CMAQ Emissions Calculator Toolkit

Documentation of Emissions Data for the On-Road Diesel Technologies Tool

This document serves as a supplement to the documentation for the spreadsheet tool associated with the Advanced Diesel Truck/Engine Technologies category of CMAQ-funded projects, specifically, the On-Road Diesel Retrofit and On-Road Diesel Repower/Replacement emission reductions calculators.

The MOVES Methodology cites specific inputs/outputs and post-processing that were used to generate the national-scale emission rates used within the tool.

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MOVES METHODOLOGY

The emission reductions calculators for the On-Road Diesel Technologies toolkit rely on running exhaust, start exhaust and extended idle exhaust emissions rates as well as national-scale activity rates within MOVES. The rates were obtained with a set of MOVES runs in which one MOVES run represents one project year, and were generated on the National scale. MOVES3[1] was used to obtain the emission rates used in the tool.

National-Scale Run

A national-scale run used to obtain emission rates was set up with the following parameters:

Table 1. National-Scale Run Parameters

Category	Variable	Input
Description	-----	<blank>
Scale	Model	Onroad
	Domain/Scale	National
	Calculation Type	Inventory
Time Spans	Time Aggregation Level	Year
	Years	[2018-2040]
	Months	All Selected
	Days	All Selected
	Hours	All Selected
Geographic Bounds	-----	Nation
Vehicles/Equipment	On-Road Vehicle Equipment	All Fuel/Type Combinations Selected
Road Type	Road Types	All Selected
Pollutants and Processes (selected)	Total Gaseous Hydrocarbons	Running Exhaust, Start Exhaust, Crankcase Running Exhaust, Crankcase Start Exhaust, Refueling Displacement Vapor Loss, Refueling Spillage Loss, Extended Idle Exhaust, Auxiliary Power Exhaust
	Non-methane Hydrocarbons	Running Exhaust, Start Exhaust, Crankcase Running Exhaust, Crankcase Start Exhaust, Refueling Displacement Vapor Loss, Refueling Spillage Loss, Extended Idle Exhaust, Auxiliary Power Exhaust
	Volatile Organic Compounds	Running Exhaust, Start Exhaust, Crankcase Running Exhaust, Crankcase Start Exhaust, Refueling Displacement Vapor Loss, Refueling Spillage Loss, Extended Idle Exhaust, Auxiliary Power Exhaust

[1] https://www.epa.gov/moves/latest-version-motor-vehicle-emission-simulator-moves

Category	Variable	Input
	Carbon Monoxide (CO)	Running Exhaust, Start Exhaust, Crankcase Running Exhaust, Crankcase Start Exhaust, Extended Idle Exhaust, Auxiliary Power Exhaust
	Oxides of Nitrogen (NOx)	Running Exhaust, Start Exhaust, Crankcase Running Exhaust, Crankcase Start Exhaust, Extended Idle Exhaust, Auxiliary Power Exhaust
	Primary Exhaust PM2.5 – Total	Running Exhaust, Start Exhaust, Crankcase Running Exhaust, Crankcase Start Exhaust, Extended Idle Exhaust, Auxiliary Power Exhaust
	Primary PM2.5 – Brakewear Particulate	Brakewear
	Primary PM2.5 – Tirewear Particulate	Tirewear
	Primary Exhaust PM10 – Total	Running Exhaust, Start Exhaust, Crankcase Running Exhaust, Crankcase Start Exhaust, Extended Idle Exhaust, Auxiliary Power Exhaust
	Primary PM10 – Brakewear Particulate	Brakewear
	Primary PM10 – Tirewear Particulate	Tirewear
	Atmospheric CO2	Running Exhaust, Start Exhaust, Extended Idle Exhaust, Auxiliary Power Exhaust
	CO2 Equivalent, and prerequisites	Running Exhaust, Start Exhaust, Extended Idle Exhaust, Auxiliary Power Exhaust
	Total Energy Consumption	Running Exhaust, Start Exhaust, Extended Idle Exhaust, Auxiliary Power Exhaust
Manage Input Data Series	-----	<blank>
Strategies	Rate of Progress	<blank>
General Output	Units	Mass: kilograms, Energy: Million BTU, Distance: miles
	Activity	Distance Traveled, Source Hours, Hotelling Hours, Source Hours Operating, Source Hours Parked, Population, Starts
Output Emissions Detail	Always	Hour, County
	On Road/Off Road	Road Type, Source Use Type
	For All Vehicle/Equipment Combinations	Model Year, Fuel Type, Emission Process

Category	Variable	Input
Advanced Performance Features	-----	<blank>

Post-MOVES Run Data Processing:

Results from the national-scale MOVES run were utilized to obtain four different kinds of data for use in the spreadsheet tool.

