Appendix I- Mobile Input Parameters

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Analysis Notes
MOVES-Based On-Road Emissions Estimates for the El Paso Metropolitan Planning Organization (EPMPO) El Paso-New Mexico 2015 Ozone Standard

19 December 2018 (Revised 19 June2019[1])

The Texas A&M Transportation Institute (TTI) performed the herein described "elp_nm15oz" emissions analysis for the EPMPO to meet the conformity requirements for 2015 ozone standard. The EPMPO requested the analysis through the Texas Department of Transportation (TxDOT) and provided TTI the Travel Demand Model (TDM) data sets on December 7, 2018. The EPMPO requested analyses (for 2017, 2020, 2030, 2040 and 2045) with 2017 as the baseline.

TTI used EPA's MOVES2014a on-road model (November 2016 release), the elp_nm15oz TDM, and TTI's emissions estimation utilities to produce 2017, 2020, 2030, 2040, 2045, summer weekday oxides of nitrogen (NOx) and volatile organic compounds (VOC) estimates for the part of Dona Ana County, NM in the TDM.

SCOPE OF EMISSIONS ANALYSIS

1. **Methodology**: *Vehicle exhaust and evaporative emissions*: Detailed, hourly, disaggregate, MOVES rates-per-activity, TDM link-based method with the most recent version of MOVES.[2]
2. **Analysis Years:** 2017, 2020, 2030, 2040, 2045.
3. **Seasonal Period:** *Summer*: June through August weekday (average Monday through Friday).
4. **Geography:** The part of Dona Ana County, NM within the El Paso regional TDM.[3]
5. **Pollutants:** NOx, VOC.

[1] Revised (TTI, June 19, 2019) to make emissions modeling for the part of Dona Ana County, NM in the EPMPO regional TDM the primary focus (e.g., by removing references to El Paso County emissions modeling).

[2] MOVES2014a was released November 2015, then updated December 2015, November 2016, and December 2017. The December 2017 MOVES2014a release only corrected a non-road mobile post-processing script. MOVES2014b was released August 2018. MOVES2014b improves the non-road component and updates chemical mechanism outputs, neither of which apply to on-road mobile emission rates used in regional conformity analyses. TTI used the November 2016 MOVES2014a release.

[3] Only part of Dona Ana County is in the El Paso TDM.

6. Sources: Gasoline- and diesel-powered MOVES source use types (SUT).

Table 1. Modeled Emissions Sources.

SUT	Gasoline	Diesel
Motorcycle	X	-
Passenger Car	X	X
Passenger Truck	X	X
Light Commercial Truck	X	X
Intercity Bus	-	X
Transit Bus	-	X
School Bus	X	X
Refuse Truck	X	X
Single Unit Short-Haul Truck	X	X
Single Unit Long-Haul Truck	X	X
Motor Home	X	X
Combination Short-Haul Truck	X	X
Combination Long-Haul Truck	-	X

7. Tools: MOVES and TTI's MOVES-based inventory development utilities[4] were used: RatesCalc – produces and/or compiles emissions rate tables from MOVES output; EmsCalc – calculates hourly link emissions for a county (or coded partial-county area) using the estimated link VMT and speeds, VMT mixes, off-network activity, and emissions factors from RatesCalc (or MOVES or RatesAdj); TransVMT – estimates the on-road fleet VMT and operational speeds for use in air quality analyses (input to EmsCalc), based on TDM data sets; VMTmixBuild – formats gasoline and diesel MOVES source type (vehicle type) VMT mix input to EmsCalc; OffNetActCalc – calculates source-hours-parked (SHP), source-hours-extended-idling (SHI), auxiliary power unit (APU) usage hours, and starts inputs to EmsCalc; VehpopulationBuild – calculates vehicle population estimates input to OffNetActCalc based on vehicle registration data and other factors; and MOVESfleetInputBuild – produces sourcetypeagedistribution and avft (i.e., fuel fractions) table inputs to MOVES, based on vehicle registration data, MOVES default data, and VMT mix estimates.

[4] *TTI Emissions Inventory Estimation Utilities Using MOVES: MOVES2014aUtl User's Guide*, TTI, August 2016.

DEVELOPMENT OF ON-ROAD FLEET LINK-VMT AND SPEEDS

8. Travel Demand Models: TTI received the new elp_nm15oz TDM data sets (i.e., trip matrices and four-time-period, non-directional, average non-summer weekday traffic [ANSWT] assignments) from the EPMPO on December 7, 2018. Data sets included the 2017 baseline year, 2020, 2030, 2040, and 2045 future analysis years. TTI post-processed the data sets to determine average seasonal weekday, county, hourly, directional, Highway Performance Monitoring System (HPMS)-consistent, network link VMT and volumes, and added intrazonal link VMT estimates, coded for county and partial-county areas. Method details are found in *MOVES2014a-Based Travel Demand Model Link Emissions Estimation Method* (TTI, August 2016).

9. Adjustments to TDM VMT: The ANSWT network link volumes and VMT and added intrazonal link VMT were factored to be consistent with HPMS VMT, to reflect seasonal weekday activity, to allocate by hour, and to allocate by direction of travel. Seasonal weekday and hourly distribution factors were developed using the latest available multi-year, El Paso County aggregate Texas Department of Transportation (TxDOT) Automatic Traffic Recorder [ATR] traffic count data (2007 – 2016).[5] TTI used these El Paso County factors to model the relatively small, adjacent, portion of Dona Ana County in the regional TDM.

a. **Historical Analysis Year HPMS Consistency and Seasonal Weekday Adjustments (No historical year emission analysis was required):**
   HPMS consistency: When required, the historical year TDM total ANSWT link VMT is adjusted to the seasonal (summer or winter) VMT using county-level VMT control totals. The VMT control total is county total, annual average daily traffic (AADT) HPMS VMT (from TxDOT's Roadway Inventory Annual Reports, adjusted to the seasonal weekday form (using seasonal factor described below).
   Seasonal adjustment: County-level seasonal (summer) weekday factors are produced and applied to the county-level AADT HPMS VMT to develop the historical year VMT control totals. These factors are calculated as the ratio of the average seasonal weekday-to-AADT ATR counts.

b. **2017, 2020, 2030, 2040, 2045 Year HPMS Consistency and Seasonal Adjustments:**
   HPMS consistency: TTI applied the HPMS adjustment factor to total ANSWT link VMT for each year. The validation year HPMS adjustment factor is 2012 HPMS VMT (first adjusted to ANSWT using the 2012 ANSWT/AADT ATR count ratio) to 2012 validation year total ANSWT link VMT. See Table 4 in Attachment 1, Page 11.[6]
   Seasonal adjustment: County-level seasonal (summer) weekday factors were produced and used with the 2017, 2020, 2030, 2040, and 2045 analysis years. These factors were calculated as the ratio of the seasonal weekday-to-ANSWT counts. See Table 5 in Attachment 1, Page 10.

[5] All the ATR-based factors used were from the prior analysis.
[6] The HPMS adjustment factor was not updated for this analysis. TTI used the HPMS adjustment factor previously developed by TTI for a prior El Paso Destino 2045 MTP emissions analysis (April 2018) (using the EPMPO-provided 2012 validation-year TDM dataset).

c. Seasonal Weekday Hourly VMT Distribution:
County level, seasonal weekday, hourly travel factors were developed and used to allocate the 24-hour link VMT/volume estimates to each hour of the day – a single set was used for all analysis years. In order to maintain VMT proportions within each of the four time periods, the hourly fractions were normalized within each time period. See Table 6 in Attachment 1, Page 11.

d. Directional Factors:
Directional factors were applied to link volumes/VMT by time-of-day period. A single set of directional split factors by TDM network functional class and area type was used for both seasons and all years. These are the same factors applied in the prior El Paso conformity analysis.

10. Hourly Congested Speeds: TTI estimated directional, hourly operational link speeds using the TTI speed model, which estimates delay on each link as function of volume-to-capacity, and applies it to the link's estimated free-flow speed. TTI estimated the local streets category link average operational speeds represented by the centroid connector links, as centroid connector TDM input speeds; and represented as added intrazonal links, as the zone's average centroid connector input speed.

DEVELOPMENT OF VMT MIX

11. VMT Mix: Using latest available classification counts (2005-2014) and associated year-end registration data (2013), TTI estimated the El Paso County time-of-day (AM Peak, Mid-Day, PM Peak, Overnight) VMT mixes by the four MOVES road types. No seasonal adjustments are made for VMT mix. The methodology is described in *Developing MOVES Source Use Types and VMT Mix for Conformity Analysis* (TTI, August 2016).

OFF-NETWORK ACTIVITY

12. Vehicle Population Estimates: The El Paso County vehicle population estimates were based on Texas Department of Motor Vehicles (TxDMV) registration data, vehicle population factors derived from the VMT mix, and VMT-based growth estimates for future years where registration data is not available. No vehicle population estimates were developed for Dona Ana. Dona Ana was essentially treated as an extension of El Paso throughout this analysis.

a. Historical Analysis Year Vehicle Population Estimates (Not required):
TxDMV registration data: El Paso County historical analysis year vehicle population estimates are based on the analysis year TxDMV mid-year registration data for El Paso County. This registration data is aggregated into vehicle registration categories (motorcycles, passenger cars, trucks less than or equal to 8,500 pounds gross vehicle rating [GVWR], trucks greater than 8,500 pounds and less than or equal to 19,500 pounds GVWR, and trucks greater than 19,500 pounds GVWR).
Vehicle population factors: Since the TxDMV registration data does not include each SUT/fuel type combination, vehicle population factors were developed using the analysis year 24-hour VMT mix. These factors were applied to vehicle registrations aggregated by category to split each category into each SUT/fuel type combination included in the analysis.

VMT-based growth estimates: For historical analysis years (i.e., where registration data exists), VMT-based growth estimates are typically not required.

b. 2017, 2020, 2030, 2040, 2045 Analysis Year Vehicle Population Estimates:
TxDMV registration data: As described for historical vehicle population estimates, the registration data were aggregated by vehicle registration category. Since registration data were not available for future year analyses, the most recent mid-year TxDMV registration data sets (2014) were used.
Vehicle population factors: As described for historical vehicle population estimates, vehicle population factors developed using the analysis year 24-hour VMT mix were applied to vehicle registrations aggregated by category to split each category into each SUT/fuel type combinations included in the analysis; thus creating the base (2014) vehicle population estimates.
VMT-based growth estimates: For each analysis year, VMT-based growth estimates were calculated by dividing the El Paso County analysis year summer Weekday VMT by the El Paso County 2014 summer Weekday VMT. These growth estimates were applied to the base vehicle population estimates to scale the base estimates up to the analysis year.

13. Source Hours Parked (SHP) Estimates:

a. El Paso County: For each analysis year, hourly SHP by vehicle type (SUT/fuel type combination) was estimated as a function of total hours (hours a vehicle exists) minus the vehicle type's hours of operation on roads (source hours operating [SHO]). Since the SHP was calculated on an hourly basis, the total number of hours (of each vehicle's existence) within the time period is equal to the vehicle population. The hourly SHO, which is the same as the vehicle hours of travel (VHT), was calculated by applying the analysis year VMT mix to the link VMT and dividing the link VMT by the associated link speed.

b. Dona Ana: For each analysis year, the hourly SHP by vehicle type for the Dona Ana area was calculated by scaling the El Paso County activity based on the ratio of the Dona Ana VMT to the El Paso County VMT; thus treating Dona Ana as an extension of El Paso.

14. Vehicle Starts Estimates:

a. El Paso County: Engine starts were based on the MOVES national default starts per vehicle and the county-level vehicle population estimates. For each analysis year, the hourly vehicle type starts were calculated as the product of the MOVES default weekday starts/vehicle by the county-level vehicle population estimates.

b. Dona Ana: For each analysis year, the hourly vehicle starts in the Dona Ana area were calculated by scaling the El Paso County activity based on the ratio of the Dona Ana VMT to the El Paso County VMT; thus treating Dona Ana as an extension of El Paso.

15. Hotelling, Extended Idle (or Source Hours Idling, SHI), and APU Hours:

a. El Paso County: For each analysis year, the summer weekday hotelling activity was based on information from the Texas Commission on Environmental Quality (TCEQ) *Extended Idle Study* (TTI, 2017-2018). This study established a 2017 winter weekday (24-hour) hotelling activity base by Texas county. The 2017 base hotelling activity for El Paso County was scaled to each analysis year (analysis year/season) weekday based on the ratio of the 24-hour analysis year seasonal weekday combination long-haul truck VMT to the combination long-haul truck VMT from a 2017 base year (as truck VMT increases, so does the hotelling activity). The analysis year 24-hour hotelling activity was distributed to each hour of the day using hourly factors, which were created as the inverse of the hourly VHT fractions calculated from the analysis year link VMT and speeds. The hotelling activity was disaggregated into each operating mode category using proportions developed from model year travel fractions (calculated based on the source type age distribution and relative mileage accumulation rates used in the MOVES runs) and the hotelling activity distribution (recently updated to include new operating mode fractions for extended idling, APU hours, electric power, and all power off).

b. Dona Ana: For each analysis year, the hourly hotelling, SHI, and APU hours for the Dona Ana area were calculated by scaling the El Paso County activity based on the ratio of the Dona Ana VMT to the El Paso County VMT; thus treating Dona Ana as an extension of El Paso.

DEVELOPMENT OF EMISSIONS FACTORS

16. Background: TTI developed emissions rates using MOVES2014a and the TTI post-processing utility, RatesCalc, for preparing MOVES2014a-based emissions rates for input to TTI's external inventory calculation utility, EmsCalc. El Paso County summer weekday emissions rates were produced for each analysis year. These emissions rates were used for all of the El Paso TDM modeling areas including the portion of Dona Ana County in the TDM.

These on-road emissions rates were developed in terms of mass per activity unit: miles for roadway-based processes; SHP, starts, SHI, and APU hours for off-network processes. All of these activity-based rates were directly output by MOVES, except for parked vehicle evaporative emissions rates based in SHP. TTI used the RatesCalc utility to calculate emissions rates in terms of rate/SHP (as a conversion of MOVES rate/vehicle output) using the data in the county (local) input database (CDB) used in the MOVES emissions rates run and the MOVES default database. The RatesCalc utility combined the rate/distance, rate/hour (SHI and APU hours), and rate/start emissions rates tables from MOVES output, and the calculated rate/SHP emissions rates table into a final database of rates look-up tables for input to the EmsCalc utility. For additional details on the RatesCalc processing of MOVES output, see Attachment 2.

Table 2 lists the emissions processes with associated activity basis and emissions rate units. The emissions factors were developed by pollutant, speed, process, hour, road type, and SUT/FT.

Table 2. On-Road Fleet Emissions Rates Modeled by Process and Activity Factor.

Emissions Process	Activity[1]	Emissions Factor Units[2]
Running Exhaust Crankcase Running Exhaust	VMT	mass/mile (mass/mi)
Brake Wear	VMT	mass/mi
Tire Wear	VMT	mass/mi
Start Exhaust Crankcase Start Exhaust	starts	g/start
Extended Idle Exhaust Crankcase Extended Idle Exhaust	SHI	mass/shi
Auxiliary Power Exhaust	APU Hours	mass/APU hour
Evaporative Permeation Evaporative Fuel Vapor Venting Evaporative Fuel Leaks	VMT, SHP	mass/mi, mass/shp

[1] The amount of travel on roads (VMT), SHP, vehicle starts, SHI and APU hours are the basic activity factors. SHI and APU hours are for combination long-haul trucks only. Evaporative (hydrocarbon) permeation, fuel vapor venting, and fuel leaks occur both during operation and while parked.

17. MOVES Model Inputs: All of the user-specified model settings and inputs for each run were contained in a MOVES run specification (MRS) and a CDB (the MOVES2014a default database used was "MOVESDB20161117"). See Attachment 2 for details on the MRS files and CDBs developed and used to estimate the summer weekday emissions factors each analysis year.

18. Emissions Factor Post-Processing: No emissions rate adjustments were required and therefore no emissions rate adjustments via post-processing were performed.

19. Emissions Controls Modeling: Table 3 shows the modeling approaches used for the emissions control strategies. Unless otherwise stated, the control strategy was modeled in all years.

Table 3. Emissions Modeling Strategies and Approaches.

Strategy	Approach
Federal Motor Vehicle Control Program Standards	MOVES defaults.
Federal Heavy-Duty Diesel Engines Rebuild and 2004 Pull-Ahead Programs to Mitigate NO_x Off-Cycle Effects	MOVES defaults.
Gasoline Fuel – Tier 2/Tier 3 sulfur standards, Low Summer Reid Vapor Pressure (RVP)	Locality-specific user-developed inputs to MOVES. TTI produced the summer 2017 fuel formulations using summer 2017 El Paso fuel sample data (available from TCEQ's summer 2017 statewide fuel study). TTI produced summer 2020 and later conventional gasoline inputs consistent with pertinent federal and state rules, based on a combination of El Paso fuel sample data (from the TCEQ survey) and MOVES defaults or other expected future year values. Fuel formulations are provided in Attachment 2.
Federal Low Sulfur Diesel Fuel	Locality-specific user inputs to MOVES. For 2017 diesel sulfur level was based on El Paso diesel sample data (from the TCEQ 2017 survey). For the future years, diesel sulfur input values were set for consistency with the applicable federal diesel sulfur standards. Diesel formulations are provided in Attachment 2.
Inspection and Maintenance (I/M) Program	Locality-specific user-developed I/M coverage inputs to MOVES. TTI developed El Paso I/M Program inputs to MOVES using the available MOVES I/M parameters pertaining to the domain of subject I/M vehicles, consistent with current program descriptions and latest I/M modeling protocols. Attachment 2 provides a summary of the I/M program input parameters used.

Attachment 1
Adjustments to TDM VMT

Table 4. HPMS Factor.

2012 HPMS VMT	AADT-to-ANSWT Factor	HPMS-Based ANSWT VMT	2012 TDM VMT[1]	HPMS Factor
15,151,926	1.08815	16,487,568	17,815,876	0.925442459

[1] March 21, 2018 EPMPO-provided TDM data processed by TTI.

Table 5. 2017, 2020, 2030, 2040, 2045 Analysis Years TDM (ANSWT) Seasonal Weekday Factors.

Season	Seasonal Weekday Factor
Summer	0.95645

Table 6. Seasonal Weekday Hourly VMT Distributions.

Time-Period	Hour	Summer Fractions	
		24-Hour-Period	Four-Period[1]
AM Peak	7:00 a.m.	0.063690	0.343596
	8:00 a.m.	0.065525	0.353496
	9:00 a.m.	0.056148	0.302908
Mid-Day	10:00 a.m.	0.052431	0.182905
	11:00 a.m.	0.055021	0.191940
	12:00 p.m.	0.058244	0.203184
	1:00 p.m.	0.059400	0.207216
	2:00 p.m.	0.061561	0.214755
	3:00 p.m.	0.052431	0.182905
PM Peak	4:00 p.m.	0.066592	0.242258
	5:00 p.m.	0.071780	0.261132
	6:00 p.m.	0.074417	0.270726
	7:00 p.m.	0.062091	0.225884
Overnight	8:00 p.m.	0.046914	0.185357
	9:00 p.m.	0.037489	0.148119
	10:00 p.m.	0.032499	0.128404
	11:00 p.m.	0.026365	0.104168
	12:00 a.m.	0.018866	0.074540
	1:00 a.m.	0.010574	0.041778
	2:00 a.m.	0.006826	0.026970
	3:00 a.m.	0.005587	0.022074
	4:00 a.m.	0.005148	0.020340
	5:00 a.m.	0.007328	0.028953
	6:00 a.m.	0.018190	0.071869

[1] To maintain VMT proportions within the four periods, the hourly fractions were normalized within each period.

Attachment 2
MOVES Run Specifications (MRS), County Databases (CDB), Outputs, and Post-Processing

MOVES Inputs and Output:

- MRS input files: One for each analysis year (5).
- CDB inputs: One for each analysis year (5).
- The MOVES default input database (MOVESDB20161117).
- MOVES output databases: One per MOVES run (5).
- MOVES run log output text files: One per MOVES run (5).

Post-Processing Output:

- Final Rates Databases inputs to EmsCalc (5): For each MOVES output database, TTI used RatesCalc to calculate the mass/SHP off-network evaporative process rates using data from CDB, MOVES default database, and MOVES rateperprofile and ratepervehicle emissions rate output. Using the CDB and MOVES default data, the MOVES vehicle population and SHP calculation process was replicated to provide vehicle population-to-SHP ratios, which were multiplied by the MOVES rate/vehicle output yielding rate/SHP. Rates needed directly from the MOVES output and the SHP-based rates calculated by RatesCalc were tabulated in the RatesCalc output database. In addition to the MOVES pollutants specified in the pre-analysis plan, VOC and NOx, other optional pollutants were included for informational purposes (e.g., CO, PM_{10} total exhaust, PM_{10} brakewear, PM_{10} tirewear). Four rate tables were included: ttirateperdistance, ttirateperstart, ttirateperhour, and ttiratepershp; containing, respectively, the MOVES rateperdistance, rateperstart, rateperhour (SHI and APU hour-based rates), and the RatesCalc-produced SHP-based rates, each with a column added specifying units. These rates tables were input to EmsCalc emissions calculation utility. The RatesCalc utility is described in more detail in *TTI Emissions Inventory Estimation Utilities Using MOVES: MOVES2014aUtl User's Guide* (TTI, August 2016).

Table 7 describes the MOVES2014a run specification files used. Table 8 describes the CDBs built and used for the rates analysis. Table 9, Table 10, and Table 11 summarize the meteorological, fuels, and I/M program inputs used.

Table 7. MOVES Run Specification Selections by GUI Panel.

