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

Part III: Emissions Analysis Methodologies For Diesel Idling
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 fleet¹.

- 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:

\[
\text{Emissions Per Day} = \text{EF}_{\text{Base}} \times \text{AL}_{\text{IRT}}
\]

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:

<table>
<thead>
<tr>
<th>Year</th>
<th>NOx Emission Factor g/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002 – 2030</td>
<td>135 g/hr</td>
</tr>
</tbody>
</table>

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)

Quantification Of Emission Reductions

PM2.5/PM10 Emission Factor (g/hr)$^3$

<table>
<thead>
<tr>
<th>Year</th>
<th>Emission Factor (g/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>3.68</td>
</tr>
<tr>
<td>2007</td>
<td>3.43</td>
</tr>
<tr>
<td>2008</td>
<td>2.94</td>
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<tr>
<td>2009</td>
<td>2.52</td>
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<td>2010</td>
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<td>2011</td>
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<td>2015</td>
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<td>2016</td>
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<tr>
<td>2017</td>
<td>0.71</td>
</tr>
<tr>
<td>2018</td>
<td>0.58</td>
</tr>
<tr>
<td>2019</td>
<td>0.54</td>
</tr>
<tr>
<td>2020</td>
<td>0.50</td>
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<td>2022</td>
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<tr>
<td>2029</td>
<td>0.33</td>
</tr>
<tr>
<td>2030</td>
<td>0.33</td>
</tr>
</tbody>
</table>

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.
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.
Quantification Example

- Therefore, the average daily emissions reduced is:
  \[ 135 \text{ gm/hr} \times 8 \text{ hours/day} = 1080 \text{ grams/day or 2.38 lbs/day} \]

- Last, sum all emission reductions for the project:
  \[ 100 \text{ electrified spaces} \times 2.38 \text{ lbs/day} = 238 \text{ lbs/day} \]

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:

\[ \text{NER} = (\text{EF}_{\text{BASE}} \times \left(\frac{\text{AL}_{\text{IRT}}}{\text{CF}_{\text{G/LBS}}}\right)) - (\text{EF}_{\text{IRT}} \times \text{HP} \times \left(\frac{\text{AL}_{\text{IRT}}}{\text{CF}_{\text{G/LBS}}}\right)) \]

Where:
- **NER** = Net Emission Reduction
- **EF_{BASE}** = Truck baseline emission factor (NOx or PM in g/hr)
- **AL_{IRT}** = Estimated hours of use of the Idle Reduction Tech (hr/day)
- **CF_{G/LBS}** = Conversion factor for grams to pounds which is 454
- **EF_{IRT}** = 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_{IRT}** = 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 NOx 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 NOx, so the truck emission factor would be 135 g/hr
• 135 g/hr * 7 hours = 945 g/day/truck
• ’03 Kubota engine is certified NOx 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:\(^3\):

<table>
<thead>
<tr>
<th>Truck Model Year</th>
<th>PM(<em>{2.5})/PM(</em>{10}) Emission Factor g/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006 and earlier</td>
<td>3.68</td>
</tr>
<tr>
<td>2007 and later</td>
<td>0.33</td>
</tr>
</tbody>
</table>

3. Appendix C, Guidance for Quantifying and Using Long Duration Truck Idling Emission Reductions in SIPs and Transportation Conformity; EPA OTAQ
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 \([Truck_{em} - APU_{em}]\):
  \[945 \text{ g/day} - 164.5 \text{ g/day} = 780.5 \text{ g/day} \text{ or } 1.72 \text{ lbs/day}\]
AUXILIARY POWER UNITS

Quantification Example

- Sum all emissions reduction for the project:
  100 truck x 780.5 = 78,050 g/day or 171.9 lbs/day
OTHER TOOLS

- EPA’s Diesel Emissions Quantifier Tool
  http://cfpub.epa.gov/quantifier/
OTHER TOOLS

- EPA’s National Mobile Inventory Model (NMIM)
  www.epa.gov/otaq/nmim.htm
OTHER TOOLS

• Motor Vehicle Emission Simulator (MOVES)
  www.epa.gov/otaq/ngm.htm
Guidance for Quantifying and Using Long-Duration Truck Idling Emission Reductions in State Implementation Plans and Transportation Conformity

Transportation and Related Programs Office of Transportation and the States

Office of Heavy Vehicle and Fuel Use

Office of the Vehicle Planning and Standards

U.S. Environmental Protection Agency

www.epa.gov/ttncaaa1/t1/memoranda/rie_qvldti_tg.pdf