2021 Transportation Conformity

Appendix 12.10

a. MOVES Information
b. MOVES Analysis Notes

a. MOVES2014b User Documents and Tools:

- MOVES2014a User Guide
  https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100NNCY.pdf

- MOVES2014 User Interface Reference Manual Appendix: MOVES2014b
  https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100V7ER.pdf

- MOVES2014, MOVES2014a, and MOVES2014b Technical Guidance: Using MOVES to Prepare Emission Inventories for State Implementation Plans and Transportation Conformity
  https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100V7EY.pdf

ANALYSIS NOTES - DEVELOPMENT OF BEXAR COUNTY SUMMER WEEKDAY EMISSIONS ESTIMATES FOR AAMPO MOBILITY 2045 MTP 2021-2024 TIP CONFORMITY DEMONSTRATION

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CC: Laura Norton, TxDOT - TPP

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SUBJECT: AAMPO Mobility 2045 Metropolitan Transportation Plan (MTP),
2021-2024 TIP – Analysis Description

INTRODUCTION

Under the sponsorship of the Texas Department of Transportation (TxDOT), the Texas A&M Transportation Institute (TTI) produced San Antonio area, on-road mobile source emissions estimates in support of the Alamo Area Metropolitan Planning Organization (AAMPO) transportation planning efforts. This analysis description is for Bexar County, the one ozone nonattainment county of the five counties in the AAMPO travel demand model (TDM). Results are representative of a typical summer weekday for the years 2017, 2025, 2035, and 2045.

This report details a reanalysis of the AAMPO TDM model following updates to transportation projects contained within the TDM. This reanalysis replaces an earlier analysis of the 2017, 2025, 2035, and 2045 TDMs which was originally undertaken and reported to TxDOT and AAMPO in December 2020. The reanalysis was triggered by updates to the 2017 and 2025 networks only. However, because the 2017 network is used as a base year for projecting hotelling activities, the TTI team reanalyzed all networks (2017, 2025, 2035 and 2045). This was necessary because changes in travel patterns in the 2017 network (due to a TDM update) influence Long-Haul Combination Truck VMT. This Long-Haul Combination Truck VMT is used to project futue hotelling activiries from the baseline winter weekday hotelling estimates reported in the Texas Commission on Environmental Quality (TCEQ) extended idling study[1]. Thus, changes in the 2017 network theoretically affect the emissions for each analysis year.

[1] https://www.tceq.texas.gov/assets/public/implementation/air/am/contracts/reports/mob/582177430806-20191201-TTI-HeavyDutyVehicleIdleActivityStudy.pdf

While the quantitative effects of these new hoteling emissions are small, the full reanalysis ensure consistency of methods and data that are the foundation of regulatory emission analysis.

TTI used its on-road inventory development methodology to produce regional emissions estimates of the detail and quality suited for state implementation planning for air quality control and transportation conformity analyses. This document provides details of the disaggregate, TDM link-based rates-per-activity emissions estimation process. The methodology produces MOVES2014b-based county emissions rate look-up tables based on local conditions for external emissions calculations performed at detailed, disaggregate, temporal, and spatial levels, using the latest planning assumptions, available data, models, and procedures.

Hourly inventories were estimated by Motor Vehicle Emission Simulator (MOVES) source use type (SUT) and fuel type (FT) combination (or vehicle type) and TDM roadway class. TDMs were post-processed to estimate hourly, directional, link (roadway segment)-level vehicle miles of travel (VMT), and operational speeds for the roadway-based emissions calculations. Using estimates of vehicle hours traveled (VHT, also termed source hours operating [SHO] in MOVES), vehicle populations, truck hotelling activity, and other data, TTI estimated hourly off-network activity factors for the parked vehicle-based emissions calculations. Off-network activity types are source-hours-parked (SHP); starts; source hours extended idling (SHXI); and auxiliary power unit (APU) hours (emissions-producing components of combination long-haul truck hotelling hours). Off-network evaporative rates (in mass/SHP form, not directly available from MOVES) were produced using a post-processing procedure and were compiled with other rates produced directly by MOVES to yield look-up tables of all rates in activity terms needed for the external emissions calculations (see Table 6, Page 13). Rates were post-processed to factor in the effects unavailable in MOVES, as appropriate (i.e., Texas Low Emissions Diesel [TxLED] effects for TxLED fuel, required in Bexar County). The analyses used TTI's MOVES-based inventory development utilities for use with MOVES2014b.[2,3] The Environmental Protection Agency's (EPA) Technical Guidance[4] is the primary reference on appropriate inputs and use of MOVES.