Navigation Panel	Detail Panel[1]	Selection		
Scale[1]	Model; Domain/Scale; Calculation Type	On-Road; County; Emissions Rates		
Time Spans[1]	Time Aggregation Level; Years – Months – Days – Hours	Hour; <***Year***> - July - Weekday - All		
Geographic Bounds[1]	Region; Selections; Domain Input Database	Zone and Link; El Paso; mvs14a_elp_nm15oz_<***Year***>s_er_CDB_in[1]		
On-Road Vehicle Equipment	SUT/Fuel Combinations	SUT	Gasoline	Diesel
		Motorcycle	X	-
		Passenger Car	X	X
		Passenger Truck	X	X
		Light Commercial Truck	X	X
		Intercity Bus	-	X
		Transit Bus	-	X
		School Bus	X	X
		Refuse Truck	X	X
		Single Unit Short-Haul Truck	X	X
		Single Unit Long-Haul Truck	X	X
		Motor Home	X	X
		Combination Short-Haul Truck	X	X
		Combination Long-Haul Truck	-	X
Road Type	Selected Road Types	Off-Network – Rural Restricted Access – Rural Unrestricted Access – Urban Restricted Access – Urban Unrestricted Access		
Pollutants and Processes[2]	VOC; CO; NO_x; Primary Exhaust PM_{10}; Primary PM_{10} Brakewear; Primary PM_{10} Tirewear, etc.	Dependent on pollutant: Running Exhaust, Start Exhaust, Extended Idle Exhaust, Auxiliary Power Exhaust, Crankcase Running Exhaust, Crankcase Start Exhaust, Crankcase Extended Idle Exhaust, Evap Permeation, Fuel Vapor Venting, Fuel Leaks		
Manage Input Data Sets	Additional Input Database Selections	None		
Strategies	Rate Of Progress	Not Applicable		
General Output	Output Database; Units; Activity	mvs14a_elp_nm15oz_<***Year***><***season***>wkd_er_out[1]; Pounds, KiloJoules, Miles; Hotelling Hours, Population, Starts (not adjustable, pre-selected)		
Output Emissions Detail	Always; For All Vehicles/Equipment; On Road	Time: Hour – Location: Link – Pollutant; Fuel Type, Emissions Process; Source Use Type		
Advanced Performance Measures	Aggregation and Data Handling	All check boxes "un-checked"		

[1] County scale allows only one year per run. The years include 2017, 2020, 2030, 2040, and 2045. Each MRS file was named similar to its output database, "mvs14a_elp_nm15oz_<***Year***>swkd_er.mrs."

[2] Only the pollutants retained in the final rates inputs to the emissions calculations are listed. Other pollutant selections were required as pre-requisites for the pollutants selected. Also, other pollutants were optionally included for potential informational purposes, but not reported.

Table 8. MOVES CDB Input Tables.

Input Table	Category	Notes
year	Time	Designates analysis year as a base year (base year means that local activity inputs will be supplied rather than forecast by the model).
state	Geography	Identifies the state (Texas) for the analysis.
county	Geography/ Meteorology	Identifies county of analysis with local altitude and barometric pressure. TTI used input data based on 2017 El Paso County weather stations.
zonemonthhour	Meteorology	Summer hourly temperature and relative humidity for the county. TTI used input data developed by TCEQ based on summer (June through August) 2017 El Paso County weather station data.
roadtype	Activity	Lists the MOVES road types and associated ramp activity fractions. Road type ramp fractions were set to 0.
Hpmsvtypeyear[1]	Activity (Defaults)	TTI used MOVES default national annual VMT by HPMS vehicle category.
roadtypedistribution[1]		TTI used MOVES default road type VMT fractions.
monthvmtfraction[1]		TTI used MOVES default month VMT fractions.
dayvmtfraction[1]		TTI used MOVES default day VMT fractions.
hourvmtfraction[1]		TTI used MOVES default hour VMT fractions.
avgspeeddistribution[1]		TTI used MOVES default average speed distributions.
sourcetypeyear[1]	Fleet (Defaults)	TTI used MOVES default national SUT populations.
sourcetypeage-distribution	Fleet	TTI estimated SUT age fractions using TxDMV mid-year county vehicle registration data and MOVES defaults (consistent with the registration data year), as needed. The latest available mid-year registration data were used for future years.
avft	Fleet	TTI estimated SUT fuel fractions using TxDMV vehicle registration data and defaults, where needed. Local data sets used were consistent with sourcetypeagedistribution tables. The avft estimate is also consistent with the analysis VMT mix.
zone	Activity	Start, hotelling, and SHP zone allocation factors. County = zone, and all factors were set to 1.0 (required for county scale analyses).
zoneroadtype	Activity	SHO zone/roadtype allocation factors. County = zone, and all factors were set to 1.0 (required for county scale analyses).
fuelsupply	Fuel	The fuel supply (marketshares) were set to indicate one gasoline and one diesel fuel formulation (i.e., marketshares = 1.0) for the county.
fuelformulation	Fuel	TTI based summer gasoline formulations on actual summer 2017 El Paso County survey data. For the future years TTI used a combination of MOVES defaults and gasoline properties estimated from local survey data with adjustments where needed for consistency with pertinent fuel regulations (e.g., summer RVP limit and Tier 3 sulfur standard). The diesel fuel formulations were actual for 2017 and for future years, set consistent with federal sulfur standards.
countyyear	Stage II	N/A.
imcoverage	I/M	TTI used local set-ups, updated for use with MOVES2014a, to represent El Paso County program based on current I/M rules, latest modeling protocols, and the available MOVES I/M parameters (i.e., MOVES I/M "teststandards" and "imfactors") for the I/M vehicles.
Hotellingactivity-distribution	activity	Used the updated distribution from TCEQ's 2017 long-haul truck hotelling/idling study (developed by EPA for next MOVES release).

[1] Use of default activity and population inputs for the MOVES rates mode runs is a basic aspect of the rates-per-activity emissions estimation method, which calculates the emissions inventory estimates via post-processing. The process uses actual, local vehicle activity estimates external to MOVES in the emissions calculations.

Table 9. Meteorological Inputs to MOVES: Temperature (T) - Fahrenheit, Relative Humidity (RH) - Percent, Barometric Pressure (BP) - Inches of Mercury.

Hour	Summer		
	T	RH	BP
1	79.77	42.73	26.159
2	78.51	45.05	
3	77.31	47.11	
4	76.27	49.05	
5	75.38	50.63	
6	74.47	52.45	
7	73.96	53.51	
8	75.19	51.26	
9	77.54	46.95	
10	80.13	42.42	
11	82.81	37.98	
12	85.38	33.88	
13	87.54	30.66	
14	89.27	28.03	
15	90.68	25.90	
16	91.85	24.01	
17	92.09	24.18	
18	91.62	24.77	
19	90.74	25.75	
20	89.02	28.24	
21	86.68	32.05	
22	84.78	34.61	
23	82.97	37.00	
24	81.28	40.04	

[1] Average hourly from weather stations within El Paso County—June through August 2017 (provided by TCEQ). HourID 1 is 12 a.m. to 1 a.m., etc.

Table 10. MOVES Gasoline and Diesel Fuel Formulation Inputs.

Field	Units	2017		Future Years	
		CG	Diesel	CG	Diesel
fuelFormulationID	-	17703	30637	18703	30011
fuelSubtypeID	-	12	20	12	20
RVP	psi	6.94	0	7.00	0
sulfurLevel	ppm	19.56	6.37	10.00	11
ETOHVolume	vol.%	9.60	0	9.60	0
MTBEVolume	vol.%	0	0	0	0
ETBEVolume	vol.%	0	0	0	0
TAMEVolume	vol.%	0	0	0	0
aromaticContent	vol.%	26.67	0	26.67	0
olefinContent	vol.%	5.50	0	5.50	0
benzeneContent	vol.%	1.30	0	0.63	0
e200	vap.%	48.74	0	48.74	0
e300	vap.%	87.84	0	87.84	0
volToWtPercentOxy	-	0.3653	0	0.3653	0
BioDieselEsterVolume	vol.%	/N	/N	/N	/N
CetaneIndex	-	/N	/N	/N	/N
PAHContent	vol.%	/N	/N	/N	/N
T50	°F	206.12	0	206.12	0
T90	°F	306.72	0	306.72	0

TTI (June 2018) based the CG formulations on TCEQ's summer 2017 (latest available) fuel survey samples from El Paso County. The 2017 CG properties are actual averages (fuel grade averages weighted by relative sales volumes). The Future Years CG properties are latest available 2017 actual values except with RVP, average sulfur level, and average benzene content set to the "expected" values (MOVES defaults, consistent with the pertinent regulatory standards). The 2017 diesel sulfur level is the statewide average from TCEQ's 2017 survey. Future Years diesel sulfur was conservatively set to the maximum level of the last three of TCEQ's statewide diesel surveys (2011, 2014, 2017), within the federal ultra low sulfur diesel 15 ppm average annual standard. Fuel subtype IDs 12 and 20 are 10% ethanol-blend gasoline and conventional diesel, respectively.

Local I/M Inputs to MOVES

MOVES adjusts emissions (HC, CO, and NO_x) at the source-type level to incorporate the benefits of the local I/M program design defined using the MOVES I/M coverage table parameters. TTI produced the I/M coverage input parameters to represent El Paso I/M program designs as specified in the Texas I/M SIP and Texas rules, using the current Texas I/M modeling protocol, and compliance and waiver rates. The El Paso I/M program requires annual emissions testing of gasoline vehicles within a 2-through-24 year vehicle age coverage window (motorcycles, military tactical vehicles, diesel-powered vehicles, and antique vehicles are excluded). A gas cap integrity test is required on all these vehicles, and depending on the model year, the vehicle emissions testing may utilize on-board diagnostics (OBD) or the Two-Speed Idle (2500 RPM/Idle) test. For additional Texas I/M program details, see the current I/M SIP, Revision to the State Implementation Plan Mobile Source Strategies, Inspection and Maintenance State Implementation Plan Revision, TCEQ, February 12, 2014.

Table 11. MOVES I/M Coverage Table Input Descriptions for El Paso County.[1]

YearID	Begin Model Year[2]	End Model Year[2]	Test Standard Description (ID)	Source Use Type (I/M Compliance Factor)[3]
2007 through 2019	*X*	1995	2500 RPM/Idle (12)	Passenger Car (93.12%) Passenger Truck (91.26%) Light Commercial Truck (85.67%)
	X	1995	Evp Cap (41)	
	1996	*Y*	Exh OBD (51)	
	1996	*Y*	Evp Cap, OBD (45)	
2020 through 2050	*X*	*Y*	Exh OBD (51)	
	X	*Y*	Evp Cap, OBD (45)	

[1] Common parameters for Texas MOVES imcoverage records not shown include: annual test cycle, gasoline fuel type. The MOVES pollutants and processes affected are exhaust HC, CO, NO_x, and tank vapor venting HC.

[2] Begin model year (*X*) and end model year (*Y*) define the range of model years covered, where "*X*" and "*Y*," respectively, are calculated as YearID – 24, and YearID – 2.

[3] MOVES I/M compliance factors were calculated as a combination of Texas I/M modeling protocol compliance and waiver rates, and the regulatory class coverage adjustments provided in Section 4.10.6 of *MOVES Technical Guidance* (EPA, November 2015), along with the formula: I/M compliance factor = (compliance rate) × (1.0 - waiver rate) × (regulatory class coverage adjustment). Compliance and waiver rates are 96 percent and 3 percent. Regulatory class adjustments are passenger car – 100 percent, passenger truck – 98 percent, and light commercial truck – 92 percent.

Attachment 3:
Source Type Age and Fuel Engine Fractions Inputs to MOVES

El Paso County 2014 Age Distribution Inputs to MOVES (used for 2017, 2020, 2030, 2040, and 2045)

Age	MC	PC	PT	LCT	IBus	TBus	SBus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.045935	0.053900	0.026733	0.026733	0.055548	0.055650	0.055556	0.064759	0.062455	0.080736	0.064928	0.009782	0.044007
1	0.079804	0.070772	0.037056	0.037056	0.049844	0.049946	0.049851	0.058272	0.060276	0.097975	0.058445	0.015801	0.048909
2	0.069402	0.060117	0.033846	0.033846	0.046005	0.046100	0.046012	0.053507	0.079702	0.150497	0.053673	0.014296	0.050486
3	0.042856	0.046863	0.035079	0.035079	0.042194	0.055697	0.032610	0.028999	0.066630	0.104892	0.039988	0.006772	0.032874
4	0.031289	0.049364	0.034467	0.034467	0.037253	0.034095	0.035647	0.022977	0.037945	0.036093	0.035305	0.010534	0.017742
5	0.080386	0.040653	0.028561	0.028561	0.031054	0.034678	0.042221	0.030317	0.032680	0.034013	0.029436	0.021068	0.031415
6	0.073146	0.064144	0.058164	0.058164	0.039992	0.048516	0.046183	0.023359	0.109659	0.093698	0.037928	0.029345	0.043640
7	0.096114	0.066662	0.060009	0.060009	0.052280	0.047012	0.047736	0.081433	0.047749	0.057695	0.049441	0.044394	0.094086
8	0.078472	0.061945	0.055914	0.055914	0.053395	0.033713	0.055776	0.060642	0.069535	0.064010	0.050348	0.042889	0.070679
9	0.063826	0.060570	0.053565	0.053565	0.055067	0.052559	0.049572	0.057049	0.069717	0.057569	0.051939	0.049661	0.061342
10	0.045602	0.055428	0.061812	0.061812	0.053502	0.043092	0.048835	0.034170	0.053558	0.040882	0.050306	0.036117	0.041119
11	0.054839	0.053694	0.053524	0.053524	0.049301	0.041983	0.041807	0.033378	0.042484	0.033007	0.046365	0.029345	0.032913
12	0.039694	0.051897	0.055451	0.055451	0.046064	0.042452	0.043802	0.024143	0.034858	0.026419	0.043333	0.033860	0.032437
13	0.031455	0.043310	0.053863	0.053863	0.044038	0.048613	0.039741	0.029530	0.035585	0.027473	0.041306	0.051919	0.043530
14	0.024715	0.042587	0.047742	0.047742	0.041777	0.032808	0.043136	0.040271	0.039034	0.021921	0.039197	0.082769	0.052520
15	0.024049	0.033234	0.039570	0.039570	0.040613	0.031807	0.039913	0.057677	0.032498	0.019697	0.037984	0.078254	0.044225
16	0.017142	0.027351	0.033474	0.033474	0.030598	0.037111	0.031314	0.052718	0.018337	0.009478	0.022205	0.055681	0.037120
17	0.011401	0.021668	0.033913	0.033913	0.024835	0.033826	0.029099	0.025424	0.017974	0.010221	0.034115	0.040632	0.028101
18	0.011401	0.016127	0.022415	0.022415	0.020412	0.030975	0.024947	0.032795	0.009259	0.005665	0.020938	0.033860	0.025898
19	0.008405	0.015798	0.023979	0.023979	0.026464	0.025322	0.031789	0.041995	0.014706	0.006044	0.024651	0.048157	0.032080
20	0.007240	0.011279	0.022920	0.022920	0.020257	0.021952	0.015251	0.029313	0.009622	0.003876	0.023297	0.040632	0.020867
21	0.004660	0.008904	0.016038	0.016038	0.016633	0.018163	0.018167	0.013318	0.007081	0.002748	0.015998	0.029345	0.017990
22	0.003911	0.006789	0.013027	0.013027	0.012252	0.015769	0.014653	0.011855	0.005991	0.001875	0.013989	0.024831	0.012870
23	0.003994	0.005559	0.009793	0.009793	0.013801	0.015855	0.018594	0.018450	0.005991	0.002168	0.010346	0.030098	0.014209
24	0.003162	0.004365	0.009074	0.009074	0.015450	0.023149	0.020950	0.013061	0.004720	0.001735	0.013522	0.024078	0.012572
25	0.001831	0.003615	0.008759	0.008759	0.015324	0.017611	0.011953	0.020123	0.005084	0.001442	0.017413	0.017306	0.009605
26	0.002496	0.002877	0.009512	0.009512	0.014173	0.013781	0.014128	0.011515	0.004720	0.001180	0.015355	0.015049	0.007859
27	0.002164	0.002357	0.005600	0.005600	0.014695	0.012718	0.014276	0.010304	0.001452	0.000678	0.014965	0.015801	0.006202
28	0.003828	0.001917	0.007022	0.007022	0.012327	0.010714	0.012460	0.005268	0.003813	0.000875	0.010998	0.016554	0.006083
29	0.002996	0.001624	0.005782	0.005782	0.010701	0.009139	0.010634	0.005263	0.001997	0.000762	0.011609	0.012039	0.005596
30	0.033785	0.014631	0.043334	0.043334	0.014149	0.015191	0.013386	0.008114	0.014887	0.004677	0.020675	0.039127	0.021026

Texas Statewide 2017 Fuel Engine Fractions Summary[1]

SUT	Fuel Type	Model Year															
		2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.990	0.993	0.999	1.000	0.993	0.995	0.997	0.996	0.996
PC	Diesel	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.010	0.007	0.001	0.000	0.007	0.005	0.003	0.004	0.004
PT	Gas	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.987	0.985	0.977	0.981	0.975	0.979	0.982	0.982	0.983
PT	Diesel	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.013	0.015	0.023	0.019	0.025	0.021	0.018	0.018	0.017
LCT	Gas	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.962	0.955	0.941	0.948	0.938	0.946	0.951	0.951	0.956
LCT	Diesel	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.038	0.045	0.059	0.052	0.062	0.054	0.049	0.049	0.044
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
RT	Gas	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.002	0.002	0.005	0.001	0.003	0.003	0.005	0.004	0.005
RT	Diesel	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.998	0.998	0.995	0.999	0.997	0.997	0.995	0.996	0.995
SUShT	Gas	0.396	0.396	0.396	0.396	0.371	0.219	0.234	0.274	0.351	0.287	0.256	0.238	0.232	0.245	0.260	0.268
SUShT	Diesel	0.604	0.604	0.604	0.604	0.629	0.781	0.766	0.726	0.649	0.713	0.744	0.762	0.768	0.755	0.740	0.732
SULhT	Gas	0.396	0.396	0.396	0.396	0.371	0.219	0.234	0.274	0.351	0.287	0.256	0.238	0.232	0.245	0.260	0.268
SULhT	Diesel	0.604	0.604	0.604	0.604	0.629	0.781	0.766	0.726	0.649	0.713	0.744	0.762	0.768	0.755	0.740	0.732
MH	Gas	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.510	0.530	0.540	0.560	0.570	0.590	0.600
MH	Diesel	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.490	0.470	0.460	0.440	0.430	0.410	0.400
CShT	Gas	0.094	0.094	0.094	0.094	0.199	0.110	0.057	0.081	0.052	0.058	0.031	0.050	0.051	0.052	0.055	0.077
CShT	Diesel	0.906	0.906	0.906	0.906	0.801	0.890	0.943	0.919	0.948	0.942	0.969	0.950	0.949	0.948	0.945	0.923
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2017 Fuel Engine Fractions Summary[1] - (Continued)

SUT	Fuel Type	Model Year														
		2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989	1988	1987
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.997	0.997	0.998	0.998	0.999	0.999	0.999	1.000	0.999	0.999	0.997	0.999	0.999	1.000	0.987
PC	Diesel	0.003	0.003	0.002	0.002	0.001	0.001	0.001	0.000	0.001	0.001	0.003	0.001	0.001	0.000	0.013
PT	Gas	0.989	0.992	0.981	0.993	0.992	0.981	0.995	0.991	0.986	0.985	0.994	0.989	0.992	0.997	0.996
PT	Diesel	0.011	0.008	0.019	0.007	0.008	0.019	0.005	0.009	0.014	0.015	0.006	0.011	0.008	0.003	0.004
LCT	Gas	0.908	0.949	0.929	0.950	0.927	0.971	0.932	0.974	0.974	0.951	0.937	0.984	0.976	0.952	0.986
LCT	Diesel	0.092	0.051	0.071	0.050	0.073	0.029	0.068	0.026	0.026	0.049	0.063	0.016	0.024	0.048	0.014
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.042	0.114	0.147	0.121	0.010	0.090	0.124	0.229	0.250	0.265
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.958	0.886	0.853	0.879	0.990	0.910	0.876	0.771	0.750	0.735
RT	Gas	0.006	0.002	0.169	0.404	0.019	0.012	0.010	0.105	0.031	0.210	0.101	0.204	0.029	0.106	0.106
RT	Diesel	0.994	0.998	0.831	0.596	0.981	0.988	0.990	0.895	0.969	0.790	0.899	0.796	0.971	0.894	0.894
SUShT	Gas	0.311	0.350	0.348	0.435	0.436	0.427	0.673	0.508	0.519	0.511	0.465	0.539	0.572	0.640	0.654
SUShT	Diesel	0.689	0.650	0.652	0.565	0.564	0.573	0.327	0.492	0.481	0.489	0.535	0.461	0.428	0.360	0.346
SULhT	Gas	0.311	0.350	0.348	0.435	0.436	0.427	0.673	0.508	0.519	0.511	0.465	0.539	0.572	0.640	0.654
SULhT	Diesel	0.689	0.650	0.652	0.565	0.564	0.573	0.327	0.492	0.481	0.489	0.535	0.461	0.428	0.360	0.346
MH	Gas	0.630	0.660	0.680	0.710	0.740	0.770	0.790	0.820	0.850	0.850	0.850	0.850	0.850	0.850	0.850
MH	Diesel	0.370	0.340	0.320	0.290	0.260	0.230	0.210	0.180	0.150	0.150	0.150	0.150	0.150	0.150	0.150
CShT	Gas	0.084	0.090	0.107	0.134	0.147	0.146	0.275	0.117	0.117	0.160	0.161	0.144	0.114	0.157	0.163
CShT	Diesel	0.916	0.910	0.893	0.866	0.853	0.854	0.725	0.883	0.883	0.840	0.839	0.856	0.886	0.843	0.837
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2020 Fuel Engine Fractions Summary[1]

