

## The Congestion Mitigation and Air Quality Improvement (CMAQ) Program:

### Part III: Emissions Analysis Methodologies For Diesel Idling



Federal Highway Administration

**RESOURCE CENTER**



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## Topics/Overview

- Background on Idle Reduction
- Truck Stop Electrification (TSE)
- Auxiliary Power Units (APU)
- Other Assessment Tools

## Background on Idle Reduction

- Recent CARB study reported HDD trucks contribute 30% of NOx and 65% of PM while comprising only 2% of the on-road fleet<sup>1</sup>.
- A significant portion of the duty cycle for Class 8 trucks consists of extended idle
- Truckers idle to power sleeper cab a/c, heat, appliances, etc.
- On average, these trucks idle ~ 30 to 40% of their duty cycle or 6-10 hrs/day/truck, 1500-3000 hrs/truck/yr.

1. Analysis of HDD Truck Activity and Emissions Data, Tau Huai, et al.

## Eligibility Under SAFETEA-LU

- SAFETEA-LU expanded CMAQ eligibility to Advanced Truck Stop Electrification and Diesel Retrofits
- Idle reduction projects must be located w/n or in proximity to and benefiting the nonattainment or maint. area.
- For on-board APUs or DFH, the vehicle must travel w/n or in proximity to a primarily benefiting the nonattainment or maint. area.
- Operating assistance is not an eligible activity for TSE projects under CMAQ, only capital costs.
- General requirement to assess emission benefits of the project

## Definitions

- Long Duration Truck Idling Emission: the operation of the truck's propulsion engine when not engaged in gear for a period of 15 consecutive minutes, except for routine stoppages, traffic, etc.
- Idle Reduction Technology: consists of the use of alternative energy source in lieu of the main truck engine for the purposes of reducing long duration truck idling, may be mobile or stationary.
- Class 8 Truck: means a truck with a gross vehicle weight rating (GVWR) of 33,001 pounds and over. GVWR includes weight of the truck, payload, fuel and driver.

## TRUCK STOP ELECTRIFICATION (TSE)

- TSE involves electrifying truck parking spaces typically at large truck stop facilities without modifications to the truck.
- Utilizes power from the power grid to operate on-board truck equipment.



## TRUCK STOP ELECTRIFICATION (TSE)

To determine the emissions (g/day) from an individual truck prior to the use of an idle reduction technology use the following equation:

$$\text{Emissions Per Day} = \text{EF}_{\text{Base}} * \text{AL}_{\text{IRT}}$$

Where:

$\text{EF}_{\text{Base}}$  = Truck baseline emission factor (NOx or PM in g/hr)

$\text{AL}_{\text{IRT}}$  = Estimated hours of use of idle reduction technology (hr/day)





## TRUCK STOP ELECTRIFICATION (TSE)

### Quantification Of Emission Reductions

- Step 1. Determine the historical idling activity of the trucks associated with the truck parking spaces involved in the project.
2. From the number above, determine the number of hours the trucks are idled per day for an avg. annual weekday.
3. Select the emission factor for the criteria air pollutant or precursor.

## TRUCK STOP ELECTRIFICATION (TSE)

### Quantification Of Emission Reductions

- NOx Emission Factor For Long Duration Idling For Heavy Duty Diesel Vehicles<sup>2</sup>:

Year	NOx Emission Factor g/hr
2002 – 2030	135 g/hr

2. Appendix B, Guidance for Quantifying and Using Long Duration Truck Idling Emission Reductions in SIPs and Transportation Conformity; EPA OTAQ

## TRUCK STOP ELECTRIFICATION (TSE)

2006	and earlier	3.68
2007		3.43
2008		2.94
2009		2.52
2010		2.16
2011		1.88
2012		1.60
2013		1.38
2014		1.10
2015		0.89
2016		0.79
2017		0.71
2018		0.58
2019		0.54
2020		0.50
2021		0.47
2022		0.44
2023		0.41
2024		0.39
2025		0.38
2026		0.36
2027		0.35
2028		0.34
2029		0.33
2030		0.33

### Quantification Of Emission Reductions

PM2.5/PM10 Emission Factor (g/hr)<sup>3</sup>



3. Appendix C, Guidance for Quantifying and Using Long Duration Truck Idling Emission Reductions in SIPs and Transportation Conformity; EPA OTAQ

## TRUCK STOP ELECTRIFICATION (TSE)

### Quantification Of Emission Reductions

Step 4. Multiply the emission factor in step 3 by the number of hours per day the idle reduction technology will be used.



## TRUCK STOP ELECTRIFICATION (TSE)

### Quantification Example

Estimate the long duration idle NOx emission reduction for 2007 from a Class 8 truck stop using TSE with:

- 100 truck stop spaces
- Est. historic average 10 hrs/day idling activity
- You have estimated that the project will reduce 8 of the 10 hours of idling.