1. **Activity rates –** To obtain national-scale activity rates, population, vehicle miles traveled, and hoteling hours were extracted from the results for all light-duty and heavy-duty vehicles.
2. **Emissions associated with Vehicle Miles Traveled –** To obtain emission rates for emissions that are generated on a per-miles basis (namely, running exhaust, tirewear, brakewear, and crankcase running exhaust), the post-processing script, "EmissionRates.sql" and the resulting output table 'movesrates' were used.
3. **Emissions associated with population –** To obtain emission rates for start exhaust and crankcase start exhaust emissions on a population basis, population activity and start emissions were extracted from the output database (tables 'movesactivityoutput' and 'movesoutput'). Emission rates were obtained by dividing emissions for a given vehicle type, model year, road type, and fuel type by population for a given vehicle type, model year, road type and fuel type. This table yielded start emissions/population.
4. **Emissions associated with extended idling –** To obtain emission rates for extended idle exhaust, crankcase extended idle exhaust, as well as auxiliary power (APU) exhaust on a hoteling hours basis, hoteling hours activity and idling and APU emissions were extracted from the output database (tables 'movesactivityoutput' and 'movesoutput'). Emission rates were obtained by dividing emissions for a given vehicle type, model year, road type, and fuel type by hotelling for a given vehicle type, model year, road type and fuel type. This table yielded start emissions/hoteling hours.

USER-SUPPLIED EMISSION RATES

Some users may be interested in incorporating local data into the tool's emission rates, which are originally based on national-scale MOVES runs. For those unfamiliar with developing local MOVES runs, please refer to EPA's mobile-source emissions modeling guidance and documentation for highway vehicles.[2] This section provides basic instructions on how to import local emission rates into the On-Road Diesel Technologies Tool.

Develop Local Emissions Inventories in MOVES

Using the national-scale run parameters listed in the table above, develop local emission rates. The CMAQ Emissions Calculator Toolkit is not prescriptive about which MOVES inputs are derived from local

[2] EPA, https://www.epa.gov/moves/tools-develop-or-convert-moves-inputs

data. Users only must specify the same output parameters and details as the national-scale run. Complete any local MOVES runs for the selected calendar years and any other parameters listed above.

Import Local Running Emissions Rates

Users may take the following steps to replace default running emission rates with the local data prepared in MOVES:

1. The MOVES output needs to be reformatted for use in the tool, as described below:

    - Unhide the 'runningRates' tab in Excel and ensure that the local moves output has the following fields: yearID, pollutantID, processID, sourcetypeID, fueltypeID, modelyearID, and roadtypeID.
    - Users should join the 'movesoutput' and the 'movesactivityoutput' tables using the yearID, modelyearID, sourcetypeID, fueltypeID, and roadtypeID fields. Include columns for emission quantities, activitytypeID, and activity quantities.
    - Include emissions only from diesel fuel types (fueltypeID 2) in the post-processed data.
    - Include emissions from trucks and school buses in the post-processed data.
    - Include the following pollutants in the post-processed data: CO, NOx, VOC, and all particulate matter pollutants.
    - Include only emissions from running exhaust and crankcase running exhaust processes in the post-processed data.
    - When joining the two MOVES output tables, include only distance traveled results (activitytypeID 1) in the post-processed data.
    - Be sure to sum emission quantities where values in the fields listed above are the same, to ensure no repeated combinations exist in the post-processed data.
    - Include a column in the post processed data for emissionRate. Emission rates are calculated by dividing the emission quantity by the distance traveled in each entry.
    - Be sure to include appropriate units columns in the post processed table.

2. The local MOVES running emissions data should now be structured in exactly the same way as the national default data. Export the resulting local emission rates table in .csv or .xlsx file format.

3. Delete any data in the 'runningRates' tab in Excel and then copy and paste the running rates local data into the sheet. Make sure not to delete the existing table column headings, as the tool uses these labels as references in calculations. Save the Diesel Technologies tool under a different file name and then run each module to ensure the new local running data produces different rates than the national defaults.