SUT	Fuel Type	Model Year															
		2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.990	0.993	0.999	1.000	0.993	0.995
PC	Diesel	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.010	0.007	0.001	0.000	0.007	0.005
PT	Gas	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.987	0.985	0.977	0.981	0.975	0.979
PT	Diesel	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.013	0.015	0.023	0.019	0.025	0.021
LCT	Gas	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.962	0.955	0.941	0.948	0.938	0.946
LCT	Diesel	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.038	0.045	0.059	0.052	0.062	0.054
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
RT	Gas	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.002	0.002	0.005	0.001	0.003	0.003
RT	Diesel	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.998	0.998	0.995	0.999	0.997	0.997
SUShT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.371	0.219	0.234	0.274	0.351	0.287	0.256	0.238	0.232
SUShT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.629	0.781	0.766	0.726	0.649	0.713	0.744	0.762	0.768
SULhT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.371	0.219	0.234	0.274	0.351	0.287	0.256	0.238	0.232
SULhT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.629	0.781	0.766	0.726	0.649	0.713	0.744	0.762	0.768
MH	Gas	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.510	0.530	0.540	0.560
MH	Diesel	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.490	0.470	0.460	0.440
CShT	Gas	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.199	0.110	0.057	0.081	0.052	0.058	0.031	0.050	0.051
CShT	Diesel	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.801	0.890	0.943	0.919	0.948	0.942	0.969	0.950	0.949
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2020 Fuel Engine Fractions Summary[1] - (Continued)

SUT	Fuel Type	Model Year														
		2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.997	0.996	0.996	0.997	0.997	0.998	0.998	0.999	0.999	0.999	1.000	0.999	0.999	0.997	0.999
PC	Diesel	0.003	0.004	0.004	0.003	0.003	0.002	0.002	0.001	0.001	0.001	0.000	0.001	0.001	0.003	0.001
PT	Gas	0.982	0.982	0.983	0.989	0.992	0.981	0.993	0.992	0.981	0.995	0.991	0.986	0.985	0.994	0.989
PT	Diesel	0.018	0.018	0.017	0.011	0.008	0.019	0.007	0.008	0.019	0.005	0.009	0.014	0.015	0.006	0.011
LCT	Gas	0.951	0.951	0.956	0.908	0.949	0.929	0.950	0.927	0.971	0.932	0.974	0.974	0.951	0.937	0.984
LCT	Diesel	0.049	0.049	0.044	0.092	0.051	0.071	0.050	0.073	0.029	0.068	0.026	0.026	0.049	0.063	0.016
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.042	0.114	0.147	0.121	0.010	0.090	0.124
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.958	0.886	0.853	0.879	0.990	0.910	0.876
RT	Gas	0.005	0.004	0.005	0.006	0.002	0.169	0.404	0.019	0.012	0.010	0.105	0.031	0.210	0.101	0.204
RT	Diesel	0.995	0.996	0.995	0.994	0.998	0.831	0.596	0.981	0.988	0.990	0.895	0.969	0.790	0.899	0.796
SUShT	Gas	0.245	0.260	0.268	0.311	0.350	0.348	0.435	0.436	0.427	0.673	0.508	0.519	0.511	0.465	0.539
SUShT	Diesel	0.755	0.740	0.732	0.689	0.650	0.652	0.565	0.564	0.573	0.327	0.492	0.481	0.489	0.535	0.461
SULhT	Gas	0.245	0.260	0.268	0.311	0.350	0.348	0.435	0.436	0.427	0.673	0.508	0.519	0.511	0.465	0.539
SULhT	Diesel	0.755	0.740	0.732	0.689	0.650	0.652	0.565	0.564	0.573	0.327	0.492	0.481	0.489	0.535	0.461
MH	Gas	0.570	0.590	0.600	0.630	0.660	0.680	0.710	0.740	0.770	0.790	0.820	0.850	0.850	0.850	0.850
MH	Diesel	0.430	0.410	0.400	0.370	0.340	0.320	0.290	0.260	0.230	0.210	0.180	0.150	0.150	0.150	0.150
CShT	Gas	0.052	0.055	0.077	0.084	0.090	0.107	0.134	0.147	0.146	0.275	0.117	0.117	0.160	0.161	0.144
CShT	Diesel	0.948	0.945	0.923	0.916	0.910	0.893	0.866	0.853	0.854	0.725	0.883	0.883	0.840	0.839	0.856
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2030 Fuel Engine Fractions Summary[1]

SUT	Fuel Type	Model Year															
		2030	2029	2028	2027	2026	2025	2024	2023	2022	2021	2020	2019	2018	2017	2016	2015
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988
PC	Diesel	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012
PT	Gas	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980
PT	Diesel	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
LCT	Gas	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947
LCT	Diesel	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
RT	Gas	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
RT	Diesel	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997
SUShT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396
SUShT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604
SULhT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396
SULhT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604
MH	Gas	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
MH	Diesel	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
CShT	Gas	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094
CShT	Diesel	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2030 Fuel Engine Fractions Summary[1] - (Continued)

SUT	Fuel Type	Model Year														
		2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.988	0.988	0.988	0.988	0.990	0.993	0.999	1.000	0.993	0.995	0.997	0.996	0.996	0.997	0.997
PC	Diesel	0.012	0.012	0.012	0.012	0.010	0.007	0.001	0.000	0.007	0.005	0.003	0.004	0.004	0.003	0.003
PT	Gas	0.980	0.980	0.980	0.980	0.987	0.985	0.977	0.981	0.975	0.979	0.982	0.982	0.983	0.989	0.992
PT	Diesel	0.020	0.020	0.020	0.020	0.013	0.015	0.023	0.019	0.025	0.021	0.018	0.018	0.017	0.011	0.008
LCT	Gas	0.947	0.947	0.947	0.947	0.962	0.955	0.941	0.948	0.938	0.946	0.951	0.951	0.956	0.908	0.949
LCT	Diesel	0.053	0.053	0.053	0.053	0.038	0.045	0.059	0.052	0.062	0.054	0.049	0.049	0.044	0.092	0.051
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
RT	Gas	0.003	0.003	0.003	0.003	0.002	0.002	0.005	0.001	0.003	0.003	0.005	0.004	0.005	0.006	0.002
RT	Diesel	0.997	0.997	0.997	0.997	0.998	0.998	0.995	0.999	0.997	0.997	0.995	0.996	0.995	0.994	0.998
SUShT	Gas	0.396	0.371	0.219	0.234	0.274	0.351	0.287	0.256	0.238	0.232	0.245	0.260	0.268	0.311	0.350
SUShT	Diesel	0.604	0.629	0.781	0.766	0.726	0.649	0.713	0.744	0.762	0.768	0.755	0.740	0.732	0.689	0.650
SULhT	Gas	0.396	0.371	0.219	0.234	0.274	0.351	0.287	0.256	0.238	0.232	0.245	0.260	0.268	0.311	0.350
SULhT	Diesel	0.604	0.629	0.781	0.766	0.726	0.649	0.713	0.744	0.762	0.768	0.755	0.740	0.732	0.689	0.650
MH	Gas	0.500	0.500	0.500	0.500	0.500	0.500	0.510	0.530	0.540	0.560	0.570	0.590	0.600	0.630	0.660
MH	Diesel	0.500	0.500	0.500	0.500	0.500	0.500	0.490	0.470	0.460	0.440	0.430	0.410	0.400	0.370	0.340
CShT	Gas	0.094	0.199	0.110	0.057	0.081	0.052	0.058	0.031	0.050	0.051	0.052	0.055	0.077	0.084	0.090
CShT	Diesel	0.906	0.801	0.890	0.943	0.919	0.948	0.942	0.969	0.950	0.949	0.948	0.945	0.923	0.916	0.910
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2040 Fuel Engine Fractions Summary[1]

SUT	Fuel Type	Model Year															
		2040	2039	2038	2037	2036	2035	2034	2033	2032	2031	2030	2029	2028	2027	2026	2025
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988
PC	Diesel	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012
PT	Gas	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980
PT	Diesel	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
LCT	Gas	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947
LCT	Diesel	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
RT	Gas	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
RT	Diesel	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997
SUShT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396
SUShT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604
SULhT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396
SULhT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604
MH	Gas	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
MH	Diesel	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
CShT	Gas	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094
CShT	Diesel	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2040 Fuel Engine Fractions Summary[1] - (Continued)

SUT	Fuel Type	Model Year														
		2024	2023	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.990
PC	Diesel	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.010
PT	Gas	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.987
PT	Diesel	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.013
LCT	Gas	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.962
LCT	Diesel	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.038
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
RT	Gas	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.002
RT	Diesel	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.998
SUShT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.371	0.219	0.234	0.274
SUShT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.629	0.781	0.766	0.726
SULhT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.371	0.219	0.234	0.274
SULhT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.629	0.781	0.766	0.726
MH	Gas	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
MH	Diesel	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
CShT	Gas	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.199	0.110	0.057	0.081
CShT	Diesel	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.801	0.890	0.943	0.919
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2045 Fuel Engine Fractions Summary[1]

SUT	Fuel Type	Model Year															
		2045	2044	2043	2042	2041	2040	2039	2038	2037	2036	2035	2034	2033	2032	2031	2030
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988
PC	Diesel	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012
PT	Gas	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980
PT	Diesel	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
LCT	Gas	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947
LCT	Diesel	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
RT	Gas	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
RT	Diesel	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997
SUShT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396
SUShT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604
SULhT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396
SULhT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604
MH	Gas	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
MH	Diesel	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
CShT	Gas	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094
CShT	Diesel	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2045 Fuel Engine Fractions Summary[1] - (Continued)

SUT	Fuel Type	Model Year														
		2029	2028	2027	2026	2025	2024	2023	2022	2021	2020	2019	2018	2017	2016	2015
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988
PC	Diesel	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.010
PT	Gas	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980
PT	Diesel	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
LCT	Gas	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947
LCT	Diesel	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
RT	Gas	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
RT	Diesel	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997
SUShT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396
SUShT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604
SULhT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396
SULhT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604
MH	Gas	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
MH	Diesel	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
CShT	Gas	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094
CShT	Diesel	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Analysis Notes -- Update
MOVES-Based On-Road Emissions Estimates for the El Paso Metropolitan Planning Organization (EPMPO) El Paso-New Mexico 2015 Ozone Standard

19 June 2019[1]

The Texas A&M Transportation Institute (TTI) performed the herein described "elp_nm15oz" emissions analysis update for the EPMPO's conformity requirement for the Sunland Park, NM, 2015 ozone standard, marginal nonattainment area (NAA). The EPMPO requested the analysis through the Texas Department of Transportation (TxDOT) and provided TTI the Travel Demand Model (TDM) data sets on December 7, 2018. TTI re-verified these TDM data sets with the EPMPO on June 11, 2019 for use in this emissions analysis update. The EPMPO requested analyses for 2017, 2020, 2030, 2040 and 2045, with 2017 as the baseline.

In this update, the Sunland Park NAA TAZ (including intra-zonal and zonal connector traffic) and links were explicitly identified (and verified by TTI and the EPMPO), and TTI's link-based methodology, consistent with previous El Paso conformity analyses, was applied to estimate Sunland Park NAA TDM network link-based emissions. Similarly, for estimating off-network emissions for the Sunland Park NAA, off-network activity components (source-hours-parked for evaporative processes, starts, extended idling) were estimated using the methodology consistent with previous analyses as described in the section "OFF-NETWORK ACTIVITY" found later in the document.

TTI used EPA's MOVES2014a on-road model (November 2016 release), the elp_nm15oz TDM, and TTI's TDM link-based emissions estimation utilities to produce 2017, 2020, 2030, 2040, 2045, summer weekday oxides of nitrogen (NOx) and volatile organic compounds (VOC) estimates for the Sunland Park NAA.

[1]TTI performed this regional emissions analysis update in order to directly produce Sunland Park NAA emissions estimates at the TDM network link level using TTI's detailed, disaggregate, link-based methodology.

SCOPE OF EMISSIONS ANALYSIS

1. **Methodology**: *Vehicle exhaust and evaporative emissions*: Detailed, hourly, disaggregate, MOVES rates-per-activity, TDM link-based method with the most recent version of MOVES.[2]

2. **Analysis Years:** 2017, 2020, 2030, 2040, 2045.

3. **Seasonal Period:** *Summer*: June through August weekday (average Monday through Friday).

4. **Geography:** Sunland Park NAA.[3]

5. **Pollutants:** NOx, VOC.

6. **Sources:** Gasoline- and diesel-powered MOVES source use types (SUT).

Table 1. Modeled Emissions Sources.

SUT	Gasoline	Diesel
Motorcycle	X	-
Passenger Car	X	X
Passenger Truck	X	X
Light Commercial Truck	X	X
Intercity Bus	-	X
Transit Bus	-	X
School Bus	X	X
Refuse Truck	X	X
Single Unit Short-Haul Truck	X	X
Single Unit Long-Haul Truck	X	X
Motor Home	X	X
Combination Short-Haul Truck	X	X
Combination Long-Haul Truck	-	X

[2] MOVES2014a was released November 2015, then updated December 2015, November 2016, and December 2017. The December 2017 MOVES2014a release only corrected a non-road mobile post-processing script. MOVES2014b was released August 2018. MOVES2014b improves the non-road component and updates chemical mechanism outputs, neither of which apply to on-road mobile emission rates used in regional conformity analyses. TTI used the November 2016 MOVES2014a release.

[3] The Sunland Park NAA is included in the southern part of Dona Ana County that is included in the El Paso TDM.

7. Tools: MOVES and TTI's MOVES-based inventory development utilities[4] were used: RatesCalc – produces and/or compiles emission rate tables from MOVES output; EmsCalc – calculates hourly link emissions for a county (or coded partial-county area) using the estimated link VMT and speeds, VMT mixes, off-network activity, and emission factors from RatesCalc (or MOVES or RatesAdj); TransVMT – estimates the on-road fleet VMT and operational speeds for use in air quality analyses (input to EmsCalc), based on TDM data sets; VMTmixBuild – formats gasoline and diesel MOVES source type (vehicle type) VMT mix input to EmsCalc; OffNetActCalc – calculates source-hours-parked (SHP), source-hours-extended-idling (SHI), auxiliary power unit (APU) usage hours, and starts inputs to EmsCalc; VehpopulationBuild – calculates vehicle population estimates input to OffNetActCalc based on vehicle registration data and other factors; and MOVESfleetInputBuild – produces sourcetypeagedistribution and avft (i.e., fuel fractions) table inputs to MOVES, based on vehicle registration data, MOVES default data, and VMT mix estimates.

DEVELOPMENT OF ON-ROAD FLEET LINK-VMT AND SPEEDS

8. Travel Demand Models: TTI received the new elp_nm15oz TDM data sets (i.e., trip matrices and four-time-period, non-directional, average non-summer weekday traffic [ANSWT] assignments) from the EPMPO on December 7, 2018. Data sets included the 2017 baseline year, 2020, 2030, 2040, and 2045 future analysis years. TTI post-processed the data sets to determine average seasonal weekday, county, hourly, directional, Highway Performance Monitoring System (HPMS)-consistent, network link VMT and volumes, and added intrazonal link VMT estimates, coded for county and partial-county areas. Method details are found in *MOVES2014a-Based Travel Demand Model Link Emissions Estimation Method* (TTI, August 2016).

9. Adjustments to TDM VMT: The ANSWT network link volumes and VMT and added intrazonal link VMT were factored to be consistent with HPMS VMT, to reflect seasonal weekday activity, to allocate by hour, and to allocate by direction of travel. Seasonal weekday and hourly distribution factors were developed using the latest available multi-year, El Paso County aggregate Texas Department of Transportation (TxDOT) Automatic Traffic Recorder [ATR] traffic count data (2007 – 2016).[5] TTI used these El Paso County factors to model the relatively small, Sunland Park NAA, nestled adjacent to El Paso County in the regional TDM.

a. Historical Analysis Year HPMS Consistency and Seasonal Weekday Adjustments (No historical year emission analysis was required):
HPMS consistency: When required, the historical year TDM total ANSWT link VMT is adjusted to the seasonal (summer or winter) VMT using county-level VMT control totals. The VMT control total is county total, annual average daily traffic (AADT) HPMS VMT (from TxDOT's Roadway Inventory Annual Reports, adjusted to the seasonal weekday form (using seasonal factor described below).

[4] *TTI Emissions Inventory Estimation Utilities Using MOVES: MOVES2014aUtl User's Guide*, TTI, August 2016.
[5] All the ATR-based factors used were from the prior analysis.

Seasonal adjustment: County-level seasonal (summer) weekday factors are produced and applied to the county-level AADT HPMS VMT to develop the historical year VMT control totals. These factors are calculated as the ratio of the average seasonal weekday-to-AADT ATR counts.

b. 2017, 2020, 2030, 2040, 2045 Year HPMS Consistency and Seasonal Adjustments:
HPMS consistency: TTI applied the HPMS adjustment factor to total ANSWT link VMT for each year. The validation year HPMS adjustment factor is 2012 HPMS VMT (first adjusted to ANSWT using the 2012 ANSWT/AADT ATR count ratio) to 2012 validation year total ANSWT link VMT. See Table 4 in Attachment 1, Page 11.[6]
Seasonal adjustment: County-level seasonal (summer) weekday factors were produced and used with the 2017, 2020, 2030, 2040, and 2045 analysis years. These factors were calculated as the ratio of the seasonal weekday-to-ANSWT counts. See Table 5 in Attachment 1, Page 10.

c. Seasonal Weekday Hourly VMT Distribution:
County level, seasonal weekday, hourly travel factors were developed and used to allocate the 24-hour link VMT/volume estimates to each hour of the day – a single set was used for all analysis years. In order to maintain VMT proportions within each of the four time periods, the hourly fractions were normalized within each time period. See Table 6 in Attachment 1, Page 11.

d. Directional Factors:
Directional factors were applied to link volumes/VMT by time-of-day period. A single set of directional split factors by TDM network functional class and area type was used for both seasons and all years. These are the same factors applied in the prior El Paso conformity analysis.

10. Hourly Congested Speeds: TTI estimated directional, hourly operational link speeds using the TTI speed model, which estimates delay on each link as function of volume-to-capacity, and applies it to the link's estimated free-flow speed. TTI estimated the local streets category link average operational speeds represented by the centroid connector links, as centroid connector TDM input speeds; and represented as added intrazonal links, as the zone's average centroid connector input speed.

DEVELOPMENT OF VMT MIX

11. VMT Mix: Using latest available classification counts (2005-2014) and associated year-end registration data (2013), TTI estimated the El Paso County time-of-day (AM Peak, Mid-Day, PM Peak, Overnight) VMT mixes by the four MOVES road types. No seasonal adjustments are made for VMT mix. The methodology is described in *Developing MOVES Source Use Types and VMT Mix for Conformity Analysis* (TTI, August 2016).

[6] The HPMS adjustment factor was not updated for this analysis. TTI used the HPMS adjustment factor previously developed by TTI for a prior El Paso Destino 2045 MTP emissions analysis (April 2018) (using the EPMPO-provided 2012 validation-year TDM dataset).

OFF-NETWORK ACTIVITY

12. Vehicle Population Estimates: The El Paso County vehicle population estimates (used for estimating off-network SHP and starts activity) were based on Texas Department of Motor Vehicles (TxDMV) registration data, vehicle population factors derived from the VMT mix, and VMT-based growth estimates for future years where registration data is not available. Vehicle population estimates were not readily available and were not developed for the New Mexico areas. Under the assumption that regional off-network activity per mile is relatively stable, off-network activity for the Sunland Park NAA was estimated as an extension of El Paso County off-network activity. The off-network activity estimates for the Sunland Park NAA were calculated as the product of the total VMT ratio (Sunland Park NAA-to-El Paso County) and the El Paso County off-network activity, for each activity type.

a. Historical Analysis Year Vehicle Population Estimates (Not required):
   TxDMV registration data: El Paso County historical analysis year vehicle population estimates are based on the analysis year TxDMV mid-year registration data for El Paso County. This registration data is aggregated into vehicle registration categories (motorcycles, passenger cars, trucks less than or equal to 8,500 pounds gross vehicle rating [GVWR], trucks greater than 8,500 pounds and less than or equal to 19,500 pounds GVWR, and trucks greater than 19,500 pounds GVWR).
   Vehicle population factors: Since TxDMV data does not include each SUT/fuel type combination, vehicle population factors were developed using the analysis year 24-hour VMT mix. These factors were applied to vehicle registrations aggregated by category to split each category into each SUT/fuel type combination included in the analysis.
   VMT-based growth estimates: For historical analysis years (i.e., where registration data exists), VMT-based growth estimates are typically not required.

b. 2017, 2020, 2030, 2040, 2045 Analysis Year Vehicle Population Estimates:
   TxDMV registration data: As described for El Paso County historical vehicle population estimates, the registration data were aggregated by vehicle registration category. Since registration data were not available for future year analyses, the most recent mid-year TxDMV registration data sets (2014) were used.
   Vehicle population factors: As described for historical vehicle population estimates, factors developed using the analysis year 24-hour VMT mix were applied to vehicle registrations aggregated by category to split each category into each SUT/fuel type combination in the analysis; thus creating the base (2014) vehicle population estimates.
   VMT-based growth estimates: For each analysis year, VMT-based growth estimates were calculated by dividing the El Paso County analysis year summer Weekday VMT by the El Paso County 2014 summer Weekday VMT. These growth estimates were applied to the base vehicle population estimates to scale the base estimates up to the analysis year.

13. Source Hours Parked (SHP) Estimates: For each analysis year, the hourly SHP by vehicle type for the Sunland Park NAA was calculated as an extension of El Paso County activity by multiplying the El Paso County SHP by the total VMT ratio, Sunland Park NAA VMT-to-El Paso County VMT.