[2] On November 16, 2020 EPA released MOVES3, EPA's latest official version of its on-road emissions model. With its release EPA intends to establish a two-year grace period before MOVES3 is considered the latest, official emissions model for use in transportation conformity. Employing this grace period, MOVES2014b (released August 2018) is considered the latest, official release of MOVES, for transportation conformity purposes. TTI used MOVES2014b in this analysis.

[3] *TTI Emissions Inventory Estimation Utilities Using MOVES: MOVES2014aUtl User's Guide*, TTI, August 2016 (also applies to MOVES2014b).

[4] *MOVES2014, MOVES2014a, and MOVES2014b Technical Guidance: Using MOVES to Prepare Emission Inventories for Sate Implementation Plans and Transportation Conformity*, EPA, August 2018.

SUMMARY OF ANALYSIS RESULTS

Table 1 summarizes the total Bexar County VMT, average network speeds, NOx and VOC calculated for each analysis year.

Table 1 - Bexar County Summer Weekday Emissions Summary (US tons/day)

County	Year	VMT	Speed	NO_X	VOC
Bexar	2017	48,024,000	28.6	35.51	22.44
	2025	59,404,339	27.0	16.93	14.81
	2035	72,075,344	25.1	10.64	10.24
	2045	83,969,790	22.4	10.76	9.91

Detailed results are provided in the accompanying electronic data submittal. Attachment 4 list the files and contents of the electronic data submittal.

SCOPE OF EMISSION ANALYSIS

1. Methodology: Detailed, hourly, disaggregate, MOVES rates-per-activity, TDM link-based method with the most recent version of MOVES (MOVES2014b, using the grace period for on-road mobile emissions modeling for transportation conformity purposes).[5]

2. Analysis Years: Baseline year 2017; forecast years 2025, 2035, 2045.

3. Seasonal Period: Average summer weekday (June through August, Monday through Friday).

4. Geography: Bexar County.

5. Pollutants: Oxides of nitrogen (NOx) and volatile organic compounds (VOC).[6]

6. Sources: Gasoline- and diesel-powered MOVES source use types (Table 2).

Table 2. 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

[5] Under the grace period EPA is associating with MOVES3 (released November 2020), MOVES2014b (released August 2018) is considered the latest, official release of MOVES, for transportation conformity purposes. TTI used MOVES2014b in this analysis.

[6] VOC and NOx are the reported pollutants. Some other pollutants were included in MOVES runs and inventory utility output but not reported.

7. Link-Based Emissions Estimation Process Components and Utilities: Basic inventory components and the TTI utilities used for generating the estimates are outlined separately.

- Components: The emissions estimation process required development of the following major components for Bexar County for the emissions calculations:
  - Hourly, directional, link-level, on-road fleet VMT, and average speeds.
  - SUT/fuel type (i.e., vehicle type) time-of-day VMT mix.
  - Vehicle type populations; [7]
  - Hourly, vehicle type SHP.
  - Hourly, vehicle type starts.
  - Hourly, diesel combination long-haul truck hotelling (emissions generating SHXI and APU hours components); and
  - Hourly vehicle type pollutant and process mass emissions rates: mass per mile, mass per SHP, mass per start, mass per SHXI, and mass per APU hour.
- Utilities: TTI used its emissions estimation utilities to produce the input components and the emissions estimates in tab-delimited hourly and 24-hour emissions, and activity summary file formats.[8] The utilities include:
  - RatesCalc – produces and/or compiles emissions rate tables from MOVES output;
  - RatesADJ – makes adjustments to MOVES or RatesCalc emissions rates output;
  - EmsCalc – calculates hourly link emissions for a county using the estimated link VMT and speeds, VMT mixes, off-network activity, and emissions factors from MOVES, RatesCalc, or RatesAdj;
  - TransVMT – estimates the fleet VMT and operational speeds for use in air quality analyses (input to EmsCalc), based on TDM data sets;
  - VMTmixBuild – formats vehicle type VMT mix input to EmsCalc;
  - OffNetActCalc – calculates SHP, SHXI, APU 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 AAMPO Mobility 2045 MTP TDM data sets on the following dates:

- Analysis years 2035, 2045: November 2020.
- Analysis years 2017, 2025: July 2021.

Each TDM data set (per analysis year) contained trip matrices and four-time-period, directional, average non-summer weekday traffic [ANSWT] assignments used in the link-based emission inventory methods.

[7] Vehicle populations are an intermediate parameter used to calculate estimates of the off-network vehicle source hours parked and starts activity.