## TRUCK STOP ELECTRIFICATION (TSE)

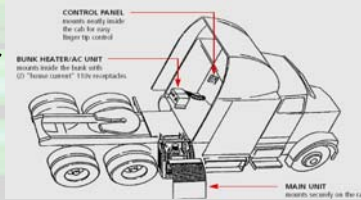
### Quantification Example

- Therefore, the average daily emissions reduced is:  
 $135 \text{ gm/hr} * 8 \text{ hours/day} = 1080 \text{ grams/day}$  or  $2.38 \text{ lbs/day}$
- Last, sum all emission reductions for the project:  
 $100 \text{ electrified spaces} * 2.38 \text{ lbs/day} = 238 \text{ lbs/day}$

1 gram = .002205 lbs

## AUXILIARY POWER UNITS

- Mobile idle reduction technology usually consists of an after market Auxiliary Power Unit (APU) that allows the truck to shut down.
- APUs can be diesel powered, battery or combinations of both
- Provide a/c, heat, power for sleeper cab appliances as well as battery charging and start assist for the main engine
- Typically use 0.2 gal/hr vs. 1.0 gal/hr for main diesel engine



## AUXILIARY POWER UNITS

### Quantification Of Emission Reductions

- To determine the net emissions reductions for long duration truck idling use the following equation:

$$NER = (EF_{BASE} * (AL_{IRT} / CF_{GL/LBS})) - (EF_{IRT} * HP * (AL_{IRT} / CF_{GL/LBS}))$$

Where: Truck Idling Emissions APU Emissions

NER = Net Emission Reduction

EF<sub>BASE</sub> = Truck baseline emission factor (NOx or PM in g/hr)

AL<sub>IRT</sub> = Estimated hours of use of the Idle Reduction Tech (hr/day)

CF<sub>GL/LBS</sub> = Conversion factor for grams to pounds which is 454

EF<sub>IRT</sub> = Idle reduction tech emission factor (NOx or PM in g/bhp-hr)

HP = Average daily horsepower load (range 4-8 hp) depending on technology

AL<sub>IRT</sub> = Estimated hours of use of the idle reduction technology (hr/day)



## AUXILIARY POWER UNITS

### Quantification Of Emission Reductions

- Step 1. Determine the historic idling activity for the truck involved in the project.
2. Select the emission factor for the criteria pollutant or precursor.
3. Multiply the emission factor in Step 2 by the number of hours per day the idle reduction technology is estimated to be used.
- 4(a). Determine the emission factor for the mobile idle reduction technology .
- 4(b). Multiply the emission factor from 4(a) by the avg. horsepower load of the APU.

## AUXILIARY POWER UNITS

### Quantification Of Emission Reductions

Step 4(c). Multiply the g/hr factor by the number of operation hours (per day) it is estimated to be used.

5. Determine the net emission reduction.

6. Sum all emission reductions for the project.



## AUXILIARY POWER UNITS

### Quantification Example

Estimate the long-duration NO<sub>x</sub> emission reductions for 100 Class 8 trucks in 2007 using an APU equipped with a 2003 Kubota engine. The vehicle will use this technology 7 hours per day:

- We are evaluating for NO<sub>x</sub>, so the truck emission factor would be 135 g/hr
- $135 \text{ g/hr} * 7 \text{ hours} = 945 \text{ g/day/truck}$
- '03 Kubota engine is certified NO<sub>x</sub> emission level in 40 CFR 89 is 4.7 g/bhp-hr.

## AUXILIARY POWER UNITS

- Particulate Emission Factors For Long Duration Idling For Heavy Duty Diesel Vehicles<sup>3</sup>:

Truck Model Year	PM <sub>2.5</sub> /PM <sub>10</sub> Emission Factor g/hr
2006 and earlier	3.68
2007 and later	0.33

3. Appendix C, Guidance for Quantifying and Using Long Duration Truck Idling Emission Reductions in SIPs and Transportation Conformity; EPA OTAQ

## AUXILIARY POWER UNITS

### Quantification Example

- Convert the APU engine NOx emission level into g/h by multiplying by the avg. hp load factor. In this case, it is 5hp for summer week days:  
 $4.7 \text{ g/bhp-h} \times 5\text{hp} = 23.5 \text{ g/hr}$
- Multiply the g/hr emission factor by the number of hours/day the technology is estimated to be used:  
 $23.5 \text{ g/hr} \times 7 \text{ hrs} = 164.5 \text{ g/day}$
- Determine the net emission reduction [ $Truck_{em} - APU_{em}$ ]:  
 $945 \text{ g/day} - 164.5 \text{ g/day} = 780.5 \text{ g/day}$  or  $1.72 \text{ lbs/day}$

## AUXILIARY POWER UNITS

### Quantification Example

- Sum all emissions reduction for the project:  
 $100 \text{ truck} \times 780.5 = 78,050 \text{ g/day}$  or  $171.9 \text{ lbs/day}$