14. Vehicle Starts Estimates: For each analysis year, hourly vehicle starts in Sunland Park NAA were calculated as an extension of El Paso County activity by multiplying the El Paso County starts by the total VMT ratio, Sunland Park NAA VMT-to-El Paso County VMT.

15. Hotelling, Extended Idle (or Source Hours Idling, SHI), and APU Hours: For each analysis year, the hourly hotelling, SHI, and APU hours for the Sunland Park NAA were calculated as an extension of El Paso County activity by multiplying the El Paso County hourly hotelling, SHI, and APU hours by the total VMT ratio, Sunland Park NAA VMT-to-El Paso County VMT.

DEVELOPMENT OF EMISSION FACTORS

16. Background: TTI developed emission rates using MOVES2014a and the TTI post-processing utility, RatesCalc, for preparing MOVES2014a-based emission rates for input to TTI's inventory calculation utility, EmsCalc. El Paso County summer weekday emission rates were produced for each analysis year. These emission rates were used for all the El Paso TDM modeling areas including the Sunland Park NAA in the TDM.

These on-road rates were developed in terms of mass per activity unit: miles for roadway-based processes; SHP, starts, SHI, and APU hours for off-network processes. All activity-based rates were directly output by MOVES, except parked vehicle evaporative emission rates based in SHP. TTI used the RatesCalc utility to calculate emission rates in terms of rate/SHP (as a conversion of MOVES rate/vehicle output) using data in the county (local) input database (CDB) used in the MOVES emission rates run and the MOVES default database. The RatesCalc utility combined the rate/distance, rate/hour (SHI and APU hours), and rate/start emission rates tables from MOVES output, and the calculated rate/SHP emission rates into a database of rates look-up tables input to the EmsCalc utility. Attachment 2 provides details on RatesCalc processing.

Table 2 lists the emissions processes with associated activity basis and emission rate units. The emission factors were developed by pollutant, speed, process, hour, road type, and SUT/FT.

Table 2. On-Road Fleet Emission rates Modeled by Process and Activity Factor.

Emissions Process	Activity[1]	Emissions Factor Units[2]
Running Exhaust Crankcase Running Exhaust	VMT	mass/mile (mass/mi)
Brake Wear	VMT	mass/mi
Tire Wear	VMT	mass/mi
Start Exhaust Crankcase Start Exhaust	starts	g/start
Extended Idle Exhaust Crankcase Extended Idle Exhaust	SHI	mass/shi
Auxiliary Power Exhaust	APU Hours	mass/APU hour
Evaporative: Permeation, Fuel Vapor Venting, Fuel Leaks	VMT, SHP	mass/mi, mass/shp

[1] VMT, SHP, starts, SHI and APU hours are the basic activity factors. SHI and APU hours are for combination long-haul trucks. Evaporative permeation, fuel vapor venting, and fuel leaks occur both during operation and while parked.

17. MOVES Model Inputs: All of the user-specified model settings and inputs for each run were contained in a MOVES run specification (MRS) and a CDB (the MOVES2014a default database used was "MOVESDB20161117"). See Attachment 2 for details on the MRS files and CDBs developed and used to estimate the summer weekday emission factors each analysis year.

18. Emissions Factor Post-Processing: No emission rate adjustments were required and therefore no emission rate adjustments via post-processing were performed.

19. Emissions Controls Modeling: Table 3 shows the modeling approaches used for the control strategies. Unless otherwise stated, the emissions control strategy was modeled in all years.

Table 3. Emissions Modeling Strategies and Approaches.

Strategy	Approach
Federal Motor Vehicle Control Program Standards	MOVES defaults.
Federal Heavy-Duty Diesel Engines Rebuild and 2004 Pull-Ahead Programs to Mitigate NO_x Off-Cycle Effects	MOVES defaults.
Gasoline Fuel – Tier 2/Tier 3 sulfur standards, Low Summer Reid Vapor Pressure (RVP)	Locality-specific user-developed inputs to MOVES. TTI produced the summer 2017 fuel formulations using summer 2017 El Paso fuel sample data (available from TCEQ's summer 2017 statewide fuel study). TTI produced summer 2020 and later conventional gasoline inputs consistent with pertinent federal and state rules, based on a combination of El Paso fuel sample data (from the TCEQ survey) and MOVES defaults or other expected future year values. Fuel formulations are provided in Attachment 2.
Federal Low Sulfur Diesel Fuel	Locality-specific user inputs to MOVES. For 2017 diesel sulfur level was based on El Paso diesel sample data (from the TCEQ 2017 survey). For the future years, diesel sulfur input values were set for consistency with the applicable federal diesel sulfur standards. Diesel formulations are provided in Attachment 2.
Inspection and Maintenance (I/M) Program	Locality-specific user-developed I/M coverage inputs to MOVES. TTI developed El Paso I/M Program inputs to MOVES using the available MOVES I/M parameters pertaining to the domain of subject I/M vehicles, consistent with current program descriptions and latest I/M modeling protocols. Attachment 2 provides a summary of the I/M program input parameters used.

Attachment 1
Adjustments to TDM VMT

Table 4. HPMS Factor.

2012 HPMS VMT	AADT-to-ANSWT Factor	HPMS-Based ANSWT VMT	2012 TDM VMT[1]	HPMS Factor
15,151,926	1.08815	16,487,568	17,815,876	0.925442459

[1] March 21, 2018 EPMPO-provided TDM data processed by TTI.

Table 5. 2017, 2020, 2030, 2040, 2045 Analysis Years TDM (ANSWT) Seasonal Weekday Factors.

Season	Seasonal Weekday Factor
Summer	0.95645

Table 6. Seasonal Weekday Hourly VMT Distributions.

Time-Period	Hour	Summer Fractions	
		24-Hour-Period	Four-Period[1]
AM Peak	7:00 a.m.	0.063690	0.343596
	8:00 a.m.	0.065525	0.353496
	9:00 a.m.	0.056148	0.302908
Mid-Day	10:00 a.m.	0.052431	0.182905
	11:00 a.m.	0.055021	0.191940
	12:00 p.m.	0.058244	0.203184
	1:00 p.m.	0.059400	0.207216
	2:00 p.m.	0.061561	0.214755
	3:00 p.m.	0.052431	0.182905
PM Peak	4:00 p.m.	0.066592	0.242258
	5:00 p.m.	0.071780	0.261132
	6:00 p.m.	0.074417	0.270726
	7:00 p.m.	0.062091	0.225884
Overnight	8:00 p.m.	0.046914	0.185357
	9:00 p.m.	0.037489	0.148119
	10:00 p.m.	0.032499	0.128404
	11:00 p.m.	0.026365	0.104168
	12:00 a.m.	0.018866	0.074540
	1:00 a.m.	0.010574	0.041778
	2:00 a.m.	0.006826	0.026970
	3:00 a.m.	0.005587	0.022074
	4:00 a.m.	0.005148	0.020340
	5:00 a.m.	0.007328	0.028953
	6:00 a.m.	0.018190	0.071869

[1] To maintain VMT proportions within the four periods, the hourly fractions were normalized within each period.

Attachment 2
MOVES Run Specifications (MRS), County Databases (CDB), Outputs, and Post-Processing

MOVES Inputs and Output:

- MRS input files: One for each analysis year (5).
- CDB inputs: One for each analysis year (5).
- The MOVES default input database (MOVESDB20161117).
- MOVES output databases: One per MOVES run (5).
- MOVES run log output text files: One per MOVES run (5).

Post-Processing Output:

- Final Rates Databases inputs to EmsCalc (5): For each MOVES output database, TTI used RatesCalc to calculate the mass/SHP off-network evaporative process rates using data from CDB, MOVES default database, and MOVES rateperprofile and ratepervehicle emission rate output. Using the CDB and MOVES default data, the MOVES vehicle population and SHP calculation process was replicated to provide vehicle population-to-SHP ratios, which were multiplied by the MOVES rate/vehicle output yielding rate/SHP. Rates needed directly from the MOVES output and the SHP-based rates calculated by RatesCalc were tabulated in the RatesCalc output database. In addition to the MOVES pollutants specified in the pre-analysis plan, VOC and NOx, other optional pollutants were included for informational purposes (e.g., CO, PM_{10} total exhaust, PM_{10} brakewear, PM_{10} tirewear). Four rate tables were included: ttirateperdistance, ttirateperstart, ttirateperhour, and ttiratepershp; containing, respectively, the MOVES rateperdistance, rateperstart, rateperhour (SHI and APU hour-based rates), and the RatesCalc-produced SHP-based rates, each with a column added specifying units. These rates tables were input to EmsCalc emissions calculation utility. The RatesCalc utility is described in more detail in *TTI Emissions Inventory Estimation Utilities Using MOVES: MOVES2014aUtl User's Guide* (TTI, August 2016).

Table 7 describes the MOVES2014a run specification files used. Table 8 describes the CDBs built and used for the rates analysis. Table 9, Table 10, and Table 11 summarize the meteorological, fuels, and I/M program inputs used.

Table 7. MOVES Run Specification Selections by GUI Panel.

Navigation Panel	Detail Panel[1]	Selection		
Scale[1]	Model; Domain/Scale; Calculation Type	On-Road; County; Emission rates		
Time Spans[1]	Time Aggregation Level; Years – Months – Days – Hours	Hour; <***Year***> - July - Weekday - All		
Geographic Bounds[1]	Region; Selections; Domain Input Database	Zone and Link; El Paso; mvs14a_elp_nm15oz_<***Year***>s_er_CDB_in[1]		
On-Road Vehicle Equipment	SUT/Fuel Combinations	SUT	Gasoline	Diesel
		Motorcycle	X	-
		Passenger Car	X	X
		Passenger Truck	X	X
		Light Commercial Truck	X	X
		Intercity Bus	-	X
		Transit Bus	-	X
		School Bus	X	X
		Refuse Truck	X	X
		Single Unit Short-Haul Truck	X	X
		Single Unit Long-Haul Truck	X	X
		Motor Home	X	X
		Combination Short-Haul Truck	X	X
		Combination Long-Haul Truck	-	X
Road Type	Selected Road Types	Off-Network – Rural Restricted Access – Rural Unrestricted Access – Urban Restricted Access – Urban Unrestricted Access		
Pollutants and Processes[2]	VOC; CO; NO_x; Primary Exhaust PM_{10}; Primary PM_{10} Brakewear; Primary PM_{10} Tirewear, etc.	Dependent on pollutant: Running Exhaust, Start Exhaust, Extended Idle Exhaust, Auxiliary Power Exhaust, Crankcase Running Exhaust, Crankcase Start Exhaust, Crankcase Extended Idle Exhaust, Evap Permeation, Fuel Vapor Venting, Fuel Leaks		
Manage Input Data Sets	Additional Input Database Selections	None		
Strategies	Rate Of Progress	Not Applicable		
General Output	Output Database; Units; Activity	mvs14a_elp_nm15oz_<***Year***><***season***>wkd_er_out[1]; Pounds, KiloJoules, Miles; Hotelling Hours, Population, Starts (not adjustable, pre-selected)		
Output Emissions Detail	Always; For All Vehicles/Equipment; On Road	Time: Hour – Location: Link – Pollutant; Fuel Type, Emissions Process; Source Use Type		
Advanced Performance Measures	Aggregation and Data Handling	All check boxes "un-checked"		

[1] County scale allows only one year per run. The years include 2017, 2020, 2030, 2040, and 2045. Each MRS file was named similar to its output database, "mvs14a_elp_nm15oz_<***Year***>swkd_er.mrs."

[2] Only the pollutants retained in the final rates inputs to the emissions calculations are listed. Other pollutant selections were required as pre-requisites for the pollutants selected. Also, other pollutants were optionally included for potential informational purposes, but not reported.

Table 8. MOVES CDB Input Tables.

Input Table	Category	Notes
year	Time	Designates analysis year as a base year (base year means that local activity inputs will be supplied rather than forecast by the model).
state	Geography	Identifies the state (Texas) for the analysis.
county	Geography/ Meteorology	Identifies county of analysis with local altitude and barometric pressure. TTI used input data based on 2017 El Paso County weather stations.
zonemonthhour	Meteorology	Summer hourly temperature and relative humidity for the county. TTI used input data developed by TCEQ based on summer (June through August) 2017 El Paso County weather station data.
roadtype	Activity	Lists the MOVES road types and associated ramp activity fractions. Road type ramp fractions were set to 0.
Hpmsvtypeyear[1]	Activity (Defaults)	TTI used MOVES default national annual VMT by HPMS vehicle category.
roadtypedistribution[1]		TTI used MOVES default road type VMT fractions.
monthvmtfraction[1]		TTI used MOVES default month VMT fractions.
dayvmtfraction[1]		TTI used MOVES default day VMT fractions.
hourvmtfraction[1]		TTI used MOVES default hour VMT fractions.
avgspeeddistribution[1]		TTI used MOVES default average speed distributions.
sourcetypeyear[1]	Fleet (Defaults)	TTI used MOVES default national SUT populations.
sourcetypeage-distribution	Fleet	TTI estimated SUT age fractions using TxDMV mid-year county vehicle registration data and MOVES defaults (consistent with the registration data year), as needed. The latest available mid-year registration data were used for future years.
avft	Fleet	TTI estimated SUT fuel fractions using TxDMV vehicle registration data and defaults, where needed. Local data sets used were consistent with sourcetypeagedistribution tables. The avft estimate is also consistent with the analysis VMT mix.
zone	Activity	Start, hotelling, and SHP zone allocation factors. County = zone, and all factors were set to 1.0 (required for county scale analyses).
zoneroadtype	Activity	SHO zone/roadtype allocation factors. County = zone, and all factors were set to 1.0 (required for county scale analyses).
fuelsupply	Fuel	The fuel supply (marketshares) were set to indicate one gasoline and one diesel fuel formulation (i.e., marketshares = 1.0) for the county.
fuelformulation	Fuel	TTI based summer gasoline formulations on actual summer 2017 El Paso County survey data. For the future years TTI used a combination of MOVES defaults and gasoline properties estimated from local survey data with adjustments where needed for consistency with pertinent fuel regulations (e.g., summer RVP limit and Tier 3 sulfur standard). The diesel fuel formulations were actual for 2017 and for future years, set consistent with federal sulfur standards.
countyyear	Stage II	N/A.
imcoverage	I/M	TTI used local set-ups, updated for use with MOVES2014a, to represent El Paso County program based on current I/M rules, latest modeling protocols, and the available MOVES I/M parameters (i.e., MOVES I/M "teststandards" and "imfactors") for the I/M vehicles.
Hotellingactivity-distribution	activity	Used the updated distribution from TCEQ's 2017 long-haul truck hotelling/idling study (developed by EPA for next MOVES release).

[1] Use of default activity and population inputs for the MOVES rates mode runs is a basic aspect of the rates-per-activity emissions estimation method, which calculates the emissions inventory estimates via post-processing. The process uses actual, local vehicle activity estimates external to MOVES in the emissions calculations.

Table 9. Meteorological Inputs to MOVES: Temperature (T) - Fahrenheit, Relative Humidity (RH) - Percent, Barometric Pressure (BP) - Inches of Mercury.

Hour	Summer		
	T	RH	BP
1	79.77	42.73	26.159
2	78.51	45.05	
3	77.31	47.11	
4	76.27	49.05	
5	75.38	50.63	
6	74.47	52.45	
7	73.96	53.51	
8	75.19	51.26	
9	77.54	46.95	
10	80.13	42.42	
11	82.81	37.98	
12	85.38	33.88	
13	87.54	30.66	
14	89.27	28.03	
15	90.68	25.90	
16	91.85	24.01	
17	92.09	24.18	
18	91.62	24.77	
19	90.74	25.75	
20	89.02	28.24	
21	86.68	32.05	
22	84.78	34.61	
23	82.97	37.00	
24	81.28	40.04	

[1] Average hourly from weather stations within El Paso County—June through August 2017 (provided by TCEQ). HourID 1 is 12 a.m. to 1 a.m., etc.

Table 10. MOVES Gasoline and Diesel Fuel Formulation Inputs.

Field	Units	2017		Future Years	
		CG	Diesel	CG	Diesel
fuelFormulationID	-	17703	30637	18703	30011
fuelSubtypeID	-	12	20	12	20
RVP	psi	6.94	0	7.00	0
sulfurLevel	ppm	19.56	6.37	10.00	11
ETOHVolume	vol.%	9.60	0	9.60	0
MTBEVolume	vol.%	0	0	0	0
ETBEVolume	vol.%	0	0	0	0
TAMEVolume	vol.%	0	0	0	0
aromaticContent	vol.%	26.67	0	26.67	0
olefinContent	vol.%	5.50	0	5.50	0
benzeneContent	vol.%	1.30	0	0.63	0
e200	vap.%	48.74	0	48.74	0
e300	vap.%	87.84	0	87.84	0
volToWtPercentOxy	-	0.3653	0	0.3653	0
BioDieselEsterVolume	vol.%	/N	/N	/N	/N
CetaneIndex	-	/N	/N	/N	/N
PAHContent	vol.%	/N	/N	/N	/N
T50	°F	206.12	0	206.12	0
T90	°F	306.72	0	306.72	0

TTI (June 2018) based the CG formulations on TCEQ's summer 2017 (latest available) fuel survey samples from El Paso County. The 2017 CG properties are actual averages (fuel grade averages weighted by relative sales volumes). The Future Years CG properties are latest available 2017 actual values except with RVP, average sulfur level, and average benzene content set to the "expected" values (MOVES defaults, consistent with the pertinent regulatory standards). The 2017 diesel sulfur level is the statewide average from TCEQ's 2017 survey. Future Years diesel sulfur was conservatively set to the maximum level of the last three of TCEQ's statewide diesel surveys (2011, 2014, 2017), within the federal ultra low sulfur diesel 15 ppm average annual standard. Fuel subtype IDs 12 and 20 are 10% ethanol-blend gasoline and conventional diesel, respectively.

Local I/M Inputs to MOVES

MOVES adjusts emissions (HC, CO, and NO_x) at the source-type level to incorporate the benefits of the local I/M program design defined using the MOVES I/M coverage table parameters. TTI produced the I/M coverage input parameters to represent El Paso I/M program designs as specified in the Texas I/M SIP and Texas rules, using the current Texas I/M modeling protocol, and compliance and waiver rates. The El Paso I/M program requires annual emissions testing of gasoline vehicles within a 2-through-24 year vehicle age coverage window (motorcycles, military tactical vehicles, diesel-powered vehicles, and antique vehicles are excluded). A gas cap integrity test is required on all these vehicles, and depending on the model year, the vehicle emissions testing may utilize on-board diagnostics (OBD) or the Two-Speed Idle (2500 RPM/Idle) test. For additional Texas I/M program details, see the current I/M SIP, Revision to the State Implementation Plan Mobile Source Strategies, Inspection and Maintenance State Implementation Plan Revision, TCEQ, February 12, 2014.

Table 11. MOVES I/M Coverage Table Input Descriptions for El Paso County.[1]

YearID	Begin Model Year[2]	End Model Year[2]	Test Standard Description (ID)	Source Use Type (I/M Compliance Factor)[3]
2007 through 2019	*X*	1995	2500 RPM/Idle (12)	Passenger Car (93.12%) Passenger Truck (91.26%) Light Commercial Truck (85.67%)
	X	1995	Evp Cap (41)	
	1996	*Y*	Exh OBD (51)	
	1996	*Y*	Evp Cap, OBD (45)	
2020 through 2050	*X*	*Y*	Exh OBD (51)	
	X	*Y*	Evp Cap, OBD (45)	

[1] Common parameters for Texas MOVES imcoverage records not shown include: annual test cycle, gasoline fuel type. The MOVES pollutants and processes affected are exhaust HC, CO, NO_x, and tank vapor venting HC.

[2] Begin model year (*X*) and end model year (*Y*) define the range of model years covered, where "*X*" and "*Y*," respectively, are calculated as YearID – 24, and YearID – 2.

[3] MOVES I/M compliance factors were calculated as a combination of Texas I/M modeling protocol compliance and waiver rates, and the regulatory class coverage adjustments provided in Section 4.10.6 of *MOVES Technical Guidance* (EPA, August 2018), along with the formula: I/M compliance factor = (compliance rate) × (1.0 - waiver rate) × (regulatory class coverage adjustment). Compliance and waiver rates are 96 percent and 3 percent. Regulatory class adjustments are passenger car – 100 percent, passenger truck – 98 percent, and light commercial truck – 92 percent.