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

TTI post-processed the data sets to determine average summer weekday, county-coded, hourly, directional, Highway Performance Monitoring System (HPMS)-consistent, network link VMT and volumes, and added intrazonal link VMT estimates (TDM network ANSWT VMT plus intrazonal ANSWT VMT is referred to herein as "total model VMT"). Method details are found in *MOVES2014a-Based Travel Demand Model Link Emissions Estimation Method* (TTI, August 2016)[9].

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 summer weekday activity, to allocate by hour, and to allocate total link volumes by direction of travel. The summer weekday and hourly distribution factors were developed using the latest available 10-year, aggregate TxDOT, San Antonio District, Automatic Traffic Recorder (ATR) traffic count data (2010 – 2019).

a. 2017 Historical Year HPMS Consistency and Summer Weekday Adjustments:

HPMS consistency: The 2017 historical year total model VMT was adjusted to summer weekday VMT using county-level VMT control totals. The VMT control total is county total, annual average daily traffic (AADT) HPMS VMT (from TxDOT's 2017 Roadway Inventory Annual Report), adjusted to the summer weekday form using the seasonal adjustment. County control total VMT divided by county total model VMT produces the adjustment applied by county, to total model VMT at the link level. See Table 8 in Attachment 1, Page 16.

Seasonal adjustment: The seasonal (summer) weekday factor for converting county AADT HPMS VMT to county, summer weekday VMT control totals was calculated as the ratio average summer weekday-to-AADT ATR counts. See Table 9 in Attachment 1, Page 16.

b. 2025, 2035, 2045 Forecast Years HPMS Consistency and Summer Weekday Adjustments:

HPMS consistency: TTI applied an HPMS adjustment factor to total model link-level VMT for each year. The validation year HPMS adjustment factor was calculated as 2015 HPMS VMT (first adjusted to ANSWT form using the ANSWT/AADT ATR count ratio [based on aggregate 2015 ATR data from the five TDM counties]) divided by 2015 validation year total model VMT.[10] See Table 8 in Attachment 1, Page 16.

Seasonal adjustment: A county-level seasonal (summer) weekday factor was produced and used with the 2025, 2035, and 2045 analysis years. This factor was calculated as the ratio of the summer weekday-to-ANSWT counts. See Table 9 in Attachment 1, Page 16.

c. Summer Weekday Hourly VMT Distribution:

County level, summer 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 10 in Attachment 1, Page 17.

[9] Note that although this document refers to the MOVES2014a version of MOVES (the latest at the time of its writing) it applies equally for MOVES2014b. The TTI TDM link-based emissions analysis methods are the same between both the "a" and "b" versions of MOVES2014.

[10] Calculated with the five-county region VMT totals (HPMS and total model).

d. Directional Factors:

Directional split factors were applied to total link volumes by functional class and area type. These directional split factors, carried forward from the prior analysis, were created by aggregating TDM link-level volumes by direction for each functional class/area type. Link-level directional volumes were divided by total volumes for each functional class/area type to estimate the direction split. This process was used for each TDM analysis year and time period.

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: The VMT mix designates the vehicle categories included in the analysis and specifies the fraction of on-road fleet VMT attributable to each vehicle type.

- Method: VMT mixes were estimated using TTI's VMT mix method.[11] The method sets Texas vehicle registration category aggregations for MOVES SUT categories for developing the VMT mixes, as well as for developing other fleet parameters needed elsewhere in the process (e.g., SUT age distributions, vehicle population estimates).
- Temporal and spatial aspects: The VMT mixes are produced in five-year increments and are applied to analysis years as follows:
    - 2015 VMT mix – 2013 through 2017 analysis years.
    - 2020 VMT mix – 2018 through 2022 analysis years.
    - 2025 VMT mix – 2023 through 2027 analysis years, and so on.

  No seasonal adjustments are made for the VMT mix. Average weekday vehicle type VMT mixes by MOVES road type and by four time-of-day periods (AM Peak, Mid-Day, PM Peak, Overnight) were estimated for the TxDOT San Antonio District for use with all TDM counties, Bexar, specifically in this analysis.[12]
- Data sources: TTI used the latest available multi-year TxDOT San Antonio District vehicle classification counts (2009-2018) and associated Texas Department of Motor Vehicles (TxDMV) year-

[11] *Developing MOVES Source Use Types and VMT Mix for Conformity Analysis* (TxDOT Air Quality / Conformity IAC-A - TTI Task 409252-0643: Maintain, Update and Enhance Traffic Activity Estimation and Forecasting Methods), Texas Department of Transportation, Austin, TX, August 2016.