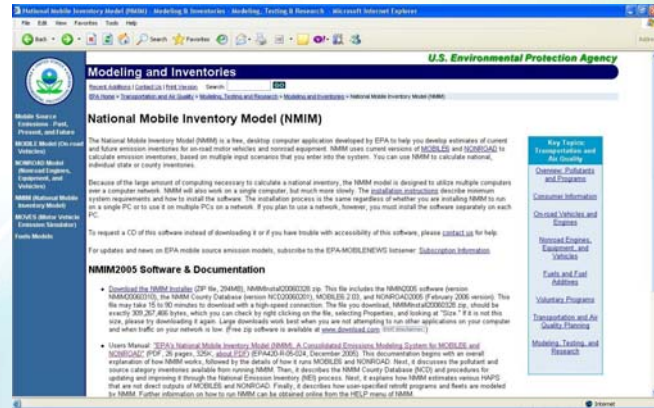
## OTHER TOOLS

- EPA's Diesel Emissions Quantifier Tool  
<http://cfpub.epa.gov/quantifier/>

A screenshot of the EPA Diesel Emissions Quantifier tool interface. The page title is "Diesel Emissions Quantifier" and it is part of the "U.S. Environmental Protection Agency" website. The main heading is "The Diesel Emissions Quantifier". Below this, there is a section for "Basic Information" with a "Continue to" button. The "Basic Information" section includes a "Select a Name" dropdown menu, a radio button for "quantifying emissions", and a "Select a State" dropdown menu. There is also a "Choose the U.S. state for which you want to enter your information" dropdown menu. The page footer includes the "U.S. Department of Transportation and its Agencies" logo and the "U.S. Environmental Protection Agency" logo.

## OTHER TOOLS

- EPA's National Mobile Inventory Model (NMIM)  
[www.epa.gov/otaq/nmim.htm](http://www.epa.gov/otaq/nmim.htm)





## OTHER TOOLS

- Motor Vehicle Emission Simulator (MOVES)  
[www.epa.gov/otaq/ngm.htm](http://www.epa.gov/otaq/ngm.htm)

The screenshot shows a web browser window displaying the EPA website for MOVES. The page title is "MOVES (Motor Vehicle Emission Simulator) - EPA". The main content area is titled "MOVES (Motor Vehicle Emission Simulator)" and includes a description of the system, contact information for EPA mobile source emission models, and a list of documents and software. The left sidebar contains navigation links for "Mobile Source", "MOVES", and "Tools". The right sidebar contains links for "Key Topics", "Customer Information", and "Voluntary Programs".

**MOVES (Motor Vehicle Emission Simulator)**

To keep pace with new analysis needs, modeling approaches, and data, the EPA's Office of Transportation and Air Quality (OTAQ) is developing a modeling system termed the **MOVES** (Motor Vehicle Emission Simulator) (MOVES). This new system will estimate emissions for on-road and nonroad sources, cover a broad range of pollutants, and allow multiple scale analysis from local-scale analysis to national inventory estimation. Initially implemented MOVES will serve as the replacement for MOBILE and NONROAD. The new system will not necessarily be a single piece of software, but instead will encompass the necessary tools, algorithms, underlying data and guidance necessary for use in all official analyses associated with regulatory development, compliance with statutory requirements, and national/global inventory projections. This project was previously known as the New Generation Mobile Source Emissions Model (NGM).

For further information on MOVES, email [pubinfo@epa.gov](mailto:pubinfo@epa.gov)

For updates and news on EPA mobile source emission models, subscribe to the EPAAMOBLENEWS listserve: [Subscription Information](#)

For further information or assistance regarding this web page, contact:  
AOD Information Line, phone (754) 214-4036 or email [aodinfo@epa.gov](mailto:aodinfo@epa.gov)

[MOVES2004 Software & Documentation](#) | [Planning Documentation](#) | [EPA's Motor Vehicle Conference/Workshop Papers and Presentations](#) | [Background Support](#) | [Technical Background](#) | [More mobile sources modeling pages](#)

**Get MOVES2004 Software & Documentation**

- Synopsis & Request for Comments [26-103](#)
- MOVES2004 Installation Package [2004-20](#) (Note: This is a very large file and will take a long time to download)
  - Important instructions for skipping the installation file [EE-103](#)
- Installation Patch #2 (Download and execute this supplemental installation for required corrections to the version of MOVES2004 currently posted on the MOVES website, (includes all previous patches) [12-204-20](#)
  - Instructions for skipping and executing the patch installation file [26-103](#)
- Documentation
  - [26-103](#) [Background to MOVES2004](#) (also available as a PDF file, 10 pages, 2004) (EPA430-D-05-002, March 2005) provides a general overview of MOVES2004 and its documentation.
  - [Class User's Guide](#), PDF, 32 pages, 1.1 Mb (EPA430-P-04-019, November 2004)
  - [Software Design Reference Manual](#), PDF, 142 pages, 1.1 Mb (EPA430-P-04-017, November 2004)

EPA-338-B-04-001  
January 2004

**Guidance for Quantifying and Using  
Long Duration Truck Idling Emission  
Reductions in State Implementation  
Plans and Transportation Conformity**

Transportation and Regional Program Division  
Office of Transportation and Air Quality

and

Air Quality Strategies and Standards Division  
Office of Air Quality Planning and Standards

U.S. Environmental Protection Agency

[www.epa.gov/ttncaaa1/t1/memoranda/rie\\_qvldti\\_tg.pdf](http://www.epa.gov/ttncaaa1/t1/memoranda/rie_qvldti_tg.pdf)