

SmartWay 2011 Truck Tool Technical Documentation



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United States Version

1-27-2011

1.0 Overview

This document provides detailed background information on the data sources, calculation methods, and assumptions used within the new SmartWay 2011 Truck Tool. The SmartWay Truck Tool utilizes the most up-to-date emission factors, in combination with detailed vehicle activity data, to estimate emissions and associated performance metrics. While the primary purpose of the previous version of the truck carrier tool (FLEET) was to help fleets estimate the likely fuel and emission reduction benefits of specific advanced technologies (e.g., through the adoption of certified aerodynamic retrofits) relative to a pre-control baseline, the primary purpose of the new tool is to help fleets calculate actual pollutant emissions for specific truck types and applications and track their emissions performance over time. Shippers can, in turn, use the data that truck carriers report using these tools to develop more advanced emissions inventories associated with their freight activity and to track their emissions performance over time.

The new tool allows the user to evaluate fleet performance in terms of different mass-based performance metrics for CO₂, NO_x, and PM (PM₁₀ and PM_{2.5}), including:¹

- Grams per mile
- Grams per average payload ton-mile
- Grams per thousand cubic foot-miles
- Grams per thousand utilized cubic foot-miles

The tool can also generate estimates of emissions associated with the total miles, loaded miles, and revenue miles traveled by a fleet. Fleet performance can then be assessed at the truck-class and/or fuel-type level, or on an aggregated basis across all classes and fuels.

¹ At this time the 2011 Truck Tool does not calculate performance metrics for specialty fleets that track their activity in terms of hours of use rather than miles traveled or freight hauled (e.g., refuse haulers and utility fleets). Future modifications may be made to the current tool to accommodate such fleets.

The new tool also collects extensive information on fleet operations and truck body types, allowing detailed segmentation of Partner fleets for more appropriate, equitable comparisons. For example, fleets that cube-out with low payloads (e.g., those hauling potato chips) will be able to compare themselves to similar fleets on a simple grams per mile basis, rather than a mix of fleets that includes fleets that routinely weigh-out. Similarly, fleets that operate in primarily short-haul, urban environments at relatively low average speeds will have fundamentally different emission rates and constraints than long-haul fleets operating at highway speeds. By collecting detailed information on fleet operations (short vs. long, TL vs. LTL, urban vs. highway, etc), as well as truck class (2b through 8b) and body type (dry van, reefer, flatbeds, etc.), individual fleets can compare their performance to other, similar fleets, which can help them to better manage their emissions performance.

2.0 Data Inputs and Sources

The SmartWay Truck Tool user provides most vehicle characteristic, operational, and activity data needed for emissions performance estimation (see Section 3 for more information). The tool calculates emissions by multiplying fleet activity data with EPA-approved emission rate factors that are stored in look-up tables within the tool.

The tool contains different types of emission rate factors for different pollutants. CO₂ factors are expressed in grams of CO₂ *per gallon of fuel*.² NO_x and PM factors are expressed in *grams of pollutant per mile traveled* for operating emissions, and in *grams per hour* for idle emissions. In general, CO₂ factors are independent of the truck types, classes, and operational practices in a fleet. NO_x and PM factors, however, vary depending upon a number of parameters, including:

- Truck class
- Engine model year/emission certification standard
- Vehicle speed
- Vehicle driving pattern (referred to as “drive cycle”)

In addition, PM emissions will also vary with the application of PM control retrofits, including diesel oxidation catalysts (DOC), closed crankcase ventilation (CCV), and diesel particulate filters (DPF, or “PM traps”). In the tool, PM control retrofits are assumed to have the same impact on operating and idle emission factors.³

2.1 CO₂ Factors

EPA populated the SmartWay Truck Tool with CO₂ factors that are based on fuel consumption. These factors and their sources are summarized below in Table 1.

² At this time other greenhouse gases such as methane (CH₄) and nitrous oxide (N₂O) are not included in the 2011 Truck Tool.

³ Future versions of the tool may account for differences in retrofit effectiveness for running versus idle emissions.

Table 1. CO₂ Factors by Fuel Type*

	g/gal	Source⁴
Gasoline	8,887	(i)
Diesel	10,180	(ii)
Biodiesel (B100)	9,460	(iii)
Ethanol (E100)	5,764	(iv)
CNG	7,030	(v)
LNG	4,394	(vi)
LPG	5,790	(vii)

* 100% combustion (oxidation) assumed

Note that the tool calculates tailpipe emissions from biofuel blends (gasoline/ethanol, diesel/biodiesel) by applying separate emission factors to the user-specified volume of each blend component. The tool then adds the emissions from each blend component together to determine total CO₂ emissions. Therefore emission factors for specific blend ratios are not needed for CO₂.

Within the tool, users may provide their CNG fuel use estimates in terms of gasoline-equivalent gallons (on a Btu basis), or in standard cubic feet (scf). If CNG consumption is expressed in scf, the tool applies a fuel factor expressed in grams per scf (57.8), based on 983 Btu/scf and 58,819 g CO₂/mmBtu.⁵

⁴ i) Final Rule on Light-Duty Vehicle Greenhouse Gas Emissions Standards and Corporate Average Fuel Economy Standards (75 FR 25324, May 7, 2010). The gasoline factor used in this rule was sourced from the California Air Resources Board and is based on measurement of carbon from a gasoline test fuel (indolene).

ii) Fuel economy calculations in 40 C.F.R 600.113 available at http://edocket.access.gpo.gov/cfr_2004/julqtr/pdf/40cfr600.113-93.pdf.

iii) Tables IV.A.3-2 and 3-3 in A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions, available at <http://www.epa.gov/oms/models/analysis/biodsl/p02001.pdf>

iv) Final Rule on Mandatory Reporting of Greenhouse Gases (70 FR 56260, October 30, 2009). Full source documentation is available on pp. 31-32 in the Technical Support Document, *Petroleum Products and Natural Gas Liquids: Definitions, Emission Factors, Methods and Assumptions*, available at www.epa.gov/climatechange/emissions/downloads09/documents/SubpartMMProductDefinitions.pdf.

v) Calculations of Lifecycle Greenhouse Gas Emissions for the 2005 Gasoline and Diesel Baselines in the Notice of Availability of Expert Peer Review Record supporting the proposed revisions to the Renewable Fuel Standard Program (74 FR 41359) available in Docket EPA-HQ-OAR-2005-0161-0925.1 (Spreadsheet “Emission Factors”).

vi) Assuming 74,720 Btu/gal lower heating value (<http://www.afdc.energy.gov/afdc/fuels/properties.html>), and 0.059 g/Btu (from CNG calculation, source vi).

vii) Table C-1 in the Final Rule on Mandatory Reporting of Greenhouse Gases (70 FR 56260, October 30, 2009). Full source documentation is available in Table A-39 and pg. A-60 of the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2007* available at

http://epa.gov/climatechange/emissions/downloads/US_GHG_Inv_Annexes_1990-2007.pdf

⁵ See footnote 4, v.

2.2 NOx and PM Factors

The SmartWay Truck Tool contains NO_x, PM₁₀ and PM_{2.5} emission factor outputs for on-road operation from EPA's MOVES2010 model, for gasoline, diesel, and E10 for all heavy truck classes (2b – 8b) under national default temperature and fuel conditions, for model years 1988 through 2010 (see Appendix A for a full list of factors). The emission factors are broken out by general drive cycle type (urban or highway), and average speed range, as discussed below.

Idle emission factors for NO_x and PM were developed separately by model year, truck class, and fuel type (diesel and gasoline). MOVES2010 does not currently provide idle factors in terms of grams per hour, so we ran MOVES2010 using the Project Level scale with a single link and with an average speed of zero. We performed runs for typical winter and summer conditions and took the average of outputs from those runs obtain g/hr factors. The resulting idle factors are presented in Appendix B.⁶

This section describes the process we followed to select the on-road emission factors from MOVES2010 for use in the Truck Tool. Emission factors in grams per mile were developed for gasoline, E10,⁷ and diesel fuel types for all MOVES source types that correspond to MOBILE6 heavy duty vehicle classes, 2b-8b inclusive. The MOVES source types modeled are shown in the table below. Of these, note school buses, refuse trucks and motor homes represent only a small fraction of total activity.

Table 2. MOVES Source Types Associated with Class 2b – 8b Vehicles

Source Type ID	Source Type Name
31	Passenger Truck
32	Light Commercial Truck
43	School Bus
51	Refuse Truck
52	Single Unit Short-haul Truck
53	Single Unit Long-haul Truck
54	Motor Home
61	Combination Short-haul Truck
62	Combination Long-haul Truck

⁶ The idle factors correspond to short-term idling. Factors for long-term extended idling will be higher (at least for late model engines), since engine operation temperatures and loads at idle are generally not high enough to activate late-model emission controls such as SCR and EGR. Adjustment factors to account for the difference between short and long-term idling may be applied in the future, utilizing the reported differences between long and short-term hours on the Activity Information page in the SmartWay Truck Tool.

⁷ E15 can be modeled as well, if the required fuel specifications are provided.

Separate factors were developed for “Urban” and “Highway/Rural” roadway types. These factors were apportioned according to MOVES operating mode groups, which correspond to speed ranges of 0-25 mph, 25-50 mph, and 50+ mph.

Emission factors calculated by the model, output by MOVES source type, were then converted to a MOBILE6 vehicle class basis. In this way, the Truck tool can select appropriate emission factors for use by:

- weight class
- model year
- road type (urban vs highway/rural)
- speed distribution

The following describes the methodology for the emission factor calculation.

Calculation of MOVES emission factors by operating mode

In calculating emission factors, the primary goal is to disaggregate factors by the percentage of time a given type of vehicle spends operating at certain speeds. The ranges of speeds analyzed include 0-25 mph, 25-50 mph, and greater than 50 mph. These speed ranges correspond to MOVES operating modes #11-16, 21-29, and 30-40 inclusive, where each operating mode is defined by both the speed of the vehicle and its vehicle specific power (VSP). First, for a given source type and model year, the fraction of emissions attributable to each range of speed was determined. Emissions for a vehicle can be expressed in Equation 1:

Equation 1

$$E^{\prime} = A_1E_1^{\prime} + A_2E_2^{\prime} + A_3E_3^{\prime} + A_I E_I + A_B E_B$$

Where:

- E^{\prime} = uncorrected⁸ mass emissions calculated based on operating mode and emissions contribution by speed bin
- A_{1-3} = the sum of activity fractions (in seconds) over speed range n. (A_I and A_B represent the activity associated with the individual operating modes for idling and braking, respectively.)
- E_{1-3}^{\prime} = the weighted average emissions over a given speed range n. (E_I and E_B represent the emissions associated with the individual operating modes for idling and braking, respectively.)

⁸ Subsequent adjustment factors are presented in Equation 3 below.

The following figure shows a range of emissions and activity fractions for an example source type and model year. The operating mode (or VSP bin) are shown on the X-axis. The dashed red line presents the fraction of vehicle activity associated with a given operating mode, while the black circles present average HC emissions for each operating mode.

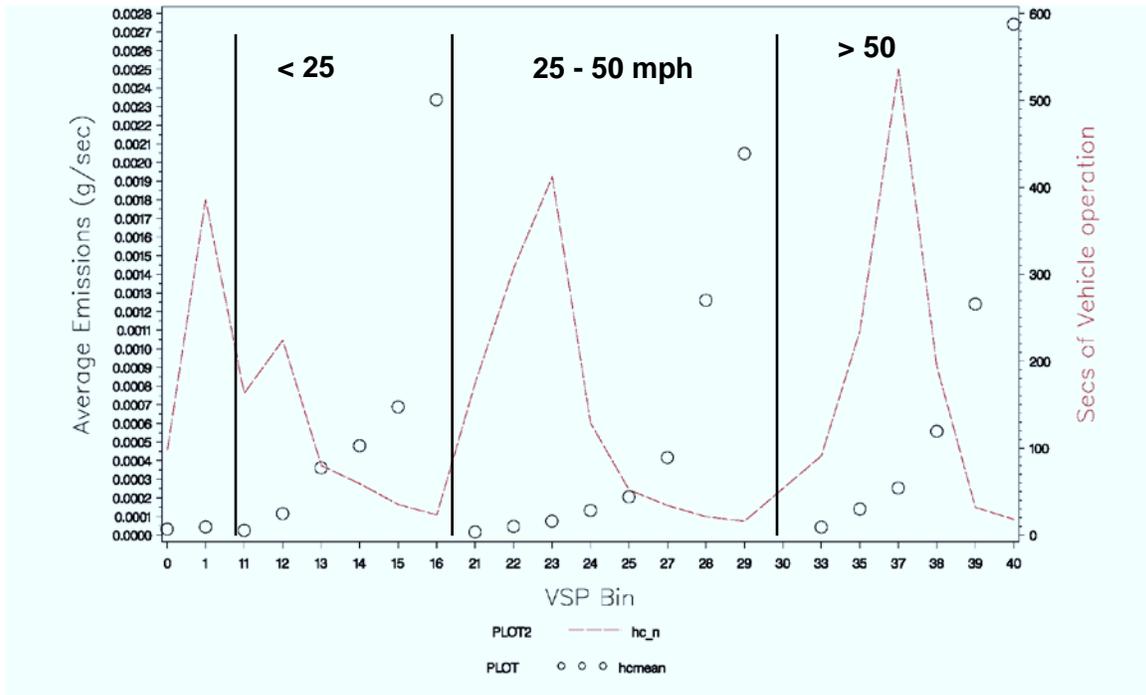


Figure 1. Example Emissions and Activity Fractions by Operating Mode

For our purposes, A_n from Equation 1 is obtained by retaining the “opmodedistribution” table from the Operating Mode Distribution Generator (OMDG), which is created during a MOVES run. This table contains operating mode fractions by source type, roadway type, and pollutant/process. The sum of the operating mode fractions in each speed bin constitutes A_n .

E_n is derived from data obtained from the default MOVES “emissionratebyage” table. This table contains emission rates by pollutant process, operating mode, and age group for a wide variety of *sourcebinIDs*. For this analysis, a MySQL query was used to select *sourcebinIDs* corresponding to the source type, fuel type, and calendar year of interest, and limited our rate selection to the 4-5 year age group. The emissions obtained here were then converted to a source type basis (from their current *sourcebinID* basis); this was done by retaining the “sourcebindistribution” table from the Source Bin Distribution Generator (SBDG),

which is created during each MOVES run, and weighting the activity fractions for each source type and model year combination in this table with the data from the “emissionratebyage” table described above. Having finished this mapping, an emission rate is generated, by source type and model year, for each operating mode (corresponding to the circles in the figure above). Since E_n for each speed range represents the average emissions of the range weighted by the activity in that range, the weighted average emissions can be calculated from the 0-25 mph speed bin, E_1 , as follows in Equation 2:

Equation 2

$$E_1 = \frac{R_{11}T_{11} + R_{12}T_{12} + R_{13}T_{13} + R_{14}T_{14} + R_{15}T_{15} + R_{16}T_{16}}{\sum_{11}^{16} R_n}$$

Where:

R_n = The activity fraction for operating mode n, obtained from the OMDG table
 T_n = The emissions for operating mode n.

Other speed bins will use different operating modes in their calculations; the equation above is merely an example illustrating the calculation method for the first speed bin. Having calculated an appropriate E_n for each speed range for a given source type and model year, Equation 1 can be used, along with the appropriate activity fraction, to arrive at a total uncorrected emissions value. In and of itself, this emission factor has little value in estimating emissions. However, it can be used along with the modeled emission factor for a particular source type and model year to arrive at an overall adjustment factor, as shown in Equation 3:

Equation 3

$$Z = \frac{E}{E'}$$

Where:

E = The modeled emission, obtained from MOVES outputs, for an individual source type and model year
 E' = The uncorrected emissions for an individual source type and model year, calculated using operating mode distributions and emission factors from the “emissionratebyage” table

This overall adjustment factor, in turn, can be applied to each individual emissions component, E_n , as shown in Equation 4:

Equation 4

$$E_n = ZE_n'$$

The adjusted emissions, E_n , are subsequently used to calculate a total, corrected emission factor for a given source type and model year combination, as described by Equation 5:

Equation 5

$$E = A_1E_1 + A_2E_2 + A_3E_3 + A_I E_I + A_B E_B$$

In this way, a representative emission factor is calculated by operating mode/speed group. This will allow the Truck Tool to adjust the default operating mode percentages (A_n) to more accurately represent a user-provided speed profile for the vehicles they are modeling. Default operating mode percentages may also be used, as calculated above.

Conversion of emission factors from source type basis to weight class

Ultimately, emission factor lookup tables are required for use in the Truck tool by weight class, fuel type, and model year. However, modeled output from MOVES is aggregated by source type. Therefore a post-processing tool was developed to convert vehicle emission factors from source types to weight class based on internal MOVES tables. The conversion methodology used in this tool is described below.

First, the adjusted emissions and activity output from MOVES are combined, by *pollutantID*, by joining the “movesoutput” and “movesactivityoutput” tables by calendar year, source type, fuel type and model year. The sourcetype and model year for each record are combined in a new field, *sourcetypeodelyearID*.

Next, the emissions and activity output from the first step are combined with the MOVES “sizeweightfraction” table by joining on the *sourcetypeodelyearID*. The “sizeweightfraction” table contains, for a given combination of source type and model year, the fraction of vehicles apportioned across *weightclassID*. Given the *weightclassID*, the portion of emissions and activity attributable to a given range of vehicle weights is determined, and subsequently, those weights (along with fuel type) are mapped back to MOBILE6 vehicle classes, which are based on GVWR. (This is achieved with a separate lookup table, “M6VehType”, which is derived from Appendix B, Table 3 of the EPA’s MOBILE6.2 User’s Guide.) For each calendar year, *sourcetypeodelyearID* and *pollutantID*, the *sizeweightfraction* is multiplied by the emissions (in grams) and activity (in miles) to obtain *EmissionFrac* and *ActivityFrac*, respectively.

Finally, the *EmissionFrac* and *ActivityFrac* calculated above are summed by *yearID*, *pollutantID*, *fueltypeID*, and MOBILE6 vehicle type (e.g., HDDV8b). This provides total emissions and activity independent of the MOVES source type or vehicle model year. Finally, the aggregated emissions are divided by the activity to arrive at g/mi emission factors, presented in Appendix A.

Modeling E10 Emission Rates

In a MOVES run that uses nationwide defaults for fuel supply, the model includes many thousands of fuel formulations on a by-county basis in its calculations. In addition to diesel fuels, many counties in the model defaults are characterized by varying market shares of gasoline and E10. This intertwining of fuel mixtures by market share can make isolation of nationwide E10-based and gasoline-based emission factors from the model somewhat difficult.

In order to isolate E10 emission factors, an external database tool was used to alter the MOVES “*fuelsupply*” table for two scenarios: one in which market shares for E10 and gasoline fuels were set to 1 and 0, respectively, and the inverse case, in which market shares for E10 and gasoline fuels were set to 0 and 1. Importing the updated “*fuelsupply*” tables using external MySQL scripts, separate E10 and gasoline MOVES runs were then performed using the newly updated information.

Sensitivity Analysis Results

The relative emissions impact of different speed regimes were evaluated for four road types – urban arterial, urban freeway, rural arterial, and rural freeway. To simplify the sensitivity analysis, MOVES outputs were generated for diesel long-haul combination trucks, model year 2008, run for the 2011 calendar year, using national average defaults (e.g., fuel specifications, temperatures, etc). The results of the analysis are shown for NO_x and PM_{2.5} below.

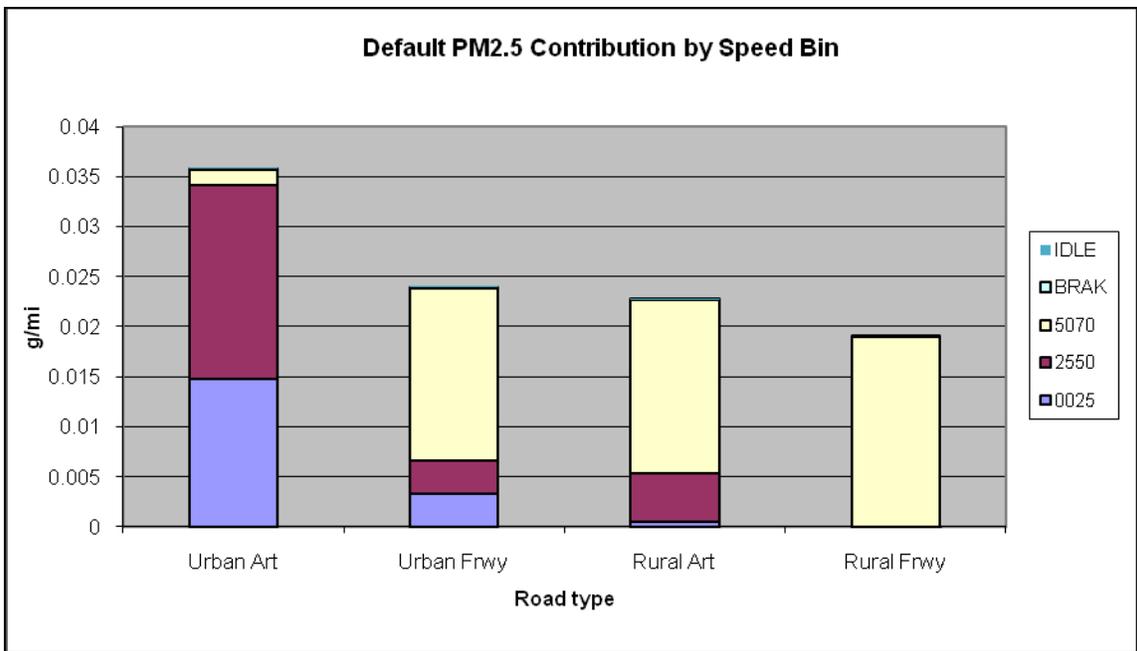
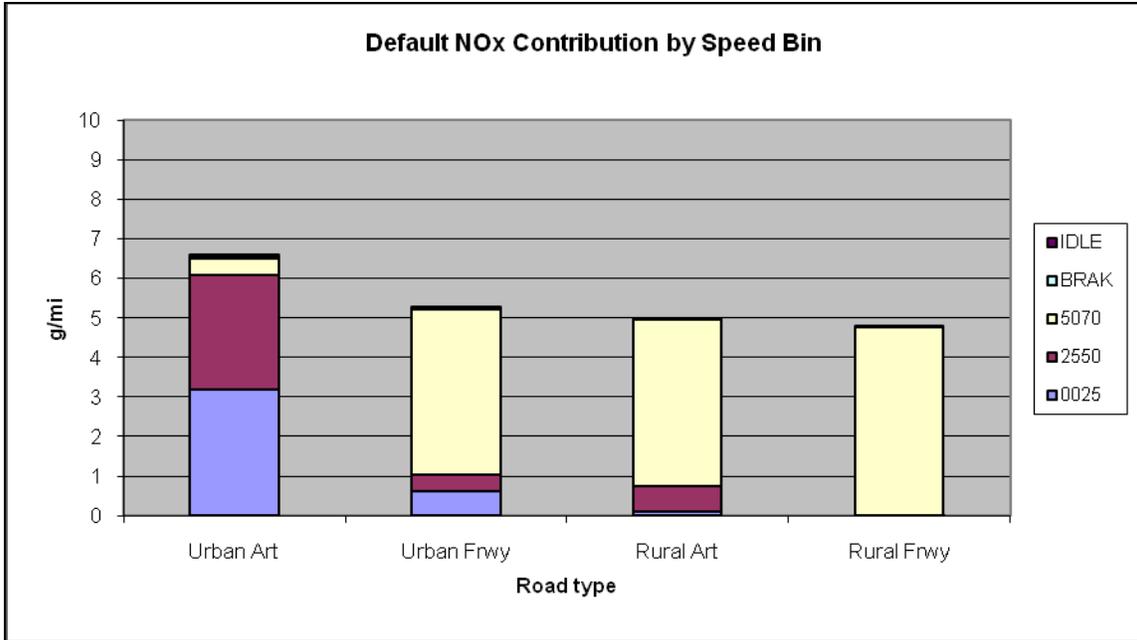


Figure 2. Default NOx and PM_{2.5} Emission Contribution by Speed Bin

As shown in the above charts, the emissions for urban freeways, rural arterials, and rural freeways are all heavily dominated by high speed (50 – 70 mph)

operation.⁹ In addition, actual emission levels are relatively insensitive to road type across these three types. However, speed distribution appears to have a significant bearing on emissions for urban arterial operation. Accordingly, the recommendation for Truck Tool application was to develop fully disaggregated emission factor look up tables (retaining all four road types), and then weight urban freeway, rural arterial, and rural freeway road type operations in order to aggregate emission lookup tables within the SmartWay tool to reflect “urban” (i.e., urban arterial) and “other” road types. In addition, under this approach users can choose default speed distributions for these selections, or specify the percent of operation by major speed range (0 – 25, 25 – 50, 50 – 70). Given the relative insensitivity to speed for the “other” category, specifying speed distributions would only be permitted for urban arterial operation.

Under this approach, the user is given the follow input options:

- Specify % Highway/Rural (“other”) operation fraction
- Specify % urban operation distribution by speed bin, or select “default speed distribution”

Data entry is handled through the addition of a popup screen for non-default data entry (see [Truck Tool User Guide](#) for details).

2.3 Alternative Fuels

NO_x and PM emission factors are not available from MOVES2010 for certain alternative fuels, including biodiesel, E85, natural gas, and LPG. Accordingly, EPA used adjustment factors from a number of sources described below to estimate NO_x and PM factors for these other fuels.

NO_x and PM emission factors for biodiesel were based on the findings from an EPA study, [A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions](#) (EPA420-P-02-001, October 2002). This study developed regression equations to predict the percentage change in NO_x and PM emission rates relative to conventional diesel fuel, as a function of biodiesel blend percentage, expressed in the following form:

⁹ This finding is consistent with the 2008 SmartWay partner data submissions, wherein 87% of Partners selected the 50+ mph category as the most representative of their non-urban operations.

Equation 6

$$\% \text{ change in emissions} = \{\exp[a \times (\text{vol}\% \text{ biodiesel})] - 1\} \times 100\%$$

Where:

a = 0.0009794 for NO_x, and

a = -0.006384 for PM

Using Equation 6, adjustment factors were developed for biodiesel blends based on the percentage of the biofuel component,¹⁰ and then these adjustment factors were applied to the appropriate conventional diesel emission factors in Appendix A (see Section 2.2 for the sources of conventional diesel emission factors). Note that the fleet-average blend value is assumed to be the same for all truck classes, since the biofuel consumption data is not collected at the truck class level. (This assumption holds for ethanol consumption data inputs as well.)

For gasoline-ethanol blends, the SmartWay Truck tool only accepts fuel consumption estimates for E10 and E85 since, unlike biodiesel where the biofuel fraction can vary significantly, ethanol is generally blended with gasoline at two discrete levels: 10% (E10) and 85% (E85). As discussed in Section 2.2 above, NO_x and PM factors for E10 were output directly from MOVES2010. Given the lack of heavy-duty E85 test data, adjustment factors for E85 were based on emissions estimates for light-duty vehicle cited by the US DOE Alternative Fuels and Advanced Vehicles Data Center.¹¹ These estimates come from a technical paper published in the Journal of Air & Waste Management.¹² Relative to conventional gas vehicles, the authors of this paper estimate that vehicles running on E85 provide an **average NO_x reduction of 54%** (based on 73 vehicle tests), and an **average PM reduction of 34%** (based on 3 vehicle tests). These adjustment factors are applied to the appropriate gasoline engine emission factors in Appendix A to develop emission factors for E85.

If the consumption level of E10 is unknown, the Truck Tool user may also specify national average default blend levels for ethanol. National totals for gasoline use for 2009 were obtained from the Energy Information Administration's (EIA) Annual Energy Outlook Reference Case for 2010, Table 46 (Transportation Sector Energy Use by Fuel Type within a Mode). Summing the energy use values for light-duty gasoline vehicles, commercial light trucks, and freight trucks from the table yields an estimate of 16,234 TBtu (15,605 + 322 + 306) for 2009. National fuel ethanol consumption estimates for 2009 were also obtained from

¹⁰ Biodiesel blend percentage is calculated by dividing B100-equivalent gallons by total fuel gallons at the fleet level – see the [Truck Tool User Guide](#) for details regarding biodiesel use inputs.