[12] Using the same data sets and a similar procedure, aggregate (i.e., 24-hour, all road-types) TxDOT district-level weekday vehicle type VMT mixes were also produced for use in the vehicle population estimation, discussed in item 12.

end registration data (2018), along with MOVES default data, as needed (i.e., appropriate for each analysis year).[13]

- Vehicle types: TTI estimates the VMT mix for 13 MOVES emission rate model SUTs by the predominant fuel types, gasoline, and diesel. The vehicle types in the VMT mix are the 22 gasoline and diesel MOVES SUT combinations (and their associated acronyms) shown in Table 3.

Table 3. Vehicle Types Delineated in Local VMT Mix.

Source Use Type	Gasoline	Diesel
Motorcycle	MC_G	-
Passenger Car	PC_G	PC_D
Passenger Truck	PT_G	PT_D
Light Commercial Truck	LCT_G	LCT_D
Intercity Bus	-	IBus_D
Transit Bus	-	TBus_D
School Bus	SBus_G	SBus_D
Refuse Truck	RT_G	RT_D
Single Unit Short-Haul Truck	SUShT_G	SUShT_D
Single Unit Long-Haul Truck	SULhT_G	SULhT_D
Motor Home	MH_G	MH_D
Combination Short-Haul Truck	CShT_G	CShT_D
Combination Long-Haul Truck	-	CLhT_D

OFF-NETWORK ACTIVITY

To estimate the off-network emissions, county-level, hourly estimates of the SHP and starts activity were required for each vehicle type. Hourly SHXI and APU hours estimates were needed for combination long-haul trucks. For estimation of the SHP and vehicle starts, vehicle population estimates were also needed.

12. Vehicle Population Estimates: The vehicle population estimates by county were based on TxDMV county registration data (latest available end-of-year [2018]), vehicle population factors derived from the VMT mix, and county-level VMT-based growth estimates for future years where actual registration data were not yet available.[14]

[13] TTI updated the VMT mix analysis for the State of Texas early in FY2020 using latest available data, within the standard method framework (TTI, August 2016).

[14] Since the latest available TxDMV registrations data was 2018 data, vehicle population estimation for each future analysis year (2025, 2035, and 2045) required growth factors.

a. Historical Analysis Year Vehicle Population Estimates (not used)[15]:

TxDMV registration data: Historical analysis year vehicle population estimates are based on TxDMV registration data corresponding to the historical analysis year. This registration data is aggregated into vehicle registration categories (see Table 4).

Table 4. TxDMV Vehicle Registration Aggregations and Associated Vehicle Types for Estimating Vehicle Populations.

Vehicle Registration[1] Aggregation	Associated Vehicle Type[2]
Motorcycles	MC_G
Passenger Cars (PC)	PC_G; PC_D
Trucks <= 8,500 gross vehicle weight rating (GVWR) (pounds)	PT_G; PT_D; LCT_G; LCT_D
Trucks > 8,500 and <= 19,500 GVWR	RT_G; RT_D SUShT_G; SUShT_D MH_G; MH_D IBus_D TBus_D SBus_G; SBus_D
Trucks >19,500 GVWR	CShT_G; CShT_D
NA[2]	SULhT_G; SULhT_D CLhT_D

[1] To estimate vehicle populations, TxDMV county registration data extracts were used, consisting of 1) light-duty cars, trucks, and motorcycles; 2) heavy-duty diesel trucks; and 3) heavy-duty gasoline trucks.

[2] Vehicle population factors are the 24-hour weekday VMT mix fraction for each vehicle type in a category divided by the sum of the VMT mix fractions for all vehicle types in a category, except long-haul trucks. The long-haul vehicle type populations are estimated using a long-haul-to-short-haul VMT mix ratio applied to the short-haul SUT population estimate. The acronyms for the associated vehicle types are defined in Table 3.

Vehicle population factors: Since the TxDMV registration data does not include each SUT/fuel type combination, vehicle population factors are developed using the 24-hour VMT mix for the analysis year. These factors are applied to vehicle registrations aggregated by category to split each category into each SUT/fuel type combination included in the analysis (as shown in Table 3).

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

[15] Due to a gap in available TxDMV registration data (i.e., no TxDMV 2017 registration data were available, and the nearest previous year of registration data is 2014), for vehicle population estimation purposes, the 2017 baseline year was also treated using the future year procedure (i.e., based on the latest available 2018 registrations and a negative growth scaling factor).

b. 2017 Baseline Year, and 2025, 2035, 2045 Future 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 TxDMV registration data sets (2018) were used.

Vehicle population factors: As described for the historical vehicle population estimation procedure, 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 combination included in the analysis, creating the base (2018) vehicle population estimates.

