that they are derived from.

This change has been made.

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23. Section 6.1.1: In the case of evaporative emissions using toxic fraction data from onroad vehicles makes complete sense because the mechanism of evaporation is independent of the type of vehicle.

24. Section 6.1.1: An alternate source of toxic fraction information is Sam Reddy's ReddyEvap model. This model uses physical chemistry and compound properties to calculate gasoline vapor compositions for different liquid gasoline compositions. The model also calculates vapor composition for different conditions such as Reid vapor pressure, ethanol content, fuel tank fill level, atmospheric pressure, and tank temperature.

We will consider this model for future versions of MOVES.

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25. Section 6.1.2: I seem to recall (I could be remembering incorrectly) that ReddyEvap also calculates the increased permeation of gasoline hydrocarbon compounds when ethanol is present in the gasoline – a synergistic effect. The data in Table 23 don't seem to show this effect.

We will consider this model for future versions of MOVES.