¹¹ See http://www.afdc.energy.gov/afdc/vehicles/emissions_e85.html, last validated August 20, 2009.

¹² http://www.afdc.energy.gov/afdc/pdfs/technical_paper_feb09.pdf

the EIA, totaling 894 TBtu (see Table 10.3, consumption minus denaturant in <http://www.eia.doe.gov/aer/txt/ptb1003.html>). Assuming 114,100 Btu/gallon of gasoline, and 76,100 Btu/gallon of E100,¹³ **ethanol is estimated to constitute 7.7% of gasoline fuel consumption in the U.S., on a volumetric basis.**¹⁴

Emission adjustment factors were used for gaseous fuels (LPG, CNG and LNG) that were cited by the Alternative Fuels and Advanced Vehicles Data Center, Table 2: NREL/UWV Field Tests of Natural Gas Vehicle Emissions.¹⁵ These factors were developed by the National Renewable Energy Lab and University of West Virginia based on field studies on natural gas vehicles. For this assessment, it was assumed that CNG and LNG emissions were identical. In addition, it was also assumed LPG vehicle emissions would be equal to natural gas vehicle emissions.¹⁶ To be conservative, the smallest emission reduction estimates were selected from Table 2 (**86% for PM and 17% for NOx**) relative to comparable diesel vehicles. These adjustment factors are then applied to the diesel emission factors in Appendix A for to develop emission factors for these fuels.

The same adjustment factors are applied for all model years in the Truck Tool because model year-specific emissions data do not appear to be available at this time. Note, however, that the emissions from the combustion of alternative fuels may be different for older trucks (with minimal emission controls) and newer trucks (with extensive control systems in place) due to vehicle emission standards.

2.4 PM Control Effectiveness

The Truck Tool applies adjustment factors to the PM emission factors in Appendix A and B for any pre-2007 diesel truck for which Partners have installed a specific retrofit control device. The following adjustment factors were obtained from EPA OTAQ (presented as a % reduction in emissions; see Section 3.2 below for details):

- Diesel oxidation catalyst (DOC) – 25%
- Closed crankcase ventilation (CCV) – 5%
- Diesel particulate filter (DPF) – 90%

¹³ <https://www.afdc.energy.gov/afdc/prep/popups/gges.html>, last verified 12-29-10.

¹⁴ $16,234 \text{ TBtu gasoline} \times 10^{12} \text{ Btu/TBtu} / 114,100 \text{ Btu/gal} = 1.42 \times 10^{11} \text{ gallons of gasoline}$;
 $894 \text{ TBtu E100} \times 10^{12} \text{ Btu/TBtu} / 76,100 \text{ Btu/gal} = 0.118 \times 10^{11} \text{ gallons of E100}$;
 $0.118 / (1.42 + 0.118) = 7.7\%$. Note this methodology disregards the relatively small volumes of ethanol consumed as E85.

¹⁵ http://www.afdc.energy.gov/afdc/vehicles/emissions_natural_gas.html, last validated August 24, 2009.

¹⁶ The PM and NOx estimates cited by this source for LPG vehicles were actually slightly lower than for natural gas vehicles - http://www.afdc.energy.gov/afdc/vehicles/emissions_propane.html. However, based on engineering judgment it was assumed that LPG PM and NOx emissions would be similar to comparable CNG vehicles.

The tool applies these adjustment factors to pre-2007 PM operating and idle emission estimates. The tool also allows for situations where CCVs are applied in combination with either DOCs or DPFs. In such a case, the reduction effectiveness is calculated additively. For example, if pre-control operating emissions were 1.0 g/mile for a diesel truck, and a CCV and DPF were applied, the resulting emission rate would be:

Equation 7

$$1.0 \times [1 - (0.25 + 0.05)] = 0.07 \text{ g/mile, post-control}$$

However, the Truck Tool assumes that DOC and DPF application are mutually exclusive.

3.0 Emission and Activity Estimation

The emission rates and adjustment factors discussed above are combined with appropriate activity data (provided by the Partners) to calculate mass emissions at the fleet and/or division level for CO₂, NO_x and PM, as described below.

3.1 CO₂

CO₂ is calculated within the Truck Tool utilizing emission factors expressed in *grams per gallon of fuel*, as discussed in Section 2.1 above. The general equation for calculating CO₂ emissions using reported fuel consumption values is as follows:

Equation 8

$$E_{CO_2} = ((F - B) \times EF_F) + (B \times EF_B)$$

Where:

E_{CO_2} = grams CO₂ per year

F = Fossil Fuel (Gallons per year)

B = Biofuel (Gallons per year)

EF_F = Fossil Fuel Emissions Factor (g/gal based on fuel type)

EF_B = Biofuel Emissions Factor (g/gal based on biofuel type)

3.2 NO_x and PM

Unlike CO₂ emissions which only vary with fuel type, NO_x and PM emission rates also vary substantially depending upon model year and/or emission certification level, vehicle class, drive cycle, speed, and operation mode (running or idle). For this reason, EPA developed lookup tables in the Truck Tool with emission factors that correspond to user-supplied inputs regarding their fleet activity. The NO_x and PM emission rates expressed in *grams per mile* were combined with the appropriate mileage metric (i.e., total miles) in order to estimate mass emissions. The general equation for calculating NO_x emissions is as follows:

Equation 9

$$E_{NO_x} = (M_C \times ((GPM_H \times HDC) + (GPM_{U1} \times UDC_1) + (GPM_{U2} \times UDC_2) + (GPM_{U3} \times UDC_3) + (GPM_{U4} \times UDC_4))) \times T_{CY} / T_{CT} + (GPH_I \times H_I \times T_{CY})$$

Where:

E_{NO_x} = grams NO_x per year for a given truck class

M_C = Miles driven for Truck Class C per year

GPM_H = Grams/mi (by truck class & engine yr) for Highway/Rural Driving

HDC = Highway drive cycle % (% of miles under highway/rural driving)

$GPM_{U1/2/3/4}$ = Grams/mi (by truck class & engine yr) for Urban Driving by mode (1 = 0 – 25 mph; 2 = 25 – 50 mph; 3 = 50+ mph; 4 = deceleration)

UDC_{1/2/3/4} = Urban drive cycle % (% of miles under urban driving conditions, by mode (1,2,3,4))

T_{CY} = Number of trucks for a given Class/Year combination

T_{CT} = Number of trucks total for a given Class

GPH_I = Grams per hour (by truck class & engine year) for Idling

H_I = Hours of Idling per year (average per truck per year by class)

PM emissions for non-diesel vehicles are calculated using an equation identical to that for NOx, utilizing PM emission factors. PM emission for diesel vehicles may be adjusted for PM control effectiveness, as shown below.

Equation 10

$$E_{PM} = ((M_C \times ((GPM_H \times HDC) + (GPM_{U1} \times UDC_1) + (GPM_{U2} \times UDC_2) + (GPM_{U3} \times UDC_3) + (GPM_{U4} \times UDC_4))) \times T_{CY} / T_{CT}) + (GPH_I \times H_I \times T_{CY}) \times (1 - (0.3 \times T_{DOC} / T_{CT})) \times (1 - (0.3 \times T_{CCV} / T_{CT})) \times (1 - (0.9 \times T_{DPF} / T_{CT}))$$

Where:

E_{PM} = grams PM per year for a given truck class

T_{DOC} = Number of trucks using Diesel Oxidation Catalysts by class

T_{CCV} = Number of trucks using Closed Crankcase Ventilation by class

T_{DPF} = Number of trucks using Diesel Particulate Filters by class

0.3 = Effectiveness of DOC & CCV (30%) at reducing particulate matter

0.9 = Effectiveness of DPFs (90%) at reducing particulate matter

Note the above calculation methodology assumes that the same highway/urban drive cycle fractions apply across all model years of a given truck class. Similarly, the method assumes that estimated idle hours apply equally to all model years of a given truck class.

The above methodology also utilizes estimates for the fraction of miles traveled associated with different road types and speed categories, as shown in the equations above. The Truck Tool user must provide an estimate of the percent of total miles associated with highway/rural driving for each truck class. The user may also provide percentages for the miles spent driving in urban conditions (e.g., unrestricted access, surface roads in well-traveled urban areas), for different speed categories (0 – 25 / 25 – 50 / 50+ mph). This information may be obtained from analysis of truck ECM or possibly GPS data. If urban speed distribution data is not available, the user may select to use default distributions, obtained from the MOVES model. The default speed distributions for urban operation (as defined in Section 2.2 above) varies with vehicle class and model year. However, the variation over model years is very slight (typically with a range of 1 to 2 percent for the largest speed category), the percentages were averaged over all model years for a given speed category/vehicle type combination for use within the Truck Tool.

Table 3 presents the resulting default urban speed distributions by speed category for each truck class, for both diesel and gasoline vehicles.¹⁷

¹⁷ The Truck Tool utilizes the diesel vehicle default speed distributions for non-gasoline vehicles (LPG, LNG, CNG).

Vehicle Class	Speed Group	Percent by Class
<i>Diesels</i>		
HDDV2b	0 - 25	35%
	25 - 50	38%
	50+	13%
	Deceleration	15%
HDDV3	0 - 25	41%
	25 - 50	36%
	50+	12%
	Deceleration	11%
HDDV4	0 - 25	42%
	25 - 50	35%
	50+	12%
	Deceleration	11%
HDDV5	0 - 25	42%
	25 - 50	35%
	50+	12%
	Deceleration	11%
HDDV6	0 - 25	42%
	25 - 50	35%
	50+	12%
	Deceleration	10%
HDDV7	0 - 25	42%
	25 - 50	35%
	50+	12%
	Deceleration	10%
HDDV8a	0 - 25	44%
	25 - 50	35%
	50+	12%
	Deceleration	9%
HDDV8b	0 - 25	45%
	25 - 50	34%
	50+	12%
	Deceleration	8%

Vehicle Class	Speed Group	Percent by Class
<i>Gasoline</i>		
HDGV2b	0 - 25	43%
	25 - 50	31%
	50+	10%
	Deceleration	15%
HDGV3	0 - 25	45%
	25 - 50	34%
	50+	11%
	Deceleration	11%
HDGV4	0 - 25	45%
	25 - 50	34%
	50+	11%
	Deceleration	10%
HDGV5	0 - 25	46%
	25 - 50	33%
	50+	10%
	Deceleration	11%
HDGV6	0 - 25	46%
	25 - 50	33%
	50+	10%
	Deceleration	11%
HDGV7	0 - 25	45%
	25 - 50	32%
	50+	10%
	Deceleration	14%
HDGV8a	0 - 25	45%
	25 - 50	34%
	50+	11%
	Deceleration	10%
HDGV8b	0 - 25	43%
	25 - 50	31%
	50+	10%
	Deceleration	15%

Table 3. Default Speed Category Distributions by Vehicle Class for Urban Operation (MOVES2010 basis)¹⁸

As seen in the above table, the MOVES model assumes that some fraction of vehicle operation is associated with “deceleration” events, evaluated

¹⁸ These values represent the urban component of driving only. If the user specifies a non-zero percentage for Highway/Rural driving, the values in the above table are automatically renormalized, so as to make the sum across urban and highway operation modes equal to 100%.

independently from other operation due to their unique emission rate patterns.¹⁹ However, it is assumed that most Truck Tool users will not know their fleet's deceleration fraction. As such, the Truck Tool will adjust any values input by the user to include a deceleration fraction based on MOVES model percentages. If the user selects the default urban speed distributions, the Truck Tool will adjust the urban values from Table 3 to account for the percentage of miles specified for Highway/Rural operation as well. The following provides an illustrative example for calculating PM emissions for diesels given a specific set of road type / speed category distributions. NOx emission calculations will follow the same procedure.

User specifies 1 Class 8b diesel, Model year 2011, traveling 100,000 mi/yr.

User specifies the following Road type/speed category distributions:

40% highway/rural
 30% 0-25 mph
 20% 25-50 mph
 10% 50+ mph

For highway/rural operation, the lookup value from MOVES is 0.0195 g/mi for PM2.5

For urban operation, the lookup values are as follows:

0-25: 0.031 g/mi
 25-50: 0.052 g/mi
 50+: 0.012 g/mi
 deceleration: 0.002 g/mi

Now the urban speed distribution percentage inputs must to account for deceleration, as follows:

0-25: $30\% \times \text{sum of default percentages for the three speed bins (but excluding default deceleration fraction)} = 30\% \times (45\% + 34\% + 12\%) = 27.5\%$

25-50: $20\% \times \text{sum of default percentages (45\% + 34\% + 12\%)} = 18.3\%$

50+: $10\% \times \text{sum of default percentages (45\% + 34\% + 12\%)} = 9.2\%$

deceleration: the remaining percentage, which equals $100\% - 40\% \text{ (highway)} - 27.5\% - 18.3\% - 9.2\% = 5.1\%$

Now apply these percentage weights to the total mileage, and then multiply by the corresponding emission factors to obtain mass, as follows:

Highway/rural component: $0.40 \times 100,000 \times 0.0195 = 780 \text{ grams}$
 0-25 urban component: $0.275 \times 100,000 \times 0.031 = 826 \text{ grams}$
 25 - 50 urban component: $0.183 \times 100,000 \times 0.052 = 952 \text{ grams}$
 50+ urban component: $0.092 \times 100,000 \times 0.012 = 110 \text{ grams}$
 Deceleration urban component: $0.051 \times 100,000 \times 0.002 = 10 \text{ grams}$

Therefore total = 2,678 grams of PM2.5 (This value will then be summed with any other model year/vehicle class combinations and converted to short tons.)

As discussed in Section 2.3, the Truck Tool assumes that B100-equivalent biodiesel volumes are distributed proportionately across all diesel vehicle classes. For example, if a fleet uses 100 B-100 equivalent gallons of biodiesel, and 1,000 gallons of fuel total, the tool assumes that B10 ($100 / 1,000 = 10$) is the blend used by each truck class. Accordingly, emission rate adjustment factors are calculated for B10 using Equation 6, and applied to the diesel emission factors for each vehicle class.

Emission calculations for ethanol blends follow a different methodology, however, applying discrete emission factors for gasoline and E10 from MOVES (and adjusted gasoline emission factors for E85) with the specific fuel volume estimates provided by the user. The following provides an example illustrating how the miles of travel are apportioned across different blend volumes, in order to estimate mass emissions.

User specifies 1,000 gallons of fuel total, and 10,000 miles of travel total

User inputs:

100 gallons of E10

100 gallons of E85

Therefore there are 800 gallons of pure gasoline ($1,000 - 100 - 100$)

Apportion the 10,000 miles of travel across the different blend levels using gasoline-gallon equivalent (gge) factors (from <https://www.afdc.energy.gov/afdc/prep/popups/gges.html>) as follows:

100 gallons of E10 is equivalent to $100/1.05 = 95$ gallons of gasoline*

100 gallons of E85 is equivalent to $100/1.39 = 72$ gallons of gasoline

Therefore there are $800 + 95 + 72 = 967$ gasoline equivalent gallons of fuel, total.

Applying the energy-equivalent fuel volume ratios to the 10,000 miles of total travel:

gasoline (E0) miles = $10,000 \times 800/967 = 8,273$ miles

E10 miles = $10,000 \times 95/967 = 982$ miles

E85 miles = $10,000 \times 72/967 = 745$ miles

Finally, multiplying these mileage values by the appropriate E0 and E10 gram/mile emission factors from MOVES results in the desired mass emission estimates. Similarly, multiplying the E85 miles by the E85 emission factors (adjusted from E0 factors as discussed in Section 2.3, provides mass emissions associated with E85.

* E10 gge factor developed from linear interpolation of E100 and gasoline Btu/gallon values

In addition, if national default ethanol blend levels are specified for gasoline fuel use, the Truck Tool assumes that *all* ethanol consumed is in an E10 blend. Therefore, assuming 1,000 gallons of gasoline are specified by the user, there

would be 770 gallons of E10 (1,000 x .077 – see Section 2.3), and 230 (1,000 - 770) gallons of gasoline. Mass emissions would then be calculated for the gasoline and E10 components of the fuel as in the above example, apportioning total miles across gasoline and E10 in order to apply the appropriate g/mi factors.

Finally, note that the PM factors output by the MOVES model for use in the Truck Tool are expressed in terms of PM_{2.5}. The MOVES model assumes a fixed ratio of PM₁₀ / PM_{2.5} for a given fuel type, as summarized below:

- Gasoline – 1.086
- Diesel – 1.031
- CNG – 1.000

These factors were applied directly to the PM_{2.5} emission factors to obtain mass emission and performance metrics for PM₁₀ within the Truck Tool. In addition, it was assumed that LNG and LPG had PM ratios equivalent to the CNG value (1.00). Ethanol was assumed to have a ratio equal to that for gasoline, while the ratio for biodiesel was assumed to equal that for diesel.

3.3 Activity Calculations

The Truck Tool requires users to provide specific activity information on fuel consumption, miles traveled, payload, capacity volume, and capacity volume utilization at the vehicle class level for the emissions performance assessment (see Section 4.0 below). While the user may provide direct data inputs for any or all of these activity parameters, the Truck Tool also allows the user to select default values for payload and volume determination, in the absence of fleet-specific information. (Direct inputs for payload are highly preferred over the use of calculator defaults.) The data sources and assumptions used to develop these default values are discussed below.

Default Payload Distributions

Average payloads can vary widely among fleets, even within a given vehicle class, depending upon commodity type and body/trailer type. (While the Truck Tool does collect commodity information, this information is not used in determining payloads.) However, common body types were identified within each vehicle class, along with associated payload distributions, using data from the US Census Bureau's 2002 Vehicle Inventory Use Survey (VIUS).²⁰ The VIUS collected self-reported data from thousands of truck operators involved in freight movement across the U.S. In order to identify common body and trailer types at the vehicle class level, the following filters were first applied to the full VIUS dataset.

²⁰ See <http://www.census.gov/svsd/www/vius/2002.html>.

- BUSINESS = 1 (for-hire transportation or warehousing), or 2 (vehicle leasing and rental). This filter thereby excluded non-freight vehicles such as utilities, construction, and agriculture;
- FUEL = 1 (Gasoline), or 2 (Diesel). Alternative fuel vehicles such as CNG and LPG were excluded;
- P_EMPTY <> 100. That is, vehicles operating empty 100% of the time were excluded;
- TRUCK_SORTER <>1 – excludes light-duty vehicle body types;
- VIUS_GVW >2 – gross vehicle weight rating > 8,500 lbs;
- BODYTYPE <> 5 (armored), 7 (concrete mixer), 8 (concrete pumper), 9 (crane), 11 (dump), 15 (utility service), 16 (other service), 17 (street sweeper), 20 (wrecker), 21 (trash/garbage/recycling), 22 (vacuum);
- TRAILERTYPE <> 4 (dump), 8 (mobile home toter), 13 (trailer-mounted equipment).

After applying these screens, 14,540 records remained in the VIUS dataset for further analysis. Each of these records corresponded to survey responses from individual fleets of varying sizes, truck classes, and services. These records were then sorted by vehicle class according to the VIUS_GVW field to identify major body types within each class, and the corresponding payload averages and standard deviations. Average payload from VIUS was assumed to equal WEIGHTAVG – WEIGHTEMPTY.

Body types constituting approximately 5 percent or more of the total VIUS class-level vehicle count were included in the Truck Tool Payload Calculator, as described in Section 3.3.2.b of the Truck Tool User Guide.²¹ In addition, the payload averages and ranges for “Other” body type categories were set equal to the class-level values within the VIUS (i.e., averaged across all body types). Table 4 presents the payload averages, standard deviations, minimum and maximum values for common body types by vehicle class.²² Note that the average values and standard deviations presented below are not weighted by fleet size.

Table 4. Average Payload and Standard Deviation (short tons) for Common Body Types, by Vehicle Class (VIUS 2002 basis – diesel and gasoline)

<u>Body/trailer type</u>	<u>Average payload (tons)</u>	<u>Std Deviation</u>	<u>Max</u>	<u>Min</u>	<u>Vehicle Count (N)</u>	<u>% of Vehicle Class</u>
Class 2b						

²¹ Trailer types representing less than 5 percent of the Class 8b category are also presented, due to the relatively large vehicle populations within this class.

²² Given the lack of data on non-diesel heavy-duty vehicles, payload ranges are assumed to apply to all fuel types.

<u>Body/trailer type</u>	<u>Average payload (tons)</u>	<u>Std Deviation</u>	<u>Max</u>	<u>Min</u>	<u>Vehicle Count (N)</u>	<u>% of Vehicle Class</u>
flatbed/stake/platform	1.3	0.4	2.0	0.8	756	7%
step/walk-in	1.2	0.4	2.3	0.3	5,591	52%
van (basic enclosed)	1.1	0.7	2.9	0.0	3,897	36%
All (other)	1.2	0.6	2.9	0.0	10,794	
Class 3						
step/walk-in	2.1	0.5	3.8	0.4	39,555	60%
van (basic enclosed)	1.8	0.8	4.5	0.0	20,490	31%
All (other)	1.9	0.7	4.5	0.0	65,544	
Class 4						
flatbed/stake/platform	2.1	0.9	3.4	0.3	3,502	10%
step/walk-in	3.1	0.8	5.2	0.2	12,554	37%
van (basic enclosed)	2.7	0.8	5.0	0.2	15,385	45%
All (other)	2.8	0.8	5.2	0.2	34,025	
Class 5						
step/walk-in	4.1	0.9	5.4	0.3	14,058	41%
van (basic enclosed)	3.2	1.2	6.5	0.0	17,595	51%
All (other)	3.4	1.3	6.5	0.0	34,670	
Class 6						
flatbed/stake/platform	4.5	1.9	8.8	0.5	6,986	6%
reefer	5.0	1.5	8.5	0.8	7,301	6%
step/walk-in	5.3	1.1	8.5	0.5	27,711	23%
van (basic enclosed)	4.7	1.5	10.0	0.5	74,600	61%
All (other)	4.9	1.5	10.0	0.4	121,747	
Class 7 - straight trucks						
beverage	8.2	3.1	14.1	0.5	2,617	8%
flatbed/stake/platform	5.5	3.2	12.0	0.0	2,762	8%
reefer	7.1	1.9	10.6	4.5	4,203	13%
tank (fluid)	6.8	2.3	10.0	0.0	3,272	10%
van (basic enclosed)	5.9	2.2	11.0	1.0	18,278	55%
All (other)	6.3	2.4	14.1	0.0	33,250	
Class 7 - combination trucks						
flatbed/stake/platform	5.2	0.4	6.0	5.0	869	13%
reefer	3.6	1.0	4.5	2.5	484	7%
van (basic enclosed)	5.0	1.6	7.8	0.0	4,948	75%
All (other)	5.0	1.6	7.8	0.0	6,585	
Class 8a - straight trucks						
flatbed/stake/platform	9.1	4.9	25.5	1.0	4,070	28%

<u>Body/trailer type</u>	<u>Average payload (tons)</u>	<u>Std Deviation</u>	<u>Max</u>	<u>Min</u>	<u>Vehicle Count (N)</u>	<u>% of Vehicle Class</u>
tank (fluid)	12.9	3.6	22.0	4.0	3,668	25%
van (basic enclosed)	9.7	4.6	24.5	1.0	5,390	37%
All (other)	10.9	4.7	25.5	1.0	14,526	
Class 8a - combination trucks						
beverage	12.3	4.4	18.5	1.0	4,994	5%
flatbed/stake/platform	9.9	4.3	21.2	1.4	8,139	8%
van (basic enclosed)	10.6	4.0	21.5	0.3	79,757	76%
All (other)	10.5	4.1	21.5	0.3	104,842	
Class 8b - combination trucks						
flatbed	23.9	4.0	60.0	10.5	64,385	12%
reefer	22.2	2.9	32.3	6.0	67,028	12%
tanker	26.0	4.7	49.5	15.4	42,100	8%
Dry van (single trailer)	19.5	6.7	40.4	0.5	313,057	57%
Dry van (double trailer)	20.6	5.8	41.3	7.5	10,468	2%
Dry van (triple trailer)	27.1	3.2	31.8	24.5	283	0%
specialty	24.5	5.0	52.5	8.3	43,047	8%
Chassis (container)	22.2	4.3	32.5	2.0	8,398	2%
All (other)	21.6	6.1	60.0	0.5	548,767	

The values above serve as the basis for the default payload ranges provided in the Truck Tool payload calculator. For most vehicle class/body type combinations,²³ five default ranges are offered for Partner selection:

- Range 1: from 0 tons to (Average payload – 2 x standard deviation);
- Range 2: from (Average payload – 2 x standard deviation) to (Average payload – 1 x standard deviation);
- Range 3: from (Average payload – 1 x standard deviation) to (Average payload + 1 x standard deviation);
- Range 4: from (Average payload + 1 x standard deviation) to (Average payload + 2 x standard deviation); and,
- Range 5: from (Average payload + 2 x standard deviation) to VIUS Maximum observed value.

Once a particular range is selected, the payload calculator estimates the

²³ In a few instances, the maximum VIUS value for a particular vehicle class/body type combination was less than the Range 4 minimum value. In these cases the Payload Calculator simply indicates Range 5 as “not available”.

midpoint of the range in order to estimate class level average payloads. The estimated midpoint payload values for each body type are weighted by one of the four allocation methods specified by the user in the payload calculator: # miles, # trips, % operation, and # vehicles by body type. The weighted sum is then used as the class level average payload, which in turn is used directly in determining grams per ton-mile performance metrics for the fleet.

Payload data based on bills of lading and entered directly into the Truck Tool (without using the payload calculator) are validated using the same VIUS data described above, corresponding to the “Other” body types in the calculators.²⁴

Default Capacity Volumes

The Truck Tool also provides a volume calculator to estimate the cubic feet associated with the common straight truck body types (classes 2b through 7) identified using the VIUS dataset, as well as typical trailer, container, carrier, and tanker sizes, for combination trucks (classes 8a and b). Capacity volumes in cubic feet are relatively easy to estimate for many combination trucks. Per unit interior volume defaults are assumed for standard dry vans - no high cubes, reefers, etc.), and containers. Trailer calculations assume an 8' x 9' cross-section, and the exterior length less 1/2 foot. 20 and 40 foot container dimensions are referenced in many places, such as <http://www.mussonfreight.com/containers/containers.html>.²⁵ Table 5 summarizes the default volumes assumed for a number of standard trailers, containers, tankers, and bulk carriers.

Table 5. Default Average Cubic Feet (Class 8a – 8b trucks)

Type	Size	Cubic Feet
Trailers	28ft	1,980
	40ft	2,844
	42ft	2,988
	45ft	3,204
	48ft	3,420
	53ft	3,780
	57ft	4,068
	28x28	3,960
	40x28	4,824
	40x40	5,688
	48x48	6,840
	28x28x28	5,940
	Containers	20ft
40ft		2,347

²⁴ For class 7 trucks, direct entries are validated against the payload distributions for straight trucks; for class 8a trucks, direct entries are validated against the distributions for combination trucks.

²⁵ 53 foot containers are assumed to have interior dimensions of 52' 5" x 7' 8" x 7' 10"

	53ft	3,148
Tankers	Small (3,000 gal)	401
	Medium (5,250 gal)	702
	Large (7,500 gal)	1,003
Bulk Carriers	Small (22'x8'10.25')	1,804
	Medium (32'x8'x11')	2,816
	Large (42'x8.5'x11.5')	4,106

Cargo volume capacity data is often not readily available for straight trucks, however. Such trucks are highly variable in their configuration and when volume estimates are found, the data often do not permit cross-referencing with vehicle class. Most highway infrastructure and operating agencies, including enforcement, are concerned about weight (e.g., pavement and structure damage), but not cubic capacity. The operating agencies are also concerned about maximum dimensions, of length, height and width (for, respectively, turning radii, vertical clearance, and lane width) but the shape of the box and its relation to the truck superstructure, not these maximums, dictates cubic capacity. Little public research on the cubic capacity of the box has been done, and thus little information is published.