VMT-based growth estimates: For each analysis year, a VMT-based growth (or negative growth) estimate was calculated by dividing the baseline year and each analysis year, summer weekday, Bexar County VMT estimate by the associated Bexar County, 2018 summer weekday VMT estimate. The resulting growth estimates were applied to the base vehicle population estimates to scale from the base (2018) to the 2017 baseline year and to each of the future analysis year vehicle population estimates.

13. SHP: The SHP was estimated as a function of total hours (hours a vehicle exists) minus its SHO.

- The vehicle type SHP estimates were calculated for each hour of the day based on the link VMT and speeds (Items 9 and 10) to estimate SHO, the VMT mix used in the link-based emissions analysis (Item 11), and the vehicle population estimates (Item 12).
- The VMT mix was applied to the link VMT to produce VMT estimates by vehicle type. Link VMT was divided by the link speed to produce SHO estimates. SHO was aggregated across links, then subtracted from source hours (equal to vehicle population, since source hours equals the number of hours in the period multiplied by the vehicle population, and each period is one hour) resulting in SHP estimates by vehicle type.
- This is performed by county for each analysis year and hour of day.

14. Starts: Engine starts were based on the MOVES national default starts per vehicle per hour by vehicle type, and the local vehicle type vehicle population estimates.

- MOVES default weekday starts per vehicle were calculated using MOVES national scale inventory mode national default run activity output, as vehicle starts (for the MOVES weekday day type) divided by vehicle population. This was performed by hour and SUT/fuel type.
- The local vehicle starts activity estimates were calculated as the product of national default starts/vehicle and the local vehicle type population estimates.
- The weekday vehicle starts estimates for each vehicle type are calculated by county for each analysis year and hour of day.

15. SHXI and APU Hours as a Function of Hotelling Hours: During hotelling, the truck's main engine is assumed to be in idling mode or its diesel auxiliary power unit is in use, or it is using electric power or no power. For each activity scenario, hotelling hours were first estimated followed by the hours attributed to the two emissions-producing hotelling components, SHXI and diesel APU hours.

- County, analysis year, summer weekday hotelling hours were first estimated using: 24-hour weekday hotelling hour estimates for a 2017 base year (estimates from recent TCEQ extended idling study); base and analysis year scenario VMT, speeds, and VMT mix; and analysis year scenario SHP estimation data.[16]
    - The 2017 base year county hotelling hours estimates for a 24-hour weekday from the TCEQ study were scaled to each analysis scenario using the ratio of analysis scenario-to-base combination long-haul truck 24-hour VMT (as truck VMT increases, so does the hotelling activity).
    - The 24-hour hotelling estimates were then distributed to each hour of day using the hotelling hours hourly distribution calculated for the analysis scenario as the inverse of the hourly distribution of VHT (or SHO, from the SHP calculation process, Item 13) for combination long-haul trucks. Within each hour, SHP and hotelling hours were compared, and if hotelling hours exceeded SHP, hotelling hours were set equal to SHP.
- SHXI and APU hours components of hotelling hours were then estimated for each hour using the hourly hotelling hours estimates, combination long-haul truck travel fractions (calculated from local age distributions and moves default relative mileage accumulation rates), and hotelling activity distributions for each model year (Table 5).
    - The SHXI and APU hours activity distribution fractions were each first multiplied by the travel distribution (model year operating mode activity fraction multiplied by the associated model year travel fraction).
    - The product of the SHXI fractions and travel fractions were then summed to produce the total SHXI fraction, and the same process was performed for APU hours to produce the total APU hours fraction. (The sum of the SHXI and APU hours fractions subtracted from 1.0 results in the fraction of hotelling hours with electric power or no power in use.)
    - The total SHXI and APU hours fractions were then each multiplied by the hotelling hours for each hour of the day to produce the SHXI and APU hours estimates for each hour.
    - This was performed for Bexar County for each analysis scenario (analysis year summer weekday).

[16] Base estimates of hotelling hours are 2017 winter weekday estimates, developed by TTI as part of a truck extended idling study that produced county 24-hour hotelling estimate totals for all Texas counties, sponsored by TCEQ starting in 2017. The study report is available here: https://www.tceq.texas.gov/assets/public/implementation/air/am/contracts/reports/mob/582177430806-20191201-TTI-HeavyDutyVehicleIdleActivityStudy.pdf

Table 5. Hotelling Activity Distributions by Model Year.