Attachment 3:
Source Type Age and Fuel Engine Fractions Inputs to MOVES

El Paso County 2014 Age Distribution Inputs to MOVES (used for 2017, 2020, 2030, 2040, and 2045)

Age	MC	PC	PT	LCT	IBus	TBus	SBus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.045935	0.053900	0.026733	0.026733	0.055548	0.055650	0.055556	0.064759	0.062455	0.080736	0.064928	0.009782	0.044007
1	0.079804	0.070772	0.037056	0.037056	0.049844	0.049946	0.049851	0.058272	0.060276	0.097975	0.058445	0.015801	0.048909
2	0.069402	0.060117	0.033846	0.033846	0.046005	0.046100	0.046012	0.053507	0.079702	0.150497	0.053673	0.014296	0.050486
3	0.042856	0.046863	0.035079	0.035079	0.042194	0.055697	0.032610	0.028999	0.066630	0.104892	0.039988	0.006772	0.032874
4	0.031289	0.049364	0.034467	0.034467	0.037253	0.034095	0.035647	0.022977	0.037945	0.036093	0.035305	0.010534	0.017742
5	0.080386	0.040653	0.028561	0.028561	0.031054	0.034678	0.042221	0.030317	0.032680	0.034013	0.029436	0.021068	0.031415
6	0.073146	0.064144	0.058164	0.058164	0.039992	0.048516	0.046183	0.023359	0.109659	0.093698	0.037928	0.029345	0.043640
7	0.096114	0.066662	0.060009	0.060009	0.052280	0.047012	0.047736	0.081433	0.047749	0.057695	0.049441	0.044394	0.094086
8	0.078472	0.061945	0.055914	0.055914	0.053395	0.033713	0.055776	0.060642	0.069535	0.064010	0.050348	0.042889	0.070679
9	0.063826	0.060570	0.053565	0.053565	0.055067	0.052559	0.049572	0.057049	0.069717	0.057569	0.051939	0.049661	0.061342
10	0.045602	0.055428	0.061812	0.061812	0.053502	0.043092	0.048835	0.034170	0.053558	0.040882	0.050306	0.036117	0.041119
11	0.054839	0.053694	0.053524	0.053524	0.049301	0.041983	0.041807	0.033378	0.042484	0.033007	0.046365	0.029345	0.032913
12	0.039694	0.051897	0.055451	0.055451	0.046064	0.042452	0.043802	0.024143	0.034858	0.026419	0.043333	0.033860	0.032437
13	0.031455	0.043310	0.053863	0.053863	0.044038	0.048613	0.039741	0.029530	0.035585	0.027473	0.041306	0.051919	0.043530
14	0.024715	0.042587	0.047742	0.047742	0.041777	0.032808	0.043136	0.040271	0.039034	0.021921	0.039197	0.082769	0.052520
15	0.024049	0.033234	0.039570	0.039570	0.040613	0.031807	0.039913	0.057677	0.032498	0.019697	0.037984	0.078254	0.044225
16	0.017142	0.027351	0.033474	0.033474	0.030598	0.037111	0.031314	0.052718	0.018337	0.009478	0.022205	0.055681	0.037120
17	0.011401	0.021668	0.033913	0.033913	0.024835	0.033826	0.029099	0.025424	0.017974	0.010221	0.034115	0.040632	0.028101
18	0.011401	0.016127	0.022415	0.022415	0.020412	0.030975	0.024947	0.032795	0.009259	0.005665	0.020938	0.033860	0.025898
19	0.008405	0.015798	0.023979	0.023979	0.026464	0.025322	0.031789	0.041995	0.014706	0.006044	0.024651	0.048157	0.032080
20	0.007240	0.011279	0.022920	0.022920	0.020257	0.021952	0.015251	0.029313	0.009622	0.003876	0.023297	0.040632	0.020867
21	0.004660	0.008904	0.016038	0.016038	0.016633	0.018163	0.018167	0.013318	0.007081	0.002748	0.015998	0.029345	0.017990
22	0.003911	0.006789	0.013027	0.013027	0.012252	0.015769	0.014653	0.011855	0.005991	0.001875	0.013989	0.024831	0.012870
23	0.003994	0.005559	0.009793	0.009793	0.013801	0.015855	0.018594	0.018450	0.005991	0.002168	0.010346	0.030098	0.014209
24	0.003162	0.004365	0.009074	0.009074	0.015450	0.023149	0.020950	0.013061	0.004720	0.001735	0.013522	0.024078	0.012572
25	0.001831	0.003615	0.008759	0.008759	0.015324	0.017611	0.011953	0.020123	0.005084	0.001442	0.017413	0.017306	0.009605
26	0.002496	0.002877	0.009512	0.009512	0.014173	0.013781	0.014128	0.011515	0.004720	0.001180	0.015355	0.015049	0.007859
27	0.002164	0.002357	0.005600	0.005600	0.014695	0.012718	0.014276	0.010304	0.001452	0.000678	0.014965	0.015801	0.006202
28	0.003828	0.001917	0.007022	0.007022	0.012327	0.010714	0.012460	0.005268	0.003813	0.000875	0.010998	0.016554	0.006083
29	0.002996	0.001624	0.005782	0.005782	0.010701	0.009139	0.010634	0.005263	0.001997	0.000762	0.011609	0.012039	0.005596
30	0.033785	0.014631	0.043334	0.043334	0.014149	0.015191	0.013386	0.008114	0.014887	0.004677	0.020675	0.039127	0.021026

Texas Statewide 2017 Fuel Engine Fractions Summary[1]

SUT	Fuel Type	Model Year															
		2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.990	0.993	0.999	1.000	0.993	0.995	0.997	0.996	0.996
PC	Diesel	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.010	0.007	0.001	0.000	0.007	0.005	0.003	0.004	0.004
PT	Gas	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.987	0.985	0.977	0.981	0.975	0.979	0.982	0.982	0.983
PT	Diesel	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.013	0.015	0.023	0.019	0.025	0.021	0.018	0.018	0.017
LCT	Gas	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.962	0.955	0.941	0.948	0.938	0.946	0.951	0.951	0.956
LCT	Diesel	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.038	0.045	0.059	0.052	0.062	0.054	0.049	0.049	0.044
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
RT	Gas	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.002	0.002	0.005	0.001	0.003	0.003	0.005	0.004	0.005
RT	Diesel	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.998	0.998	0.995	0.999	0.997	0.997	0.995	0.996	0.995
SUShT	Gas	0.396	0.396	0.396	0.396	0.371	0.219	0.234	0.274	0.351	0.287	0.256	0.238	0.232	0.245	0.260	0.268
SUShT	Diesel	0.604	0.604	0.604	0.604	0.629	0.781	0.766	0.726	0.649	0.713	0.744	0.762	0.768	0.755	0.740	0.732
SULhT	Gas	0.396	0.396	0.396	0.396	0.371	0.219	0.234	0.274	0.351	0.287	0.256	0.238	0.232	0.245	0.260	0.268
SULhT	Diesel	0.604	0.604	0.604	0.604	0.629	0.781	0.766	0.726	0.649	0.713	0.744	0.762	0.768	0.755	0.740	0.732
MH	Gas	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.510	0.530	0.540	0.560	0.570	0.590	0.600
MH	Diesel	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.490	0.470	0.460	0.440	0.430	0.410	0.400
CShT	Gas	0.094	0.094	0.094	0.094	0.199	0.110	0.057	0.081	0.052	0.058	0.031	0.050	0.051	0.052	0.055	0.077
CShT	Diesel	0.906	0.906	0.906	0.906	0.801	0.890	0.943	0.919	0.948	0.942	0.969	0.950	0.949	0.948	0.945	0.923
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2017 Fuel Engine Fractions Summary[1] - (Continued)

SUT	Fuel Type	Model Year														
		2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989	1988	1987
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.997	0.997	0.998	0.998	0.999	0.999	0.999	1.000	0.999	0.999	0.997	0.999	0.999	1.000	0.987
PC	Diesel	0.003	0.003	0.002	0.002	0.001	0.001	0.001	0.000	0.001	0.001	0.003	0.001	0.001	0.000	0.013
PT	Gas	0.989	0.992	0.981	0.993	0.992	0.981	0.995	0.991	0.986	0.985	0.994	0.989	0.992	0.997	0.996
PT	Diesel	0.011	0.008	0.019	0.007	0.008	0.019	0.005	0.009	0.014	0.015	0.006	0.011	0.008	0.003	0.004
LCT	Gas	0.908	0.949	0.929	0.950	0.927	0.971	0.932	0.974	0.974	0.951	0.937	0.984	0.976	0.952	0.986
LCT	Diesel	0.092	0.051	0.071	0.050	0.073	0.029	0.068	0.026	0.026	0.049	0.063	0.016	0.024	0.048	0.014
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.042	0.114	0.147	0.121	0.010	0.090	0.124	0.229	0.250	0.265
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.958	0.886	0.853	0.879	0.990	0.910	0.876	0.771	0.750	0.735
RT	Gas	0.006	0.002	0.169	0.404	0.019	0.012	0.010	0.105	0.031	0.210	0.101	0.204	0.029	0.106	0.106
RT	Diesel	0.994	0.998	0.831	0.596	0.981	0.988	0.990	0.895	0.969	0.790	0.899	0.796	0.971	0.894	0.894
SUShT	Gas	0.311	0.350	0.348	0.435	0.436	0.427	0.673	0.508	0.519	0.511	0.465	0.539	0.572	0.640	0.654
SUShT	Diesel	0.689	0.650	0.652	0.565	0.564	0.573	0.327	0.492	0.481	0.489	0.535	0.461	0.428	0.360	0.346
SULhT	Gas	0.311	0.350	0.348	0.435	0.436	0.427	0.673	0.508	0.519	0.511	0.465	0.539	0.572	0.640	0.654
SULhT	Diesel	0.689	0.650	0.652	0.565	0.564	0.573	0.327	0.492	0.481	0.489	0.535	0.461	0.428	0.360	0.346
MH	Gas	0.630	0.660	0.680	0.710	0.740	0.770	0.790	0.820	0.850	0.850	0.850	0.850	0.850	0.850	0.850
MH	Diesel	0.370	0.340	0.320	0.290	0.260	0.230	0.210	0.180	0.150	0.150	0.150	0.150	0.150	0.150	0.150
CShT	Gas	0.084	0.090	0.107	0.134	0.147	0.146	0.275	0.117	0.117	0.160	0.161	0.144	0.114	0.157	0.163
CShT	Diesel	0.916	0.910	0.893	0.866	0.853	0.854	0.725	0.883	0.883	0.840	0.839	0.856	0.886	0.843	0.837
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2020 Fuel Engine Fractions Summary[1]

SUT	Fuel Type	Model Year															
		2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.990	0.993	0.999	1.000	0.993	0.995
PC	Diesel	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.010	0.007	0.001	0.000	0.007	0.005
PT	Gas	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.987	0.985	0.977	0.981	0.975	0.979
PT	Diesel	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.013	0.015	0.023	0.019	0.025	0.021
LCT	Gas	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.962	0.955	0.941	0.948	0.938	0.946
LCT	Diesel	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.038	0.045	0.059	0.052	0.062	0.054
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
RT	Gas	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.002	0.002	0.005	0.001	0.003	0.003
RT	Diesel	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.998	0.998	0.995	0.999	0.997	0.997
SUShT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.371	0.219	0.234	0.274	0.351	0.287	0.256	0.238	0.232
SUShT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.629	0.781	0.766	0.726	0.649	0.713	0.744	0.762	0.768
SULhT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.371	0.219	0.234	0.274	0.351	0.287	0.256	0.238	0.232
SULhT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.629	0.781	0.766	0.726	0.649	0.713	0.744	0.762	0.768
MH	Gas	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.510	0.530	0.540	0.560
MH	Diesel	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.490	0.470	0.460	0.440
CShT	Gas	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.199	0.110	0.057	0.081	0.052	0.058	0.031	0.050	0.051
CShT	Diesel	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.801	0.890	0.943	0.919	0.948	0.942	0.969	0.950	0.949
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2020 Fuel Engine Fractions Summary[1] - (Continued)

SUT	Fuel Type	Model Year														
		2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.997	0.996	0.996	0.997	0.997	0.998	0.998	0.999	0.999	0.999	1.000	0.999	0.999	0.997	0.999
PC	Diesel	0.003	0.004	0.004	0.003	0.003	0.002	0.002	0.001	0.001	0.001	0.000	0.001	0.001	0.003	0.001
PT	Gas	0.982	0.982	0.983	0.989	0.992	0.981	0.993	0.992	0.981	0.995	0.991	0.986	0.985	0.994	0.989
PT	Diesel	0.018	0.018	0.017	0.011	0.008	0.019	0.007	0.008	0.019	0.005	0.009	0.014	0.015	0.006	0.011
LCT	Gas	0.951	0.951	0.956	0.908	0.949	0.929	0.950	0.927	0.971	0.932	0.974	0.974	0.951	0.937	0.984
LCT	Diesel	0.049	0.049	0.044	0.092	0.051	0.071	0.050	0.073	0.029	0.068	0.026	0.026	0.049	0.063	0.016
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.042	0.114	0.147	0.121	0.010	0.090	0.124
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.958	0.886	0.853	0.879	0.990	0.910	0.876
RT	Gas	0.005	0.004	0.005	0.006	0.002	0.169	0.404	0.019	0.012	0.010	0.105	0.031	0.210	0.101	0.204
RT	Diesel	0.995	0.996	0.995	0.994	0.998	0.831	0.596	0.981	0.988	0.990	0.895	0.969	0.790	0.899	0.796
SUShT	Gas	0.245	0.260	0.268	0.311	0.350	0.348	0.435	0.436	0.427	0.673	0.508	0.519	0.511	0.465	0.539
SUShT	Diesel	0.755	0.740	0.732	0.689	0.650	0.652	0.565	0.564	0.573	0.327	0.492	0.481	0.489	0.535	0.461
SULhT	Gas	0.245	0.260	0.268	0.311	0.350	0.348	0.435	0.436	0.427	0.673	0.508	0.519	0.511	0.465	0.539
SULhT	Diesel	0.755	0.740	0.732	0.689	0.650	0.652	0.565	0.564	0.573	0.327	0.492	0.481	0.489	0.535	0.461
MH	Gas	0.570	0.590	0.600	0.630	0.660	0.680	0.710	0.740	0.770	0.790	0.820	0.850	0.850	0.850	0.850
MH	Diesel	0.430	0.410	0.400	0.370	0.340	0.320	0.290	0.260	0.230	0.210	0.180	0.150	0.150	0.150	0.150
CShT	Gas	0.052	0.055	0.077	0.084	0.090	0.107	0.134	0.147	0.146	0.275	0.117	0.117	0.160	0.161	0.144
CShT	Diesel	0.948	0.945	0.923	0.916	0.910	0.893	0.866	0.853	0.854	0.725	0.883	0.883	0.840	0.839	0.856
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2030 Fuel Engine Fractions Summary[1]

SUT	Fuel Type	Model Year															
		2030	2029	2028	2027	2026	2025	2024	2023	2022	2021	2020	2019	2018	2017	2016	2015
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988
PC	Diesel	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012
PT	Gas	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980
PT	Diesel	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
LCT	Gas	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947
LCT	Diesel	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
RT	Gas	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
RT	Diesel	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997
SUShT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396
SUShT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604
SULhT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396
SULhT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604
MH	Gas	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
MH	Diesel	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
CShT	Gas	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094
CShT	Diesel	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2030 Fuel Engine Fractions Summary[1] - (Continued)

SUT	Fuel Type	Model Year														
		2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.988	0.988	0.988	0.988	0.990	0.993	0.999	1.000	0.993	0.995	0.997	0.996	0.996	0.997	0.997
PC	Diesel	0.012	0.012	0.012	0.012	0.010	0.007	0.001	0.000	0.007	0.005	0.003	0.004	0.004	0.003	0.003
PT	Gas	0.980	0.980	0.980	0.980	0.987	0.985	0.977	0.981	0.975	0.979	0.982	0.982	0.983	0.989	0.992
PT	Diesel	0.020	0.020	0.020	0.020	0.013	0.015	0.023	0.019	0.025	0.021	0.018	0.018	0.017	0.011	0.008
LCT	Gas	0.947	0.947	0.947	0.947	0.962	0.955	0.941	0.948	0.938	0.946	0.951	0.951	0.956	0.908	0.949
LCT	Diesel	0.053	0.053	0.053	0.053	0.038	0.045	0.059	0.052	0.062	0.054	0.049	0.049	0.044	0.092	0.051
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
RT	Gas	0.003	0.003	0.003	0.003	0.002	0.002	0.005	0.001	0.003	0.003	0.005	0.004	0.005	0.006	0.002
RT	Diesel	0.997	0.997	0.997	0.997	0.998	0.998	0.995	0.999	0.997	0.997	0.995	0.996	0.995	0.994	0.998
SUShT	Gas	0.396	0.371	0.219	0.234	0.274	0.351	0.287	0.256	0.238	0.232	0.245	0.260	0.268	0.311	0.350
SUShT	Diesel	0.604	0.629	0.781	0.766	0.726	0.649	0.713	0.744	0.762	0.768	0.755	0.740	0.732	0.689	0.650
SULhT	Gas	0.396	0.371	0.219	0.234	0.274	0.351	0.287	0.256	0.238	0.232	0.245	0.260	0.268	0.311	0.350
SULhT	Diesel	0.604	0.629	0.781	0.766	0.726	0.649	0.713	0.744	0.762	0.768	0.755	0.740	0.732	0.689	0.650
MH	Gas	0.500	0.500	0.500	0.500	0.500	0.500	0.510	0.530	0.540	0.560	0.570	0.590	0.600	0.630	0.660
MH	Diesel	0.500	0.500	0.500	0.500	0.500	0.500	0.490	0.470	0.460	0.440	0.430	0.410	0.400	0.370	0.340
CShT	Gas	0.094	0.199	0.110	0.057	0.081	0.052	0.058	0.031	0.050	0.051	0.052	0.055	0.077	0.084	0.090
CShT	Diesel	0.906	0.801	0.890	0.943	0.919	0.948	0.942	0.969	0.950	0.949	0.948	0.945	0.923	0.916	0.910
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2040 Fuel Engine Fractions Summary[1]

SUT	Fuel Type	Model Year															
		2040	2039	2038	2037	2036	2035	2034	2033	2032	2031	2030	2029	2028	2027	2026	2025
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988
PC	Diesel	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012
PT	Gas	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980
PT	Diesel	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
LCT	Gas	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947
LCT	Diesel	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
RT	Gas	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
RT	Diesel	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997
SUShT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396
SUShT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604
SULhT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396
SULhT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604
MH	Gas	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
MH	Diesel	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
CShT	Gas	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094
CShT	Diesel	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2040 Fuel Engine Fractions Summary[1] - (Continued)

SUT	Fuel Type	Model Year														
		2024	2023	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.990
PC	Diesel	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.010
PT	Gas	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.987
PT	Diesel	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.013
LCT	Gas	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.962
LCT	Diesel	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.038
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
RT	Gas	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.002
RT	Diesel	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.998
SUShT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.371	0.219	0.234	0.274
SUShT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.629	0.781	0.766	0.726
SULhT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.371	0.219	0.234	0.274
SULhT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.629	0.781	0.766	0.726
MH	Gas	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
MH	Diesel	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
CShT	Gas	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.199	0.110	0.057	0.081
CShT	Diesel	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.801	0.890	0.943	0.919
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2045 Fuel Engine Fractions Summary[1]

SUT	Fuel Type	Model Year															
		2045	2044	2043	2042	2041	2040	2039	2038	2037	2036	2035	2034	2033	2032	2031	2030
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988
PC	Diesel	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012
PT	Gas	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980
PT	Diesel	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
LCT	Gas	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947
LCT	Diesel	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
RT	Gas	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
RT	Diesel	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997
SUShT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396
SUShT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604
SULhT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396
SULhT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604
MH	Gas	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
MH	Diesel	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
CShT	Gas	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094
CShT	Diesel	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2045 Fuel Engine Fractions Summary[1] - (Continued)

SUT	Fuel Type	Model Year														
		2029	2028	2027	2026	2025	2024	2023	2022	2021	2020	2019	2018	2017	2016	2015
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988
PC	Diesel	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.010
PT	Gas	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980
PT	Diesel	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
LCT	Gas	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947
LCT	Diesel	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
RT	Gas	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
RT	Diesel	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997
SUShT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396
SUShT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604
SULhT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396
SULhT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604
MH	Gas	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
MH	Diesel	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
CShT	Gas	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094
CShT	Diesel	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

APPENDIX B:
EMISSIONS ESTIMATION UTILITIES FOR MOVES-BASED EMISSIONS INVENTORIES

TTI EMISSIONS ESTIMATION UTILITIES FOR MOVES2014A-BASED EMISSIONS INVENTORIES

The following is a summary of utilities developed by TTI (written in the Visual Basic programming language) for producing detailed, link-based, hourly, and 24-hour emissions estimates for on-road mobile sources using the latest version of EPA's MOVES model (MOVES2014a). These utilities produce inputs used with the MOVES model, make special adjustments to the emissions factors (when required), and multiply them with travel model link-based or Highway Performance Monitoring System (HPMS)-based (virtual link) activity estimates to produce emissions at user-specified temporal and spatial scales.

The main utilities for calculating hourly and 24-hour emissions using MOVES are TRANSVMT, VirtualLinkVMT, VehPopulationBuild, OffNetActCalc, MOVESactivityInputBuild, MOVESfleetInputBuild, RatesCalc, RatesAdj, and EmsCalc. The TRANSVMT and VirtualLinkVMT prepare the link VMT and speeds activity input. The VehPopulationBuild utility builds the vehicle population used to calculate the off-network activity. The OffNetActCalc utility builds the SHP, starts, SHI, and APU hours required to estimate emissions using the rate-per-activity emissions rates produced by the RatesCalc or RatesAdj utilities. The MOVESactivityInputBuild and MOVESfleetInputBuild utilities build inputs used in MOVES. The RatesCalc utility assembles the emissions rates from the MOVES output in terms of rate-per-activity, including rate-per-SHP for the evaporative emissions processes. The RatesAdj utility makes special adjustments to the emissions rates when required. The EmsCalc utility calculates emissions by hourly time periods, producing a tab-delimited summary file (including 24-hour totals), hourly link emissions output files (optional), and an optional tab-delimited summary file by MOVES source classification code (SCC).

A process flow diagram follows the utility descriptions.

TRANSVMT

The TRANSVMT utility post-processes travel demand models (TDMs) to produce hourly, on-road vehicle, seasonal and day-of-week specific, directional link VMT, and speed estimates. The TRANSVMT utility processes a TDM traffic assignment by multiplying the link volumes by the appropriate HPMS, seasonal, or other VMT factors. Hourly factors are then used to distribute the link VMT to each hour in the day. The TTI speed model is used to estimate the operational time-of-day link speeds for each direction. Since intrazonal links are not included in the TDM, special intrazonal links are created and the VMT and speeds for these special links are estimated using the intrazonal trips from the trip matrix and the zonal radii. The link VMT and speeds produced by TRANSVMT are subsequently input to the EmsCalc utility for applying the MOVES-based emissions factors (as well as with other utilities to develop off-network activity estimates).