Available information was compiled as it relates to cargo *volume* capacity for the common straight truck body types identified in the VIUS. (Following a SAS analysis on the VIUS Microdata, grouping body type versus cubic cargo capacity, it was determined that *none* of the 246 variables in VIUS included cubic capacity information.)

Without a comprehensive data source, such as the VIUS, other strategies needed to be employed to develop examples, or ranges, of volume capacity for the various body type/truck class combinations of interest. A literature review and vendor interviews were performed to determine appropriate values for cargo volume capacity. The first step in the literature review involved preparing a list of vendors responsible for designing, manufacturing, or operating all the different truck types identified.

Cubic capacity is also dependent upon a variety of factors and is not uniform for even the same make and model, as many truck manufactures will design to specifications based on a client's unique needs for their cargo. For example, a client may request a manufacturer to design a truck interior to best accommodate the delivery of a certain size of parcel, and install shelving or otherwise compartmentalize to that end. Consideration was given to these factors during the review.

The literature review encompassed Internet searches of vendors of the truck types described above. Sources explored included truck manufacturers, dealers, and fleet lessors of vehicles such as Budget/U-haul/Enterprise/Ryder/E-Dart).

Additionally, validation searches were performed on websites outlining current truck sales to help identify the appropriate size/class of the vehicles and applicable specifications. The following information was collected from these searches for over 40 different vehicles currently available on the market:

- Length, width, height of the cargo hold
- Reported cargo space (cubic feet)
- Gross Vehicle Weight
- Payload
- Manufacturer
- Make/Model
- Reference website

Outreach to key stakeholders in the commercial vehicle industry was also performed to further validate the information collected from the literature and resource review. Contact was made with representatives from Volvo Trucks North America; the American Transportation Research Institute (ATRI); the Commercial Vehicle Safety Alliance (CVSA); the Truck Manufacturers Association (TMA); Federal Highway Administration (FHWA) Truck Size and Weight; and a wide variety of trucking manufactures and other vendors.

The results of this review are provided in Table 6 below for straight trucks, class 2b through 7. In those instances where multiple vehicle models were identified for a given body type/vehicle class combination, simple averages were calculated across models.²⁶ Consistent with the Payload Calculator methodology, the value for “Other” body types was set equal to the average across all body types identified for a given truck class.

Table 6. Estimated Capacity Volumes (cubic feet) for Common Straight Truck Body Types, by Vehicle Class

Body/trailer type	Average Capacity Volume (Cubic Feet)
Class 2b	
flatbed/stake/platform	336
step/walk-in	314
van (basic enclosed)	340
Other	330
Class 3	
step/walk-in	547
van (basic enclosed)	450

²⁶ Ideally in the future capacity estimates would be weighted by model sales data or other sources of information related to the relative frequency of the different vehicle makes and models.

Body/trailer type	Average Capacity Volume (Cubic Feet)
Other	599
Class 4	
flatbed/stake/platform	448
step/walk-in	700
van (basic enclosed)	808
Other	830
Class 5	
step/walk-in	670
van (basic enclosed)	1,515
Other	1,233
Class 6	
flatbed/stake/platform	672
reefer	1,521
step/walk-in	1,496
van (basic enclosed)	1,380
Other	1,267
Class 7	
beverage	1,505*
flatbed/stake/platform	728
reefer	1,774
tank (fluid)	267
van (basic enclosed)	1,552
Other	1,505

*Set equal to "Other" due to lack of data

Once a default capacity volume is selected, the volume calculator weights the volume estimates for each body type by one of the four allocation methods: # miles, # trips, % operation, and # vehicles by body type. The weighted sum is then used as the class level average capacity volume, which in turn is used directly in determining grams per volume-mile performance metrics for the fleet.

A list of websites utilized in the literature review is provided below.

Truck manufacturers:

www.gmc.com

www.chevrolet.com

www.ford.com

www.freightlinersprinterusa.com

www.silvercrowncoach.com

Fleet operators:

www.uhaul.com
www.pensketruckrental.com
www.budgettruck.com
www.hendersonrentals.co.nz
www.hackneybeverage.com
www.hackneyusa.com
www.fedex.com
www.grummanolson.com

Other sources:

www.usedtruckdepot.com
www.usedtrucks.ryder.com
www.truckingauctions.com
www.truckpaper.com
www.motortrend.com
files.harc.edu/Projects/Transportation/FedExReportTask3.pdf

The detailed findings of this review are presented in Appendix D.

3.4 Data Validation

The SmartWay Truck Tool has a number of standard range and value checks that must be passed before Partners can submit their data to EPA. Many of these checks simply confirm the presence of required data (e.g., total miles for each truck class selected), or the accuracy of logical relationships (e.g., revenue miles < = total miles). The list of these basic checks is provided below. Partners will not be able to finalize their fleet files until all errors have been resolved.

Table 7. Basic Range and Logical Checks – Conditions Resulting in Error or Warning Messages

Screen	Description	Type
Contact Info	Missing data in any required field. (Optional fields: Address2, Toll-Free Phone, Phone Extension, Fax, Salutation & Middle Initial)	Error
General Info	Blank long-haul vs. short-haul percentages	Error
General Info	No fuel types checked	Error
General Info	PM Reductions checked but no PM reduction values entered	Error
General Info	Blank for percentage of truckloads that utilize 100% of available cargo capacity	Error
General Info	No commodities selected	Error
Activity Info	Blanks for any checked truck class field	Error
Activity Info	Blanks for any Data Source field	Error
Model Year	No truck classes selected	Error

Screen	Description	Type
Model Year	No truck counts entered for a selected (checked) truck class	Error
Activity Info	Zeros for Total Miles, Revenue Miles, Gallons of Fuel, Payload or Volume	Error
Activity Info	Revenue Miles > Total Miles Driven	Error
Activity Info	Empty Miles > Total Miles Driven	Error
Activity Info	Capacity Utilization > 100% or = 0%	Error
Activity Info	Biofuel gallons > Total Fuel gallons	Error
Activity Info	Average Payload outside 2 standard deviations or outside 1 standard deviation without an explanation	Error
Activity Info	Average Payload outside 1 standard deviation (with explanation)	Warning
Activity Info	Average Volume outside 2 standard deviations or outside 1 standard deviation without an explanation	Error
Activity Info	Average Volume outside 1 standard deviation (with explanation)	Warning
Activity Info	Average Idle Hours > 8,760 (8,760 = 365 x 24)	Error
Activity Info	Truck body types on payload and volume calculators not in agreement	Error
Activity Info	Miles per truck > 125,000 for classes 2b – 7 or miles per truck > 200,000 for classes 8a and 8b	Warning
Activity Info	Miles per truck > 500,000	Error
Activity Info	Miles per gallon outside 1 standard deviation (but within 2 standard deviations) from average for that truck class	Warning
Activity Info	Miles per gallon outside 2 standard deviations from average for that truck class	Error
PM Reductions	Value in any PM Reductions field > value in corresponding Model Year field	Error
PM Reductions	Values for PM Trap + DOC (together) > value in corresponding Model Year field	Error

Also note that there is an implicit validation check on all numeric fields because the system will not accept any non-numeric characters (including minus signs) within these fields.

Additional, rigorous validity checks of key data inputs are also needed to ensure the overall quality of the performance metrics calculated by the Truck Tool. Validity checks serve three purposes to this end. First, unusually high or low values can be identified and flagged for the user's attention before finalizing inputs. For example, a user may misplace a decimal or inadvertently add an extra zero upon data entry. By comparing these data entries to reliable industry averages and distributions, these values can be flagged allowing users to quickly correct such errors.

Second, under certain circumstances Partners may operate their fleets under atypical conditions, resulting in extreme (outlier) data values. For example, permitted heavy-haul operations may routinely exceed industry-average payload values by 10 or more tons. By flagging such data entries Partners have the

opportunity to provide additional information regarding their unique operating conditions through use of the Truck Tool comment fields.

Finally, independent criteria can be established to ensure that data inputs are never allowed to exceed certain physically-constrained absolute limits. For example, a truck cannot exceed roughly 500,000 miles per year, even with dual drivers and minimal maintenance time, simply due to the available hours per year and highway speed limits. Similarly, conventional engine technology will necessarily limit the maximum possible mpg obtainable by a truck under even optimistic operating conditions. Data values above these absolute maximum levels are not allowed by the Truck Tool, and users are required to modify the associated inputs before proceeding.

Four key parameters were identified for detailed validity checks of class-level data inputs: average annual miles per truck, average payload, average volume, and miles per gallon (mpg). The data sources and validation rules associated with each of these parameters is discussed below.

Annual Miles per Truck

Appendix C presents a number of parameter distributions compiled from draft SmartWay partner submissions of their 2008 fleet files, including annual miles per truck by vehicle class.²⁷ As seen in the histograms, the class 2b through class 7 distributions are highly skewed toward relatively low mileage rates. On the other hand, the class 8b mileage data appears to resemble a normal distribution centered at approximately 100,000 miles per year. (Class 8a vehicles present a much less “organized” distribution, with substantial spread over a very large range of values.) As such, it was decided to implement a 2-tiered warning system, applying the following rules:

- For class 2b through 7 vehicles, raise a warning flag if annual mileage is > 125,000 miles per year;
- For class 8a/b vehicles, flag if mileage is > 200,000 miles per year;
- For all classes, do not allow mileage values greater than 500,000 miles per year.

Average Payload

As summarized in Table 4 above, the VIUS data was used to develop default payload ranges for different common body types, by truck class. Ranges are centered around the average payload value, with boundaries at one and two times the standard deviation of the payload distribution. While the tool will flag any payload input more than one standard deviation from the average value, and

²⁷ Note that this data was collected before implementing rigorous validation routines. As such it may contain inaccurate/erroneous data points. However, the data provides a reasonable “first cut” at establishing warning levels for Partners to confirm or modify their data inputs.

requires an explanation for any entry greater than two standard deviations from the average, the tool will allow any non-zero payload to be entered.

Average Capacity Volume

As discussed in Section 3.3, data regarding straight truck capacity volumes was extremely limited. As such, it was not possible to develop distributional estimates for this parameter. Accordingly, a simple validation criteria was implemented, applying a “yellow flag” to data entries differing from the default value for a given body type by +/- 25%, and a “red flag” to values greater than 50%.²⁸

Average Miles per Gallon

The distribution of diesel mpg values for SmartWay partners (based on draft 2008 data) is shown in Appendix C by vehicle class. The mpg values for class 6 and larger vehicles appear to be roughly normally distributed, while the distributions for the smaller vehicles do not appear to follow a clear pattern.²⁹ In order to remove potentially erroneous values from the data, the top and bottom 5% of mpg values were dropped from the distributions, and averages and standard deviations were calculated for the remaining data. This process preferentially removed high end values from the original distributions, thereby lowering both sample averages and standard deviations. The resulting values are presented in Table 8. These values were used to develop five ranges for validation of class-level mpg estimates based on standard deviations, similar to the ranges developed for average payload described above.

²⁸ For this parameter “red flag” warnings simply note that the associated value is far from the typical value for that body type/class, while “yellow flag” warnings note that the value is somewhat larger/smaller than anticipated. Explanations are not requested for warnings.

²⁹ The smaller vehicle class distributions also have substantially smaller sample sizes, increasing their associated uncertainty.

Table 8. SmartWay Partner Average MPG, Standard Deviation, and Validation Ranges for Diesel Vehicles (2008 Data Submittal)

Class	Avg	Std dev	Range									
			1		2		3		4		5	
			min	max	min	max	min	max	min	max	min	max*
2b	11.68	4.01	> 0.00	3.66	3.66	7.67	7.67	15.69	15.69	19.70	19.70	24.96
3	9.11	3.63	> 0.00	1.85	1.85	5.48	5.48	12.74	12.74	16.37	16.37	23.28
4	10.04	2.53	> 0.00	4.98	4.98	7.51	7.51	12.57	12.57	15.10	15.10	20.16
5	8.13	2.72	> 0.00	2.69	2.69	5.41	5.41	10.85	10.85	13.57	13.57	18.72
6	7.59	1.38	> 0.00	4.83	4.83	6.21	6.21	8.97	8.97	10.35	10.35	18.00
7	7.37	1.57	> 0.00	4.23	4.23	5.80	5.80	8.94	8.94	10.51	10.51	14.52
8a	5.98	0.69	> 0.00	4.60	4.60	5.29	5.29	6.67	6.67	7.36	7.36	11.16
8b	5.86	0.51	> 0.00	4.84	4.84	5.35	5.35	6.37	6.37	6.88	6.88	11.16

*Based on PERE modeling results – see below.

In addition to the standard deviation estimates derived from adjusted Partner data, upper bound mpg values were also estimated to establish absolute maximum values. These upper bound values are intended to reflect fundamental physical constraints on potential vehicle efficiency. Accordingly, if calculated mpg values exceed this upper bound limit, Partners must revise their mileage estimates, fuel consumption estimates, or both in order to lower their mpg values.

PERE Modeling

To calculate the maximum expected values for fuel economy for each of the truck classes, EPA's Physical Emission Rate Estimator (PERE) model was used. This model calculates second-by-second fuel consumption for user-defined drive cycles based on a physical model. The model takes a number of user-specified parameters, along with its own defaults, to perform these calculations for a variety of vehicle and powertrain types. The assumptions and data sources for the model inputs used are presented below.

[NOTE: The values developed using the PERE model should be considered preliminary estimates. Upper bound efficiency estimates will be revised based on improved engine modeling tools recently developed by the EPA in support of the upcoming heavy-duty vehicle Notice of Proposed Rule Making.]

Inputs to the model were chosen such that their result would define an upper limit for the fuel economy of the different truck classes. Many of the parameters were based on Internet searches for specifications of various trucks in "as-delivered" condition, prior to the addition of various vocational or cargo equipment installations that would increase drag and vehicle weight. For specifications that were not available, parameters were chosen based on engineering judgment for reasonable best-case values. An important source of information was an EPA draft document discussing the use of the PERE model by Nam and Gianelli³⁰. This document contained equations that could be used for estimates of some of the input parameters, along with information describing the use of the model.

The two most sensitive inputs to the PERE model include vehicle weight and engine size. Vehicle weights and engine sizes were taken from manufacturer supplied truck specifications where possible. For example, the Ford publication *F-250/F-350/F-450/F-550 Specifications*³¹ contains base curb weights and engine sizes for some of their offerings in the medium duty truck market. Another source of manufacturer data was in the *Kenworth T170/T270/T370 Body Builders*

³⁰ Nam, Edward and Gianelli, Robert, *Fuel Consumption Modeling of Conventional and Advanced Technology Vehicles in the Physical Emission Rate Estimator (PERE)*. US EPA Publication EPA420-P-05-001, February 2005.

³¹ FordF150.net. *F-250/F-350/F-450/F-550 Specifications*. Retrieved from http://www.fordf150.net/specs/05sd_specs.pdf

Manual³². The T170-T370 model range consists of medium duty trucks that can be delivered with a cab-only chassis. The builder's manual describes all of the dimensions relevant to the manufacturer of a body or cargo area on the rear of the chassis. As such, it includes curb weights, length and width, and gross vehicle weight ratings that were used in creating many of the PERE inputs for the class 5, 6, and 7 maximum fuel economy estimates. Where specifications for multiple trucks were found for a given class, values were selected that would result in maximum fuel economy, unless they were deemed atypical of in-use vehicles. Overall, variations in weight and engine size over the ranges found in literature did not have a large effect on fuel economy estimates compared to other inputs to the PERE model, as discussed below.

The assumed number of transmission gears for each truck class was also based on specifications found on manufacturers' web sites. However, there is a wide range in the number of gears associated with the different transmissions available. While the most efficient setup for class 2b through class 4 would likely be a 6 speed manual transmission, there are a variety of options for classes 5 through 7. Since it is common for modern class 8 trucks to have 10 gears, intermediate values were assumed based on the class 4 and 8 speeds (six for Class 5, eight for Class 6, and ten for Class 7). All trucks were modeled with manual transmissions.

The PERE model also requires shift speeds as an input to the model, but examples shift points were not found in literature or Internet searches. On-road data from class 8 trucks with 10-speed manual transmissions had been measured previously, and this data was analyzed to estimate typical up-shift speeds for the instrumented truck³³. Using derived the speed/gear curve, two other curves were created by proportionally scaling for the 6 and 8 speed trucks modeled in the study. The shift speed chart has a very strong effect on the PERE model's predicted fuel economy, but using these carefully scaled shift point curves should mitigate this source of uncertainty somewhat.

There were three other input values required for this assessment regarding the truck drivelines. First, diesel engine efficiency was taken to be 40% over the entire drive cycle. The maximum engine speeds and highway cruise speeds were adjusted as well, to account for the larger displacement of heavy duty engines turning more slowly than typical class 2b truck engines. The effects of the engine speed parameters on estimated fuel economy were relatively small however.

³² Kenworth. *Kenworth T170/T270/T370 Body Builders Manual*. Retrieved from http://www.kenworth.com/brochures/2009_Hybrid_Body_Builders_Manual.pdf

³³ U.S. EPA Contract #EP-C-06-080, Work Assignment 3-07, ongoing project with Eastern Research Group, Inc.

The road load estimation required assumptions and calculations as road load curves are not generally available in the manufacturers' literature. Two different methods of road load estimation were used and compared in an attempt to ensure the use of reasonably representative values. The results of the two methods were presented as a high and low estimate of the range of best-case fuel economy. The first method uses A, B, and C coefficient inputs for the PERE model to generate a quadratic equation of road load similar to that used by chassis dynamometers. These coefficients were estimated using the equations in Table 9 from Nam and Gianelli (2005) that provide estimates for A, B, and C based on truck weight and class. In general, A represents the rolling resistance term, C represents the aerodynamic drag term, and B is assumed to be zero. The second method of road load calculation is based on a coefficient of rolling resistance (C_R), the aerodynamic drag coefficient (C_d), and the vehicle frontal area (A_F) in a physical equation of the truck's road load, given in Equation 1 from Nam and Gianelli (2005). Coefficients of drag were based on values in literature, such as manufacturers' specifications for class 2b and in a report publication by Argonne National Laboratory³⁴. Values for C_d ranged from 0.45 for class 2b and smaller medium duty trucks, to 0.5 for the class 8 long-haul trucks. The heavier medium duty trucks were assumed to have a C_d of 0.55 as they were assumed to be essentially vocational trucks with less streamlined aerodynamics. Frontal area was taken from manufacturer specifications where available. As given in Nam and Gianelli, the product of truck height and width was multiplied by a factor of 0.93 to get an estimate of effective A_F . Engineering judgment was applied to the dimensions found in literature to ensure a representative increase in frontal area from the smaller to larger trucks. The rolling resistance values were estimated using the trends observed by both Nam and Gianelli (2005) along with Delorme Karbowski, and Sharer (2009), ranging from 0.01 for the light and medium duty trucks, down to 0.008 for the class 8 trucks.

The final input to the PERE model was the second-by-second drive cycle information. It was assumed that the best case fuel economy would be encountered during highway driving, and that any of these types of vehicles could be used for extended highway travel. For this reason, the EPA Highway Fuel Economy Test (HwFET) was chosen for the driving cycle for all truck classes. Even though the test is designed only for light duty vehicles, it was used as the best representation available for in-use highway driving.

The key values used as the inputs for the PERE model fuel economy calculations are given by truck class in Table 9.

³⁴ Delorme, A., Karbowski, D., and Sharer, P. *Evaluation of Fuel Consumption Potential of Medium and Heavy Duty Vehicles through Modeling and Simulation*. Argonne National Laboratory, DEPS-BEES-001, October 2009.

Table 9. Key Assumptions for PERE MPG Modeling

Class	Minimum Weight, lbs	Engine Disp., L	Number of Gears	Effective Gear Ratio, RPM/mph	Applicable Drive Cycle
2b	5,750	6.0	6	35	Highway (HwFET)
3	6,000	6.0	6	35	Highway (HwFET)
4	8,500	6.4	6	33	Highway (HwFET)
5	9,500	6.7	6	33	Highway (HwFET)
6	13,000	6.7	8	33	Highway (HwFET)
7	15,000	8.3	10	31	Highway (HwFET)
8	25,000	13	10	30	Highway (HwFET)

Finally, the resulting mpg outputs from the PERE model were multiplied by 1.2 to provide an additional allowance for extraordinary operating conditions. The resulting values are shown under the Range 5-max column in Table 8 above.

Non-Diesel MPG Validation

The 2008 data submissions from SmartWay partners did not include enough information on non-diesel trucks in order to develop a robust distribution of mpg values for validation purposes. Accordingly, engineering judgment was used to adjust the diesel mpg values for other fuel types, accounting for general, relative vehicle and/or fuel efficiency differences. First, a ratio was developed for adjusting diesel mpg values to comparable gasoline mpg values, based upon simulated modeling performed by Argonne National Laboratory.³⁵ The Argonne data for gas and diesel trucks was based on PSAT simulations of a typical pickup in the class 2b or class 3 range. The fuel consumption was reported for the same truck equipped with both gasoline and diesel engines over the various EPA emissions and fuel economy driving cycles. Using this data, a combined fuel economy was calculated using the method from EPA's pre-2008 combined 2-cycle fuel economy using the FTP and Highway cycles as given in 40 CFR Part 600. This method uses a weighted harmonic average of the two values, with the FTP weighted at 55% and the Highway weighted at 45%.

The difference in the calculated combined fuel economies for the gas- and diesel-powered model results showed that the diesel had a 25.9% greater fuel economy than gasoline. These results are a direct volumetric comparison rather than in terms of gasoline-equivalent gallons. As such, the diesel mpg ranges shown in Table 8 above were divided by 1.259 to obtain comparable mpg ranges for gasoline vehicles. Since CNG vehicle fuel consumption is reported in terms of gasoline-equivalent gallons, the mpg validation ranges for CNG vehicles were set equal to those for comparable gasoline vehicles.

³⁵ Delorme, A. et. al., *Impact of Advanced Technologies on Medium-Duty Trucks Fuel Efficiency*, Argonne National Laboratory, 2010-01-1929.

Validation ranges for LPG and LNG vehicles were developed from the gasoline ranges, dividing the gasoline values by the appropriate gasoline gallon equivalent factor for these fuels (1.35 for LPG and 1.52 for LNG),³⁶ thereby adjusting mpg values for volumetric energy density.

³⁶ <https://www.afdc.energy.gov/afdc/prep/popups/gges.html>

4.0 Performance Metrics

The Truck tool allows the user to calculate their emissions performance using a number of different metrics, at different levels of aggregation. Available performance metrics include:

- Grams per mile
- Grams per Payload Ton-Mile
- Grams per Thousand Cubic Foot-Miles
- Grams per Thousand Utilized Cubic Foot-Miles

The Internal Metrics report within the Truck Tool presents the results of 36 calculations ($4 \times 4 \times 3 = 48$), which represent the following four calculations for each of the three pollutants (CO_2 , NO_x , PM_{10} and $\text{PM}_{2.5}$) and for each of three different mileage types (total, payload, and loaded). Note that all capitalized fields represent fields in the user interface:

1. **g/mile:** $\sum E / M$
where E = Emissions, M = Miles Driven
2. **g/avg payload ton-mile:** $\sum E / (M \times AP)$
where E = Emissions, M = Miles Driven, AP = Average Payload
3. **g/avg cubic foot volume:** $\sum E / (M \times ACV)$
where E = Emissions, M = Miles Driven, ACV = Average Capacity Volume
4. **g/avg utilized cubic foot:** $\sum E / (M \times ACV) / CU$
where E = Emissions, M = Miles Driven, ACV = Average Capacity Volume, CU = % Cube Utilization

For all four calculations:

Emissions = grams of pollutant (as specified above)

Miles Driven = Total Miles, Payload Miles, or Loaded Miles (Total Miles minus Empty Miles)

As shown in the equations above, summations are performed for the different metrics. Each of the metrics is automatically aggregated across model years (for NO_x and PM) for all reporting purposes. Additional aggregation may be reported across truck classes, fuel types, divisions, and at the company level, as specified by the user.

4.1 Upcoming Functionality

Future versions of the Truck Tool will contain additional functionality to allow Partners to track their performance from year to year, as well as to compare their performance with other Partners.