Begin Model Year	End Model Year	OpModeFraction for opModeID/opModeName			
		200	201	203	204
		ExtendIdling	Diesel Aux	Battery AC	APU Off
1960	2009	0.8	0	0	0.2
2010	2020	0.73	0.07	0	0.2
2021	2023	0.48	0.24	0.08	0.2
2024	2026	0.4	0.32	0.08	0.2
2027	2050	0.36	0.32	0.12	0.2

DEVELOPMENT OF EMISSIONS FACTORS

16. Background: TTI developed emissions rates using MOVES2014b and the TTI post-processing utilities, RatesCalc and RatesAdj, which prepare MOVES2014b-based emissions rates for input to TTI's external inventory calculation utility, EmsCalc. Summer weekday emissions rates were produced for each analysis year by county.

These on-road emissions rates were developed in terms of mass per activity unit: miles for roadway-based processes; and SHP, starts, SHXI, and APU hours for off-network processes. All 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 (SHXI and APU hours), and rate/start emissions rates tables from MOVES output and the calculated rate/SHP emissions rates table into a database of rates look-up tables. The RatesCalc output was input to RatesAdj and further processed (adjusted for TxLED effects on NOx emissions, where applicable) into final form for input to the EmsCalc utility. For additional details on the post-processing of MOVES output, see Attachment 2. Table 6 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 6. 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
Brake Wear	VMT	mass/mile
Tire Wear	VMT	mass/mile
Start Exhaust Crankcase Start Exhaust	starts	mass/start
Extended Idle Exhaust Crankcase Extended Idle Exhaust	SHXI	mass/SHXI
Auxiliary Power Exhaust	APU Hours	mass/APU hour
Evaporative Permeation Evaporative Fuel Vapor Venting Evaporative Fuel Leaks	VMT, SHP	mass/mile, mass/SHP

[1] The amount of VMT, SHP, vehicle starts, SHXI, and APU hours are the basic activity factors. SHXI 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 MOVES2014b default database used was "MOVESDB20181022"). See Attachment 2 for details on the MRS files and CDBs developed for Bexar County and used to estimate the summer weekday emissions factors for each analysis year.

18. Emissions Factor Post-Processing Adjustments: The RatesAdj utility was used along with TxLED NOx adjustment factors to produce emission rates that account for the effects of TxLED on diesel vehicle NOx emissions. All five TDM counties except Kendall County are in the TxLED Program area, thus Bexar County emission rates were adjusted for TxLED effects. See Table 15, in Attachment 2, Page 25, for TxLED factors summary.

19. Emissions Controls Modeling: Table 7 shows the modeling approaches used for the emissions control strategies. Unless otherwise stated, the control strategy was modeled in all years.

Table 7. 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 –Federal Tier 3 Sulfur Standards, State Regional Low Reid Vapor Pressure (RVP) Program	*Locality-specific user-developed inputs to MOVES.* TTI produced the gasoline formulations based on information in TCEQ's summer 2017 and summer 2020 statewide fuel surveys. The gasoline formulations are by Texas fuel regions. For Bexar County, TTI used the formulation based on samples from the "state 7.8 RVP limit" region counties, which includes Bexar County. Summer 2017 gasoline formulations are actuals using the 2017 survey data. Future year formulations are summer 2020 actuals (latest local survey-based estimates), except with RVP, sulfur level, and benzene content set equal to the applicable MOVES defaults (i.e., expected future year values consistent with the pertinent regulatory standards). Fuel formulation inputs for Bexar County are provided in Attachment 2.
Federal Low Sulfur Diesel Fuel	*Locality-specific user inputs to MOVES.* For 2017, the diesel sulfur level was based on statewide diesel sample data (aggregate average from the TCEQ summer 2017 survey). For the future years, diesel sulfur was set to the expected level (i.e., within the ultra-low sulfur diesel average annual standard and consistent with the maximum observed values from the last four TCEQ statewide surveys. Diesel formulations are provided in Attachment 2.

[1] Four of the five AAMPO TDM counties (Bexar, Comal, Guadalupe, and Wilson) are in the eastern Texas counties group under the Texas State "7.8 RVP limit" rule. Kendall County is in the group of western Texas counties under the federal "9.0 RVP limit" volatility rule.

Attachment 1
Adjustments to TDM VMT

Table 8. HPMS Factor.

2015 HPMS AADT VMT	AADT-to-ANSWT Factor	HPMS-Based ANSWT VMT	2015 TDM VMT	HPMS Factor[1]
53,827,397.00	1.04287	56,134,977.51	60,007,443.61	0.935466904

[1] This factor and each component in its calculation are unchanged from the prior AAMPO transportation conformity emissions analysis performed by TTI (HPMS factor originally calculated by TTI, December 14, 2018).