VirtualLinkVMT

The VirtualLinkVMT utility post-processes county HPMS average annual daily traffic (AADT) VMT, centerline miles, and lane miles by functional classification and area type (from the Texas Department of Transportation's [TxDOT's] annual Roadway Inventory Functional Classification Record [RIFCREC]) to produce hourly, on-road vehicle fleet, seasonal and day-of-week specific

actual or projected VMT, and directional operational speed estimates. These estimated VMT and speeds are produced for up to 42 directional HPMS functional classification/area type combinations, or "links." The VirtualLinkVMT utility was developed for use in areas that do not have TDM networks, as well as for inventory applications for which network link-based detail is not required. The main inputs to VirtualLinkVMT are:

- County HPMS data sets, which include AADT VMT, centerline miles, and lane miles by HPMS area type and functional class;
- County-level VMT control totals;
- Hourly VMT distributions; and
- Speed model inputs to include volume/delay equation parameters adapted for HPMS, and free-flow speeds and lane capacities by HPMS functional classification and area type.

VirtualLinkVMT initially scales the county HPMS AADT VMT at the link level to the appropriate VMT (e.g., uses a county-level VMT control total-to-AADT ratio to produce seasonal, day-of-week specific VMT). Hourly factors and directional split factors are applied to the adjusted VMT on each link to estimate the hourly, directional VMT (and volumes) by HPMS link. Congested speed models, each for the high- and low-capacity links, are used to estimate the hourly operational speeds by direction for each link. The operational speeds are based on volume/capacity (v/c)-derived directional delay (minutes/mile) applied to the estimated free-flow speeds for each link. The virtual link VMT and speeds produced using the VirtualLinkVMT utility are an input to the emissions calculation utility, EmsCalc (as well as with other utilities to develop off-network activity estimates).

VehPopulationBuild

The VehPopulationBuild utility builds the sourcetypeyear data files in a format consistent with the MOVES input database table and the SUT/fuel type population input file (can be used with the EmsCalc utility to estimate emissions or the OffNetActCalc utility to estimate starts and SHP) using the VMT mix and the Texas Department of Motor Vehicles (TxDMV) registration data sets. The TxDMV registration data sets are three sets of registration data (an age registration data file, a gas trucks registration data file, and a diesel trucks registration data file) that list 31 years of registration data. The primary inputs to this utility are:

- County ID file, which specifies the county for which the output will be calculated;
- Age registration data file, which lists 31 years of registration data for the Passenger Vehicle, Motorcycles, Trucks <=6000, Trucks >6000 <=8500, Total Trucks <=8500, Gas Trucks >8500, Diesel Trucks >8500, Total Trucks >8500, and Total All Trucks vehicle categories;
- Gas trucks registration data file, which lists 31 years of registration data for the Gas >8500, Gas >10000, Gas >14000, Gas >16000, Gas >19500, Gas >26000, Gas >33000, Gas >60000, and Gas Totals gas truck categories;
- Diesel trucks registration data file, which lists 31 years of registration data for the Diesel >8500, Diesel >10000, Diesel >14000, Diesel >16000, Diesel >19500, Diesel >26000, Diesel >33000, Diesel >60000, and Diesel Totals diesel truck categories;

- VMT mix by TxDOT district, MOVES SUT, and MOVES fuel type;
- TxDOT district name file, which specifies the VMT mix TxDOT district;
- MOVES default database;
- Population factor file (optional); and
- Year ID file (optional, only used if population factors are used), which specifies the year for calculating the output.

For the desired county (from the county ID file), the age registration data (for the Passenger Vehicle, Motorcycles, Trucks <=6000, Trucks >6000 <=8500, and Total Trucks <=8500 vehicle categories) are saved in an age registration data array. The gas truck registration data (for the Gas >8500, Gas >10000, Gas >14000, Gas >16000, Gas >19500, Gas >26000, Gas >33000, and Gas >60000 gas truck categories) are saved in the gas truck section of the diesel/gas registration data array. The diesel truck registration data (for the Diesel >8500, Diesel >10000, Diesel >14000, Diesel >16000, Diesel >19500, Diesel >26000, Diesel >33000, and Diesel >60000 diesel truck categories) are saved in the diesel truck section of the diesel/gas registration data array. The age registration data array and the diesel/gas registration data array are combined to form the registration category data array (seven categories for 31 years of data and the total) using the combinations in Table 1.

Table 1. Registration Categories.

Registration Category	Vehicle Category	Data Location
1	Passenger Vehicle	Age registration data array
2	Motorcycles	
3	Total Trucks <=8500	
4	Diesel >8500, Diesel >10000, Diesel >14000, Diesel >16000	Diesel/gas registration data array
5	Diesel >19500, Diesel >26000, Diesel >33000, Diesel >60000	
6	Gas >8500, Gas >10000, Gas >14000, Gas >16000	
7	Gas >19500, Gas >26000, Gas >33000, Gas >60000	

The registration category data array is used to fill the SUT population array (by SUT and fuel type) for all vehicles except long-haul trucks. Each SUT/fuel type combination is assigned the total registrations from one or more of the registration categories in the registration category data array. Table 2 shows the SUTs and their associated registration category in the registration category data array.

Table 2. SUT/Registration Category Correlation.

SUT	Registration Category
11	2
21	1
31, 32	3
41, 42, 43, 51, 52, 54	4 + 6
61	5 + 7

SUT population factors are calculated by SUT/fuel type using the data from the VMT mix input for all SUTs except motorcycles (SUT 11) and the long-haul trucks (SUTs 53 and 62) and saved in the SUT population factors array. For SUT 21, the fuel type VMT mix is divided by the total VMT mix for SUT 21. For SUT 31, the fuel type VMT mix is divided by the total VMT mix for SUTs 31 and 32. The same process applies to SUT 32. For SUT 41, the fuel type VMT mix is divided by the total VMT mix for SUTs 41, 42, 43, 51, 52, and 54. The same process applies to SUTs 42, 43, 51, 52, and 54. For SUT 61, the fuel type VMT mix is divided by the total VMT mix for SUT 61.

For SUT 11, the SUT population factor for fuel type 1 (gasoline) is set 1 with all other factors set to 0. For SUT 53, the SUT population factors by fuel type are calculated by dividing the fuel type VMT mix for SUT 53 by the fuel type VMT mix for SUT 52. For SUT 62, the SUT population factors by fuel type are calculated by dividing the fuel type VMT mix for SUT 62 by the fuel type VMT mix for SUT 61, therefore creating a ratio of long-haul and short-haul trucks.

The SUT population factors and the population factor (if desired) are applied to the SUT population array for all SUTs except SUT 53 and 62. For SUT 53, the SUT population factors for SUT 53 are applied to the SUT population array for SUT 52. For SUT 62, the SUT population factors for SUT 62 are applied to the SUT population array for SUT 61.

Using the appropriate MySQL code, a new sourcetypeyear database table is created. The data in the SUT population array is aggregated by fuel type and used to fill the sourcetypeyear database table, along with the yearID, salesGrowthFactor, and migrationrate. For the yearID, the year of the registration data is used, unless a population factor is used, in which case the year from the year ID input is used. The salesGrowthFactor and migrationrate for each SUT is set 1. A text format of this database table is written by the utility as well. The SUT/fuel type population input file is written using the SUT population array.

OffNetActCalc

The OffNetActCalc calculates the analysis scenario (i.e., year, season, day type) SHP, starts, SHI, and APU hours by hour, SUT, and fuel type used to estimate emissions using the EmsCalc utility. The SHI and APU hours are only calculated for SUT 62, fuel type 2 (CLhT_Diesel). The SHP is calculated using either the TDM or the virtual link-based link VMT and speeds (same as used in the distance-based emissions estimation), the 24-hour or time period VMT mix (by roadway type and SUT/fuel type), and the SUT/fuel type population (from the

VehiclePopulationBuild utility). The starts activity is calculated using the SUT/fuel type population and the starts per vehicle (typically the MOVES default). The SHI and APU hours are a function of hotelling hours. This utility has two options for calculating the hotelling hours. Using the first option, the analysis scenario 24-hour hotelling hours is calculated using a user-supplied extended idle factor to the source hours operating (SHO). However, this method of estimating the hotelling hours as a direct function of the SHO does not consider the availability of locations where extended idling may occur. The second option (and suggested method) uses base data (24-hour hotelling, link VMT and speeds, and VMT mix), the analysis scenario data used to calculate the SHP, and the analysis scenario SHP to calculate the analysis scenario 24-hour hotelling hours.

For the analysis scenario first hourly VMT and speeds input, the utility applies the appropriate VMT mix (either the 24-hour VMT mix or the appropriate time period VMT mix as assigned by the user) to each link that has the desired county code; thus distributing the link VMT to each SUT/fuel type, which is added to the hourly SUT/fuel type VMT. The link VMT by SUT/fuel type is divided by the link speed to calculate the link VHT (or SHO) by SUT/fuel type, which is added to the SUT fuel/type VHT. This calculation process is repeated for each analysis scenario VMT and speeds input; therefore producing the analysis scenario hourly values for VMT by SUT/fuel type and for VHT by SUT/fuel type.

The analysis scenario hourly SUT/fuel type speed, total hours (or source hours), and SHP are then calculated. For each hour and SUT/fuel type, the hourly SUT/fuel type VMT is divided by the hourly SUT/fuel type VHT to calculate the hourly SUT/fuel type speed. The hourly SUT/fuel type total hours are set equal to the SUT/fuel type population. The hourly SUT/fuel type SHP is calculated by subtracting the hourly SUT/fuel type VHT (or SHO) from the hourly SUT/fuel type total hours. If the calculated SHP is negative (i.e., SHO is greater than the total hours), the SHP is set to 0.

To calculate the analysis scenario 24-hour hotelling hours under option 1 (as a direct function of SHO), the utility multiplies the CLhT_Diesel analysis scenario 24-hour SHO by the user-supplied extended idle factor, which represents the amount of extended idle time that must occur per SHO. For option 2 (as a function of base hotelling data), the utility calculates the base 24-hour CLhT_Diesel VMT using the base VMT and speeds inputs and the base VMT mix with the same procedure used in the analysis scenario SHP calculations. The 24-hour analysis scenario CLhT_Diesel VMT is then divided by the 24-hour base CLhT_Diesel VMT to create a scaling factor, which is then applied to the base 24-hour hotelling hours to calculate the analysis scenario 24-hour hotelling hours.

The utility then calculates the analysis scenario hourly hotelling hours. The analysis scenario hourly CLhT_Diesel SHO (from the SHP calculation process) is converted to hourly VHT fractions. The hourly hotelling fractions are calculated as the inverse of the hourly VHT fractions. The hourly hotelling fractions are then applied to the analysis scenario 24-hour hotelling hours to calculate the hourly hotelling hours. For each hour, the hourly hotelling hours are then compared to the hourly CLhT_Diesel SHP. For those hours where the hotelling hours are greater than the SHP, hotelling hours are set to the SHP for that hour.

The utility then calculates the SHI fraction and the APU fraction using the source type age distribution (same distribution used in the MOVES runs), the relative mileage accumulation rates, and the hotelling activity distribution. Travel fractions for SUT 62 (CLhT) by ageID (0 through 30) are calculated by multiplying the age distribution by the appropriate relative mileage accumulation rate, which is then converted into a distribution by dividing the individual travel fraction (ageID 0 through 30) by the sum of the travel fractions. These travel fractions are then applied to the appropriate operating mode fractions from the hotelling activity distribution (operating mode 200) and summed to calculate the SHI fraction. Using a similar process, the APU fraction is calculated using the operating mode fractions for operating mode 201. For each hour the analysis scenario hotelling hours are multiplied by the SHI fraction to calculate the analysis scenario SHI activity and by the APU fraction to calculate the analysis scenario APU hours.

MOVESactivityInputBuild

The MOVESactivityInputBuild utility builds the roadtypedistribution, hourvmtfraction, avgspeeddistribution, roadtype, hpmsvtypeday, sourcetypedayvmt, year, state, zone, zoneroadtype, monthvmtfraction, and dayvmtfraction data files in a format consistent with the MOVES input database tables using the link-based hourly VMT and speeds developed with the TRANSVMT or VirtualLinkVMT utility, the VMT mix, and the MOVES defaults. The utility also has the option of building the sourcetypeage (adjusted to reflect the 24-hour VMT mix), starts, and hotellinghours data files in a format consistent with the MVOES input database tables using the output from the OffNetActCalc utility, along with inputs from the MOVES runs and the MOVES defaults. The primary inputs to this utility are:

- Link-based hourly VMT and speeds developed with the TRANSVMT or VirtualLinkVMT utility;
- County ID file which specifies the county number in the link-based hourly VMT and speeds for which the output will be calculated;
- VMT roadway type designations, which lists associations of the link roadway types/area type combination to the VMT mix, emissions rate, and MOVES roadway types (same as used with the EmsCalc utility);
- 24-hour or time period VMT mix by roadway type, MOVES source type, and MOVES fuel type (same as used with the EmsCalc utility);
- Day ID, which specifies the MOVES day ID for calculating the output;
- Year ID, which specifies the year for calculating the output;
- Link/Ramp designations, which designates each link roadway type/area type combination to either ramp or non-ramp;
- MOVES default database;
- Month ID, which specifies the month for calculating the output;
- sourcetypeyear, SUT age, and sourcetypeage inputs from the MOVES runs (optional, only if sourcetypeage table output is to be created);

- Starts output from the OffNetActCalc utility (optional, only if starts table output is to be created); and
- Hotelling, extended idle, and APU hours output from the OffNetActCalc utility (optional, only if hotelling table output is to be created).

For each link in the link-based hourly VMT and speeds in which the county number matches the desired county ID, the link VMT is saved in a VMT summary array based on hour, link functional class, and link area type. The link VHT (link VMT/link speed) is saved in a VHT summary array based on hour, link functional class, link area type, and MOVES average speed bin ID (determined using the MOVES average speed bins and the link speed). The link VHT is also saved in a road type VHT array based on link functional class and link area type, and, if the link is specified as ramp by the link/ramp designations specified by the user, the VHT is additionally saved in the ramp segment of the road type VHT array.

A MOVES roadway type array by MOVES roadway type (roadTypeID codes 2 through 5) is also created using the data in the VMT summary array and VMT roadway type designations. For the link road types designated a MOVES road type of 6 or 8, the VMT is added to MOVES road type 2 in the MOVES roadway type array. For the link road types designated a MOVES road type of 7 or 9, the VMT is added to MOVES road type 4 in the MOVES roadway type array. An hourly VMT array (by MOVES SUT, MOVES roadway type, and hour) is formed using the data in the VMT summary array, the VMT roadway type designations, and the VMT mix. If the time period VMT mix is used, each hour is assigned a time period by the user. Otherwise, the same 24-hour VMT mix is used for all hours. An average speed distribution array (by MOVES SUT, MOVES roadway type, hour, and MOVES speed bin) is created using the VHT summary array and the VMT mix. Using the appropriate MySQL code, the MOVES roadtypedistribution, hourvmtfraction, and avgspeeddistribution default values are extracted and saved for later use.

The VMT in the MOVES roadway type array is used to produce the roadway type distribution array by MOVES SUT and MOVES roadway type. This VMT is converted to a distribution by MOVES SUT (i.e., the total for a SUT over the five MOVES roadway types should equal 1), with the distribution value for MOVES roadway type 0 (Off-Network) equal to 0. The utility writes the tab-delimited roadtypedistribution table output (optional).

The VMT in the hourly VMT array is added to the hourly VMT fraction array (by SUT, MOVES roadway type, and hour) and for those roadway types where the VMT for all hours is greater than 0, this VMT is converted to an hourly distribution. For those roadway types where the VMT is equal to 0, a value of 1 is placed in the first hour, followed by 0 in the remaining hours. The utility writes the tab-delimited hourvmtfraction table output (optional). For those SUTs where the VMT mix is greater than 0, the hourly VMT fraction array is used. Otherwise, the MOVES hourvmtfraction default values are used.

The VHT in the average speed distribution array is converted to a distribution by SUT, MOVES roadway type, hour/day (combination of hour and the day ID specified by the user), and MOVES average speed bin. The utility writes the tab-delimited avgspeeddistribution table

output (optional). For those SUTs where the VMT mix is greater than 0, the average speed distribution array is used. Otherwise, the MOVES avgspeeddistribution default values are used.

The VHT in the road type VHT array is converted to a proportion of ramp VHT by dividing the ramp segment of the road type VHT array by the total VHT for the road type in the road type VHT. The utility writes the tab-delimited roadtype table output (optional). If the ramp fraction for roadTypeID 2 is greater than 0, then roadTypeID 6 (with rampFraction equal to 0) and roadTypeID 8 (with rampFraction equal to 1) are also added to the roadtype database table. If the ramp fraction for roadTypeID 4 is greater than 0, then roadTypeID 7 (with rampFraction equal to 0) and roadTypeID 9 (with rampFraction equal to 1) are also added to the roadtype database table.

The VMT in the hourly VMT array is aggregated to create the 24-hour HPMS vehicle type VMT array. Each SUT is assigned an HPMS vehicle type (SUT 11 is HPMS vehicle type 10; SUTs 21, 31 and 32 are HPMS vehicle type 25; SUTs 41, 42, and 43 are HPMS vehicle type 40; SUTs 51, 52, 53, and 54 are HPMS vehicle type 50; and SUTs 61 and 62 are HPMS vehicle type 60). The utility writes the tab-delimited hpmsvtypeday table output (optional).

The VMT in the hourly VMT array is also aggregated by SUT to create the 24-hour SUT VMT array. Using this VMT data, the utility writes the tab-delimited sourcetypedayvmt output table (optional) in a format consistent with the MOVES input.

Using the appropriate MySQL code, the fuel year ID is extracted from the MOVES default year database table for the user-supplied year ID. The tab-delimited year table output is written (optional) using the user-supplied year ID and the extracted fuel year ID. The "isbaseYear" data is written as well (automatically set to "Y").

The utility also produces two tab-delimited summary output files. A tab-delimited VMT summary is output by hour, link road type, and link area type for the user-specified county. A tab-delimited VHT summary is output by hour, link road type, link area type, and MOVES average speed bin for the user-specified county.

The utility creates five other tab-delimited outputs (state, zone, zoneroadtype, monthvmtfraction, and dayvmtfraction tables) using the user-supplied inputs. For the state table (optional), the utility extracts the data from the MOVES default state database table where the state ID is 48 and writes this data to the tab-delimited state table output. For the zone table (optional), the utility extracts the data from the MOVES default zone data for the county ID greater than 48000 and county ID less than 49000 and writes this data to the tab-delimited zone table output with the start allocation factors, idle allocation factors, and SHP allocation factors replaced with values of 1.

For the zoneroadtype table (optional), the utility extracts the MOVES default zoneroadtype data where the zone ID greater than 480000 and zone ID less than 490000 and writes this data to the tab-delimited zoneroadtype table output, with the SHO allocation factors replaced with values of 1. For the monthvmtfraction table (optional), the utility extracts the data from the MOVES default monthvmtfraction table and writes the data to the tab-delimited monthvmtfraction table output with the month VMT fraction set to 1 for the user-supplied month

ID and 0 for all other months. For the dayvmtfraction table (optional), the utility extracts the data from the MOVES default dayvmtfraction table and writes this data to the tab-delimited dayvmtfraction table output with the day VMT fraction is set to 1 for the user-supplied day ID and 0 for all other months.

For the sourcetypeage table output (optional, also needed if the hoteling hours table output is to be created), the utility calculates the adjusted relative mileage accumulation rates (MAR) by multiplying the input relative MAR (categorized by SUT and age from the sourcetypeage input) by the SUT-specific relative MAR adjustment factors (one factor per SUT applied across all age categories). These adjustment factors are calculated using inventory SUT VMT fractions within each HPMS vehicle type and the sum of the SUT-specific normalized travel fractions within each HPMS vehicle type. The inventory SUT VMT fractions within each HPMS vehicle type are calculated by dividing the 24-hour SUT VMT by the 24-hour HPMS vehicle type VMT for the respective SUT.

For the sum of the SUT-specific normalized travel fractions within each HPMS vehicle type, the utility uses the same calculation procedures used by MOVES to calculate the normalized travel fractions. The SUT vehicle population is distributed to each age category using the SUT age distribution input. Using the sum of the vehicle population by HPMS vehicle type, the SUT population fraction for each age category within each HPMS vehicle type is calculated by dividing the SUT vehicle population by age by the sum of the vehicle population by HPMS vehicle type. The utility then calculates the initial travel fractions (by SUT and age) by multiplying the SUT population fraction for each age category within each HPMS vehicle type by the relative MAR input.

These initial travel fractions are then normalized within each HPMS vehicle type to produce the SUT and age-specific normalized travel fractions within each HPMS vehicle type. The utility then calculates the SUT-specific relative MAR adjustment factors by dividing the inventory SUT VMT fractions within each HPMS vehicle type by the sum of the SUT and age-specific normalized travel fractions (i.e., aggregated across the age category for each SUT); resulting in one SUT-specific relative MAR adjustment factor for each SUT.

For the starts table output (optional), the utility aggregates the SUT/fuel type hourly starts input (output from the OffNetActCalc utility) by SUT and multiplies the SUT hourly starts by the SUT age distribution (by SUT) to distribute the hourly SUT starts to each age category. The SUT hourly starts by age are written to the starts table output file, along with the user-supplied monthID, yearID, dayID (used to form the output hourDayID), and zoneID (set using the user-supplied county FIPS code.

For the hoteling hours table output (optional), the utility uses travel fractions specific to SUT 62 to distribute the hourly hoteling hours input (output from the OffNetActCalc utility) to each age category. These travel fractions are calculated by multiplying the SUT 62 age distribution by the calculated relative mileage accumulation rates (MOVES defaults adjusted so to reflect the emissions inventory 24-hour VMT mix) for each age category and dividing by the sum of the product for all the age categories. These travel fractions are multiplied by the hourly hoteling hours input and written to the hoteling hours table output, along with the user-supplied dayID

(used to form the output hourDayID), monthID, yearID, and zoneID (set using the user-supplied county FIPS code.