Import Local Starts Emissions Rates

Users may take the following steps to replace default starts emission rates with the local data prepared in MOVES:

1. The MOVES output needs to be reformatted for use in the tool, as described below:

- Unhide the 'startsRates' tab in Excel and ensure that the local moves output has the following fields: yearID, pollutantID, processID, sourcetypeID, fueltypeID, modelyearID, and roadtypeID.
- Users should join the 'movesoutput' and the 'movesactivityoutput' tables using the yearID, modelyearID, sourcetypeID, fueltypeID, and roadtypeID fields. Include columns for emission quantities, activitytypeID, and activity quantities.
- Include emissions only from diesel fuel types (fueltypeID 2) in the post-processed data.
- Include emissions from trucks and school buses in the post-processed data.
- Include the following pollutants in the post-processed data: CO, NOx, VOC, and all particulate matter pollutants.
- Include only emissions from start exhaust and crankcase start exhaust processes in the post-processed data.
- When joining the two MOVES output tables, include only population results (activitytypeID 6) in the post-processed data.
- Be sure to sum emission quantities where values in the fields listed above are the same, to ensure no repeated combinations exist in the post-processed data.
- Include a column in the post processed data for emissionRate. Emission rates are calculated by dividing the emission quantity by the population in each entry.
- Be sure to include appropriate units columns in the post processed table.

2. The local MOVES starts emissions data should now be structured in exactly the same way as the national default data. Export the resulting local emission rates table in .csv or .xlsx file format.

3. Delete any data in the 'startsRates' tab in Excel and then copy and paste the running rates local data into the sheet. Make sure not to delete the existing table column headings, as the tool uses these labels as references in calculations. Save the Diesel Technologies tool under a different file name and then run each module to ensure the new local starts data produces different rates than the national defaults.

Import Local Hotelling Emissions Rates

Users may take the following steps to replace default hotelling emission rates with the local data prepared in MOVES:

1. The MOVES output needs to be reformatted for use in the tool, as described below:

    - Unhide the 'hotellingRates' tab in Excel and ensure that the local MOVES output has the following fields: yearID, pollutantID, processID, sourcetypeID, fueltypeID, modelyearID, and roadtypeID.
    - Users should join the 'movesoutput' and the 'movesactivityoutput' tables using the yearID, modelyearID, sourcetypeID, fueltypeID, and roadtypeID fields. Include columns for emission quantities, activitytypeID, and activity quantities.
    - Include emissions only from diesel fuel types (fueltypeID 2) in the post-processed data.
    - Include emissions from trucks and school buses in the post-processed data.
    - Include the following pollutants in the post-processed data: CO, NOx, VOC, and all particulate matter pollutants.

- Include only emissions from crankcase extended idle, extended idel, and auxiliary power exhaust processes in the post-processed data.
- When joining the two MOVES output tables, include only extended idle activity results (activitytypeID 3) in the post-processed data.
- Be sure to sum emission quantities where values in the fields listed above are the same, to ensure no repeated combinations exist in the post-processed data.
- Include a column in the post processed data for emissionRate. Emission rates are calculated by dividing the emission quantity by the extended idle hours in each entry.
- Be sure to include appropriate units columns in the post processed table.

2. The local MOVES hotelling emissions data should now be structured in exactly the same way as the national default data. Export the resulting local emission rates table in .csv or .xlsx file format.

3. Delete any data in the 'hotellingRates' tab in Excel and then copy and paste the running rates local data into the sheet. Make sure not to delete the existing table column headings, as the tool uses these labels as references in calculations. Save the Diesel Technologies tool under a different file name and then run each module to ensure the new local hotelling data produces different rates than the national defaults.

Import Local Activity Rates

Users may take the following steps to replace default activity data with the local data prepared in MOVES:

1. To obtain a table of local activity data which is formatted in the same way as the national default activity data, simply extract the activity data from the 'movesactivityoutput' table according to the following instructions:

    - Unhide the 'activityData' tab in Excel and make sure the post-processed activity data has the following fields: yearID, sourcetypeID, fueltypeID, modelyearID, roadtypeID, and activitytypeID.
    - Extract activity rates for distance traveled, extended idle hours, and population from the 'movesactivityoutput' table.

2. The local MOVES activity data should now be structured in exactly the same way as the national default data. Export the resulting local activity data table in .csv or .xlsx file format.

3. Delete any data in the 'activityData' tab in Excel and then copy and paste the local activity data into the sheet. Make sure not to delete the existing table column headings, as the tool uses these labels as references in calculations. Save the Diesel Technologies tool under a different file name and then run the Activity Calculator module to ensure the new local activity data produces different rates than the national defaults.