Table 9. 2017 Baseline Year, and 2025, 2035, 2045 Future Year Summer Weekday Factors.

Year	Seasonal Factor Type[1]	Factor
2017	AADT-to-SWKD	1.07525
2025 and later	ANSWT-to-SWKD	1.02751

[1] SWKD is summer weekday

Table 10. Summer Weekday Hourly VMT Distributions.

Period	Hour	24-Hour-Period	Four-Period[1]
AM Peak	6-7 a.m.	0.050337	0.284620
	7-8 a.m.	0.067680	0.382682
	8-9 a.m.	0.058840	0.332698
Mid-Day	9-10 a.m.	0.049597	0.154652
	10-11 a.m.	0.048710	0.151886
	11 a.m-12 p.m.	0.051878	0.161764
	12-1 p.m.	0.054587	0.170212
	1-2 p.m.	0.056274	0.175472
	2-3 p.m.	0.059655	0.186014
PM Peak	3-4 p.m.	0.067927	0.238457
	4-5 p.m.	0.076002	0.266805
	5-6 p.m.	0.078561	0.275785
	6-7 p.m.	0.062371	0.218953
Overnight	7-8 p.m.	0.045318	0.208280
	8-9 p.m.	0.036621	0.168309
	9-10 p.m.	0.032143	0.147728
	10-11 p.m.	0.025226	0.115938
	11 p.m.-12 a.m.	0.017544	0.080632
	12-1 a.m.	0.010078	0.046318
	1-2 a.m.	0.006858	0.031519
	2-3 a.m.	0.005984	0.027502
	3-4 a.m.	0.006148	0.028256
	4-5 a.m.	0.009542	0.043855
	5-6 a.m.	0.022120	0.101663

[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 – Bexar County:

- MRS input files: One for each analysis year (4).
- CDB inputs: One for each analysis year (4).
- The MOVES default input database (MOVESDB20181022).
- MOVES output databases: One per MOVES run (4).
- MOVES run log output text files: One per MOVES run (4).

Table 11 describes the MOVES2014b run specification files used. Table 12 describes the CDBs built and used for the rates analysis.

Table 11. MOVES Run Specification Selections by Graphical User Interface 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***>[1] - July - Weekday - All		
Geographic Bounds[1]	Region; Selections; Domain Input Database	Zone and Link; Texas - Bexar County;[1] <***County Input Database (CDB) Name***>[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	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	<***MOVES Output Database Name***>[1]; Grams, 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" except "clear BaseRateOutput after rate calculations" box		

[1] County scale allows only one year per run. The years include 2017, 2025, 2035, and 2045. Bexar County FIPS code and year were included in the MRS file names and in the CDB names and output database names.

[2] Note that although only VOC and NOx were required for the analysis, other pollutants were included in the runs. For example, some pollutant selections were required as pre-requisites for the required pollutants. Other pollutants were not reported.

Table 12. 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 developed by TCEQ based on summer (June through August) 2017 weather station data for the county.
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 weather station data by county.
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 type.
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 county vehicle registration data and MOVES defaults (consistent with the registration data year), as needed. The latest available (2018 end-of-year) registration data were used for all 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 (i.e., gasoline and diesel).
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 was set to indicate one gasoline and one diesel fuel formulation for the county.
fuelformulation	Fuel	TTI based summer 2017 gasoline formulations on summer 2017 local fuel survey data. For future years, TTI used gasoline properties estimated from latest available (2020) local summer survey data, with adjustments (MOVES defaults) to reflect consistency with pertinent fuel controls (e.g., RVP limit, Tier 3 sulfur). The diesel fuel formulations were actual survey-based for 2017 and for future years, were set consistent within both the federal sulfur standard and local observations.
countyyear	Stage II	N/A.
imcoverage	I/M	Not applicable (set to NULL).
Hotellingactivity-distribution	activity	Used the updated distribution from TCEQ's 2017 long-haul truck hotelling/idling study.

[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 13 summarizes the meteorological inputs used. Table 14 summarizes the fuel formulation inputs used. Age distribution and fuel fraction inputs are summarized in Attachment 3, starting on Page 27.

Table 13. Meteorological Inputs to MOVES for Bexar County.