Appendix A: MOVES2010 NO_x/PM_{2.5} Emission Factors (g/mi)

Year & Class	Diesel NOx Decel	Diesel NOx 0 to 25	Diesel NOx 25 to 50	Diesel NOx 50 +	Diesel NOx Highway	Diesel PM 2.5 Decel	Diesel PM 2.5 0 to 25	Diesel PM 2.5 25 to 50	Diesel PM 2.5 50 +	Diesel PM 2.5 Highway
1988-2b	2.160	21.928	27.251	7.314	12.639	0.085	1.034	1.386	0.336	0.643
1988-3	2.620	30.178	42.188	10.897	18.970	0.066	1.173	1.532	0.418	0.733
1988-4	2.645	29.220	40.581	9.846	17.152	0.060	1.194	1.543	0.436	0.744
1988-5	2.594	31.317	44.473	12.226	21.757	0.068	1.242	1.573	0.428	0.771
1988-6	2.580	31.907	45.639	12.894	22.889	0.071	1.255	1.585	0.427	0.779
1988-7	2.522	34.196	50.264	15.632	27.231	0.077	1.369	1.655	0.438	0.830
1988-8a	2.364	39.664	61.936	22.420	34.854	0.098	1.619	1.832	0.465	0.916
1988-8b	2.208	44.797	73.515	28.860	39.909	0.123	1.864	2.020	0.499	0.978
1989-2b	2.319	28.042	37.479	11.367	21.494	0.084	1.242	1.540	0.387	0.766
1989-3	2.579	28.316	38.445	9.426	15.980	0.066	1.142	1.504	0.412	0.709
1989-4	2.645	29.207	40.542	9.827	17.119	0.060	1.207	1.549	0.440	0.750
1989-5	2.610	30.615	43.061	11.397	20.168	0.066	1.229	1.561	0.430	0.761
1989-6	2.566	32.477	46.753	13.552	24.111	0.071	1.310	1.613	0.436	0.803
1989-7	2.570	32.348	46.587	13.382	23.843	0.072	1.302	1.614	0.438	0.801
1989-8a	2.409	38.330	59.002	20.662	33.294	0.091	1.582	1.796	0.462	0.905
1989-8b	2.201	44.990	73.950	29.122	40.055	0.122	1.892	2.026	0.499	0.983
1990-2b	2.018	14.980	18.875	5.622	8.882	0.099	1.041	1.420	0.308	0.634
1990-3	2.062	19.693	25.736	7.018	12.096	0.083	1.147	1.507	0.376	0.706
1990-4	2.041	22.499	31.030	7.482	12.740	0.061	1.180	1.530	0.432	0.731
1990-5	2.030	22.994	32.025	8.066	14.052	0.062	1.216	1.551	0.435	0.752
1990-6	1.968	25.638	37.207	11.117	19.700	0.072	1.370	1.639	0.442	0.827
1990-7	1.962	25.819	37.583	11.361	20.007	0.072	1.382	1.646	0.443	0.832
1990-8a	1.789	31.854	50.533	18.828	28.283	0.098	1.761	1.889	0.473	0.954
1990-8b	1.673	35.450	58.781	23.448	31.492	0.117	2.007	2.052	0.495	1.006
1991-2b	1.708	12.574	15.880	4.794	7.578	0.231	0.675	0.683	0.137	0.376
1991-3	1.867	20.781	29.257	7.111	11.939	0.060	1.096	0.824	0.218	0.454
1991-4	1.763	25.143	38.032	12.208	21.136	0.082	1.465	1.059	0.340	0.751
1991-5	1.798	17.026	22.302	6.083	10.356	0.167	0.906	0.755	0.167	0.420
1991-6	1.811	23.221	34.176	9.927	17.700	0.073	1.303	0.958	0.288	0.643
1991-7	1.748	25.559	39.043	12.788	21.719	0.085	1.499	1.084	0.351	0.769
1991-8a	1.597	30.267	49.581	18.839	27.337	0.118	1.898	1.380	0.506	0.960
1991-8b	1.522	32.732	55.442	21.938	29.486	0.143	2.115	1.557	0.611	1.043
1992-2b	1.660	11.197	14.207	4.440	6.812	0.238	0.595	0.653	0.132	0.363
1992-3	1.809	18.413	24.503	6.261	10.619	0.124	0.958	0.792	0.215	0.450
1992-4	1.879	20.745	29.102	6.964	11.791	0.063	1.074	0.849	0.248	0.475
1992-5	1.877	20.848	29.459	7.136	12.301	0.060	1.080	0.828	0.224	0.463
1992-6	1.823	23.154	33.901	9.769	17.469	0.073	1.279	0.965	0.301	0.642
1992-7	1.786	24.646	37.055	11.553	20.273	0.080	1.406	1.037	0.332	0.724
1992-8a	1.609	30.647	50.434	19.049	27.738	0.122	1.923	1.408	0.529	0.978
1992-8b	1.527	32.997	56.015	22.159	29.695	0.143	2.127	1.556	0.606	1.042
1993-2b	1.750	14.060	17.757	5.114	8.325	0.216	0.747	0.714	0.154	0.396
1993-3	1.827	19.449	26.423	6.549	11.136	0.093	1.015	0.790	0.209	0.443
1993-4	1.859	21.579	30.695	7.900	14.067	0.065	1.152	0.870	0.249	0.531

Year & Class	Diesel NOx Decel	Diesel NOx 0 to 25	Diesel NOx 25 to 50	Diesel NOx 50 +	Diesel NOx Highway	Diesel PM 2.5 Decel	Diesel PM 2.5 0 to 25	Diesel PM 2.5 25 to 50	Diesel PM 2.5 50 +	Diesel PM 2.5 Highway
1993-5	1.875	20.807	29.260	7.062	12.014	0.060	1.085	0.823	0.221	0.457
1993-6	1.828	22.883	33.367	9.461	16.979	0.071	1.259	0.938	0.283	0.621
1993-7	1.803	23.849	35.416	10.614	18.762	0.076	1.343	0.997	0.314	0.682
1993-8a	1.607	30.537	50.208	18.971	27.639	0.121	1.915	1.398	0.522	0.973
1993-8b	1.528	33.013	56.098	22.156	29.738	0.142	2.133	1.552	0.601	1.042
1994-2b	1.698	12.759	16.069	4.795	7.643	0.169	1.410	1.029	0.194	0.520
1994-3	1.776	12.814	16.223	4.883	7.686	0.177	1.452	1.066	0.200	0.529
1994-4	1.878	20.694	28.962	6.893	11.717	0.098	1.619	1.249	0.267	0.623
1994-5	1.876	20.829	29.352	7.101	12.155	0.097	1.669	1.267	0.270	0.641
1994-6	1.845	22.127	31.885	8.600	15.294	0.107	1.737	1.334	0.286	0.711
1994-7	1.789	24.471	36.711	11.330	19.922	0.129	1.875	1.483	0.323	0.824
1994-8a	1.604	30.663	50.477	19.122	27.748	0.201	2.266	1.918	0.429	1.017
1994-8b	1.536	32.821	55.646	21.883	29.601	0.237	2.406	2.106	0.476	1.067
1995-2b	1.677	10.455	13.444	4.326	6.429	0.175	1.330	0.966	0.173	0.472
1995-3	1.838	19.501	26.546	6.624	11.212	0.113	1.589	1.207	0.254	0.608
1995-4	1.830	19.852	27.144	7.118	12.645	0.119	1.624	1.232	0.259	0.643
1995-5	1.850	21.997	31.646	8.434	15.113	0.106	1.742	1.334	0.285	0.710
1995-6	1.820	23.191	33.999	9.836	17.522	0.116	1.788	1.396	0.302	0.762
1995-7	1.780	24.790	37.357	11.747	20.415	0.132	1.886	1.501	0.328	0.833
1995-8a	1.595	30.998	51.323	19.537	28.094	0.212	2.256	1.966	0.444	1.027
1995-8b	1.536	32.855	55.766	21.908	29.653	0.243	2.383	2.128	0.484	1.069
1996-2b	1.677	12.164	15.276	4.662	7.324	0.163	1.369	0.988	0.183	0.495
1996-3	1.851	19.712	26.696	6.673	11.276	0.112	1.606	1.215	0.256	0.612
1996-4	1.862	21.920	31.079	8.205	14.644	0.105	1.717	1.315	0.282	0.695
1996-5	1.825	21.338	29.847	8.371	15.202	0.118	1.749	1.306	0.276	0.712
1996-6	1.823	23.633	34.683	10.202	18.239	0.122	1.824	1.435	0.311	0.787
1996-7	1.776	25.291	38.057	12.274	21.024	0.133	1.937	1.517	0.329	0.848
1996-8a	1.610	30.914	50.658	19.277	27.917	0.203	2.280	1.930	0.432	1.024
1996-8b	1.543	33.041	55.688	21.984	29.707	0.235	2.438	2.104	0.474	1.072
1997-2b	1.527	8.900	11.589	3.870	5.559	0.163	1.200	0.862	0.151	0.424
1997-3	1.735	18.753	24.765	6.955	12.736	0.127	1.594	1.171	0.245	0.637
1997-4	1.894	20.843	28.896	6.896	11.723	0.097	1.663	1.256	0.268	0.628
1997-5	1.880	21.553	30.440	7.754	13.835	0.101	1.753	1.311	0.279	0.686
1997-6	1.848	22.888	32.944	9.263	16.681	0.113	1.781	1.379	0.298	0.744
1997-7	1.816	24.199	35.667	10.814	19.178	0.126	1.850	1.467	0.320	0.804
1997-8a	1.621	31.065	50.862	19.304	28.009	0.215	2.225	1.979	0.450	1.025
1997-8b	1.554	33.071	55.618	21.931	29.690	0.248	2.347	2.144	0.491	1.068
1998-2b	1.461	8.793	11.168	3.877	5.584	0.200	0.409	0.388	0.114	0.257
1998-3	2.178	17.776	24.127	7.212	10.718	0.116	0.590	0.671	0.233	0.348
1998-4	2.245	18.306	25.213	7.464	11.014	0.107	0.600	0.694	0.242	0.353
1998-5	2.246	18.329	25.318	7.512	11.204	0.107	0.593	0.680	0.242	0.351
1998-6	2.244	18.340	25.300	7.523	11.109	0.108	0.601	0.693	0.242	0.353
1998-7	2.206	19.554	27.602	9.074	14.353	0.114	0.687	0.743	0.251	0.406

Year & Class	Diesel NOx Decel	Diesel NOx 0 to 25	Diesel NOx 25 to 50	Diesel NOx 50 +	Diesel NOx Highway	Diesel PM 2.5 Decel	Diesel PM 2.5 0 to 25	Diesel PM 2.5 25 to 50	Diesel PM 2.5 50 +	Diesel PM 2.5 Highway
1998-8a	1.964	25.756	40.371	17.480	24.102	0.164	1.168	1.085	0.309	0.585
1998-8b	1.832	28.562	46.684	21.466	26.708	0.196	1.392	1.253	0.340	0.636
1999-2b	1.295	6.670	8.794	3.243	4.262	0.202	0.383	0.360	0.104	0.243
1999-3	1.223	10.822	12.620	4.717	6.466	0.127	0.563	0.612	0.221	0.335
1999-4	1.204	11.449	13.461	5.007	6.790	0.107	0.590	0.667	0.244	0.348
1999-5	1.203	11.483	13.516	5.037	6.825	0.108	0.592	0.669	0.244	0.349
1999-6	1.194	11.809	14.030	5.362	7.698	0.110	0.617	0.680	0.247	0.367
1999-7	1.189	12.974	15.714	6.268	9.579	0.115	0.690	0.731	0.254	0.407
1999-8a	1.144	21.275	28.814	13.255	18.180	0.173	1.235	1.135	0.319	0.602
1999-8b	1.131	23.930	33.413	15.631	19.899	0.200	1.421	1.282	0.345	0.646
2000-2b	1.225	6.293	8.339	3.090	4.051	0.190	0.362	0.340	0.098	0.231
2000-3	1.215	10.790	12.556	4.690	6.447	0.126	0.561	0.608	0.218	0.333
2000-4	1.207	11.559	13.618	5.067	6.868	0.108	0.595	0.674	0.244	0.350
2000-5	1.207	11.617	13.712	5.120	6.929	0.108	0.598	0.677	0.244	0.352
2000-6	1.199	11.658	13.811	5.220	7.306	0.109	0.605	0.676	0.245	0.359
2000-7	1.195	13.311	16.205	6.480	10.059	0.117	0.712	0.751	0.257	0.421
2000-8a	1.154	20.299	27.136	12.365	17.480	0.165	1.170	1.087	0.310	0.587
2000-8b	1.139	23.847	33.231	15.521	19.892	0.199	1.419	1.285	0.346	0.649
2001-2b	1.213	5.900	8.032	2.964	3.826	0.191	0.344	0.322	0.091	0.221
2001-3	1.200	10.769	12.526	4.702	6.447	0.123	0.561	0.607	0.221	0.333
2001-4	1.200	11.402	13.403	4.995	6.769	0.107	0.589	0.663	0.244	0.348
2001-5	1.200	11.430	13.448	5.020	6.798	0.108	0.591	0.665	0.244	0.348
2001-6	1.192	11.917	14.196	5.448	7.940	0.111	0.627	0.685	0.248	0.374
2001-7	1.191	12.482	14.988	5.884	8.845	0.113	0.661	0.710	0.252	0.393
2001-8a	1.154	21.091	28.478	13.038	18.127	0.172	1.229	1.135	0.320	0.606
2001-8b	1.138	23.796	33.135	15.488	19.847	0.199	1.414	1.280	0.345	0.647
2002-2b	1.258	6.311	8.439	3.107	4.055	0.197	0.364	0.342	0.097	0.233
2002-3	1.228	10.814	12.585	4.683	6.459	0.130	0.560	0.609	0.213	0.333
2002-4	1.217	11.666	13.745	5.072	6.896	0.108	0.597	0.684	0.242	0.351
2002-5	1.217	11.666	13.745	5.072	6.896	0.108	0.597	0.684	0.242	0.351
2002-6	1.209	11.774	13.946	5.228	7.319	0.108	0.607	0.685	0.244	0.359
2002-7	1.205	12.890	15.559	6.071	9.295	0.114	0.680	0.735	0.252	0.404
2002-8a	1.160	19.605	26.044	11.719	16.916	0.159	1.122	1.050	0.304	0.573
2002-8b	1.127	23.524	32.733	15.282	19.616	0.195	1.390	1.251	0.340	0.635
2003-2b	2.435	6.234	9.630	3.346	4.200	0.168	0.324	0.305	0.088	0.207
2003-3	1.987	9.236	10.579	4.059	5.235	0.112	0.511	0.560	0.198	0.303
2003-4	1.872	9.691	10.789	4.200	5.386	0.097	0.539	0.617	0.219	0.317
2003-5	1.872	9.691	10.789	4.200	5.386	0.097	0.539	0.617	0.219	0.317
2003-6	1.864	9.777	10.919	4.269	5.552	0.098	0.547	0.618	0.220	0.323
2003-7	1.845	10.168	11.399	4.479	6.124	0.103	0.605	0.657	0.227	0.359
2003-8a	1.676	12.845	14.965	6.080	8.651	0.140	0.988	0.929	0.271	0.510
2003-8b	1.536	14.627	17.559	7.227	9.643	0.175	1.249	1.125	0.306	0.573
2004-2b	2.434	6.241	9.627	3.343	4.198	0.158	0.306	0.291	0.085	0.193

Year & Class	Diesel NOx Decel	Diesel NOx 0 to 25	Diesel NOx 25 to 50	Diesel NOx 50 +	Diesel NOx Highway	Diesel PM 2.5 Decel	Diesel PM 2.5 0 to 25	Diesel PM 2.5 25 to 50	Diesel PM 2.5 50 +	Diesel PM 2.5 Highway
2004-3	1.989	9.230	10.576	4.057	5.233	0.110	0.508	0.557	0.197	0.301
2004-4	1.872	9.691	10.790	4.200	5.387	0.097	0.539	0.617	0.219	0.317
2004-5	1.872	9.691	10.790	4.200	5.387	0.097	0.539	0.617	0.219	0.317
2004-6	1.863	9.786	10.929	4.274	5.564	0.098	0.548	0.619	0.220	0.324
2004-7	1.843	10.208	11.449	4.501	6.178	0.103	0.610	0.661	0.227	0.362
2004-8a	1.668	12.946	15.107	6.145	8.718	0.142	1.002	0.939	0.273	0.514
2004-8b	1.534	14.649	17.592	7.243	9.652	0.176	1.252	1.127	0.306	0.573
2005-2b	2.439	6.183	9.622	3.340	4.185	0.158	0.301	0.286	0.083	0.191
2005-3	1.994	9.207	10.569	4.051	5.226	0.110	0.507	0.554	0.196	0.300
2005-4	1.872	9.692	10.791	4.201	5.387	0.097	0.539	0.617	0.219	0.317
2005-5	1.872	9.692	10.791	4.201	5.387	0.097	0.539	0.617	0.219	0.317
2005-6	1.864	9.789	10.931	4.274	5.565	0.098	0.549	0.619	0.220	0.324
2005-7	1.843	10.212	11.453	4.503	6.181	0.103	0.611	0.661	0.227	0.362
2005-8a	1.668	12.950	15.113	6.148	8.720	0.142	1.002	0.939	0.273	0.514
2005-8b	1.534	14.648	17.589	7.243	9.651	0.176	1.251	1.126	0.306	0.573
2006-2b	1.936	5.188	7.435	2.503	3.278	0.158	0.295	0.281	0.080	0.187
2006-3	1.886	9.094	10.175	3.918	5.116	0.107	0.491	0.538	0.190	0.290
2006-4	1.872	9.693	10.792	4.202	5.388	0.094	0.520	0.595	0.211	0.305
2006-5	1.872	9.693	10.792	4.202	5.388	0.094	0.520	0.595	0.211	0.305
2006-6	1.863	9.801	10.946	4.281	5.583	0.095	0.532	0.599	0.213	0.314
2006-7	1.840	10.268	11.523	4.534	6.255	0.101	0.601	0.646	0.221	0.357
2006-8a	1.658	13.077	15.291	6.229	8.800	0.142	1.010	0.942	0.272	0.514
2006-8b	1.531	14.674	17.628	7.262	9.662	0.175	1.249	1.124	0.305	0.571
2007-2b	0.902	2.428	3.462	1.171	1.540	0.007	0.015	0.020	0.010	0.011
2007-3	0.930	4.532	5.048	1.949	2.548	0.004	0.024	0.030	0.013	0.015
2007-4	0.936	4.847	5.397	2.101	2.694	0.004	0.025	0.032	0.013	0.016
2007-5	0.936	4.847	5.397	2.101	2.694	0.004	0.025	0.032	0.013	0.016
2007-6	0.933	4.880	5.448	2.128	2.759	0.004	0.025	0.032	0.013	0.016
2007-7	0.926	5.028	5.628	2.207	2.980	0.004	0.027	0.035	0.014	0.018
2007-8a	0.852	6.230	7.214	2.920	4.192	0.003	0.040	0.061	0.017	0.027
2007-8b	0.773	7.256	8.692	3.576	4.794	0.003	0.051	0.085	0.020	0.031
2008-2b	0.865	2.484	3.401	1.168	1.554	0.004	0.009	0.011	0.006	0.006
2008-3	0.925	4.605	5.115	1.981	2.581	0.003	0.015	0.018	0.008	0.009
2008-4	0.936	4.847	5.397	2.101	2.695	0.002	0.015	0.020	0.008	0.010
2008-5	0.936	4.847	5.397	2.101	2.695	0.002	0.015	0.020	0.008	0.010
2008-6	0.933	4.880	5.447	2.128	2.758	0.002	0.016	0.020	0.008	0.010
2008-7	0.926	5.024	5.623	2.205	2.974	0.002	0.017	0.022	0.008	0.011
2008-8a	0.853	6.215	7.193	2.911	4.180	0.002	0.025	0.038	0.011	0.017
2008-8b	0.773	7.251	8.683	3.573	4.791	0.002	0.032	0.054	0.013	0.020
2009-2b	0.867	2.577	3.456	1.196	1.601	0.004	0.009	0.011	0.006	0.006
2009-3	0.927	4.646	5.161	2.001	2.600	0.003	0.015	0.019	0.008	0.009
2009-4	0.936	4.848	5.398	2.102	2.695	0.002	0.016	0.020	0.008	0.010
2009-5	0.936	4.848	5.398	2.102	2.695	0.002	0.016	0.020	0.008	0.010

Year & Class	Diesel NOx Decel	Diesel NOx 0 to 25	Diesel NOx 25 to 50	Diesel NOx 50 +	Diesel NOx Highway	Diesel PM 2.5 Decel	Diesel PM 2.5 0 to 25	Diesel PM 2.5 25 to 50	Diesel PM 2.5 50 +	Diesel PM 2.5 Highway
2009-6	0.933	4.881	5.447	2.128	2.758	0.002	0.016	0.020	0.008	0.010
2009-7	0.926	5.023	5.622	2.204	2.972	0.002	0.017	0.022	0.008	0.011
2009-8a	0.853	6.209	7.184	2.907	4.175	0.002	0.025	0.038	0.011	0.017
2009-8b	0.773	7.247	8.678	3.571	4.789	0.002	0.032	0.054	0.013	0.020
2010-2b	0.228	0.643	0.913	0.315	0.410	0.004	0.009	0.011	0.006	0.006
2010-3	0.210	1.022	1.147	0.442	0.573	0.003	0.015	0.018	0.008	0.009
2010-4	0.206	1.066	1.187	0.461	0.592	0.002	0.015	0.019	0.008	0.009
2010-5	0.206	1.066	1.187	0.461	0.592	0.002	0.015	0.019	0.008	0.009
2010-6	0.205	1.073	1.197	0.466	0.606	0.002	0.015	0.020	0.008	0.010
2010-7	0.204	1.111	1.242	0.486	0.659	0.002	0.016	0.021	0.008	0.011
2010-8a	0.193	1.421	1.643	0.664	0.965	0.002	0.024	0.037	0.010	0.016
2010-8b	0.181	1.700	2.035	0.837	1.126	0.002	0.031	0.053	0.012	0.020
2011-2b	0.228	0.648	0.915	0.317	0.412	0.004	0.009	0.011	0.006	0.006
2011-3	0.210	1.024	1.150	0.443	0.574	0.003	0.015	0.018	0.008	0.009
2011-4	0.206	1.067	1.187	0.461	0.592	0.002	0.015	0.019	0.008	0.009
2011-5	0.206	1.067	1.187	0.461	0.592	0.002	0.015	0.019	0.008	0.009
2011-6	0.205	1.073	1.197	0.466	0.605	0.002	0.015	0.020	0.008	0.010
2011-7	0.205	1.110	1.241	0.485	0.658	0.002	0.016	0.021	0.008	0.011
2011-8a	0.194	1.416	1.636	0.661	0.961	0.002	0.024	0.037	0.010	0.016
2011-8b	0.181	1.698	2.032	0.836	1.125	0.002	0.031	0.052	0.012	0.020

Year & Class	Gasoline NOx Decel	Gasoline NOx 0 to 25	Gasoline NOx 25 to 50	Gasoline NOx 50 +	Gasoline NOx Highway	Gasoline PM 2.5 Decel	Gasoline PM 2.5 0 to 25	Gasoline PM 2.5 25 to 50	Gasoline PM 2.5 50 +	Gasoline PM 2.5 Highway
1988-2b	0.246	3.747	7.567	3.777	4.362	0.006	0.050	0.082	0.054	0.055
1988-3	0.287	7.266	11.018	6.138	7.094	0.007	0.061	0.040	0.062	0.054
1988-4	0.285	7.078	11.096	6.173	7.171	0.007	0.061	0.040	0.062	0.055
1988-5	0.294	7.944	11.102	6.154	7.271	0.006	0.062	0.042	0.061	0.054
1988-6	0.297	7.949	11.039	6.121	7.200	0.006	0.061	0.041	0.060	0.053
1988-7	0.307	7.809	10.733	5.973	6.848	0.006	0.060	0.039	0.060	0.052
1988-8a	0.311	10.016	12.287	6.583	8.431	0.006	0.063	0.052	0.058	0.055
1988-8b	0.311	10.016	12.287	6.583	8.431	0.006	0.063	0.052	0.058	0.055
1989-2b	0.246	3.905	7.670	3.858	4.479	0.006	0.050	0.081	0.054	0.055
1989-3	0.286	7.113	10.950	6.116	6.992	0.007	0.061	0.039	0.062	0.054
1989-4	0.285	6.991	11.039	6.151	7.087	0.007	0.061	0.039	0.062	0.054
1989-5	0.302	7.576	10.668	5.968	6.744	0.006	0.060	0.038	0.060	0.052
1989-6	0.295	7.441	10.733	6.015	6.784	0.006	0.061	0.039	0.061	0.053
1989-7	0.300	7.538	10.686	5.981	6.755	0.006	0.060	0.038	0.060	0.052
1989-8a	0.424	11.067	7.912	1.733	6.217	0.006	0.041	0.016	0.010	0.044
1989-8b	0.424	11.067	7.912	1.733	6.217	0.006	0.041	0.016	0.010	0.044
1990-2b	0.154	4.121	7.535	3.214	4.050	0.002	0.016	0.070	0.054	0.054
1990-3	0.150	5.337	7.730	3.370	4.453	0.002	0.013	0.019	0.039	0.035

Year & Class	Gasoline NOx Decel	Gasoline NOx 0 to 25	Gasoline NOx 25 to 50	Gasoline NOx 50 +	Gasoline NOx Highway	Gasoline PM 2.5 Decel	Gasoline PM 2.5 0 to 25	Gasoline PM 2.5 25 to 50	Gasoline PM 2.5 50 +	Gasoline PM 2.5 Highway
1990-4	0.149	5.247	7.797	3.395	4.529	0.002	0.014	0.019	0.039	0.036
1990-5	0.154	5.539	7.609	3.319	4.336	0.002	0.013	0.019	0.038	0.034
1990-6	0.155	5.567	7.600	3.313	4.332	0.002	0.013	0.019	0.038	0.034
1990-7	0.163	5.783	7.529	3.262	4.308	0.002	0.013	0.019	0.037	0.033
1990-8a	0.232	8.568	6.042	1.025	4.151	0.002	0.008	0.010	0.006	0.028
1990-8b	0.232	8.568	6.042	1.025	4.151	0.002	0.008	0.010	0.006	0.028
1991-2b	0.158	3.719	7.457	3.157	3.931	0.006	0.069	0.046	0.021	0.032
1991-3	0.150	5.338	7.770	3.379	4.474	0.006	0.075	0.019	0.017	0.028
1991-4	0.149	5.295	7.788	3.388	4.497	0.006	0.074	0.019	0.017	0.029
1991-5	0.151	5.438	7.727	3.358	4.417	0.006	0.075	0.019	0.017	0.028
1991-6	0.153	5.542	7.682	3.336	4.359	0.006	0.075	0.019	0.017	0.028
1991-7	0.152	5.522	7.689	3.340	4.361	0.006	0.075	0.019	0.017	0.028
1991-8a	0.163	5.816	7.588	3.271	4.324	0.006	0.075	0.019	0.017	0.027
1991-8b	0.163	5.816	7.588	3.271	4.324	0.006	0.075	0.019	0.017	0.027
1992-2b	0.139	3.406	6.793	2.888	3.608	0.005	0.052	0.035	0.016	0.024
1992-3	0.149	5.270	7.797	3.392	4.512	0.004	0.056	0.015	0.013	0.022
1992-4	0.149	5.240	7.813	3.399	4.538	0.004	0.056	0.015	0.013	0.022
1992-5	0.148	5.334	7.762	3.379	4.457	0.004	0.057	0.015	0.013	0.022
1992-6	0.149	5.452	7.702	3.353	4.368	0.004	0.057	0.015	0.013	0.021
1992-7	0.149	5.444	7.705	3.355	4.370	0.004	0.057	0.015	0.013	0.021
1992-8a	0.149	5.464	7.699	3.350	4.367	0.004	0.057	0.015	0.013	0.021
1992-8b	0.149	5.464	7.699	3.350	4.367	0.004	0.057	0.015	0.013	0.021
1993-2b	0.140	3.714	6.874	2.937	3.721	0.005	0.053	0.033	0.016	0.024
1993-3	0.150	5.316	7.739	3.375	4.464	0.004	0.056	0.015	0.013	0.022
1993-4	0.149	5.262	7.780	3.389	4.509	0.004	0.056	0.015	0.013	0.022
1993-5	0.154	5.435	7.704	3.350	4.444	0.004	0.056	0.015	0.013	0.021
1993-6	0.153	5.518	7.609	3.322	4.336	0.004	0.057	0.014	0.013	0.021
1993-7	0.160	5.686	7.555	3.284	4.317	0.004	0.057	0.014	0.013	0.021
1993-8a	0.163	5.767	7.529	3.265	4.308	0.005	0.057	0.014	0.013	0.021
1993-8b	0.163	5.767	7.529	3.265	4.308	0.005	0.057	0.014	0.013	0.021
1994-2b	0.116	3.251	6.347	2.761	3.400	0.003	0.012	0.039	0.068	0.039
1994-3	0.146	5.232	7.587	3.311	4.366	0.003	0.011	0.042	0.115	0.056
1994-4	0.146	5.166	7.643	3.330	4.429	0.003	0.011	0.043	0.115	0.056
1994-5	0.148	5.207	7.633	3.322	4.425	0.003	0.011	0.042	0.114	0.056
1994-6	0.148	5.361	7.494	3.276	4.267	0.003	0.011	0.042	0.115	0.056
1994-7	0.156	5.558	7.432	3.232	4.244	0.003	0.011	0.041	0.113	0.054
1994-8a	0.227	8.415	5.934	1.006	4.077	0.004	0.014	0.021	0.025	0.040
1994-8b	0.227	8.415	5.934	1.006	4.077	0.004	0.014	0.021	0.025	0.040
1995-2b	0.115	3.273	6.367	2.770	3.415	0.003	0.015	0.035	0.019	0.025
1995-3	0.146	5.262	7.594	3.309	4.356	0.003	0.017	0.012	0.017	0.019
1995-4	0.146	5.194	7.640	3.326	4.418	0.003	0.017	0.012	0.017	0.019
1995-5	0.147	5.232	7.621	3.317	4.396	0.003	0.017	0.012	0.017	0.019
1995-6	0.152	5.473	7.498	3.261	4.265	0.003	0.017	0.012	0.016	0.018

