

Report on

REVIEW OF MOVES NONROAD UPDATE REPORTS

31 January 2018

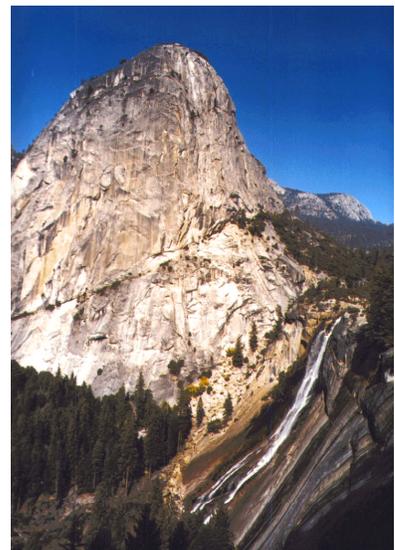
Prepared for

ICF Consulting Group, Inc.
9300 Lee Highway
Fairfax, VA 22031

Purchase Order: 17ZWPO0038

*Robert F. Sawyer, PhD
Partner*

SAWYER ASSOCIATES
PO Box 6256
Incline Village, NV 89450-6256
Phone 1-510-305-6602
email: sawyerassociates.rfs@gmail.com



Overview

The EPA MOVES emissions inventory model was designed to make use of data rich information on vehicle emissions. Data on in-use offroad emissions is woefully lacking for both Tier 4 and pre Tier 4 technology. Estimating in-use emissions from Tier 4 certification data combined with pre Tier 4 correction factors is inherently unreliable.

Response to General Charge Questions

1. Clarity of data presentation

Presentation of data sources, details, and descriptions is clear and easy to follow. Reliance on engine certification data, independent of application, is a deficiency as it the dependence on old correction factors for transient operation and deterioration. The California Air Resources Board has additional California specific offroad emissions data.

2. Analytical methods and procedures

Methods and procedures descriptions are straightforward. The accompanying tables and figures assist in the clarity of the presentation and assist reader understanding.

3. Technical appropriateness

The technical methodology is sound.

4. Assumptions in the face of meager data

The assumptions made by the EPA to make up for the basic lack of test data are reasonable.

5. Model inputs

The model inputs are consistent with processes impacting emissions, but they are incomplete in that they do not adequately treat such factors as deterioration, transient operation, ambient temperature, altitude, or fuel. The lack of in-use data prevents assessment of the uncertainty in the model output.

Tier 4 update specific comments

1. Nonroad Engine Population Growth Estimates in MOVES2001X

The methodology outlined to establish the baseline population is a reasonable, but unfortunate, compromise based on a lack of contemporary data. The database, now 22 years old, is valuable in that it contains a reasonably detailed breakdown nonroad engines by sector and fuel. It would appear that there is no provision for electricity as a fuel in any of the sectors.

(Perhaps this will be accounted for in the emission factor part of the model.) In Table 3.1, the fourth projection methodology is unclear.

The surrogate data for estimating nonroad engine population growth methodology outlined in Table 3.3 and Table 3.5 is reasonable. The use of fuel sales to develop population is an important check on projections based on historical trends, but appears, incorrectly, to assume that engine efficiencies are constant over time. Statistical methods for smoothing data are reasonable. Projections to 2060 are, of course, highly uncertain but this is not critical since the model and base data will certainly continue to be improved periodically. The methodology for developing state level nonroad engine populations is reasonable.

2. Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling-Compression-Ignition in MOVES201X

Section 1 (2): Introduction

(Note: the Table of Contents and text numbering are inconsistent.) Reliance of certification data to estimate emissions is a major problem. The statement "...updating Tier 4 emission rates will have a larger impact on future inventories than updating the Tier 2 and Tier 3 emission rates" while eventually true is not obvious because of deterioration and low turnover rates.

Section 2 (3): Emission Standards and Technology Types

The presentation of emissions standards in Table 2.1 is comprehensive and clear. Is there any evidence that manufacturers actually took full advantage of phase-in allowances? TPEM data suggest otherwise.

Section 4.4 (12): HC, CO, NO_x, PM Emission Factors Tier 4 Engines

Reliance on certification data provides an extensive amount of data, but may not be consistent with in-use emissions due to the failure of test cycles to match actual use and the chance of defeat strategies. Other than the lack of data, there is no reason to assume that deterioration factors and transient adjustment factors have not changed for Tier 4 engine applications.

Table A1: Nonroad CI Technology Distributions by HP Category and Model Year

The populations are based on projected sales. Has this been checked? (Perhaps any differences are not significant?)

Table A4: Zero-Hour, Steady-State Emission Factors for Nonroad CI Engines

The assignment of only two brake specific fuel consumption values cannot be correct. While this will not affect HC, CO, NO_x, or PM emissions, it may be a problem with CO₂ estimates and relating fuel consumption to engine populations.

Figure 2: Record Counts and Emission Factors for Tier 4 Based on Certification Data in MOVES201X

I do not detect anything that is questionable in these figures.

3. Speciation Profiles and Toxic Emission Factors in Nonroad Engines in MOVES201X

3.1 (10.3.1) Organic Gas Aggregations and Air Toxic Emission Factors

Use of the ACES Phase 1 and Phase 2 on-highway data for exhaust speciation takes advantage of a rich database and is appropriate to the Tier 4 offroad inventory. Table 3.4 has formatting and typographical problems.

3.2 (11.3.2) Polycyclic Aromatic Hydrocarbons

Again, approximations employed used onroad data for nonroad and partitioned PM_{2.5} and VOC to estimate PAH levels. Considering the lack of data, this is a reasonable approach.

3.3 (12.3.3) Metals

Lack of data required the use of onroad measurements from both diesel and gasoline engines. While not desirable, no other option was available. Equations in my copy of the report are not readable. For example:

$$2.2 \times 10^{-7} \times \frac{6.8 \times 10^{-6} \times 4.3}{4.07 \times 10^{-6} \times 20.43} = 7.78 \times 10^{-8} \quad \text{Equation 5}$$

Appendix B. TOG Speciation Map for Nonroad emissions

This table indicates that Tier 4 nonroad TOG speciation came from Tier 2 and ACES onroad data. Lacking data specific to offroad equipment, this approximation is reasonable.

Concluding comment

Considering the constrains of very limited Tier 4 offroad measurements, the EPA has made reasonable approximations and extrapolations to make up for this basic deficiency. A portable emissions measurements systems (PEMS) in-use measurement program to provide reliable emissions and activity data for the offroad sector should be a high priority.