MOVESfleetInputBuild

The MOVESfleetInputBuild utility builds the sourcetypeagedistribution database table and fuel/engine fraction inputs to MOVES using the TxDOT registration data sets and the MOVES default database tables. The TxDOT registration data sets are three sets of registration data (an age registration data file, a gas trucks registration data file, and a diesel trucks registration data file) that list 31 years of registration data. The primary inputs to this utility are:

- Age registration data file, which lists 31 years of registration data for the Passenger Vehicles, Motorcycles, Trucks <=6000, Trucks >6000 <=8500, Total Trucks <=8500, Gas Trucks >8500, Diesel Trucks >8500, Total Trucks >8500, and Total All Trucks vehicle categories;
- Gas trucks registration data file, which lists 31 years of registration data for the Gas > 8500, Gas > 10000, Gas > 14000, Gas > 16000, Gas > 19500, Gas > 26000, Gas > 33000, Gas > 60000, and Gas Totals gas truck categories;
- Diesel trucks registration data file, which lists 31 years of registration data for the Diesel > 8500, Diesel > 10000, Diesel > 14000, Diesel > 16000, Diesel > 19500, Diesel > 26000, Diesel > 33000, Diesel > 60000, and Diesel Totals diesel truck categories;
- SUT data sources input, which specifies the data source for each SUT to use when building the sourcetypeagedistribution database table;
- Fuel/engine fractions data sources input, which specifies the data source for each SUT to use when building the fuel/engine fractions;
- Default sourcetypeage distribution input;
- MOVES default database; and
- Year ID file (optional, only if year is not the registration data year as in a future year analysis), which specifies the year for calculating the output.

The SUT data sources input lists the data source for each SUT, either a single county, multiple counties, state, or MOVES default. As this input is processed, the utility maintains a list of the input sources. The same applies to the fuel/engine fractions, except data source inputs are only valid for source types 52, 53, and 61 (other are not valid due to data limitations and source type 62 are all considered diesel).

For each county (or state total) in the list of the input sources, the age registration data (for the Passenger Vehicle, Motorcycles, Trucks <=6000, Trucks >6000 <=8500, and Total Trucks <=8500 vehicle categories) are saved in an age registration data array. The gas truck registration data (for the Gas > 8500, Gas > 10000, Gas > 14000, Gas > 16000, Gas > 19500, Gas > 26000, Gas > 33000, and Gas > 60000 gas truck categories) are saved in the gas truck section of the diesel/gas registration data array. The diesel truck registration data (for the Diesel > 8500, Diesel > 10000, Diesel > 14000, Diesel > 16000, Diesel > 19500, Diesel > 26000, Diesel >

33000, and Diesel > 60000 diesel truck categories) are saved in the diesel truck section of the diesel/gas registration data array.

The age registration data array and the diesel/gas registration data array are combined to create the registration category data array (a total of seven categories for 31 years of data and the total) using the combinations in Table 1 (Registration Categories**)**. The county is compared to the data sources for each SUT in the SUT data sources input. If the county is found for a given source type, then the 31 years of registration data from the source type's corresponding category in the registration category data array are added to the SUT age distribution array. Table 3 shows the source types and their corresponding registration categories.

Table 3. SUTs/Registration Categories Correlation for SUT Age Distribution.

SUT	Registration Category
11	2
21	1
31, 32	3
52, 53	4
61, 62	5

A similar process is followed for the fuel/engine fractions array. However, only SUTs 52, 53, 61, and 62 are processed due to data limitations. The registration data are saved in the fuel/engine fractions array based on fuel type. Table 4 shows the SUTs and their corresponding registration categories.

Table 4. SUTs/Registration Categories Correlation for Fuel/Engine Fractions.

SUT	Fuel Type	Registration Category
52, 53	Diesel	4
	Gas	6
61	Diesel	5
	Gas	7
62	Diesel	5 + 7
	Gas	None – all are assumed diesel

After processing all of the counties, the data from the default sourcetypeage distribution input are processed and the data for the registration data year are saved in the default age distribution array. For each source type in which the registration data are to be used for the age distribution, the 31 years of registration data in the SUT age distribution array are converted to a distribution by dividing the source type yearly registration data by the source type total registration data. For

each source type in which the defaults are to be used, the defaults values from the default age distribution array are copied to the SUT age distribution array.

The MOVES default fuel/engine fractions are extracted from the MOVES default database (using the appropriate code for MySQL) and saved in the default fuel/engine fractions array. For source types 52, 53, and 61, the source type yearly registration data in the fuel/engine fractions array are converted to fuel/engine fractions by dividing the yearly source type diesel registration data by the sum of the yearly source type diesel registration data and the yearly source type gas registration data.

If the year ID input is used, then these fuel/engine fractions are adjusted to match the year from the year ID input. If the year from the year ID input is greater than the registration data year, then the first fuel/engine fraction is extended to match the year from the year ID input and the appropriate number of years is dropped from the end of the fuel/engine fractions to maintain the appropriate distribution. If the year from the year ID input is less than the registration data year, then the last fuel/engine fraction is extended to match the year from the year ID input and the appropriate number of years is dropped from the beginning of the fuel/engine fractions to maintain the appropriate distribution. For source type 62, all of the fuel/engine fractions in the fuel/engine fractions array are set to a value of 1.

Using the appropriate MySQL code, a new sourcetypeagedistribution database table is created and the data from the SUT age distribution array, along with the year ID (either from the registration data or the year ID input), are used to fill the new database table. A text format of this database table may be written as well. Using the appropriate MySQL code, a new AVFTfuelengfraction database table is created and the data from the fuel/engine fractions array are used to fill the new database table for SUTs 52, 53, 61, and 62. For all other SUTs, the default fuel/engine fraction array data for the appropriate year (either the registration data year or the year ID input) are used to fill the new database table. A text format of this database table may be written as well.

RatesCalc

The RatesCalc utility calculates emissions rates in terms of rate/SHP for the evaporative emissions processes using the data in the CDB used in the MOVES emissions rates run and the MOVES default database. The utility also creates copies of the rateperdistance, rateperhour, and rateperstartemissions rate tables to include the units for each pollutant. If not specified, emissions rates are assembled for each pollutant and process combination (excluding total energy and the refueling emissions processes) in the MOVES emissions rate tables. The utility also uses the movesrun database table, along with a pollutant energy or mass lookup table (mass, TEQ, or gmole), to determine the units of the emissions rates, which are added to the emissions rate tables, which will allow the user to specify any of the units available in MOVES for the MOVES emissions rate run. The type of activity used for the emissions rate calculation is determined by the process, as Table 5 shows.

Table 5. MOVES2014a Emissions Process and Corresponding Activity for Rate-per-Activity Emissions Rates.

MOVES2014a Emissions Process	Activity	Emissions Rate Units
Running Exhaust	Miles Traveled	Rate/Mile
Crankcase Running Exhaust	Miles Traveled	Rate/Mile
Start Exhaust	Starts	Rate/Start
Crankcase Start Exhaust	Starts	Rate/Start
Extended Idle Exhaust	Extended Idle Hours	Rate/Extended Idle Hour
Crankcase Extended Idle Exhaust	Extended Idle Hours	Rate/Extended Idle Hour
Auxiliary Power Exhaust	APU Hours	Rate/APU Hour
Evaporative Permeation	Miles Traveled Source Hours Parked	Rate/Mile Rate/SHP
Evaporative Fuel Vapor Venting	Miles Traveled Source Hours Parked	Rate/Mile Rate/SHP
Evaporative Fuel Leaks	Miles Traveled Source Hours Parked	Rate/Mile Rate/SHP
Brake Wear	Miles Traveled	Rate/Mile
Tire Wear	Miles Traveled	Rate/Mile

For the rateperdistance (rate/mile emissions rates) emissions rate table, the utility creates a copy of the emissions rates in the specified output database with the table name ttirateperdistance. If specific pollutants are specified, only the emissions rates for those pollutants are copied to the ttirateperdistance table. Otherwise, the entire rateperdistance table is copied to the ttirateperdistance table. The utility also adds a "Units_Per_Activity" field to the ttirateperdistance table and fills that field based on the pollutants energy or mass designation (mass, TEQ, or gmole). For those pollutants designated as mass, the mass units from the movesrun table are added to the "Units_Per_Activity" field. For those pollutants designated as gmole, the mass units from the movesrun table, along with the text "-mole" (i.e., pound-mole or gram-mole) are added to the "Units_Per_Activity" field. For those pollutants designated as TEQ, the text "TEQ" is added to the "Units_Per_Activity" field. No unit conversions are performed in this utility. The rateperstart and rateperhour, emissions rate tables are processed in a similar manner to produce the ttirateperstart and ttirateperhour, emissions rate tables.

For the evaporative emissions rates, the utility uses the CDB from the MOVES run and the MOVES default database to replicate the MOVES vehicle population and SHP calculation process. Using the emissions rates from the rateperprofile and ratepervehicle emissions rate tables, the utility calculates the rate-per-SHP emissions rates by multiplying the emissions rate by the appropriate vehicle population and dividing by the appropriate SHP value. These rate-

per-SHP emissions rates are then saved in the ttiratepershp emissions rate table. Similar to the previous RatesCalc emissions rate tables, the "Units_Per_Activity" field is added to the ttiratepershp table and filled based on the pollutants energy or mass designation.

RatesAdj

The RatesAdj utility applies emissions rate adjustments to an emissions rate database table produced by RatesCalc utility (ttirateperdistance, ttirateperstart, ttirateperhour, or ttiratepershp) or by this utility to produce a new emissions rate database table in the same format as the input emissions rate database table. The emissions rate adjustments can be linear adjustments that are applied to all emissions rates or can be applied by SUT, fuel type, pollutant, and process (adjustments may also include roadway type, average speed bin, and hour). The user has the option of selecting which pollutants will be in the new emissions rate database table, along with the output units of the emissions rates. This allows the user to perform any unit conversions between mass units (i.e., pounds to grams or pound-mole to gram-mole) without providing any addition adjustment factors. Unit conversions between unit types (i.e., gram-moles to grams or TEQ to grams) are not performed internally by the utility. These types of conversions must be made using the emissions rate adjustment factors. The utility also has the option for combining multiple emissions rate database tables into one new emissions rate database table, if the input emissions rate database tables are in the same format.

For the first input emissions rate database table, the utility extracts the emissions rates for the specified pollutants (or all the pollutants if not specified) from the input database emissions rate table, applies the emissions rate adjustments (if necessary) and any unit conversion adjustments, and saves these adjusted emissions rates. If more than one emissions rate database table is input, then the utility performs a similar calculation process to the first input emissions rate database table for each input emissions rate database table. If pollutants are found in more than one input emissions rate database table, the adjusted emissions rates are summed to produce one emissions rate.

After processing all of the input emissions rate database tables, the utility creates a new emissions rate database table in the same format as the first input emissions rate database table and writes the adjusted emissions rates to this new emissions rate database table. Using MySQL code, the utility also creates a minimum and maximum emissions rate summary for each input emissions rate table and the output emissions rate table by pollutant, process, and source type/fuel type, which is written to a tab-delimited file specified by the user.

EmsCalc

The EmsCalc utility estimates the hourly link emissions for one user-specified county using the emissions factors (either from RatesCalc or RatesAdj), the 24-hour or time period VMT mix, the hourly link VMT and speeds activity estimates (either from TRANSVMT or VirtualLinkVMT), and the off-network activity (SHP, starts, and SHI). This utility produces a tab-delimited output summary (including hourly and 24-hour totals) and hourly link emissions output files (optional). The primary inputs to EmsCalcare:

- Emissions factors from RatesCalc or RatesAdj;

- Link-based hourly VMT and speeds developed with the TRANSVMT or VirtualLinkVMT utility. For each link, the following information is input to EmsCalc: link start node, link end node, link county number, link roadway type number, link area type number, link VMT, and link operational speed estimate;
- 24-hour or time period VMT mix by roadway type, MOVES SUT, and MOVES fuel type;
- Off-network activity (SHP, starts, SHI, and APU hours) by hour and SUT/fuel type;
- VMT roadway type designations, which lists associations of the link roadway types/area type combination to the VMT mix, emissions rate, and MOVES roadway types;
- Pollutants input file, which specifies which pollutant/process combinations for which the emissions calculations will be performed and their respective units in the tab-delimited output;
- SCC input file (optional, only if the activity and emissions by SCC are to be created); and
- SCC pollutants input file (optional, only if the activity and emissions by SCC are to be created).

The emissions estimation can be categorized by two basic types based on the type of emissions factors: the roadway-based emissions and the off-network-based emissions. For the roadway-based emissions (ttirateperdistance emissions factors), the VMT for each link is distributed to each of the SUT/fuel type combinations listed in the VMT mix by roadway type (as designated in the VMT roadway type designations). If the time period VMT mix is input, each hour is assigned a time period by the user. Otherwise, the 24-hour VMT mix is used for all hours. For each pollutant/process combination in the pollutants input file, the emissions factors are selected based on the emissions rate roadway type (as designated in the VMT roadway type designations) and the link speed for each SUT/fuel type combinations listed in the VMT mix. For link speeds greater than 75 mph, the emissions factors for 75 mph are used. For link speeds less than 2.5 mph, the emissions factors for 2.5 mph are used. For those link speeds that fall between the 16 MOVES speeds, the emissions factors are interpolated using the emissions factor interpolation methodology in the following section. These SUT/fuel type combination-specific emissions factors are multiplied by the SUT/fuel type combination-specific VMT to estimate the mobile source emissions for that link by SUT/fuel type combination. If the activity and emissions by SCC are to be created, the activity and emissions are also aggregated by SCC using the SCC input file and by SCC pollutant using the SCC pollutants input file (thus allowing the user the option to combine multiple MOVES pollutants into one more aggregate pollutant).

For the off-network emissions , the ttirateperstart, ttirateperhour, and ttiratepershp emissions rates(by SUT/fuel type) are multiplied by the appropriate activity, which is determined by the emissions process (see Table 5). If the activity and emissions by SCC are to be created, the activity and emissions are also aggregated by SCC using the SCC input file and by SCC pollutant using the SCC pollutants input file (thus allowing the user the option to combine multiple MOVES pollutants into one more aggregate pollutant).

The emissions estimates are output in a tab-delimited file (including all of the SUT/fuel type combinations listed in the VMT mix on a single line, separated by a tab character) for the

specified county by pollutant, link roadway type, and SUT/fuel type combination for each of the specified episode time periods. A 24-hour (or total if all 24 hours are not specified) output is also included in the tab-delimited file. Only those pollutant/process combinations in the pollutants input file with tab-delimited output units other than "NONE" will appear in the tab-delimited output file. Prior to output, any unit conversions between mass units (i.e., pounds to grams or pound-mole to gram-mole) are performed by the utility. Unit conversions between unit types (i.e., gram-moles to grams or TEQ to grams) are not performed internally by the utility (these type of unit conversions must be done using the RatesAdj utility). This tab-delimited file also includes hourly and 24-hour summaries of the off-network activity and VMT, VHT, and speed by link road type. Link emissions may also be output by county, pollutant, process, and each SUT/fuel type combination. If specified, the tab-delimited activity and emissions by SCC output file is also created, which lists the activity and emissions for each SCC pollutant by SCC.

Emissions Factor Interpolation Methodology

To calculate emissions factors for link speeds that fall between two of the 16 MOVES speed bin speeds, an interpolation methodology similar to the methodology used with MOBILE6 is used. This methodology interpolates each emissions factor using a factor developed from the inverse link speed and the inverse high and low bounding speed bin speeds. The following is an example for a link speed of 41.2 mph.

The interpolated emissions factor (EF_{Interp}) is expressed as:

$$EF_{Interp} = EF_{LowSpeed} - FAC_{Interp} \text{ H } (EF_{LowSpeed} - EF_{HighSpeed})$$

Where:

$EF_{LowSpeed}$ = emissions factor (EF) corresponding to the speed below the link speed;

$EF_{HighSpeed}$ = EF corresponding to the speed above the link speed; and

$$FAC_{Interp} = \left(\frac{1}{Speed_{link}} - \frac{1}{Speed_{low}} \right) \Big/ \left(\frac{1}{Speed_{high}} - \frac{1}{Speed_{low}} \right)$$

Given that:

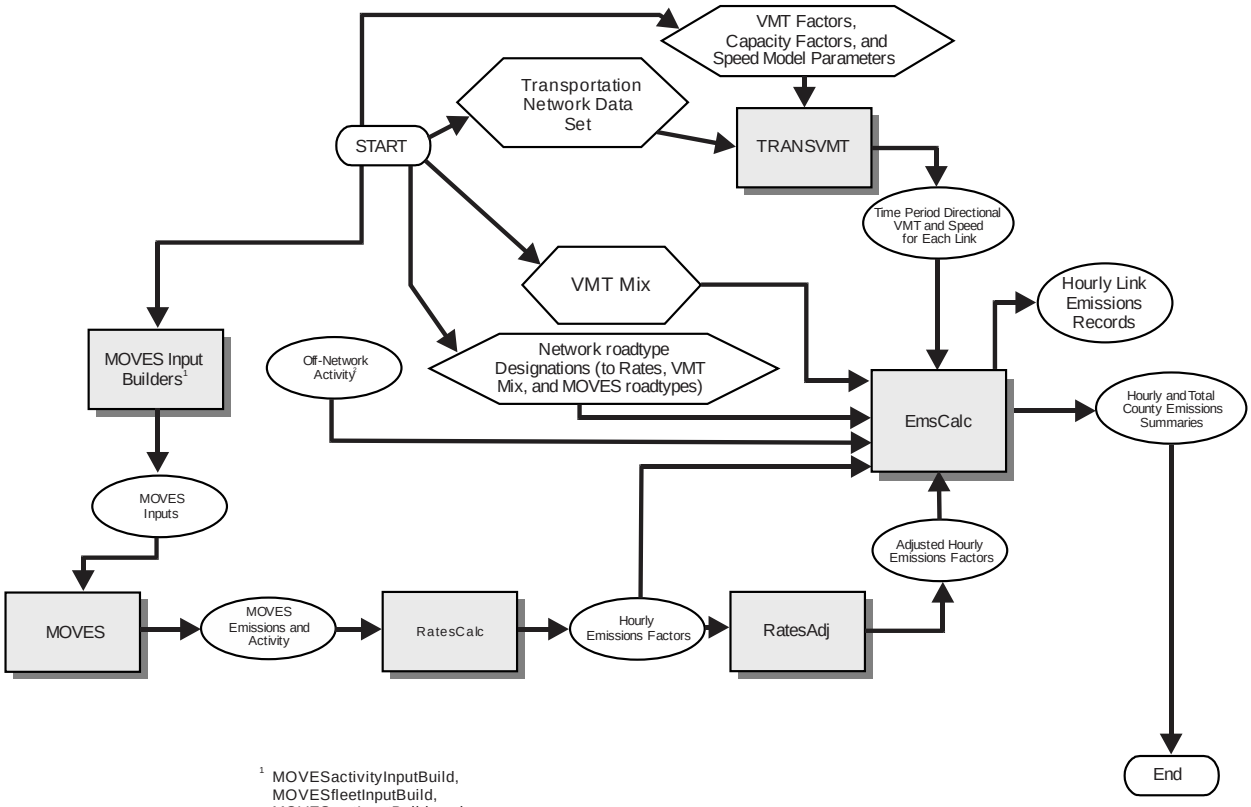
$EF_{LowSpeed}$ = 0.7413 g/mi;
$EF_{HighSpeed}$ = 0.7274 g/mi;
$Speed_{lnk}$ = 41.2 mph;
$Speed_{low}$ = 40 mph; and
$Speed_{high}$ = 45 mph.

$$FAC_{Interp} = \left(\frac{1}{41.2mph} - \frac{1}{40mph} \right) \Big/ \left(\frac{1}{45mph} - \frac{1}{40mph} \right) = \frac{-0.00073}{-0.00278} = 0.26214;$$

EF_{Interp} = 0.7413 g/mi - (0.26214) H (0.7413 g/mi - 0.7274 g/mi);

= 0.7377 g/mi.

Travel Demand Model Network Link-Based Hourly MOVES Emissions Estimates



[1] MOVESactivityInputBuild, MOVESfleetInputBuild, MOVESmetInputBuild, and VehPopulationBuild.

[2] VehPopulationBuild, and OffNetActCalc.

Developing MOVES Source Use Types and VMT Mix for Conformity Analysis

Sponsored by the
Texas Department of Transportation
August 2016

DEVELOPING MOVES SOURCE USE TYPES AND VMT MIX FOR CONFORMITY ANALYSIS

Prepared for the
Texas Department of Transportation
Transportation Planning and Programming Division

Prepared by the
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INTRODUCTION

Vehicle miles traveled (VMT) mix is a major input to the U.S. Environmental Protection Agency's (EPA) Motor Vehicle Emission Simulator (MOVES) model link-based emissions estimation process. MOVES categorized the fleet based on nine different fuel types and 13 different source use types (SUTs). VMT mix is an estimat of the fraction of on-road fleet VMT attributable to each SUT by fuel type, and is used to subdivide the total VMT estimates on each link into VMT by vehicle type. Hourly estimates by vehicle type are combined with the appropriate emissions factors in the link-emissions process.

On-road mobile emissions are dependent on the VMT assigned to each vehicle category. The VMT mix is used to distribute link VMT values to each vehicle category. Since the VMT mix can vary by time-of-day (and thus have an effect on the emissions totals), the Texas A&M Transportation Institute (TTI) VMT mix procedure allows the option to develop VMT mix by time period. Time period VMT mix (by MOVES roadway type and vehicle type) consists of four time periods: morning rush hour (AM peak), mid-day, evening rush hour (PM peak), and overnight.