Year & Class	Gasoline NOx Decel	Gasoline NOx 0 to 25	Gasoline NOx 25 to 50	Gasoline NOx 50 +	Gasoline NOx Highway	Gasoline PM 2.5 Decel	Gasoline PM 2.5 0 to 25	Gasoline PM 2.5 25 to 50	Gasoline PM 2.5 50 +	Gasoline PM 2.5 Highway
1995-7	0.151	5.445	7.507	3.267	4.269	0.003	0.017	0.012	0.017	0.019
1995-8a	0.227	8.415	5.934	1.006	4.077	0.003	0.015	0.006	0.003	0.015
1995-8b	0.227	8.415	5.934	1.006	4.077	0.003	0.015	0.006	0.003	0.015
1996-2b	0.099	1.972	3.775	1.918	2.085	0.003	0.011	0.043	0.008	0.019
1996-3	0.146	5.224	7.612	3.317	4.382	0.003	0.013	0.015	0.008	0.015
1996-4	0.146	5.168	7.651	3.331	4.433	0.003	0.013	0.015	0.008	0.015
1996-5	0.146	5.178	7.648	3.329	4.431	0.003	0.013	0.015	0.008	0.015
1996-6	0.147	5.345	7.531	3.287	4.280	0.003	0.013	0.015	0.008	0.015
1996-7	0.150	5.415	7.509	3.272	4.270	0.003	0.012	0.015	0.008	0.014
1996-8a	0.227	8.415	5.934	1.006	4.077	0.003	0.009	0.008	0.001	0.012
1996-8b	0.227	8.415	5.934	1.006	4.077	0.003	0.009	0.008	0.001	0.012
1997-2b	0.096	1.629	3.244	1.526	1.802	0.001	0.007	0.028	0.017	0.018
1997-3	0.146	5.228	7.555	3.305	4.345	0.001	0.007	0.010	0.022	0.015
1997-4	0.146	5.141	7.655	3.335	4.449	0.001	0.007	0.010	0.022	0.016
1997-5	0.146	5.171	7.622	3.325	4.415	0.001	0.007	0.010	0.022	0.016
1997-6	0.147	5.321	7.469	3.276	4.260	0.001	0.007	0.010	0.022	0.015
1997-7	0.150	5.372	7.454	3.265	4.254	0.001	0.007	0.010	0.022	0.015
1997-8a	0.227	8.415	5.934	1.006	4.077	0.001	0.004	0.004	0.003	0.012
1997-8b	0.227	8.415	5.934	1.006	4.077	0.001	0.004	0.004	0.003	0.012
1998-2b	0.128	1.318	3.079	1.589	1.681	0.001	0.008	0.026	0.010	0.014
1998-3	0.291	3.186	4.932	3.040	3.128	0.002	0.006	0.011	0.009	0.011
1998-4	0.290	3.124	4.956	3.054	3.157	0.002	0.006	0.011	0.009	0.011
1998-5	0.291	3.185	4.932	3.040	3.128	0.002	0.006	0.011	0.009	0.011
1998-6	0.292	3.224	4.914	3.029	3.108	0.002	0.006	0.011	0.009	0.011
1998-7	0.294	3.238	4.903	3.021	3.098	0.002	0.006	0.011	0.009	0.010
1998-8a	0.404	4.413	3.394	0.769	2.718	0.002	0.005	0.005	0.002	0.008
1998-8b	0.404	4.413	3.394	0.769	2.718	0.002	0.005	0.005	0.002	0.008
1999-2b	0.135	1.332	3.117	1.609	1.698	0.000	0.004	0.025	0.005	0.014
1999-3	0.290	3.204	4.927	3.038	3.120	0.000	0.003	0.005	0.002	0.009
1999-4	0.290	3.180	4.936	3.043	3.132	0.000	0.003	0.005	0.002	0.009
1999-5	0.290	3.173	4.938	3.043	3.135	0.000	0.003	0.005	0.002	0.009
1999-6	0.291	3.175	4.937	3.042	3.133	0.000	0.003	0.005	0.002	0.009
1999-7	0.291	3.221	4.917	3.031	3.110	0.000	0.003	0.005	0.002	0.009
1999-8a	0.292	3.224	4.915	3.030	3.109	0.000	0.003	0.005	0.002	0.009
1999-8b	0.292	3.224	4.915	3.030	3.109	0.000	0.003	0.005	0.002	0.009
2000-2b	0.130	1.298	3.082	1.584	1.669	0.000	0.003	0.023	0.006	0.014
2000-3	0.290	3.205	4.928	3.037	3.120	0.000	0.002	0.004	0.004	0.008
2000-4	0.290	3.183	4.936	3.042	3.131	0.000	0.002	0.004	0.004	0.008
2000-5	0.290	3.176	4.938	3.043	3.133	0.001	0.002	0.004	0.004	0.008
2000-6	0.291	3.178	4.936	3.042	3.132	0.001	0.002	0.004	0.004	0.008
2000-7	0.291	3.221	4.918	3.031	3.111	0.001	0.002	0.004	0.004	0.008
2000-8a	0.291	3.224	4.917	3.030	3.110	0.001	0.002	0.004	0.004	0.008
2000-8b	0.291	3.224	4.917	3.030	3.110	0.001	0.002	0.004	0.004	0.008

Year & Class	Gasoline NOx Decel	Gasoline NOx 0 to 25	Gasoline NOx 25 to 50	Gasoline NOx 50 +	Gasoline NOx Highway	Gasoline PM 2.5 Decel	Gasoline PM 2.5 0 to 25	Gasoline PM 2.5 25 to 50	Gasoline PM 2.5 50 +	Gasoline PM 2.5 Highway
2001-2b	0.094	1.003	2.196	1.217	1.315	0.000	0.004	0.023	0.006	0.013
2001-3	0.304	3.368	5.176	3.190	3.277	0.000	0.001	0.006	0.014	0.012
2001-4	0.304	3.346	5.184	3.194	3.287	0.000	0.001	0.006	0.014	0.012
2001-5	0.305	3.339	5.185	3.195	3.290	0.000	0.001	0.006	0.014	0.012
2001-6	0.305	3.341	5.184	3.194	3.288	0.000	0.001	0.006	0.014	0.012
2001-7	0.306	3.383	5.167	3.184	3.268	0.000	0.001	0.006	0.014	0.012
2001-8a	0.306	3.385	5.165	3.183	3.267	0.000	0.001	0.006	0.014	0.012
2001-8b	0.306	3.385	5.165	3.183	3.267	0.000	0.001	0.006	0.014	0.012
2002-2b	0.078	0.875	1.909	1.059	1.146	0.001	0.006	0.015	0.005	0.008
2002-3	0.304	3.369	5.176	3.190	3.277	0.001	0.004	0.007	0.003	0.005
2002-4	0.304	3.349	5.183	3.194	3.286	0.001	0.004	0.007	0.003	0.005
2002-5	0.305	3.342	5.185	3.195	3.289	0.001	0.004	0.007	0.003	0.005
2002-6	0.305	3.344	5.183	3.193	3.287	0.001	0.004	0.007	0.003	0.005
2002-7	0.305	3.383	5.168	3.184	3.269	0.001	0.004	0.007	0.003	0.005
2002-8a	0.306	3.385	5.166	3.183	3.267	0.001	0.004	0.007	0.003	0.005
2002-8b	0.306	3.385	5.166	3.183	3.267	0.001	0.004	0.007	0.003	0.005
2003-2b	0.081	0.930	2.014	1.116	1.208	0.000	0.004	0.017	0.004	0.009
2003-3	0.304	3.370	5.177	3.190	3.277	0.000	0.003	0.003	0.004	0.006
2003-4	0.304	3.352	5.184	3.194	3.286	0.000	0.003	0.003	0.004	0.006
2003-5	0.305	3.345	5.185	3.194	3.288	0.000	0.003	0.003	0.004	0.006
2003-6	0.305	3.347	5.183	3.193	3.286	0.000	0.003	0.003	0.004	0.006
2003-7	0.305	3.383	5.169	3.185	3.270	0.000	0.003	0.003	0.004	0.006
2003-8a	0.306	3.385	5.168	3.184	3.268	0.000	0.003	0.003	0.004	0.006
2003-8b	0.306	3.385	5.168	3.184	3.268	0.000	0.003	0.003	0.004	0.006
2004-2b	0.063	0.695	1.256	0.724	0.821	0.001	0.005	0.014	0.006	0.007
2004-3	0.296	3.276	5.032	3.100	3.185	0.001	0.005	0.006	0.005	0.006
2004-4	0.296	3.260	5.038	3.103	3.192	0.001	0.005	0.006	0.005	0.006
2004-5	0.296	3.254	5.039	3.104	3.194	0.001	0.005	0.006	0.005	0.006
2004-6	0.296	3.256	5.037	3.103	3.193	0.001	0.005	0.006	0.005	0.006
2004-7	0.297	3.288	5.025	3.096	3.178	0.001	0.005	0.006	0.005	0.006
2004-8a	0.297	3.289	5.024	3.095	3.177	0.001	0.005	0.006	0.005	0.006
2004-8b	0.297	3.289	5.024	3.095	3.177	0.001	0.005	0.006	0.005	0.006
2005-2b	0.055	0.522	1.006	0.574	0.638	0.001	0.005	0.014	0.006	0.007
2005-3	0.296	3.277	5.032	3.100	3.185	0.001	0.005	0.006	0.005	0.006
2005-4	0.296	3.262	5.038	3.103	3.192	0.001	0.005	0.006	0.005	0.006
2005-5	0.296	3.257	5.039	3.103	3.194	0.001	0.005	0.006	0.005	0.006
2005-6	0.296	3.258	5.037	3.103	3.192	0.001	0.005	0.006	0.005	0.006
2005-7	0.296	3.288	5.026	3.096	3.179	0.001	0.005	0.006	0.005	0.006
2005-8a	0.297	3.289	5.025	3.095	3.178	0.001	0.005	0.006	0.005	0.006
2005-8b	0.297	3.289	5.025	3.095	3.178	0.001	0.005	0.006	0.005	0.006
2006-2b	0.042	0.392	0.707	0.413	0.466	0.001	0.004	0.012	0.005	0.007
2006-3	0.240	2.657	4.079	2.512	2.532	0.001	0.004	0.005	0.005	0.005
2006-4	0.240	2.647	4.083	2.515	2.539	0.001	0.004	0.005	0.005	0.005

Year & Class	Gasoline NOx Decel	Gasoline NOx 0 to 25	Gasoline NOx 25 to 50	Gasoline NOx 50 +	Gasoline NOx Highway	Gasoline PM 2.5 Decel	Gasoline PM 2.5 0 to 25	Gasoline PM 2.5 25 to 50	Gasoline PM 2.5 50 +	Gasoline PM 2.5 Highway
2006-5	0.240	2.643	4.084	2.515	2.541	0.001	0.004	0.005	0.005	0.005
2006-6	0.240	2.644	4.083	2.515	2.541	0.001	0.004	0.005	0.005	0.005
2006-7	0.240	2.665	4.075	2.509	2.528	0.001	0.004	0.005	0.005	0.005
2006-8a	0.240	2.666	4.074	2.509	2.528	0.001	0.004	0.005	0.005	0.005
2006-8b	0.240	2.666	4.074	2.509	2.528	0.001	0.004	0.005	0.005	0.005
2007-2b	0.041	0.394	0.691	0.408	0.465	0.001	0.004	0.012	0.005	0.007
2007-3	0.237	2.632	4.040	2.488	2.508	0.001	0.004	0.005	0.005	0.005
2007-4	0.237	2.622	4.044	2.490	2.513	0.001	0.004	0.005	0.005	0.005
2007-5	0.237	2.619	4.044	2.490	2.516	0.001	0.004	0.005	0.005	0.005
2007-6	0.238	2.620	4.043	2.490	2.515	0.001	0.004	0.005	0.005	0.005
2007-7	0.238	2.639	4.036	2.485	2.504	0.001	0.004	0.005	0.005	0.005
2007-8a	0.238	2.640	4.035	2.484	2.503	0.001	0.004	0.005	0.005	0.005
2007-8b	0.238	2.640	4.035	2.484	2.503	0.001	0.004	0.005	0.005	0.005
2008-2b	0.043	0.478	0.732	0.449	0.525	0.000	0.003	0.008	0.003	0.004
2008-3	0.237	2.633	4.040	2.488	2.508	0.001	0.003	0.003	0.003	0.003
2008-4	0.237	2.624	4.044	2.490	2.513	0.001	0.003	0.003	0.003	0.003
2008-5	0.237	2.621	4.044	2.490	2.515	0.001	0.003	0.003	0.003	0.003
2008-6	0.238	2.622	4.043	2.489	2.514	0.001	0.003	0.003	0.003	0.003
2008-7	0.238	2.639	4.037	2.485	2.504	0.001	0.003	0.003	0.003	0.003
2008-8a	0.238	2.640	4.036	2.485	2.504	0.001	0.003	0.003	0.003	0.003
2008-8b	0.238	2.640	4.036	2.485	2.504	0.001	0.003	0.003	0.003	0.003
2009-2b	0.046	0.537	0.791	0.490	0.580	0.000	0.003	0.008	0.003	0.004
2009-3	0.237	2.634	4.041	2.488	2.508	0.001	0.003	0.003	0.003	0.003
2009-4	0.237	2.626	4.044	2.489	2.512	0.001	0.003	0.003	0.003	0.003
2009-5	0.237	2.623	4.044	2.490	2.514	0.001	0.003	0.003	0.003	0.003
2009-6	0.238	2.623	4.043	2.489	2.514	0.001	0.003	0.003	0.003	0.003
2009-7	0.238	2.639	4.038	2.485	2.505	0.001	0.003	0.003	0.003	0.003
2009-8a	0.238	2.640	4.037	2.485	2.504	0.001	0.003	0.003	0.003	0.003
2009-8b	0.238	2.640	4.037	2.485	2.504	0.001	0.003	0.003	0.003	0.003
2010-2b	0.042	0.459	0.707	0.434	0.506	0.000	0.003	0.008	0.003	0.004
2010-3	0.237	2.634	4.042	2.488	2.508	0.001	0.003	0.003	0.003	0.003
2010-4	0.237	2.627	4.044	2.489	2.512	0.001	0.003	0.003	0.003	0.003
2010-5	0.237	2.624	4.045	2.490	2.514	0.001	0.003	0.003	0.003	0.003
2010-6	0.237	2.625	4.044	2.489	2.513	0.001	0.003	0.003	0.003	0.003
2010-7	0.238	2.639	4.039	2.486	2.505	0.001	0.003	0.003	0.003	0.003
2010-8a	0.238	2.640	4.038	2.485	2.505	0.001	0.003	0.003	0.003	0.003
2010-8b	0.238	2.640	4.038	2.485	2.505	0.001	0.003	0.003	0.003	0.003
2011-2b	0.043	0.478	0.726	0.447	0.524	0.000	0.003	0.008	0.003	0.004
2011-3	0.237	2.635	4.042	2.488	2.508	0.001	0.003	0.003	0.003	0.003
2011-4	0.237	2.628	4.044	2.489	2.512	0.001	0.003	0.003	0.003	0.003
2011-5	0.237	2.626	4.045	2.489	2.513	0.001	0.003	0.003	0.003	0.003
2011-6	0.237	2.626	4.044	2.489	2.513	0.001	0.003	0.003	0.003	0.003
2011-7	0.237	2.639	4.040	2.486	2.505	0.001	0.003	0.003	0.003	0.003

Year & Class	Gasoline NOx Decel	Gasoline NOx 0 to 25	Gasoline NOx 25 to 50	Gasoline NOx 50 +	Gasoline NOx Highway	Gasoline PM 2.5 Decel	Gasoline PM 2.5 0 to 25	Gasoline PM 2.5 25 to 50	Gasoline PM 2.5 50 +	Gasoline PM 2.5 Highway
2011-8a	0.238	2.640	4.039	2.486	2.505	0.001	0.003	0.003	0.003	0.003
2011-8b	0.238	2.640	4.039	2.486	2.505	0.001	0.003	0.003	0.003	0.003

Note – highlighted cells are set equal to the row above (MOVES does not provide consistent outputs for Class 8b gasoline vehicles; therefore 8bs are set equal to 8as).

Year & Class	E10 NOx Decel	E10 NOx 0 to 25	E10 NOx 25 to 50	E10 NOx 50 +	E10 NOx Highway	E10 PM 2.5 Decel	E10 PM 2.5 0 to 25	E10 PM 2.5 25 to 50	E10 PM 2.5 50 +	E10 PM 2.5 Highway
1988-2b	0.268	4.087	8.254	4.120	4.758	0.006	0.050	0.082	0.054	0.055
1988-3	0.313	7.925	12.018	6.695	7.737	0.007	0.062	0.040	0.062	0.054
1988-4	0.310	7.720	12.102	6.733	7.821	0.007	0.062	0.040	0.062	0.055
1988-5	0.321	8.665	12.109	6.712	7.931	0.006	0.062	0.042	0.061	0.054
1988-6	0.324	8.670	12.041	6.676	7.853	0.006	0.062	0.041	0.061	0.053
1988-7	0.334	8.518	11.706	6.515	7.469	0.006	0.060	0.039	0.060	0.052
1988-8a	0.340	10.924	13.402	7.180	9.196	0.006	0.063	0.052	0.058	0.055
1988-8b	0.340	10.924	13.402	7.180	9.196	0.006	0.063	0.052	0.058	0.055
1989-2b	0.268	4.259	8.366	4.208	4.885	0.006	0.051	0.081	0.055	0.055
1989-3	0.312	7.758	11.943	6.671	7.627	0.007	0.062	0.039	0.062	0.054
1989-4	0.311	7.625	12.040	6.709	7.730	0.007	0.062	0.040	0.062	0.055
1989-5	0.329	8.263	11.636	6.509	7.356	0.006	0.060	0.038	0.061	0.052
1989-6	0.321	8.116	11.707	6.561	7.400	0.007	0.061	0.039	0.061	0.053
1989-7	0.327	8.222	11.656	6.524	7.368	0.006	0.061	0.039	0.061	0.052
1989-8a	0.462	12.071	8.630	1.890	6.781	0.006	0.042	0.016	0.010	0.044
1989-8b	0.462	12.071	8.630	1.890	6.781	0.006	0.042	0.016	0.010	0.044
1990-2b	0.168	4.495	8.218	3.506	4.418	0.002	0.016	0.071	0.054	0.054
1990-3	0.163	5.821	8.431	3.676	4.857	0.002	0.014	0.019	0.039	0.035
1990-4	0.163	5.723	8.505	3.703	4.940	0.002	0.014	0.019	0.039	0.036
1990-5	0.168	6.041	8.299	3.620	4.729	0.002	0.013	0.019	0.038	0.034
1990-6	0.169	6.072	8.289	3.613	4.726	0.002	0.013	0.019	0.038	0.034
1990-7	0.178	6.308	8.212	3.558	4.699	0.002	0.013	0.019	0.037	0.033
1990-8a	0.253	9.346	6.590	1.118	4.528	0.002	0.008	0.010	0.006	0.028
1990-8b	0.253	9.346	6.590	1.118	4.528	0.002	0.008	0.010	0.006	0.028
1991-2b	0.172	4.057	8.134	3.444	4.287	0.006	0.069	0.046	0.021	0.032
1991-3	0.163	5.823	8.475	3.685	4.879	0.006	0.075	0.019	0.017	0.029
1991-4	0.162	5.776	8.495	3.695	4.905	0.006	0.075	0.020	0.017	0.029
1991-5	0.165	5.932	8.428	3.662	4.818	0.006	0.075	0.019	0.017	0.028
1991-6	0.166	6.045	8.379	3.638	4.754	0.006	0.076	0.019	0.017	0.028
1991-7	0.165	6.023	8.386	3.643	4.757	0.006	0.076	0.019	0.017	0.028
1991-8a	0.178	6.344	8.277	3.568	4.716	0.006	0.075	0.019	0.017	0.027
1991-8b	0.178	6.344	8.277	3.568	4.716	0.006	0.075	0.019	0.017	0.027
1992-2b	0.152	3.715	7.409	3.150	3.935	0.005	0.052	0.035	0.016	0.025

Year & Class	E10 NOx Decel	E10 NOx 0 to 25	E10 NOx 25 to 50	E10 NOx 50 +	E10 NOx Highway	E10 PM 2.5 Decel	E10 PM 2.5 0 to 25	E10 PM 2.5 25 to 50	E10 PM 2.5 50 +	E10 PM 2.5 Highway
1992-3	0.162	5.748	8.504	3.700	4.921	0.004	0.057	0.015	0.013	0.022
1992-4	0.162	5.715	8.522	3.707	4.949	0.004	0.056	0.015	0.013	0.022
1992-5	0.162	5.818	8.467	3.685	4.861	0.004	0.057	0.015	0.013	0.022
1992-6	0.162	5.947	8.401	3.657	4.765	0.004	0.058	0.015	0.013	0.021
1992-7	0.162	5.938	8.404	3.659	4.766	0.004	0.058	0.015	0.013	0.021
1992-8a	0.163	5.960	8.397	3.654	4.763	0.004	0.058	0.015	0.013	0.021
1992-8b	0.163	5.960	8.397	3.654	4.763	0.004	0.058	0.015	0.013	0.021
1993-2b	0.153	4.051	7.498	3.204	4.058	0.005	0.053	0.033	0.016	0.024
1993-3	0.163	5.799	8.441	3.681	4.869	0.004	0.057	0.015	0.013	0.022
1993-4	0.162	5.739	8.486	3.697	4.918	0.004	0.056	0.015	0.013	0.022
1993-5	0.168	5.928	8.403	3.654	4.848	0.004	0.057	0.015	0.013	0.021
1993-6	0.167	6.019	8.299	3.623	4.730	0.004	0.057	0.015	0.013	0.021
1993-7	0.174	6.202	8.241	3.582	4.709	0.004	0.057	0.014	0.013	0.021
1993-8a	0.178	6.290	8.212	3.561	4.699	0.005	0.057	0.014	0.013	0.021
1993-8b	0.178	6.290	8.212	3.561	4.699	0.005	0.057	0.014	0.013	0.021
1994-2b	0.126	3.546	6.923	3.012	3.709	0.003	0.012	0.039	0.069	0.039
1994-3	0.160	5.707	8.275	3.611	4.762	0.003	0.011	0.042	0.115	0.056
1994-4	0.159	5.634	8.336	3.632	4.831	0.003	0.011	0.043	0.115	0.056
1994-5	0.161	5.680	8.325	3.623	4.826	0.003	0.011	0.043	0.115	0.056
1994-6	0.162	5.847	8.174	3.573	4.655	0.003	0.011	0.042	0.115	0.056
1994-7	0.170	6.063	8.106	3.526	4.629	0.003	0.012	0.041	0.113	0.054
1994-8a	0.248	9.179	6.472	1.098	4.447	0.004	0.014	0.021	0.025	0.040
1994-8b	0.248	9.179	6.472	1.098	4.447	0.004	0.014	0.021	0.025	0.040
1995-2b	0.125	3.570	6.944	3.022	3.724	0.003	0.015	0.035	0.019	0.025
1995-3	0.160	5.739	8.283	3.609	4.752	0.003	0.017	0.012	0.017	0.019
1995-4	0.160	5.665	8.333	3.628	4.819	0.003	0.017	0.012	0.017	0.019
1995-5	0.161	5.706	8.312	3.618	4.795	0.003	0.017	0.012	0.017	0.019
1995-6	0.166	5.970	8.178	3.557	4.652	0.003	0.017	0.012	0.017	0.019
1995-7	0.164	5.939	8.188	3.563	4.656	0.003	0.017	0.012	0.017	0.019
1995-8a	0.248	9.179	6.472	1.098	4.447	0.003	0.015	0.006	0.003	0.015
1995-8b	0.248	9.179	6.472	1.098	4.447	0.003	0.015	0.006	0.003	0.015
1996-2b	0.108	2.150	4.118	2.092	2.275	0.003	0.011	0.043	0.008	0.019
1996-3	0.159	5.698	8.302	3.618	4.779	0.003	0.013	0.015	0.008	0.015
1996-4	0.159	5.636	8.345	3.634	4.835	0.003	0.013	0.015	0.008	0.015
1996-5	0.160	5.648	8.342	3.631	4.834	0.003	0.013	0.015	0.008	0.015
1996-6	0.160	5.830	8.214	3.585	4.668	0.003	0.013	0.015	0.008	0.015
1996-7	0.163	5.906	8.190	3.569	4.658	0.003	0.013	0.015	0.008	0.014
1996-8a	0.248	9.179	6.472	1.098	4.447	0.003	0.009	0.008	0.001	0.012
1996-8b	0.248	9.179	6.472	1.098	4.447	0.003	0.009	0.008	0.001	0.012
1997-2b	0.105	1.776	3.538	1.665	1.966	0.001	0.007	0.028	0.017	0.018
1997-3	0.160	5.702	8.241	3.605	4.739	0.001	0.007	0.010	0.022	0.015
1997-4	0.159	5.607	8.350	3.638	4.853	0.001	0.007	0.010	0.022	0.016
1997-5	0.159	5.640	8.314	3.626	4.815	0.001	0.007	0.010	0.022	0.016

Year & Class	E10 NOx Decel	E10 NOx 0 to 25	E10 NOx 25 to 50	E10 NOx 50 +	E10 NOx Highway	E10 PM 2.5 Decel	E10 PM 2.5 0 to 25	E10 PM 2.5 25 to 50	E10 PM 2.5 50 +	E10 PM 2.5 Highway
1997-6	0.161	5.804	8.147	3.573	4.647	0.001	0.007	0.010	0.022	0.015
1997-7	0.163	5.859	8.130	3.561	4.640	0.001	0.007	0.010	0.022	0.015
1997-8a	0.248	9.179	6.472	1.098	4.447	0.001	0.004	0.004	0.003	0.012
1997-8b	0.248	9.179	6.472	1.098	4.447	0.001	0.004	0.004	0.003	0.012
1998-2b	0.139	1.437	3.358	1.733	1.833	0.001	0.008	0.026	0.010	0.014
1998-3	0.317	3.475	5.379	3.316	3.411	0.002	0.006	0.011	0.009	0.011
1998-4	0.317	3.407	5.406	3.331	3.444	0.002	0.006	0.011	0.009	0.011
1998-5	0.317	3.474	5.379	3.316	3.411	0.002	0.006	0.011	0.009	0.011
1998-6	0.318	3.516	5.360	3.304	3.390	0.002	0.006	0.011	0.009	0.011
1998-7	0.321	3.532	5.347	3.296	3.379	0.002	0.006	0.011	0.009	0.011
1998-8a	0.441	4.814	3.702	0.839	2.964	0.002	0.005	0.005	0.002	0.008
1998-8b	0.441	4.814	3.702	0.839	2.964	0.002	0.005	0.005	0.002	0.008
1999-2b	0.147	1.453	3.400	1.755	1.852	0.000	0.004	0.025	0.005	0.014
1999-3	0.316	3.495	5.374	3.313	3.404	0.000	0.003	0.005	0.002	0.009
1999-4	0.316	3.469	5.384	3.319	3.416	0.000	0.003	0.005	0.002	0.009
1999-5	0.317	3.461	5.386	3.320	3.419	0.000	0.003	0.005	0.002	0.009
1999-6	0.317	3.463	5.384	3.318	3.417	0.000	0.003	0.005	0.002	0.009
1999-7	0.318	3.514	5.363	3.306	3.393	0.000	0.003	0.005	0.002	0.009
1999-8a	0.318	3.516	5.361	3.305	3.391	0.000	0.003	0.005	0.002	0.009
1999-8b	0.318	3.516	5.361	3.305	3.391	0.000	0.003	0.005	0.002	0.009
2000-2b	0.142	1.416	3.361	1.728	1.820	0.000	0.003	0.023	0.006	0.014
2000-3	0.316	3.496	5.375	3.313	3.404	0.001	0.002	0.004	0.004	0.008
2000-4	0.316	3.472	5.384	3.318	3.415	0.001	0.002	0.004	0.004	0.008
2000-5	0.317	3.464	5.386	3.319	3.418	0.001	0.002	0.004	0.004	0.008
2000-6	0.317	3.466	5.384	3.318	3.416	0.001	0.002	0.004	0.004	0.008
2000-7	0.317	3.513	5.365	3.307	3.393	0.001	0.002	0.004	0.004	0.008
2000-8a	0.318	3.516	5.363	3.305	3.392	0.001	0.002	0.004	0.004	0.008
2000-8b	0.318	3.516	5.363	3.305	3.392	0.001	0.002	0.004	0.004	0.008
2001-2b	0.102	1.094	2.395	1.327	1.435	0.000	0.004	0.023	0.006	0.013
2001-3	0.332	3.673	5.645	3.479	3.574	0.000	0.001	0.006	0.014	0.012
2001-4	0.332	3.650	5.654	3.484	3.585	0.000	0.001	0.006	0.014	0.012
2001-5	0.332	3.642	5.656	3.485	3.588	0.000	0.001	0.006	0.014	0.012
2001-6	0.333	3.644	5.654	3.484	3.586	0.000	0.001	0.006	0.014	0.012
2001-7	0.333	3.690	5.636	3.473	3.565	0.000	0.001	0.006	0.014	0.012
2001-8a	0.334	3.692	5.634	3.472	3.563	0.000	0.001	0.006	0.014	0.012
2001-8b	0.334	3.692	5.634	3.472	3.563	0.000	0.001	0.006	0.014	0.012
2002-2b	0.085	0.955	2.082	1.155	1.250	0.001	0.006	0.015	0.005	0.008
2002-3	0.332	3.674	5.646	3.479	3.574	0.001	0.004	0.007	0.003	0.005
2002-4	0.332	3.653	5.654	3.484	3.584	0.001	0.004	0.007	0.003	0.005
2002-5	0.332	3.645	5.655	3.484	3.587	0.001	0.004	0.007	0.003	0.005
2002-6	0.333	3.647	5.653	3.483	3.585	0.001	0.004	0.007	0.003	0.005
2002-7	0.333	3.690	5.637	3.473	3.565	0.001	0.004	0.007	0.003	0.005
2002-8a	0.333	3.692	5.635	3.472	3.564	0.001	0.004	0.007	0.003	0.005