The Texas A&M Transportation Institute (TTI) originally developed a method for converting vehicle classification count data collected in the Federal Highway Administration (FHWA) vehicle classification categories (based on axle spacing and/or vehicle length) into the eight Mobile Source Emission Factor Model (MOBILE5) categories. This methodology was subsequently modified and expanded to include the 28 vehicle classification types contained in MOBILE6. An analogous approach to adapting these data for use with MOVES was developed in concept by TTI (Perkinson, 2008) and implemented shortly thereafter (Perkinson, 2009). This is an overview of that procedure as currently implemented.

BACKGROUND

VMT mix estimation is predicated upon the Texas Department of Transportation (TxDOT) collected FHWA axle-based classification counts and Texas Department of Motor Vehicle

(TxDMV) registration data extracts. The collection and use of these data is well established and fully documented elsewhere (Perkinson, 2003).

TxDOT classification counts separate vehicles into the standard FHWA/Highway Performance Monitoring System (HPMS) vehicle classifications (based on vehicle length/number of axles) using best practice vehicle classification count methods:

- C - Passenger vehicles;
- P - Two-axle, four-tire single-unit trucks;
- B - Buses;
- SU2 - Six-tire, two-axle single-unit vehicles;
- SU3 - Three-axle single-unit vehicles;
- SU4 - Four or more axle single-unit vehicles;
- SE4 - Three or four axle single-trailer vehicles;
- SE5 - Five-axle single-trailer vehicles;
- SE6 - Six or more axle single-trailer vehicles;
- SD5 - Five or less axle multi-trailer vehicles;
- SD6 - Six-axle multi-trailer vehicles; and
- SD7 - Seven or more axle multi-trailer vehicles.

VMT mix is estimated using the latest available multi-year TxDOT vehicle classification count data from the study area, and analysis-year-specific year-end Texas DMV county registration data. Registration data are used to separate vehicle categories by fuel type, supplemented with national defaults, consistent with the analysis year, as appropriate. No seasonal changes are assumed.

The primary concern for emissions estimation is not the actual vehicle counts, but the proportions of vehicle types by area and roadway functional classifications. For estimating VMT mix, it is critical that the data represent the various roadway functional classifications in a given area. TTI believes that this requirement is met in general by the TxDOT data. However, TTI has recognized the value of additional data, in terms of more days, different days, and more stations

(locations). As a result, TTI continues to work with TxDOT to develop a program for including additional days and stations in TxDOT's on-going vehicle classification data collection program.

Additionally, TTI realizes that many urban areas have a very refined roadway functional classification typology in their travel demand models (TDMs), well beyond those contained in the vehicle classification data. TTI's response is the aggregation of the TxDOT vehicle classification data into a robust configuration that fits the needs of all applications, consistent with the limitations of the data itself (primarily sample size/cell size). For example, TTI aggregates multiple years of classification count data into functional classification groups, and combines adjacent counties into regional estimates (based on TxDOT districts). Twenty-four hour and time period aggregations are also provided.

MOVES OVERVIEW

The current version of MOVES (MOVES2014a) is the latest step toward MOVES' goal of building upon the capability of previous modeling tools (i.e., MOBILE and the NONROAD Emission Inventory model) to replace them with a single, comprehensive modeling system to address mobile source emissions analysis requirements. NONROAD is now included in the current version of MOVES.

MOVES can be used to estimate national inventories and projections at the county-level for energy consumption (total, petroleum-based and fossil-based), carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4) from highway vehicles, as well as criteria pollutants oxides of nitrogen (NO_x), volatile organic compounds (VOC), and carbon monoxide (CO). MOVES can include life cycle (i.e., well-to-pump) effects in estimating energy consumption and emissions.

VMT MIX IN MOVES

With MOVES, "fleet" and "activity" data are critical elements of the emissions estimation process. MOVES can estimate energy consumption and CH_4 and N_2O emissions for all on-road sources from calendar years 1999 through 2050, for each county in the U.S. Fleet data refers to information characterizing the vehicle fleet such as population estimates, age distributions, survival rates, sales growth rates, and distribution across "source bins" used to estimate energy

and emissions. Activity data refers to information characterizing how the fleet operates, such as VMT, VMT growth, average speed distributions, and driving patterns.

The default database year for MOVES is 1999, so most of the default data is anchored to this year, including sales and VMT growth rates, which allow projections through 2050. In addition, all of the fleet and activity data are, in theory, available in a series of data tables in the MOVES default database, though TTI uses local data wherever possible.

MOVES is designed to support multi-scale analysis, as well as to reconcile fundamental differences between how activity data are collected and characterized, and how emissions data are collected and characterized. With regard to multi-scale analysis, MOVES uses a "modal" approach to estimating energy and emissions based on discrete vehicle power bins, and characterizes energy rates on a time basis (e.g., grams per hour) instead of the traditional mile basis (e.g., grams per mile). This approach requires the assignment of activity data into modal bins, and for conversions of mile-based activity data (VMT) to time-based activity data (e.g., source hours operating, or SHO).

With regard to reconciling differences between activity and emissions data, a long-standing challenge in generating on-road mobile source emissions inventories is the disconnect between how vehicle activity data sources characterize vehicles and how emissions or fuel economy regulations characterize vehicles. An example of this is how vehicles are characterized by the HPMS – by a combination of the number of tires and axles – as opposed to the U.S. Environmental Protection Agency's (EPA) weight-based classifications.

Reconciling activity and emissions data generally requires "mapping" between the two categories. MOVES performs this mapping internally, so that the casual MOVES user will not have to deal with external mapping. This internal mapping, however, introduces some complexity in the category definitions. Vehicles are characterized both according to activity patterns and energy/emissions performance. Thus, the model uses data for both the activity and energy/emissions methods of characterization. On the activity side, vehicles are grouped into "source use types," or use types, defined as groups expected to have unique activity patterns.

Because HPMS data are a fundamental source of activity, the MOVES source use types are defined as subsets of HPMS vehicles classifications. The majority of MOVES-related activity data are based on these classifications.

To characterize factors important for energy consumption and emissions, MOVES uses the concept of "Source Bins." Unique source bins are defined by those characteristics with the largest influence on fuel (energy) consumption and emissions. Source bins are defined completely separate from use types, but are mapped to source use types internal to MOVES by the Source Bin Distribution Generator. Table 1 provides a summary of the MOVES Fuel Types. Table 2 shows the MOVES Source Use Types.

Table 1. MOVES Fuel Type Definitions.

Code	Fuel Type
1	Gasoline
2	Diesel
3	Compressed Natural Gas (CNG)
4	Liquid Propane Gas (LPG)
5	Ethanol (E85 or E95)
6	Methanol (M85 or M95)
7	Gaseous Hydrogen
8	Liquid Hydrogen
9	Electricity

Table 2. MOVES Source Use Type Definitions.

HPMS Class	MOVES Source Use Type	Description
Passenger Cars	21 Passenger Car	All
Other 2 Axle / 4 Tire Vehicles	31 Passenger Truck	Mini-van, pick-up, etc., used primarily for personal transportation.
	32 Light Commercial Truck	Mini-van, pick-up, etc., used primarily for commercial applications. Different annual mileage and hours of operation.
Single Unit Trucks	51 Refuse Truck	Garbage and recycling trucks. Different schedule, roadway, and hours of operation.
	52 Single-Unit Short-Haul	Single-unit trucks with the majority of operation within 200 miles of home base.
	53 Single-Unit Long-Haul	Single-unit trucks with the majority of operation outside of 200 miles of home base.
	54 Motor Home	All
Buses	41 Intercity Bus	City-to-city buses. Not transit or school buses.
	42 Transit Bus	Buses used for public transit.
	43 School Bus	School and church buses.
Combination Trucks	61 Combination Short-Haul	Combination trucks with the majority of operation within 200 miles of home base.
	62 Combination Long-Haul	Combination trucks with the majority of operation outside of 200 miles of home base.
Motorcycles	11 Motorcycle	All

While it is possible to map out approximate equivalents between the old MOBILE VMT mix and MOVES source use types, such a conversion is not an effective or efficient application of the available data. Instead, TTI uses the original HPMS categories contained in the TxDOT classification counts. (Road type is an exception, as discussed in the following.)

TTI's objective is, to the extent possible, to define MOVES source use type parameters that are unique to regional conditions. There are activity parameters and fuel type parameters. Table 3 and Table 4 show a summary of the activity and fuel type parameters, followed by Table 5 that presents a summary of the road type equivalents.

Table 3. Summary of Critical MOVES Source Use Type Activity Parameters.

MOVES Activity Parameter	Method
Passenger Truck versus Light Commercial	MOVES Default
Single-Unit Short-Haul versus Long-Haul	Registration versus Observed
Refuse Truck and Motor Home	MOVES Default within Observed
Combination Short-Haul versus Long-Haul	Registration versus Observed
Motorcycles	Nominal

Table 4. Summary of Critical MOVES Source Use Type Fuel Parameters.

MOVES Fuel Parameter	Method
Passenger Vehicle and Light-Duty Truck	Registration and MOVES Default
Single-Unit and Combination Truck	Registration
Refuse Truck, Motor Home, and Bus	MOVES Default

Table 5. Summary of MOVES Road Type Equivalents.

MOVES Road Type	HPMS Roadway Functional Classification
1 Off Network	9 – Rural Local 19 – Urban Local
2 Rural Restricted Access	1 – Rural Interstate
3 Rural Unrestricted Access	2 – Rural Principal Arterial (Other) 6 – Rural Minor Arterial 7 – Rural Major Collector 8 – Rural Minor Collector
4 Urban Restricted Access	11 – Urban Principal Arterial (Interstate)
5 Urban Unrestricted Access	12 – Urban Principal Arterial (Other Freeway) 14 – Urban Principal Arterial (Other) 16 – Urban Minor Arterial 17 – Urban Collector

DISCUSSION

Latest available Texas registration data from the TxDMV provide the basis for assessing the short-haul versus long-haul aspects of fleet activity, as well as fuel. For short-haul versus long-haul, the proportion of VMT attributable to a category of vehicles registered in a given area (e.g., TxDOT district) is compared with the proportion of vehicles in that category observed (i.e., reflected in the classification counts). The locally-registered VMT is assumed to approximate short-haul activity, while the remainder is assumed to approximate long-haul activity (i.e., from outside the area). This calculation is performed for the two sub-fleets of interest (single units and combination trucks). Validation was achieved by comparing the Texas statewide allocations with the MOVES defaults (Perkinson, 2008).

For these vehicle categories (i.e., those that distinguish between short and long haul), fuel type is taken directly from the DMV registration data by TxDOT district and applied directly. However, for the passenger vehicle group (passenger vehicles and passenger trucks), a combination of model year distribution for DMV registration data and MOVES fuel fraction by model year is used, creating a Texas area-specific application of national passenger vehicle fuel type. No explicit validation is possible or necessary, since this is a direct application of MOVES default values by model year.

Future fleet age distribution is not available (the latest age distribution is carried forward, consistent with EPA guidance), however, future fuel fractions are. These are applied to reflect the analysis year. At this time, only gasoline and diesel fuels are included. Others are implicitly treated as *de minimus*. However, the procedure has the ability to incorporate additional fuel types (using either national defaults or local data), once a significant number of alternatively fueled vehicles enter the fleet. This includes the various configurations of electric power train vehicles.

The remaining vehicle categories either have no currently available regional data, or are negligible in magnitude. Refuse trucks and motor homes are included as separate vehicle categories in MOVES, along with a distinction between passenger trucks and light commercial vehicles. The former two categories, refuse trucks and motor homes, have limited local data and are only loosely related to the area of registration. The latter two categories, passenger trucks and

light commercial vehicles, are usage based and have no direct analog in the regional data (DMV registration data). Consequently, MOVES national defaults are used for both groups. Refuse trucks and motor homes are taken from the combined single unit truck category. Passenger trucks and light commercial trucks are allocated based on national defaults taken from the combined DMV defined light truck category. Motorcycles are allocated a nominal value taken from passenger vehicles.

Finally, road type is re-defined under MOVES. Fortunately, these map directly to the current roadway functional classifications used for the classification count data. No further manipulation is necessary, beyond the simple re-definition shown in Table 5.

These measures and procedures provide a functional, region-specific, disaggregate link-level application of MOVES as currently configured. Figure 1 shows a simplified process flow chart. Figure 2 shows the FHWA vehicle categories used for the classification counts.

Basic Process Flow Outline

1. MOVES – Data files of MOVES default values extracted from MOVES databases or pro forma runs.

2. TxDOT Classification Counts – Data files of standard TxDOT classification data assembled and used for determining the in-use road fleet mix.

3. TxDMV Registration Data – Data files of standard TxDMV vehicle registration summary data assembled and used for determining the in-use road fleet mix.

4. TxDOT Automatic Traffic Recorder (ATR) Data – Data files of TxDOT ATR data assembled and used to allocate VMT by season and day of week.

5. Single Unit Local vs Total SUT_HDVyy – Procedure based on registration data to generate factors to separate Single Unit versus Combined Unit trucks by region. (SUT_HDVyy has multiple outputs based on vehicle category and fuel.)

6. Combination Local vs Total SUT_HDXyy – Procedure based on registration data to generate short-haul and long-haul combination truck proportions by region.

7. Day of Week (DOW) Factors by Urban Area / TxDOT District – Seasonal day-of-week factors from TxDOT ATR data used to allocate VMT by season and day-of-week by urban area/TxDOT District.

8. Single Unit Short vs Long Haul SUT_SSHZ – Procedure to separate single unit short haul versus single unit long haul using factors generated at SUT_HDVyy and classification count data. Short and long haul are functionally defined as local and pass through.

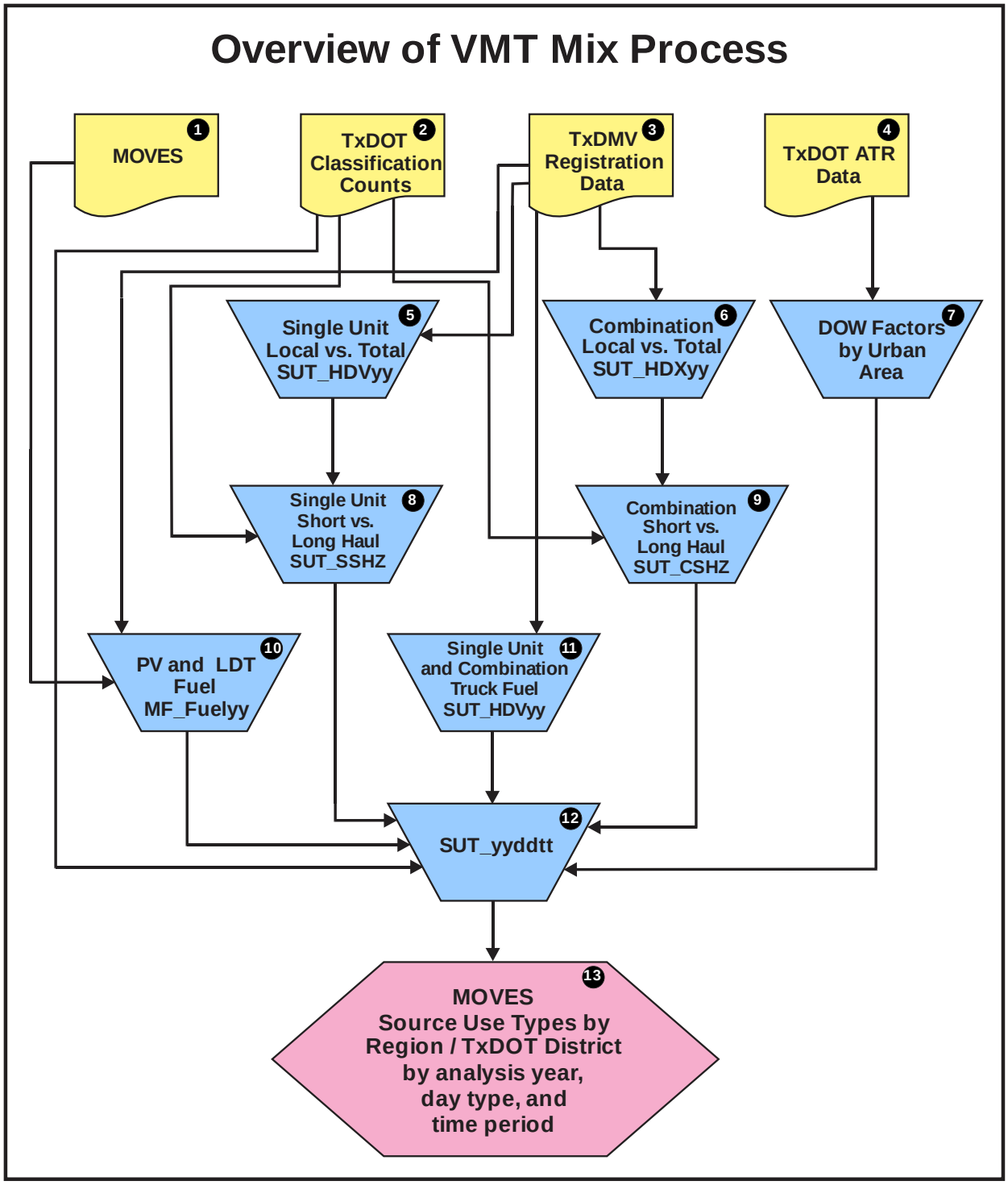
9. Combination Short vs Long Haul SUT_CSHZ – Procedure to separate combined short haul versus combined long haul using factors generated at SUT_HDXyy and classification count data. Short and long haul are functionally defined as local and pass through.

10. PV and LDT Fuel MF_Fuelyy – Procedure to generate passenger vehicle and light truck fuel allocation by year based on MOVES national default values and local registration data.

11. Single Unit and Combination Truck Fuel SUT_HDVyy – Procedure to generate single unit and combined truck fuel allocation factors from registration data. (SUT_HDVyy has multiple outputs based on vehicle category and fuel.)

12. SUT_yyddtt – Procedure to generate Source Use Type proportions by year, day type, and time period, based on the previous steps.

13. MOVES Source Use Types – Output file of MOVES Source Use Types by region, analysis year, day type, and time period.



Source: Texas A&M Transportation Institute, October 2015.

Figure 1. Simplified Overview of the VMT Mix Process.

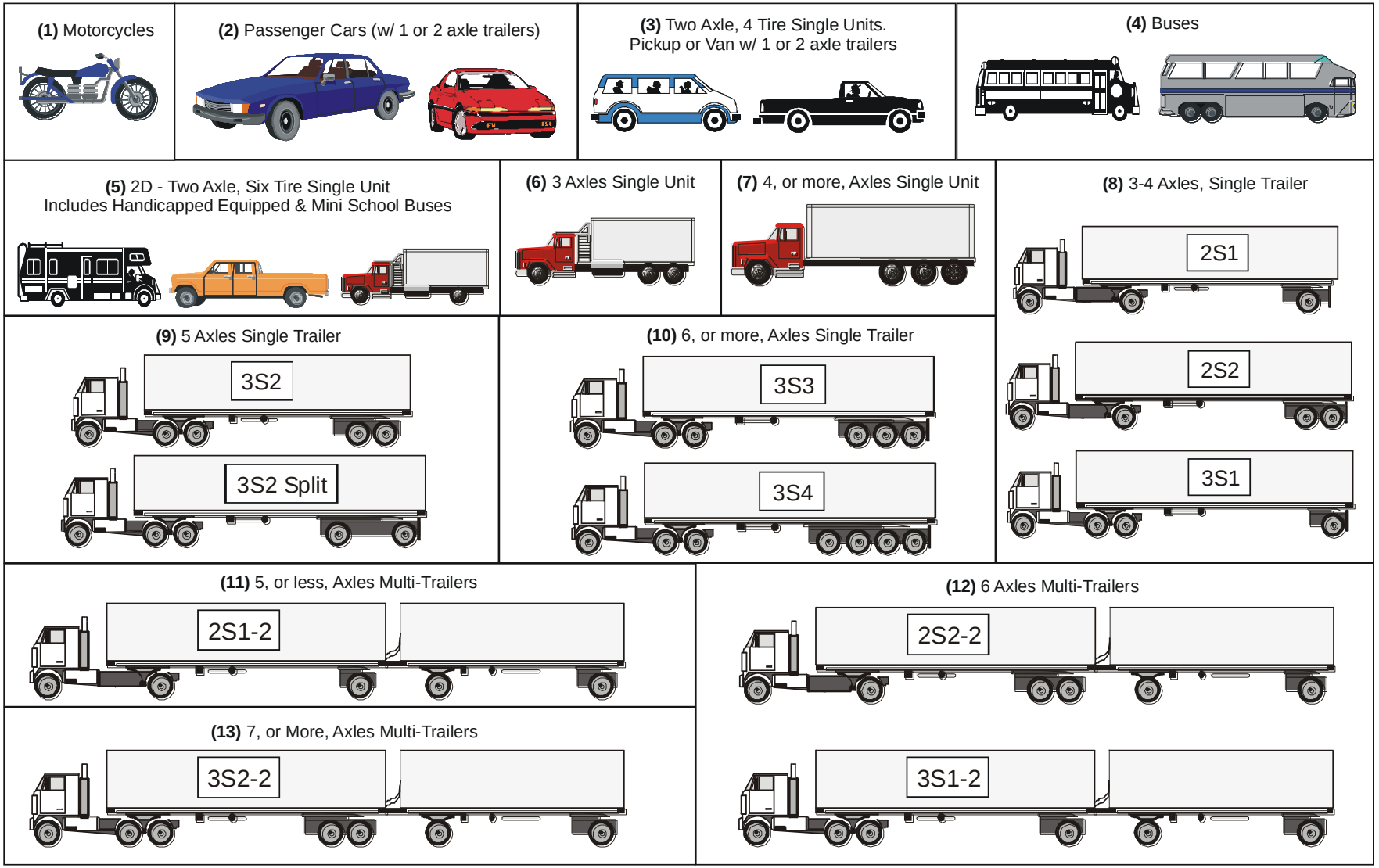


Figure 2. FHWA Vehicle Classifications.

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