Year & Class	E10 NOx Decel	E10 NOx 0 to 25	E10 NOx 25 to 50	E10 NOx 50 +	E10 NOx Highway	E10 PM 2.5 Decel	E10 PM 2.5 0 to 25	E10 PM 2.5 25 to 50	E10 PM 2.5 50 +	E10 PM 2.5 Highway
2002-8b	0.333	3.692	5.635	3.472	3.564	0.001	0.004	0.007	0.003	0.005
2003-2b	0.088	1.014	2.196	1.217	1.317	0.000	0.004	0.017	0.004	0.009
2003-3	0.332	3.676	5.646	3.479	3.574	0.000	0.003	0.003	0.004	0.006
2003-4	0.332	3.656	5.654	3.483	3.584	0.000	0.003	0.003	0.004	0.006
2003-5	0.332	3.648	5.655	3.484	3.586	0.000	0.003	0.003	0.004	0.006
2003-6	0.333	3.650	5.653	3.483	3.585	0.000	0.003	0.003	0.004	0.006
2003-7	0.333	3.690	5.638	3.474	3.566	0.000	0.003	0.003	0.004	0.006
2003-8a	0.333	3.692	5.637	3.472	3.565	0.000	0.003	0.003	0.004	0.006
2003-8b	0.333	3.692	5.637	3.472	3.565	0.000	0.003	0.003	0.004	0.006
2004-2b	0.064	0.698	1.263	0.728	0.825	0.001	0.005	0.014	0.006	0.007
2004-3	0.297	3.292	5.056	3.115	3.200	0.001	0.005	0.006	0.005	0.006
2004-4	0.297	3.276	5.062	3.118	3.208	0.001	0.005	0.006	0.005	0.006
2004-5	0.297	3.270	5.063	3.119	3.210	0.001	0.005	0.006	0.005	0.006
2004-6	0.298	3.271	5.061	3.118	3.208	0.001	0.005	0.006	0.005	0.006
2004-7	0.298	3.304	5.049	3.110	3.194	0.001	0.005	0.006	0.005	0.006
2004-8a	0.298	3.305	5.048	3.110	3.192	0.001	0.005	0.006	0.005	0.006
2004-8b	0.298	3.305	5.048	3.110	3.192	0.001	0.005	0.006	0.005	0.006
2005-2b	0.055	0.525	1.011	0.576	0.641	0.001	0.005	0.014	0.006	0.007
2005-3	0.297	3.293	5.057	3.115	3.200	0.001	0.005	0.006	0.005	0.006
2005-4	0.297	3.278	5.062	3.118	3.207	0.001	0.005	0.006	0.005	0.006
2005-5	0.297	3.273	5.063	3.118	3.209	0.001	0.005	0.006	0.005	0.006
2005-6	0.298	3.274	5.062	3.118	3.208	0.001	0.005	0.006	0.005	0.006
2005-7	0.298	3.304	5.051	3.111	3.194	0.001	0.005	0.006	0.005	0.006
2005-8a	0.298	3.305	5.049	3.110	3.193	0.001	0.005	0.006	0.005	0.006
2005-8b	0.298	3.305	5.049	3.110	3.193	0.001	0.005	0.006	0.005	0.006
2006-2b	0.042	0.394	0.710	0.415	0.468	0.001	0.004	0.013	0.005	0.007
2006-3	0.241	2.670	4.099	2.524	2.545	0.001	0.004	0.005	0.005	0.005
2006-4	0.241	2.659	4.103	2.527	2.551	0.001	0.004	0.005	0.005	0.005
2006-5	0.241	2.655	4.104	2.527	2.554	0.001	0.004	0.005	0.005	0.005
2006-6	0.241	2.656	4.103	2.527	2.553	0.001	0.004	0.005	0.005	0.005
2006-7	0.241	2.678	4.095	2.521	2.540	0.001	0.004	0.005	0.005	0.005
2006-8a	0.241	2.679	4.094	2.521	2.540	0.001	0.004	0.005	0.005	0.005
2006-8b	0.241	2.679	4.094	2.521	2.540	0.001	0.004	0.005	0.005	0.005
2007-2b	0.042	0.396	0.694	0.410	0.467	0.001	0.004	0.012	0.005	0.007
2007-3	0.238	2.645	4.059	2.500	2.520	0.001	0.004	0.005	0.005	0.005
2007-4	0.238	2.635	4.063	2.502	2.526	0.001	0.004	0.005	0.005	0.005
2007-5	0.239	2.631	4.064	2.502	2.528	0.001	0.004	0.005	0.005	0.005
2007-6	0.239	2.632	4.063	2.502	2.527	0.001	0.004	0.005	0.005	0.005
2007-7	0.239	2.652	4.056	2.497	2.516	0.001	0.004	0.005	0.005	0.005
2007-8a	0.239	2.653	4.055	2.496	2.515	0.001	0.004	0.005	0.005	0.005
2007-8b	0.239	2.653	4.055	2.496	2.515	0.001	0.004	0.005	0.005	0.005
2008-2b	0.043	0.481	0.736	0.451	0.527	0.000	0.003	0.008	0.003	0.004
2008-3	0.238	2.646	4.060	2.500	2.520	0.001	0.003	0.003	0.003	0.003

Year & Class	E10 NOx Decel	E10 NOx 0 to 25	E10 NOx 25 to 50	E10 NOx 50 +	E10 NOx Highway	E10 PM 2.5 Decel	E10 PM 2.5 0 to 25	E10 PM 2.5 25 to 50	E10 PM 2.5 50 +	E10 PM 2.5 Highway
2008-4	0.238	2.637	4.063	2.502	2.525	0.001	0.003	0.003	0.003	0.003
2008-5	0.239	2.633	4.064	2.502	2.527	0.001	0.003	0.003	0.003	0.003
2008-6	0.239	2.634	4.063	2.501	2.526	0.001	0.003	0.003	0.003	0.003
2008-7	0.239	2.652	4.056	2.497	2.516	0.001	0.003	0.003	0.003	0.003
2008-8a	0.239	2.652	4.056	2.497	2.516	0.001	0.003	0.003	0.003	0.003
2008-8b	0.239	2.652	4.056	2.497	2.516	0.001	0.003	0.003	0.003	0.003
2009-2b	0.047	0.540	0.794	0.493	0.583	0.000	0.003	0.008	0.003	0.004
2009-3	0.238	2.646	4.060	2.500	2.520	0.001	0.003	0.003	0.003	0.003
2009-4	0.238	2.638	4.063	2.501	2.524	0.001	0.003	0.003	0.003	0.003
2009-5	0.238	2.635	4.064	2.502	2.526	0.001	0.003	0.003	0.003	0.003
2009-6	0.239	2.636	4.063	2.501	2.526	0.001	0.003	0.003	0.003	0.003
2009-7	0.239	2.652	4.057	2.497	2.517	0.001	0.003	0.003	0.003	0.003
2009-8a	0.239	2.653	4.057	2.497	2.516	0.001	0.003	0.003	0.003	0.003
2009-8b	0.239	2.653	4.057	2.497	2.516	0.001	0.003	0.003	0.003	0.003
2010-2b	0.043	0.462	0.710	0.436	0.508	0.000	0.003	0.008	0.003	0.004
2010-3	0.238	2.647	4.061	2.500	2.520	0.001	0.003	0.003	0.003	0.003
2010-4	0.238	2.640	4.064	2.501	2.524	0.001	0.003	0.003	0.003	0.003
2010-5	0.238	2.637	4.064	2.502	2.526	0.001	0.003	0.003	0.003	0.003
2010-6	0.239	2.638	4.063	2.501	2.525	0.001	0.003	0.003	0.003	0.003
2010-7	0.239	2.652	4.058	2.498	2.517	0.001	0.003	0.003	0.003	0.003
2010-8a	0.239	2.653	4.058	2.497	2.517	0.001	0.003	0.003	0.003	0.003
2010-8b	0.239	2.653	4.058	2.497	2.517	0.001	0.003	0.003	0.003	0.003
2011-2b	0.044	0.481	0.730	0.449	0.526	0.000	0.003	0.008	0.003	0.004
2011-3	0.238	2.648	4.062	2.500	2.520	0.001	0.003	0.003	0.003	0.003
2011-4	0.238	2.641	4.064	2.501	2.524	0.001	0.003	0.003	0.003	0.003
2011-5	0.238	2.638	4.064	2.501	2.525	0.001	0.003	0.003	0.003	0.003
2011-6	0.239	2.639	4.064	2.501	2.525	0.001	0.003	0.003	0.003	0.003
2011-7	0.239	2.652	4.059	2.498	2.517	0.001	0.003	0.003	0.003	0.003
2011-8a	0.239	2.653	4.059	2.498	2.517	0.001	0.003	0.003	0.003	0.003
2011-8b	0.239	2.653	4.059	2.498	2.517	0.001	0.003	0.003	0.003	0.003

Note – highlighted cells are set equal to the row above (MOVES does not provide consistent outputs for Class 8b gasoline vehicles; therefore 8bs are set equal to 8as).

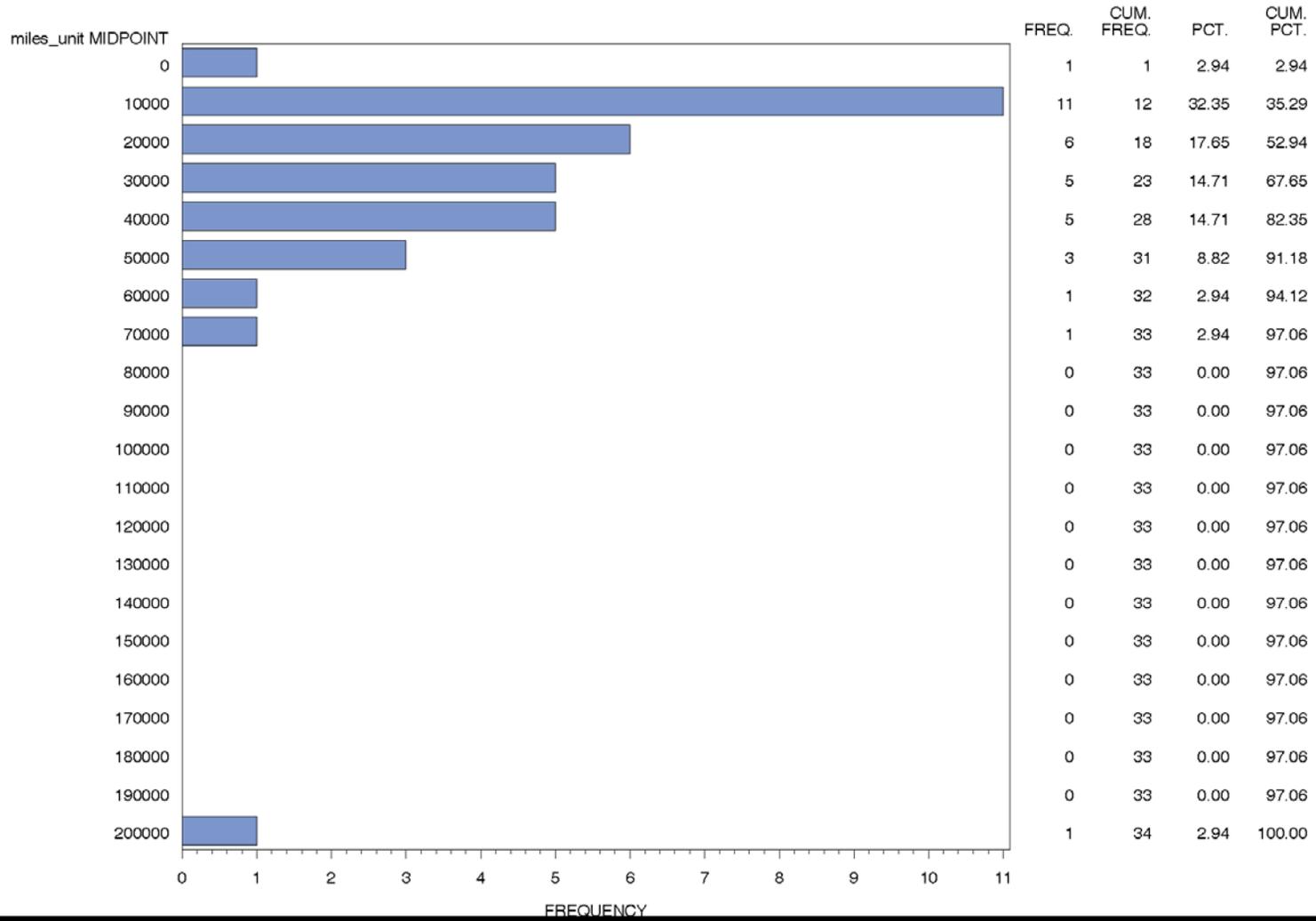
**Appendix B – NO_x and PM Idle Factors – g/hr
(MOVES2010, 2009 Calendar Year, ULSD)**

SW Idle factors (g/hr) from MOVES2010				<i>Source: David Brz, OTAQ, 4-16-10</i>		
average of Jan and July factors						
			Truck Class			
Month	Pollutant	Model Year	HDGV	LHDDV	MHDDV	HHDDV
Annual Av	NOX	1980	14.73	98.49	192.01	192.01
Annual Av	NOX	1981	14.55	131.89	192.01	192.01
Annual Av	NOX	1982	14.73	118.11	192.01	192.01
Annual Av	NOX	1983	14.46	124.77	192.00	192.00
Annual Av	NOX	1984	14.51	127.12	192.01	192.01
Annual Av	NOX	1985	14.54	127.34	192.01	192.01
Annual Av	NOX	1986	14.56	113.98	192.01	192.01
Annual Av	NOX	1987	14.51	152.05	192.01	192.01
Annual Av	NOX	1988	14.54	140.84	192.01	192.01
Annual Av	NOX	1989	14.56	157.06	192.01	192.01
Annual Av	NOX	1990	7.39	191.73	148.28	148.28
Annual Av	NOX	1991	7.45	154.90	139.42	139.42
Annual Av	NOX	1992	7.48	151.31	139.42	139.42
Annual Av	NOX	1993	7.44	164.60	139.42	139.42
Annual Av	NOX	1994	7.39	164.46	139.42	139.42
Annual Av	NOX	1995	7.45	161.26	139.42	139.42
Annual Av	NOX	1996	7.15	160.72	139.42	139.42
Annual Av	NOX	1997	6.91	141.05	139.42	139.42
Annual Av	NOX	1998	13.71	141.74	117.07	117.07
Annual Av	NOX	1999	13.77	133.81	115.47	144.33
Annual Av	NOX	2000	13.68	131.75	114.68	143.77
Annual Av	NOX	2001	13.67	117.90	110.55	145.73
Annual Av	NOX	2002	13.56	127.67	113.76	143.55
Annual Av	NOX	2003	13.54	81.34	49.00	54.71
Annual Av	NOX	2004	12.73	81.33	49.06	54.76
Annual Av	NOX	2005	6.90	81.34	49.08	54.77
Annual Av	NOX	2006	6.92	59.26	49.05	54.78
Annual Av	NOX	2007	6.93	26.22	24.49	27.37
Annual Av	NOX	2008	7.17	26.24	24.47	27.37
Annual Av	NOX	2009	7.29	26.24	24.45	27.36
Annual Av	NOX	2010	7.10	7.08	5.42	6.42
Annual Av	Total PM10	1980	2.15	6.06	4.35	4.35
Annual Av	Total PM10	1981	4.68	4.40	4.35	4.35
Annual Av	Total PM10	1982	4.65	4.44	4.35	4.35
Annual Av	Total PM10	1983	4.08	4.43	4.35	4.35
Annual Av	Total PM10	1984	4.07	4.43	4.35	4.35
Annual Av	Total PM10	1985	0.51	4.42	4.35	4.35
Annual Av	Total PM10	1986	0.33	4.46	4.35	4.35
Annual Av	Total PM10	1987	0.33	4.38	4.35	4.35
Annual Av	Total PM10	1988	1.02	4.42	4.35	4.35
Annual Av	Total PM10	1989	1.02	4.39	4.35	4.35

SW Idle factors (g/hr) from MOVES2010				<i>Source: David Brz, OTAQ, 4-16-10</i>		
average of Jan and July factors						
			Truck Class			
Month	Pollutant	Model Year	HDGV	LHDDV	MHDDV	HHDDV
Annual Av	Total PM10	1990	0.32	4.37	4.35	4.35
Annual Av	Total PM10	1991	0.27	4.11	4.35	4.35
Annual Av	Total PM10	1992	0.27	3.96	4.35	4.35
Annual Av	Total PM10	1993	0.27	4.19	4.35	4.35
Annual Av	Total PM10	1994	0.09	7.29	7.15	6.86
Annual Av	Total PM10	1995	0.11	6.67	7.11	6.80
Annual Av	Total PM10	1996	0.18	6.59	7.12	6.81
Annual Av	Total PM10	1997	0.19	5.81	7.24	6.78
Annual Av	Total PM10	1998	0.12	6.58	6.82	6.51
Annual Av	Total PM10	1999	0.06	6.24	6.88	6.49
Annual Av	Total PM10	2000	0.03	6.15	6.89	6.50
Annual Av	Total PM10	2001	0.02	5.55	6.94	6.47
Annual Av	Total PM10	2002	0.08	5.97	6.90	6.50
Annual Av	Total PM10	2003	0.04	5.14	6.23	5.87
Annual Av	Total PM10	2004	0.10	4.74	6.22	5.87
Annual Av	Total PM10	2005	0.09	4.74	5.98	5.81
Annual Av	Total PM10	2006	0.09	4.72	5.98	5.81
Annual Av	Total PM10	2007	0.06	0.18	0.19	0.20
Annual Av	Total PM10	2008	0.06	0.18	0.19	0.20
Annual Av	Total PM10	2009	0.06	0.18	0.19	0.20
Annual Av	Total PM10	2010	0.06	0.18	0.18	0.20
Truck Class Definitions						
HDGV	gasoline trucks - all classes					
LHDDV	diesel classes 2b - 5					
MHDDV	diesel classes 6 and 7					
HHDDV	diesel classes 8a and 8b					

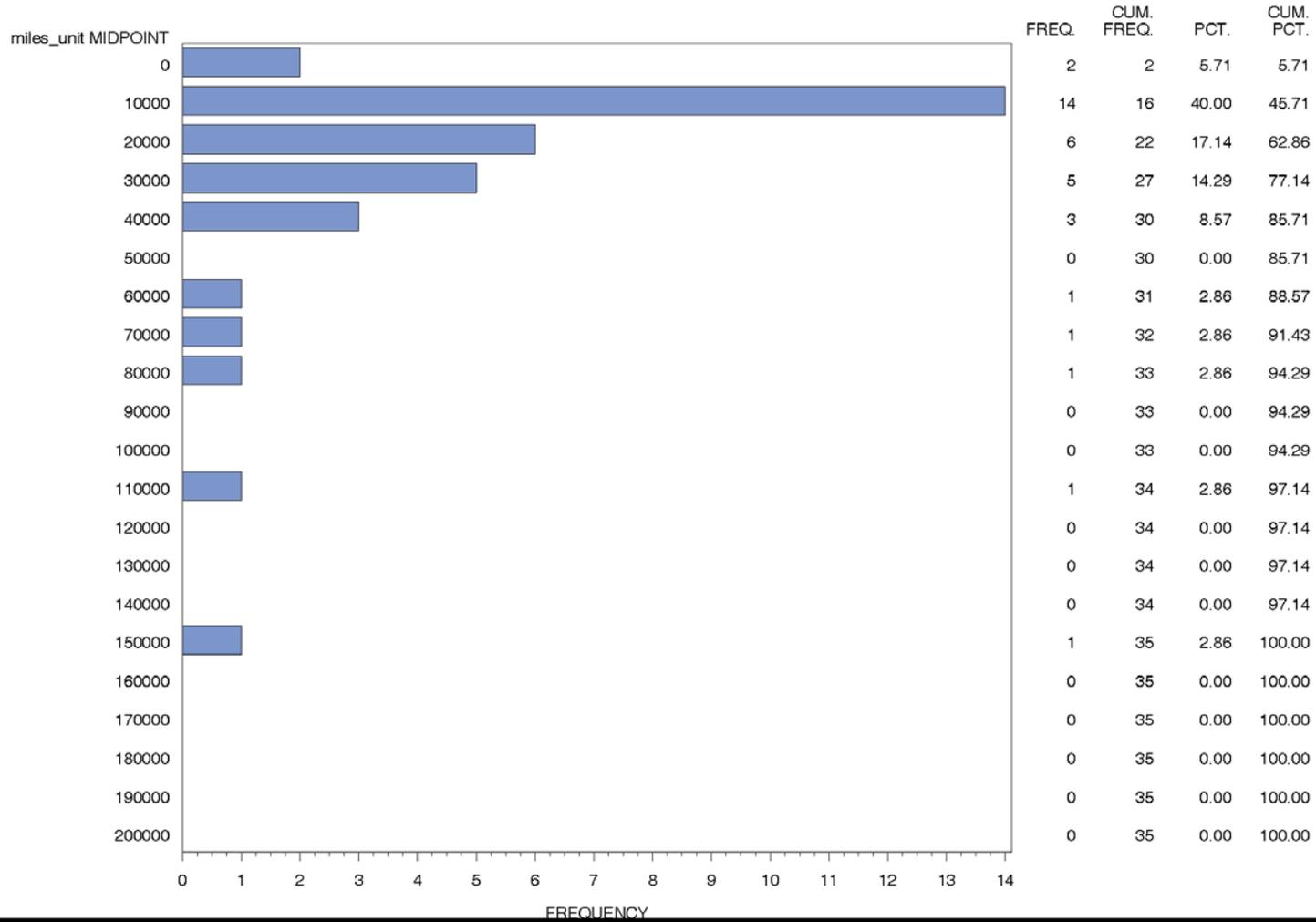
Appendix C – SmartWay Fleet Activity Distributions by Vehicle Class

Calendar Year 2008 Diesel smart way vehicles
truck_class=2B



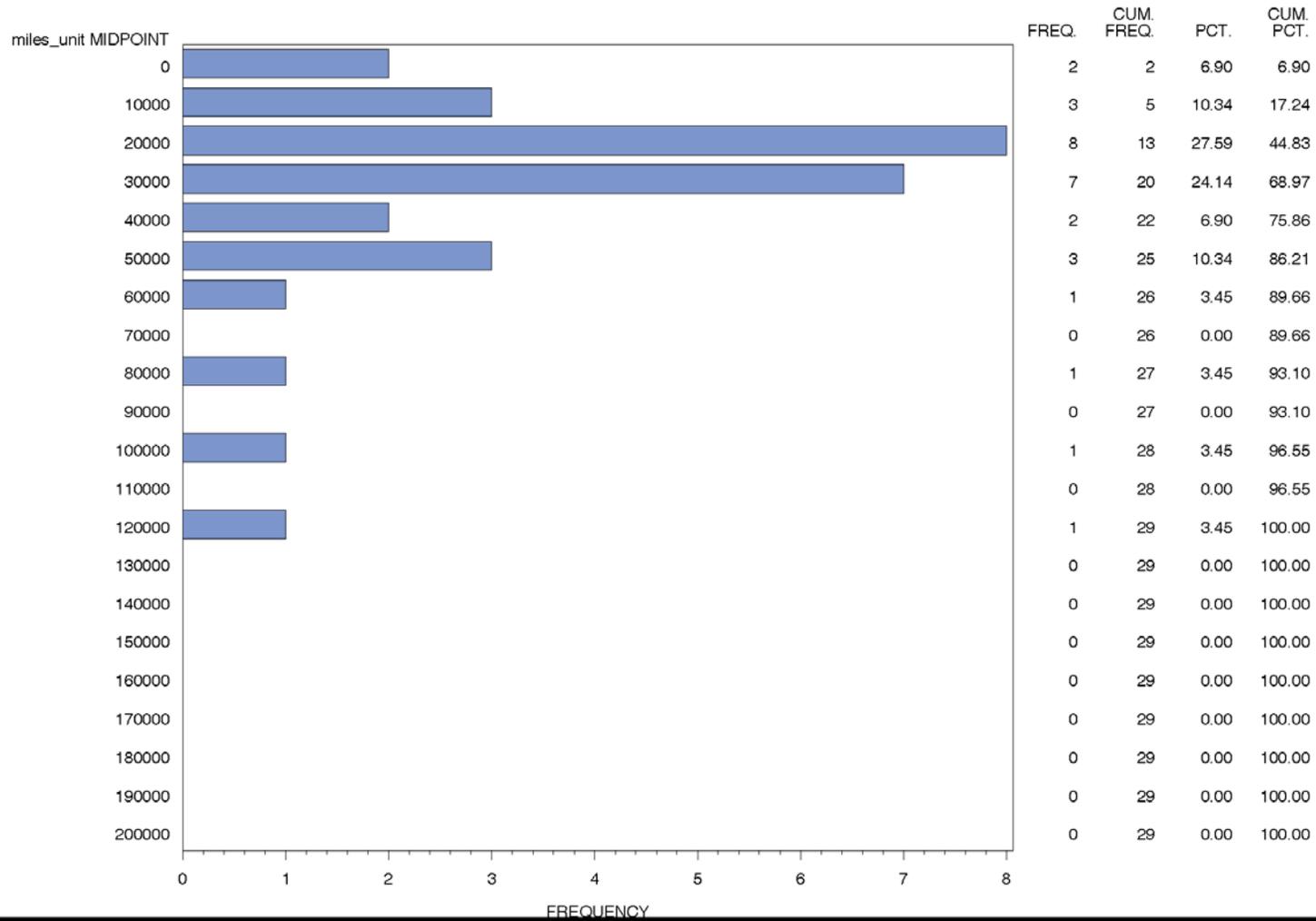
C-1

Calendar Year 2008 Diesel smart way vehicles
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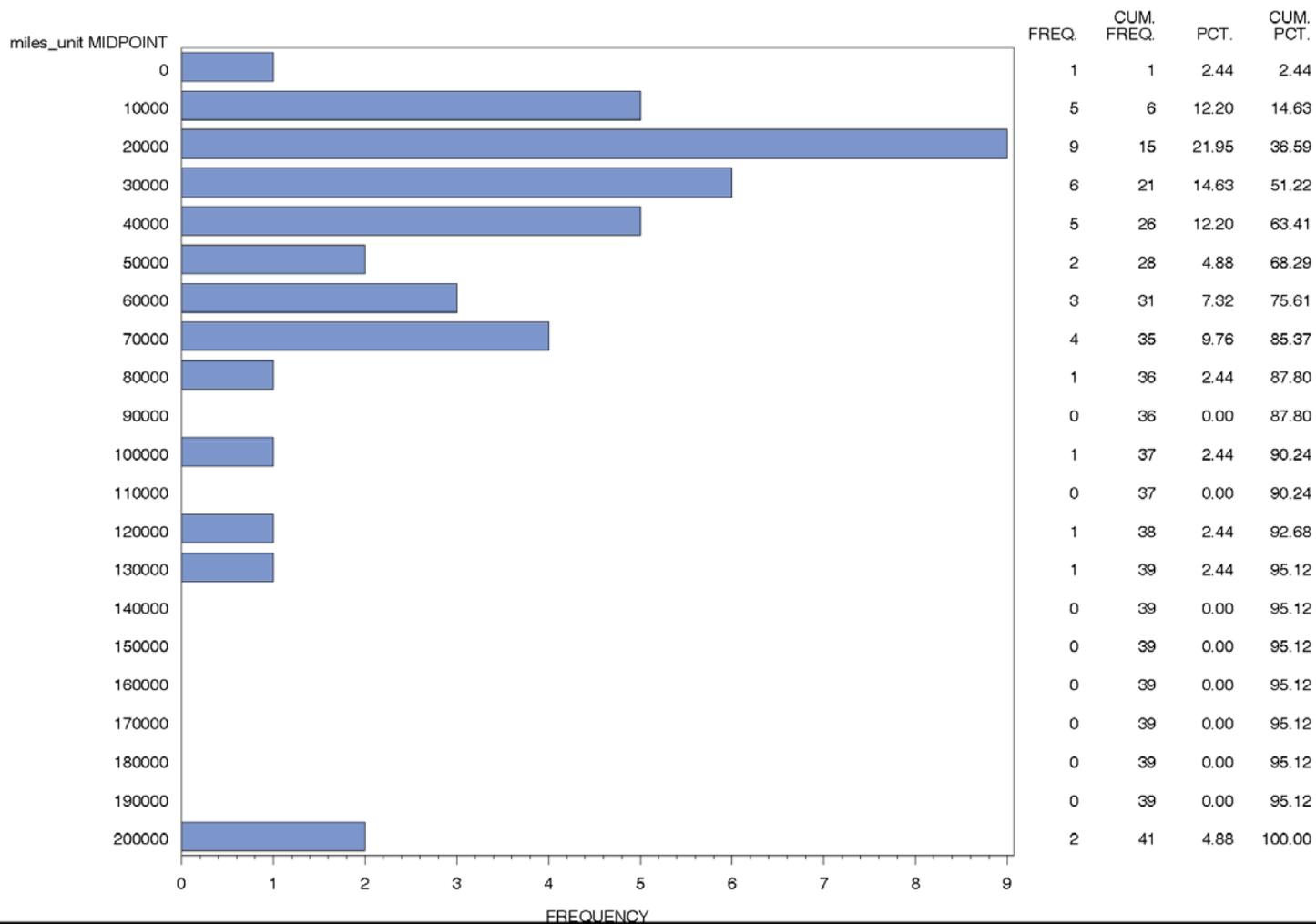


C.2

Calendar Year 2008 Diesel smart way vehicles
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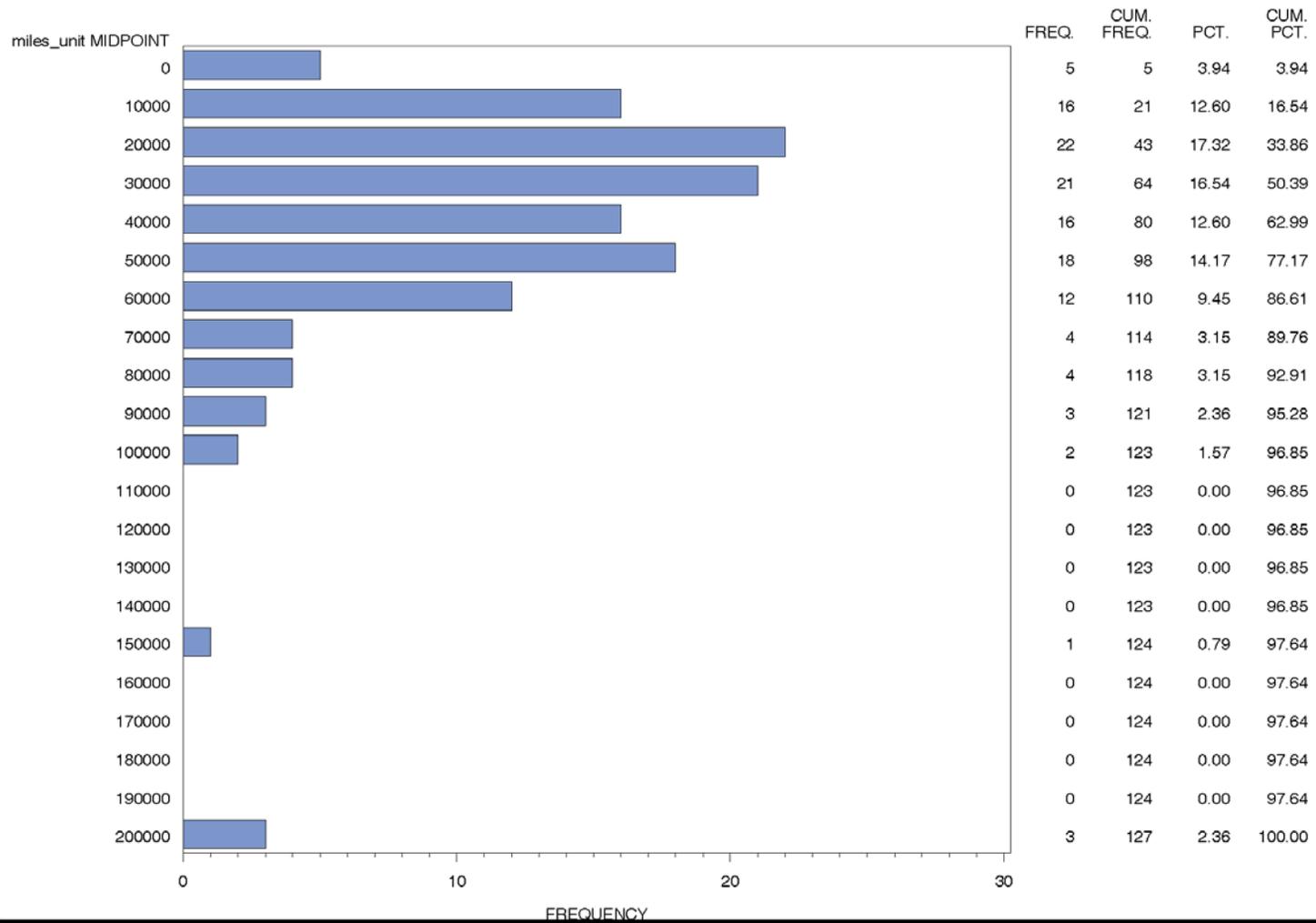


Calendar Year 2008 Diesel smart way vehicles
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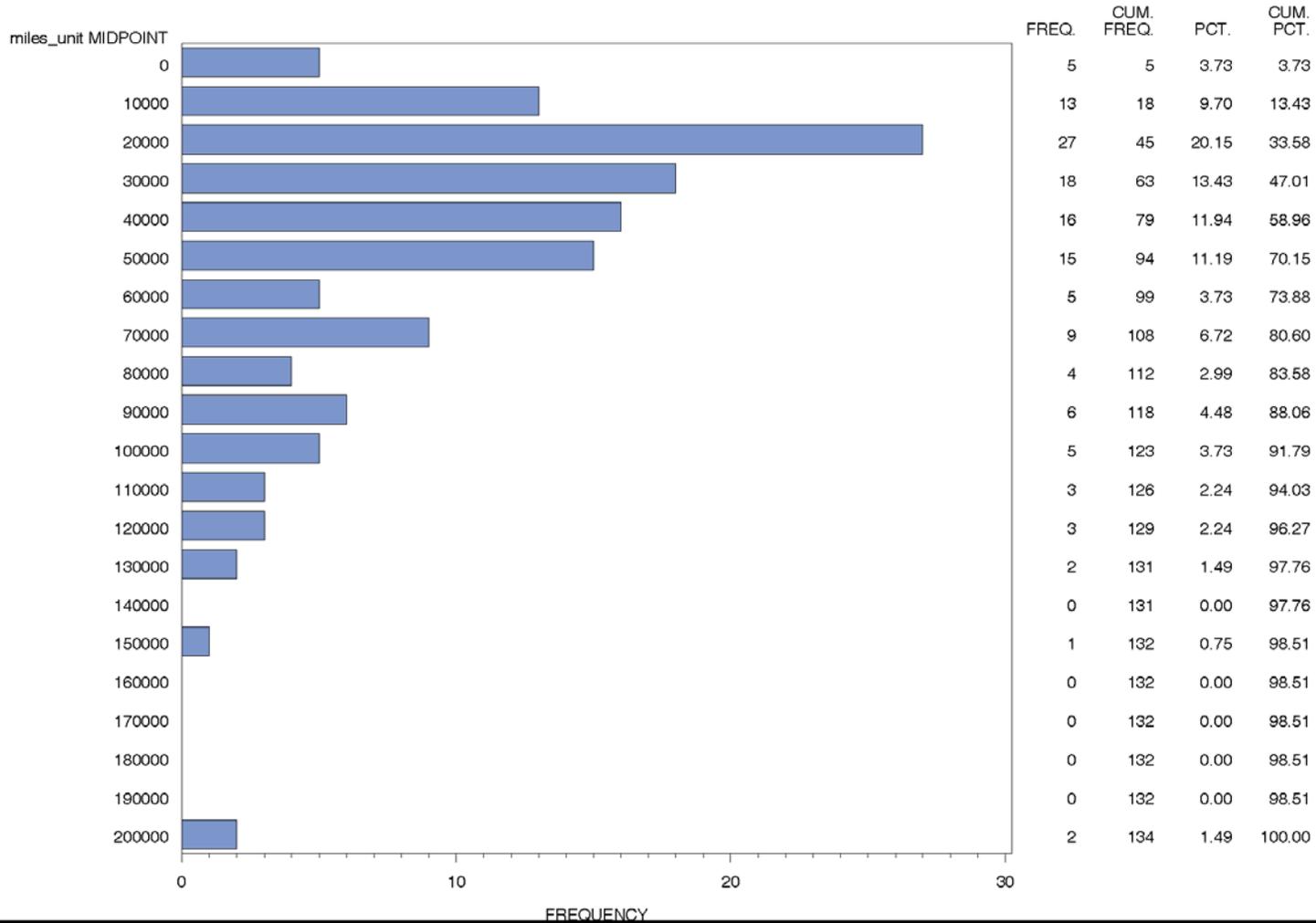
C-4

Calendar Year 2008 Diesel smart way vehicles
truck_class=6



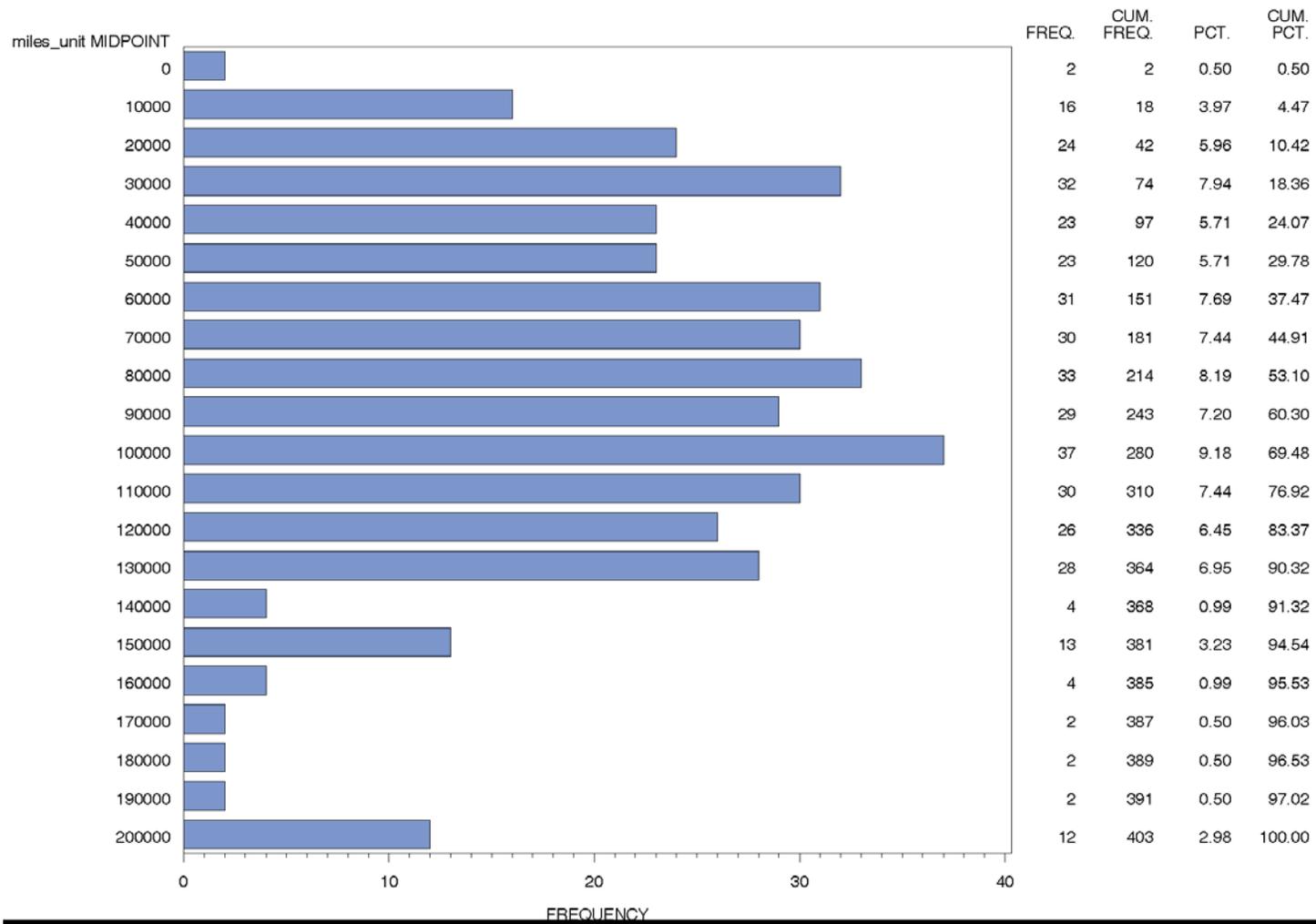
C-5

Calendar Year 2008 Diesel smart way vehicles
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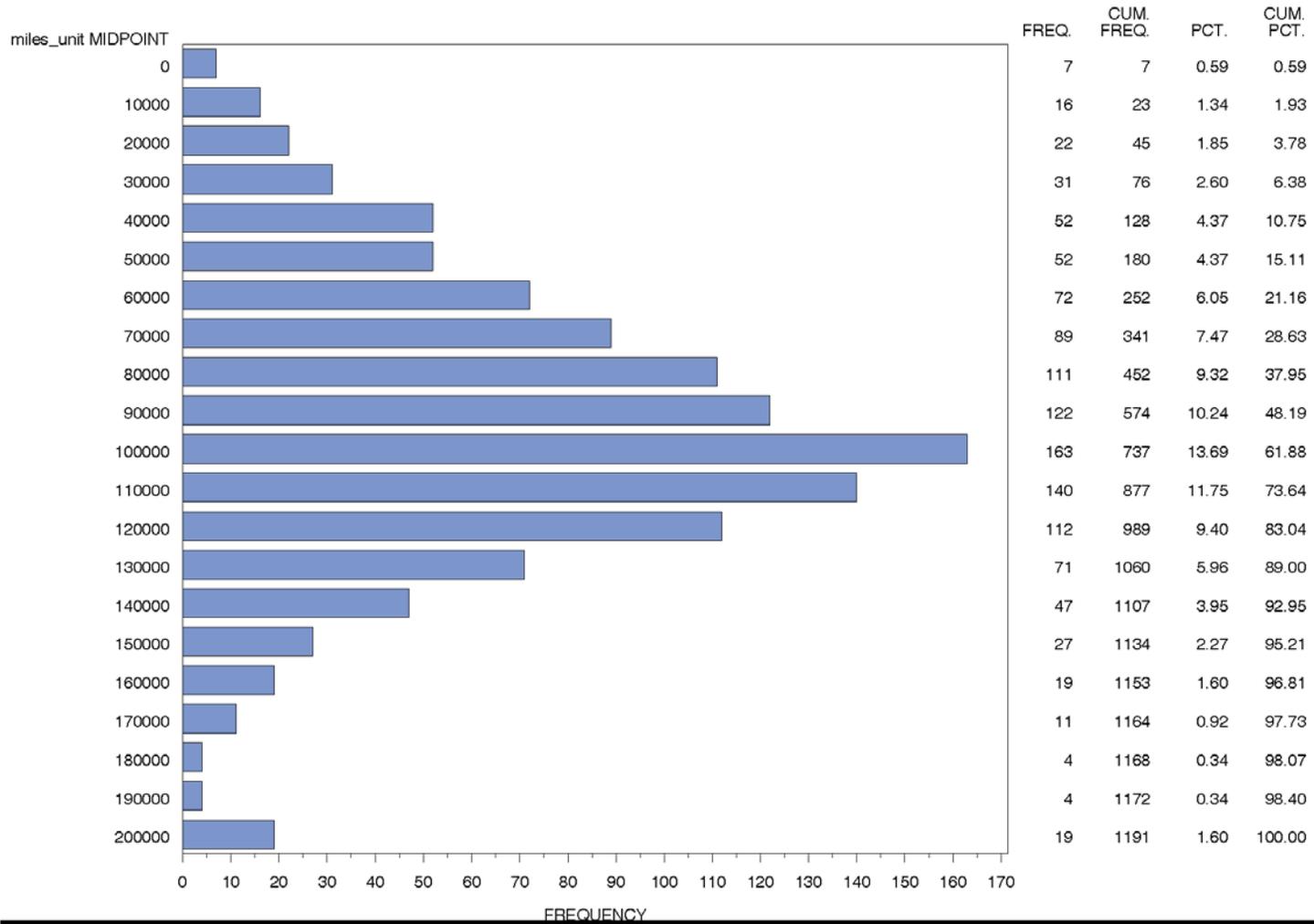
C-6

Calendar Year 2008 Diesel smart way vehicles
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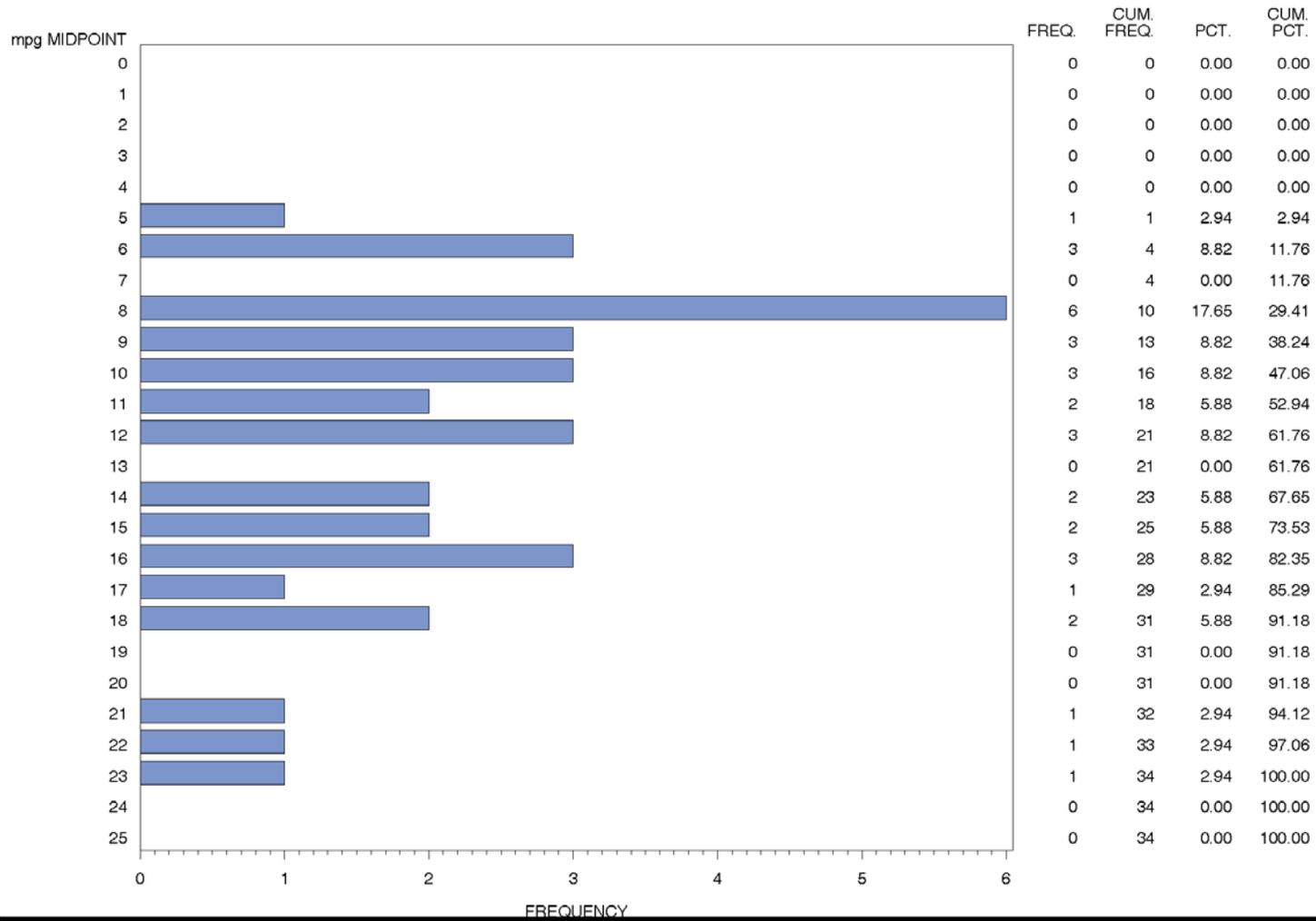


C-7

Calendar Year 2008 Diesel smart way vehicles
truck_class=8B

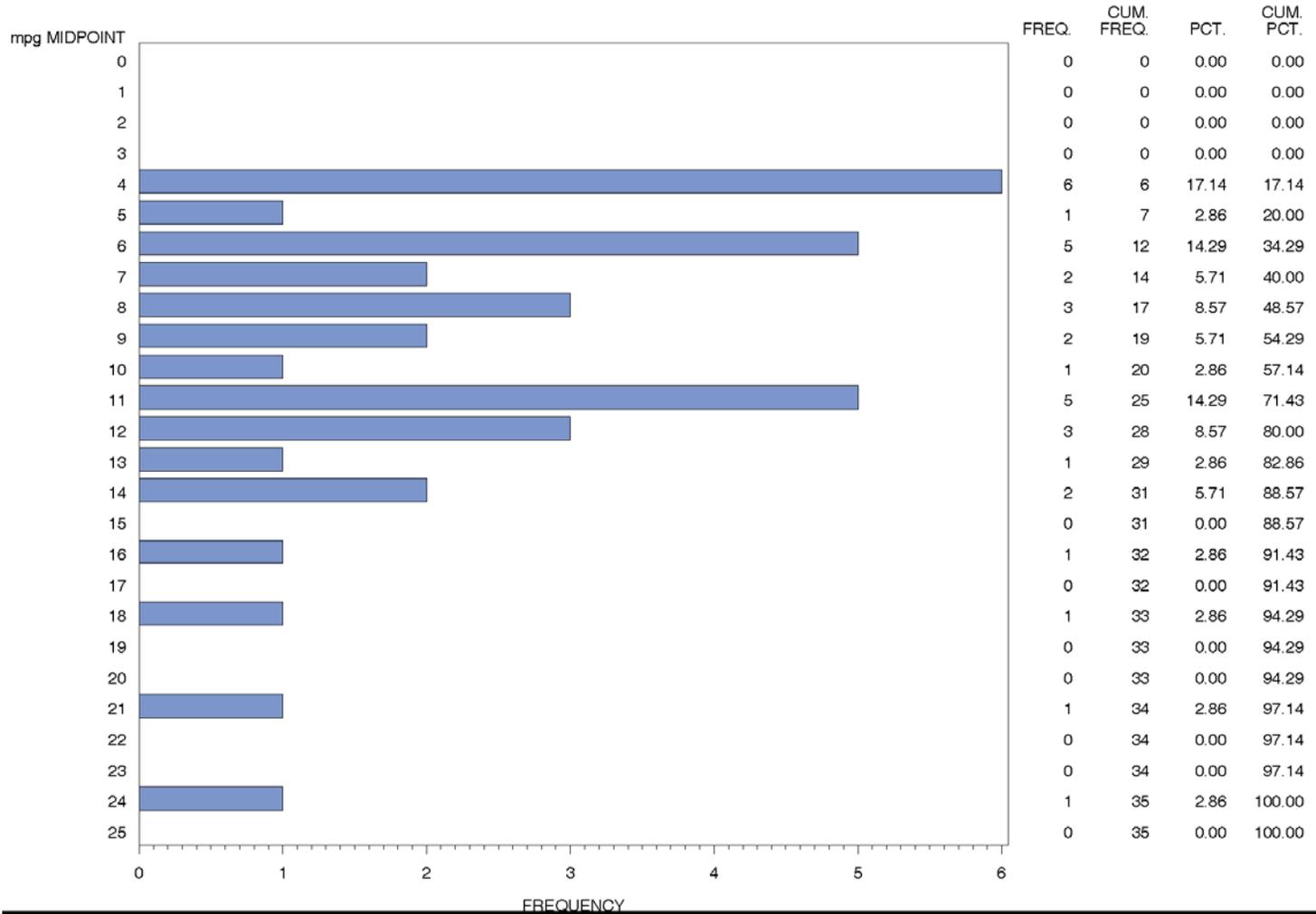


Calendar Year 2008 Diesel smart way vehicles
truck_class=2B



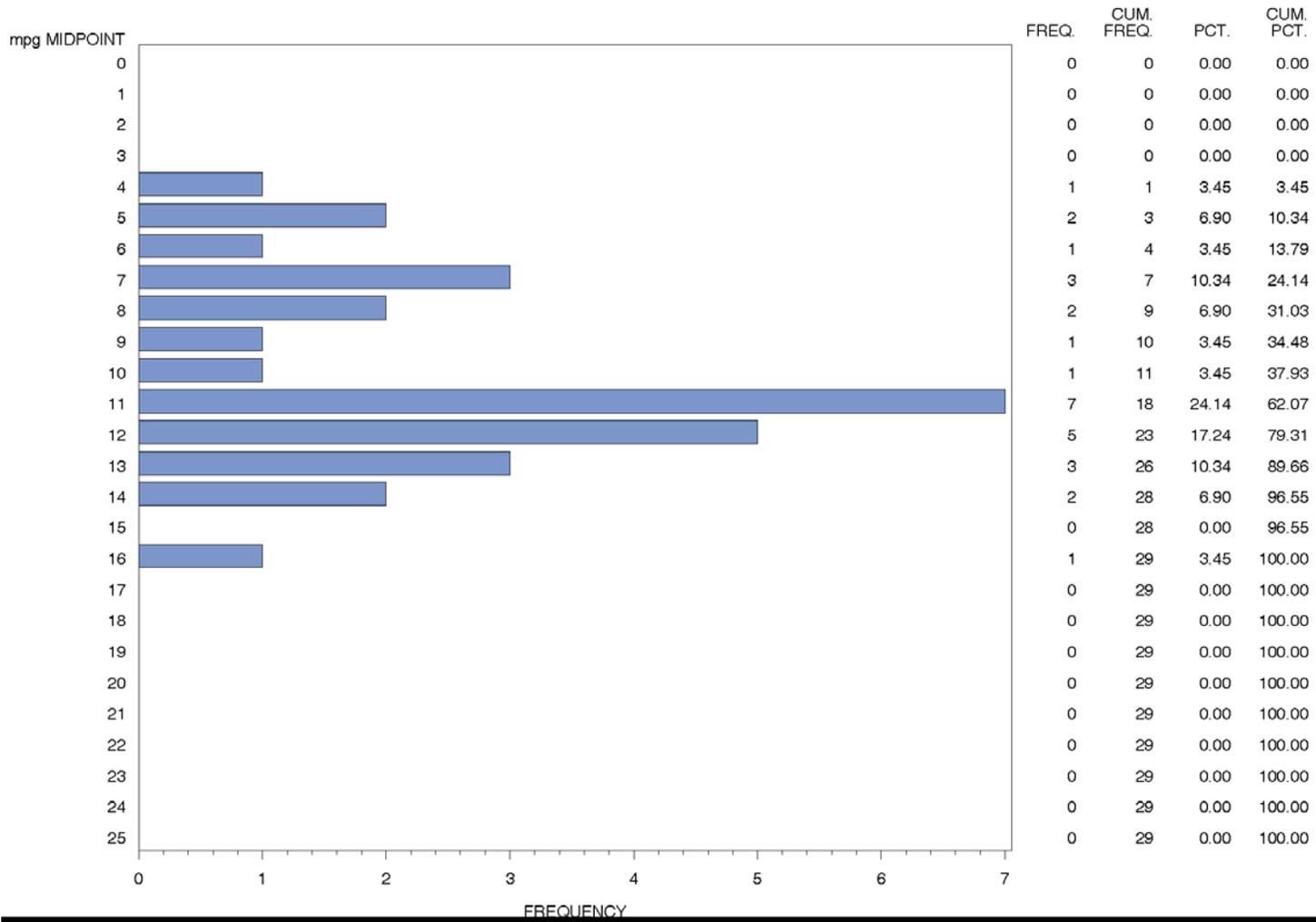
C-9

Calendar Year 2008 Diesel smart way vehicles
truck_class=3



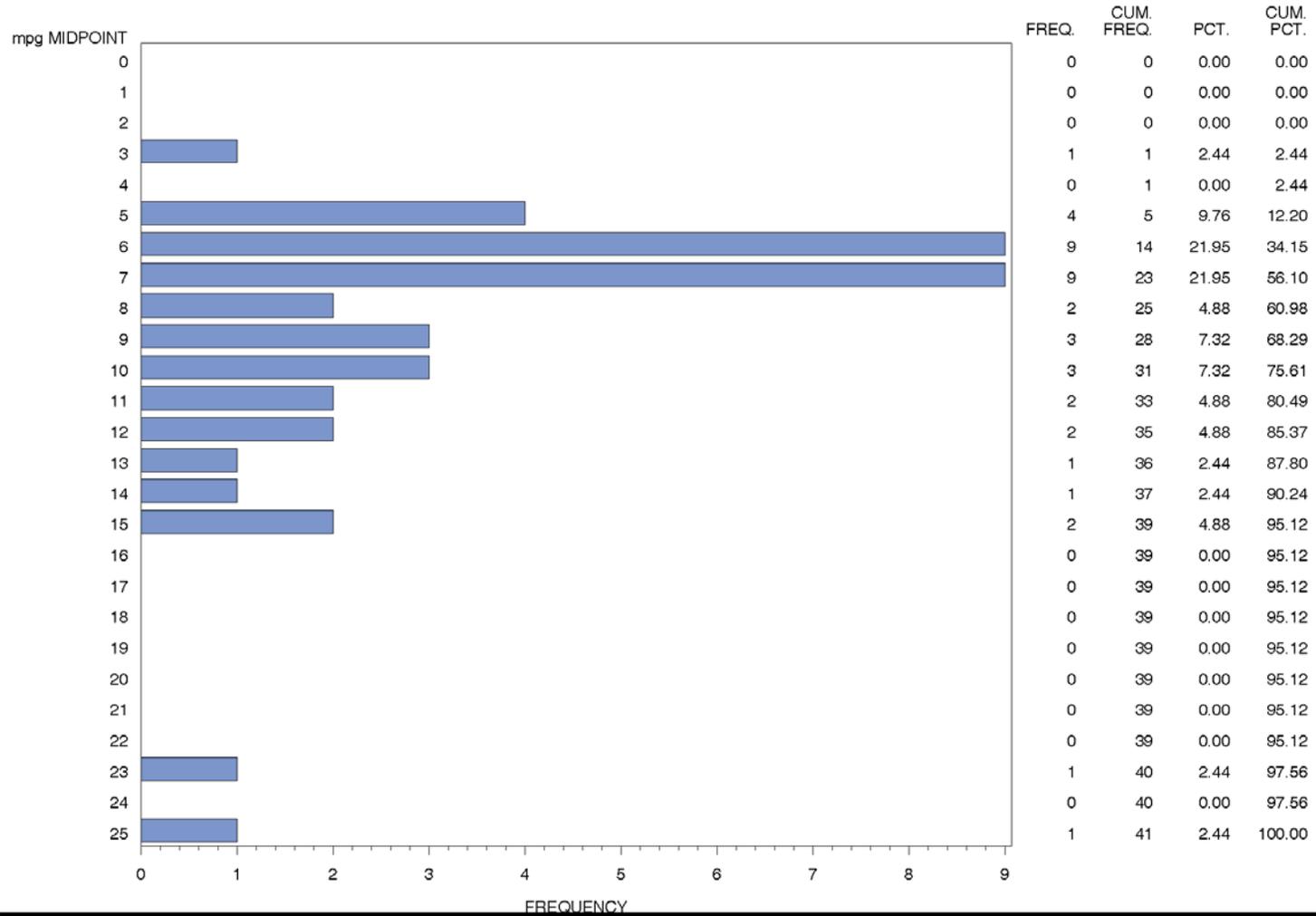
C-10

Calendar Year 2008 Diesel smart way vehicles
truck_class=4



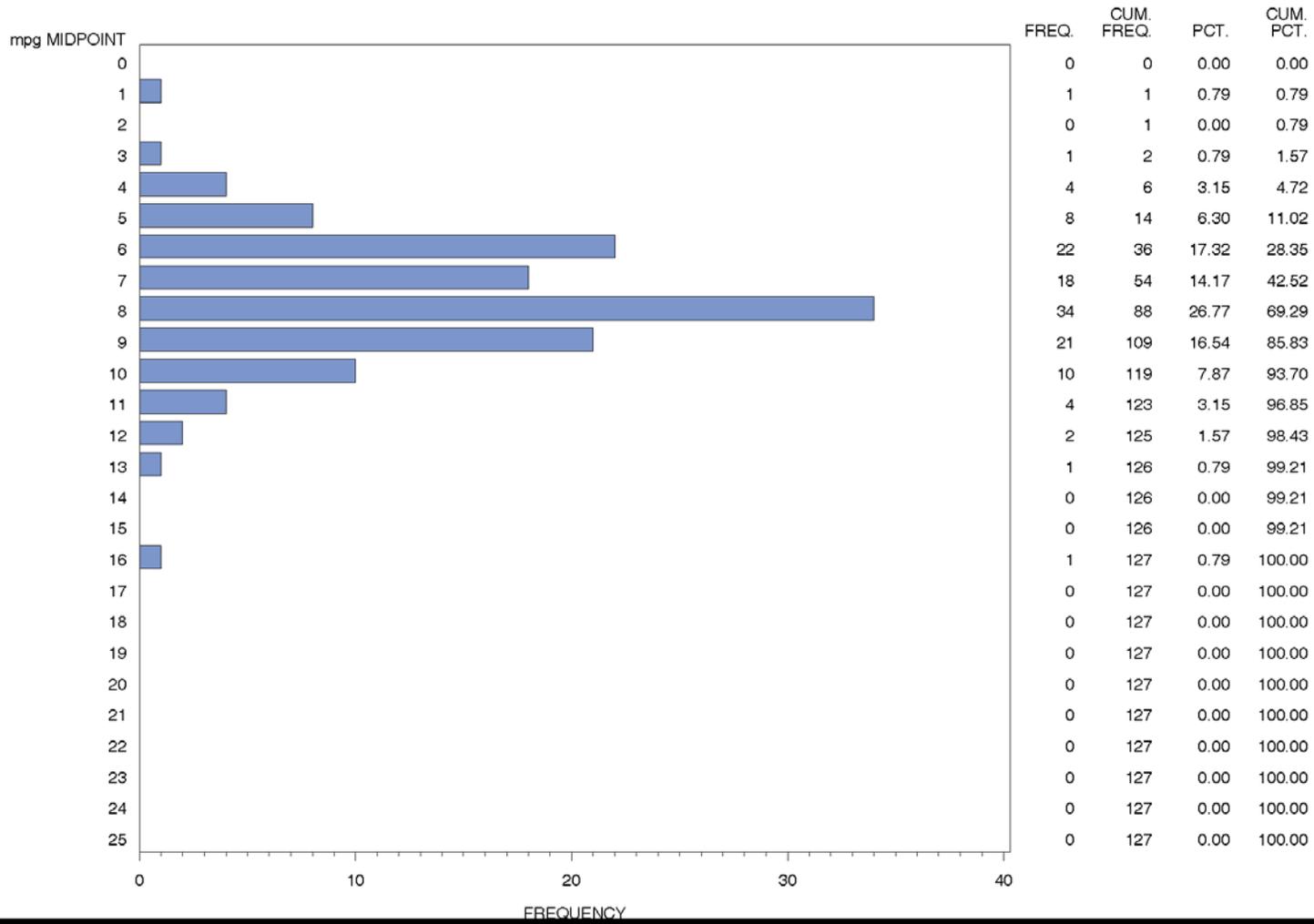
C-11

Calendar Year 2008 Diesel smart way vehicles
truck_class=5



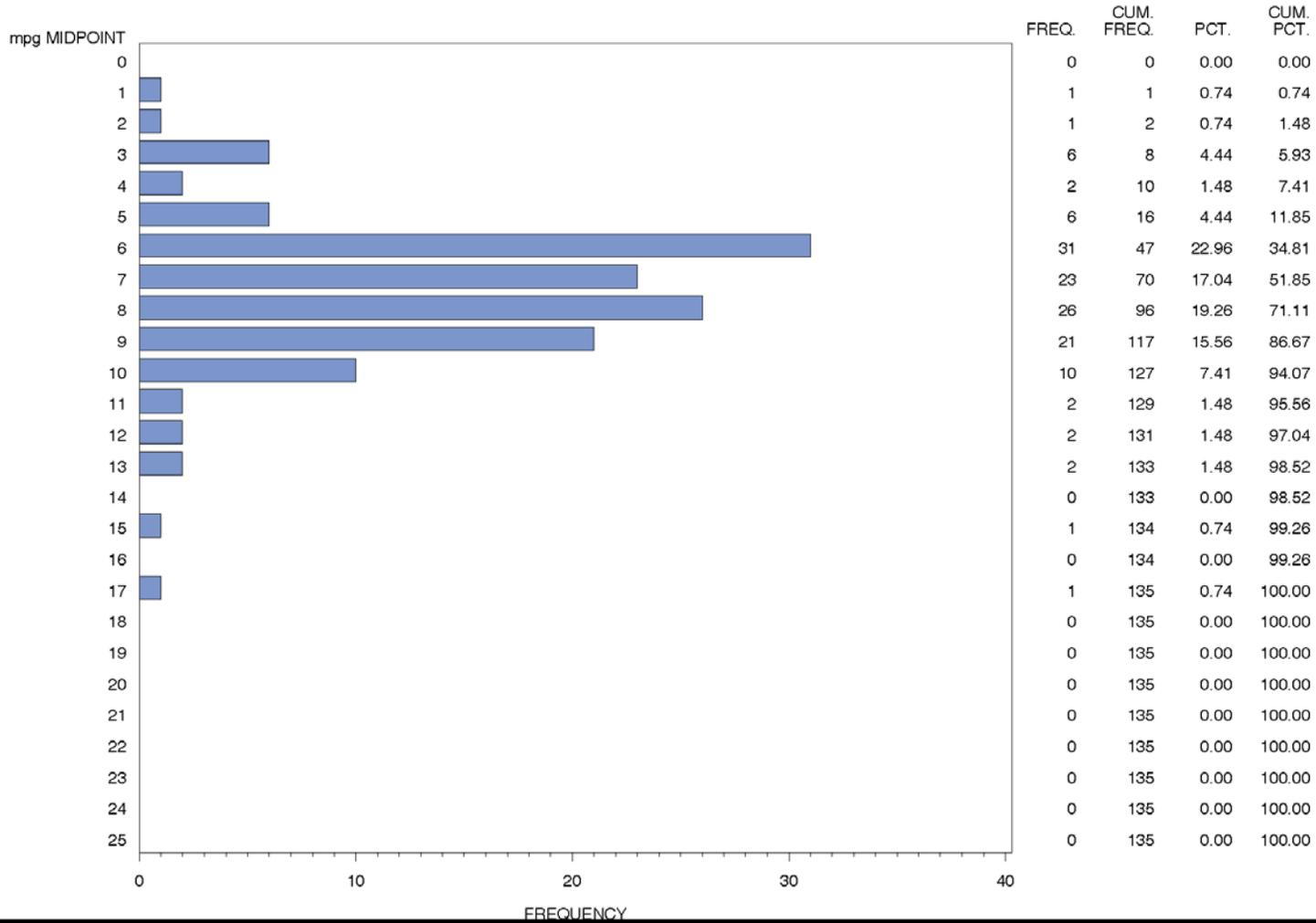
C-12

Calendar Year 2008 Diesel smart way vehicles
truck_class=6



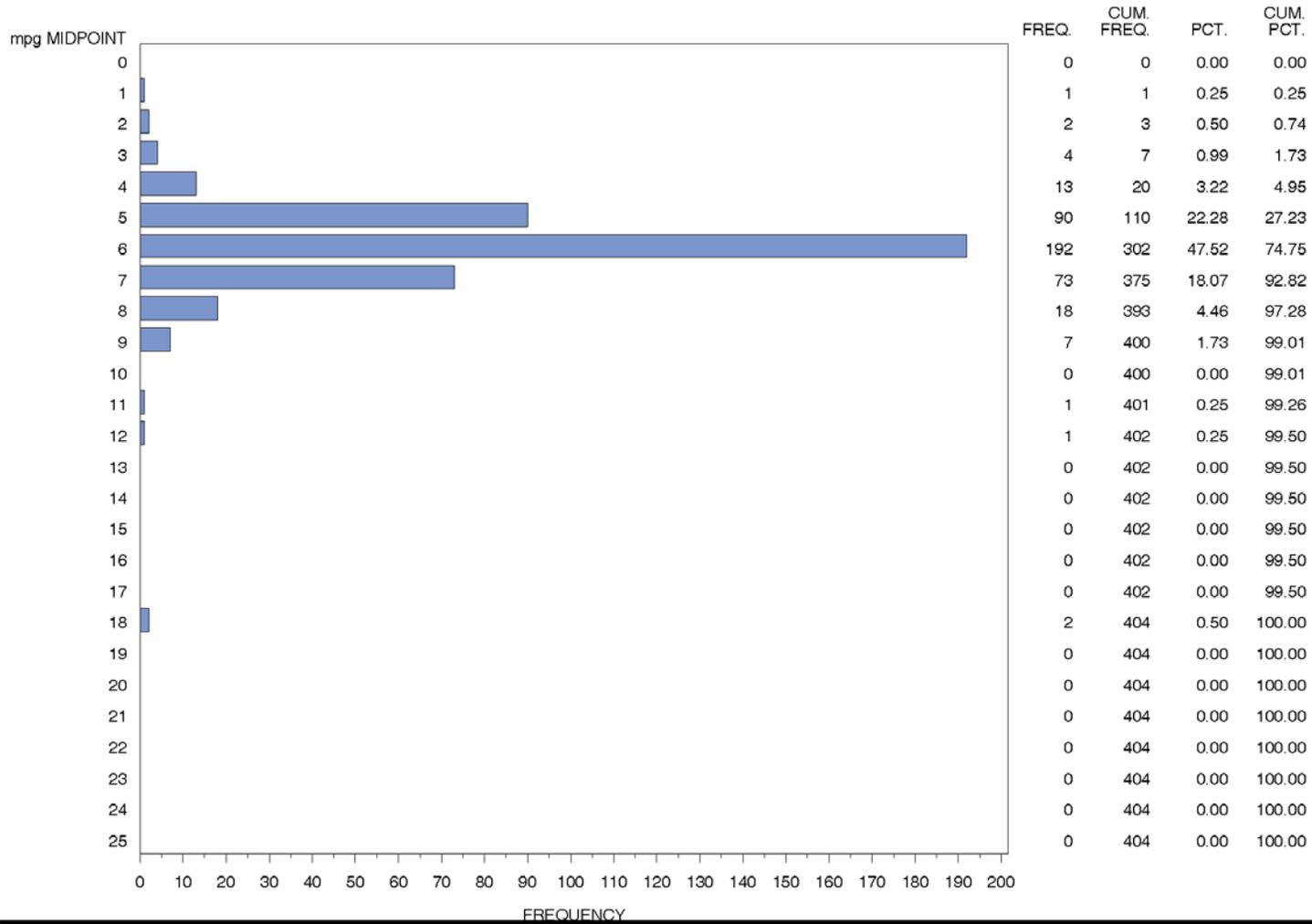
C-13

Calendar Year 2008 Diesel smart way vehicles
truck_class=7



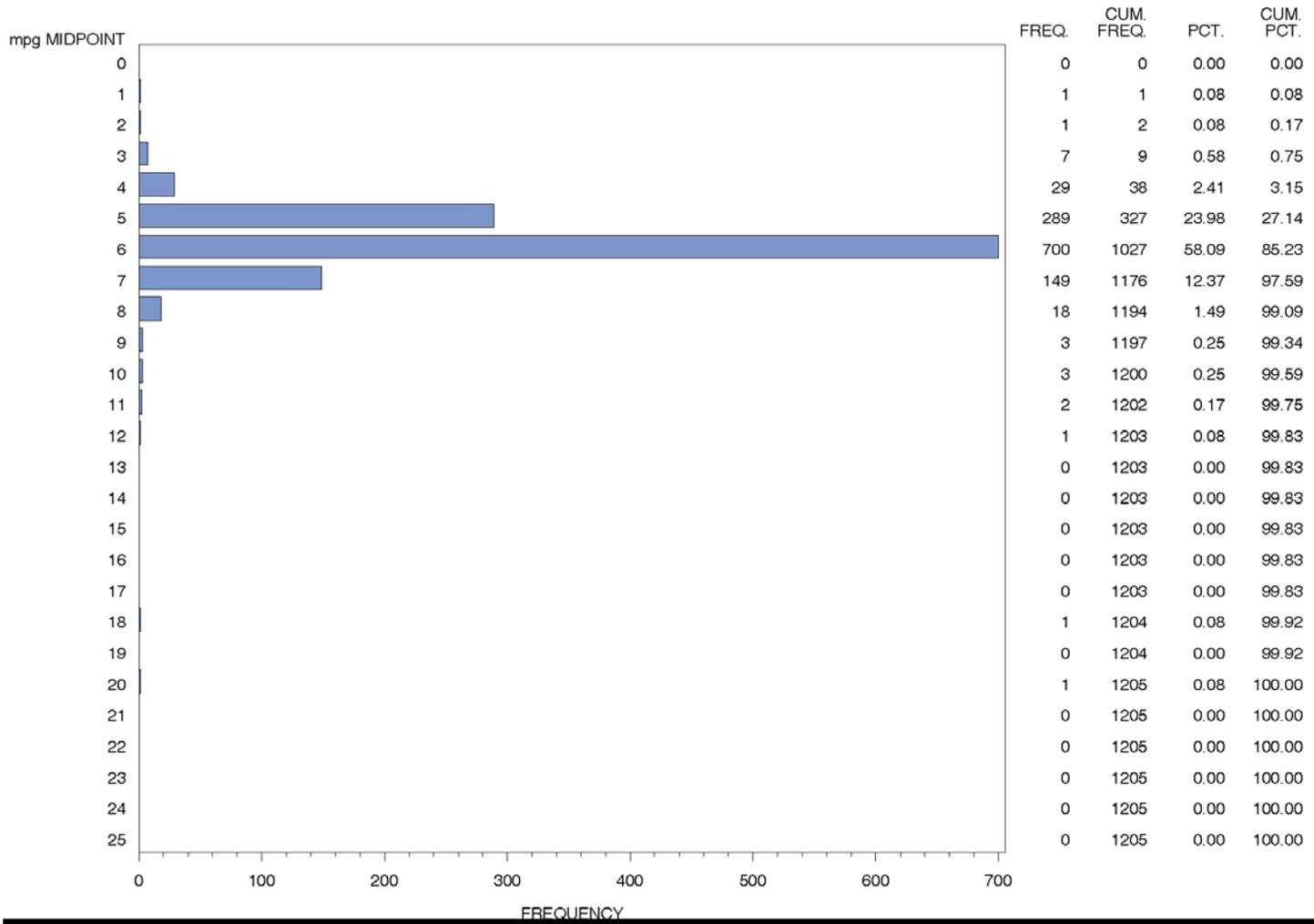
C-14

Calendar Year 2008 Diesel smart way vehicles
truck_class=8A



C-15

Calendar Year 2008 Diesel smart way vehicles
truck_class=8B



C-16

Appendix D
Cargo Volume Literature Review Summary

Classes	Application	Body Type	VIUS Category	Manuf	Model	Cargo Space (cubic feet)	Unit	Max Payload	GVW	Notes or Comments	URL
2b	Full Size Pick-up	Pick-up		Chevy	Silverado 2500HD		Cu. Ft	3,644	9,200		http://www.chevrolet.com/vehicles/2010/silverado2500hd/features.do
2b	Full Size Pick-up	Pick-up		Ford	F250		Cu. Ft	2,900	9,400		http://www.fordf150.net/specs/05sd_specs.pdf
2b	Step Van	Budget Cargo Van	step/walk-in	Ford		309	Cu. Ft	3,116	8,600		http://www.budgettruck.com/Moving-Trucks.aspx
2b	Step Van	Step Van	step/walk-in	Freightliner-Sprinter	2500 Standard Roof	318	Cu. Ft	3,469	8,550		http://www.freightlinersprinterusa.com/vehicles/cargo-van/models/specifications.php
2b	Utility Van	Utility/cargo van	van (basic enclosed)	Ford	E350	237	Cu. Ft	4,239	9,500		http://www.motortrend.com/cars/2008/ford/e_350/specifications/index.html
2b	Utility Van	Uhaul 10' Truck	van (basic enclosed)	GMC		402	Cu. Ft	2,810	8,600		http://www.uhaul.com/Reservations/EquipmentDetail.aspx?model=EL
2b	Utility Van	Budget 10' Moving Truck	van (basic enclosed)			380	Cu. Ft	3,100	8,600		http://www.budgettruck.com/Moving-Trucks.aspx
2b	Stake Truck	Stake/platform	flatbed/stake/ platform	Supreme		336	Cu. Ft				
3	Pickup	Pick-up		GMC	Sierra 3500		Cu. Ft	4,566	10,700		http://www.gmc.com/sierra/3500/specs/Standard.jsp
3	Step Van	Step Van	step/walk-in	Freightliner-Sprinter	3500 Standard Roof	547	Cu. Ft	4,845	11,030		http://www.freightlinersprinterusa.com/vehicles/cargo-van/models/3500-high-roof-170-wb-6-specs.php
3	Conventional Van	Penske 12' Cargo Van	van (basic enclosed)			450	Cu. Ft	2,600			http://www.pensketruckrental.com/commercial-truck-rentals/moving-vans/12-ft.html
3	City Delivery	Budget 16' Moving Truck				800	Cu. Ft	3,400	11,500		http://www.budgettruck.com/Moving-Trucks.aspx
4	Conventional	Uhaul 14'		Ford		733	Cu. Ft	6,190	14,050		http://www.uhaul.com/Reservations/EquipmentDetail.aspx?model=EL

Classes	Application	Body Type	VIUS Category	Manuf	Model	Cargo Space (cubic feet)	Unit	Max Payload	GVW	Notes or Comments	URL
	1 Van	Truck									quipmentDetail.aspx?model=EL
4	Conventional Van	Uhaul 17' Truck		Ford		865	Cu. Ft	5,930	14,050		http://www.uhaul.com/Reservations/EquipmentDetail.aspx?model=EL
4	Conventional Van	Penske 16' Economy Van				826	Cu. Ft	4,300	15,000		http://www.pensketruckrental.com/commercial-truck-rentals/moving-cargo-vans/16-ft.html
4	City Delivery	Penske 16' Cargo Van				1,536	Cu. Ft	5,100			http://www.pensketruckrental.com/commercial-truck-rentals/moving-cargo-vans/16-ft.html
4	Large Walk-In	Walk-in			W700 Step Van	700	Cu. Ft	5,720	16,000		http://files.harc.edu/Projects/Transportation/FedExReportTask3.pdf
4	Large Walk-In	Walk-in		Eaton Hybrid	W700 Step Van	700	Cu. Ft	5,390	16,000		http://files.harc.edu/Projects/Transportation/FedExReportTask3.pdf
4	UPS	Walk-in		Grumman							http://www.grummanolson.com/index2.htm
4	Stake Truck	Stake/platform	flatbed/stake/platform	GMC	W4500	448	Cu. Ft		14,500		http://www.usedtrucksdepot.com/browse_listdetails.php?manf=GMC&scate=Stake+Truck&catname=Medium+Duty+Trucks&main_id=208
5	Bucket Truck	Bucket truck					Cu. Ft				
5	City Delivery	Uhaul 24' Truck	van (basic enclosed)			1,418	Cu. Ft	6,500	18,000		http://www.uhaul.com/Reservations/EquipmentDetail.aspx?model=EL
5	City Delivery	Uhaul 26' Truck	van (basic enclosed)			1,611	Cu. Ft	7,400	18,000		http://www.uhaul.com/Reservations/EquipmentDetail.aspx?model=EL
5	Large Walk-In	Large Walk-in	step/walk-in			670	Cu. Ft		16,000		http://news.van.fedex.com/node/7379
6	Beverage	Beverage		Hackney	6-Bay 52" Performer	588/case capacity = 531 @ 120z cans	Cu. Ft/cases cans	11,601	21,150		http://www.hackneybeverage.com/bodycad5.htm
6	Single Axle	Budget	van (basic			1,380	Cu. Ft	12,000	25,500		http://www.budgettruck.com/Moving-

Classes	Application	Body Type	VIUS Category	Manuf	Model	Cargo Space (cubic feet)	Unit	Max Payload	GVW	Notes or Comments	URL
	Van	24' Truck	enclosed)								Trucks.aspx
6	Stake Truck	24' Stake Truck	flatbed/stake/platform	International/Supreme	24'	672	Cu. Ft		25,900		http://www.usedtrucks.ryder.com/Vehicle/VehicleSearch.aspx?VehicleTypeId=1&VehicleGroupId=5
6	Refrigerated/Reefer	24' Kold King Refrigerated	reefer	Supreme	24'	1,521	Cu. Ft				http://www.silvercrowncoach.com/supreme.php?page=product&body=refrigerated&product=21&section=specs
6	Landscape Van	Vanscape r Landscape Van	step/walk-in	Supreme	22'	1,496	Cu. Ft			Note: typical step/walk-ins do not reach this size. This is a speciality vehicle	http://www.silvercrowncoach.com/supreme.php?page=product&body=landscaping&product=30
7	Refuse	Refuse Truck					Cu. Ft				
7	Furniture	Furniture Truck				2,013	Cu. Ft				http://www.hendersonrentals.co.nz/?t=38
7	Beverage	Beverage (delivery body)		Hackney	Hackney 10-Bay-48" Aluminum	1251/case capacity = 1,100 12 oz cans	Cu. Ft/case cans	23,700	37,733		http://hackneyusa.com/
7	Stake Truck	flatbed/stake/platform	flatbed/stake/platform	Supreme	SH20096	728			33,000		http://www.usedtrucks.ryder.com/Vehicle/VehicleSearch.aspx?VehicleTypeId=1&VehicleGroupId=5
7	Refrigerated/Reefer	28' Kold King Refrigerated	reefer	Supreme	28'	1,774	Cu. Ft				http://www.silvercrowncoach.com/supreme.php?page=product&body=refrigerated&product=21&section=specs
7	Tanker Truck	tank (fluid)	tank (fluid)	Ford	F750 XL	267	Cu. Ft	2,000-4000 GAL	26,000		http://www.truckingauctions.com/browse_listdetails.php?scate=Water%20Tank%20Truck&manf=GMC&catname=H

Class	Application	Body Type	VIUS Category	Manuf	Model	Cargo Space (cubic feet)	Unit	Max Payload	GVW	Notes or Comments	URL
											eavy%20Duty%20Trucks
7	Single Axle Van	Freightliner Truck	van (basic enclosed)	Freightliner Business Class (24')	Business Class M2 112	1,552			33,000	Note: front axle lbs 12,000/rear axle 21,000 lbs (each add'l axle approx 12,000 lbs)	http://www.truckpaper.com/listingsdetail/detail.aspx?OHID=2379362