Hour	Temperature (degrees F.)	Relative Humidity (%)
1	78.99	77.90
2	77.82	81.39
3	76.91	84.04
4	76.21	85.87
5	75.69	87.13
6	75.26	88.00
7	74.88	88.78
8	75.43	87.31
9	77.66	81.44
10	80.33	72.68
11	82.98	64.24
12	85.47	57.70
13	87.72	52.12
14	89.53	48.18
15	91.03	44.94
16	92.13	43.00
17	92.60	42.18
18	92.48	42.81
19	91.50	44.95
20	89.54	50.16
21	86.61	56.89
22	84.11	62.97
23	82.12	68.75
24	80.42	73.82
Period	**Barometric Pressure (Inches of Mercury)[1]**	
24-hr	29.049	

Average hourly data (24-hr for pressure) from weather stations within Bexar County (or adjacent county, where county station data not available)—June through August 2017 (provided by TCEQ). "Hour" 1 is 12 a.m. to 1 a.m., etc.

Table 14. MOVES Gasoline and Diesel Fuel Formulation Inputs for Bexar County.

Field	Units	Summer 2017		Summer Future Years	
		Gas E	Diesel	Gas E	Diesel
fuelFormulationID	-	17702	30637	19702	30011
fuelSubtypeID	-	12	20	12	20
RVP	psi	7.54	0	7.80	0
sulfurLevel	ppm	21.28	6.37	10.00	11.00
ETOHVolume	vol. %	9.66	0	9.56	0
MTBEVolume	vol. %	0	0	0	0
ETBEVolume	vol. %	0	0	0	0
TAMEVolume	vol. %	0	0	0	0
aromaticContent	vol. %	25.35	0	22.22	0
olefinContent	vol. %	8.33	0	8.69	0
benzeneContent	vol. %	0.76	0	0.61	0
e200	vap. %	49.45	0	49.64	0
e300	vap. %	82.68	0	84.60	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	203.73	0	202.53	0
T90	°F	327.68	0	319.75	0

TTI produced the gasoline formulations based on information in TCEQ's summer 2017 and summer 2020 statewide fuel (gasoline and diesel) surveys. The gasoline formulations are by Texas fuel regions; diesel is statewide. Gas E is the east Texas formulation based on samples from "state 7.8 RVP limit" counties. Summer 2017 gasoline formulations are actuals using the 2017 survey data. Future Years formulations are summer 2020 actuals (latest local survey-based estimates), except with RVP, sulfur level, and benzene content set equal to the MOVES defaults (i.e., expected future year values consistent with the pertinent regulatory standards). Bexar County falls under Gas E. Diesel sulfur for 2017 is the statewide actual average based on TCEQ's summer 2017 fuel survey data; and for Future Years diesel sulfur is set to the expected level (i.e., within the ultra low sulfur diesel average annual standard and consistent with the maximum observed values from the last four TCEQ statewide surveys). "\N" is "null" value, or not used.

Post-Processing Output:

Each MOVES output database was post-processed using TTI's MOVES emissions rates post-processing utilities, RatesCalc and RatesAdj. First an interim "ratescalc" database was produced, followed by a "ratesadj" database containing the final on-road rate tables for subsequent input to the EmsCalc inventory calculation utility.

- RatesCalc Interim Rate Databases: Mass/SHP off-network evaporative process rates were calculated using data from the CDB, the MOVES default database, and the MOVES rateperprofile and ratepervehicle emissions rate output. RatesCalc also copied mass/mile, mass/start, and mass/hour rates along with the units into emissions rate tables. RatesCalc does not perform any unit conversions. The utility created the look-up tables ttirateperdistance, ttirateperstart, ttirateperhour (for SHXI and APU hours), and ttiratepershp in a "ratescalc" interim output database by county and analysis year.
- RatesAdj Final Rate Databases: RatesAdj extracted emissions rates from the RatesCalc rate tables for only those pollutants needed in the emissions calculations. This step also applied TxLED adjustments (see factors developed by TTI in Table 15) to Bexar County diesel vehicle NOx emissions rates (all five counties in the TDM are TxLED Program area counties, except for Kendall County).[17] TTI produced these average diesel SUT NOx adjustments using 4.8 percent and 6.2 percent reductions for 2002 and later, and 2001 and earlier model years, respectively.[18] The extracted and adjusted rate tables were placed in "outRatesAdj" databases (one each per run) for subsequent input to the on-road mobile source emissions calculator, EmsCalc.

[17] The TxLED counties list may be found at: http://www.tceq.texas.gov/airquality/mobilesource/txled/txled-affected-counties. For full details on the TCEQ TxLED factor development procedure, see the files in "mvs14-statewide-txled-analysis-06-12-17-18.zip" found at: ftp://amdaftp.tceq.texas.gov/pub/EI/onroad/txled/.

[18] Reductions as detailed in the EPA Office of Transportation and Air Quality Memorandum, RE: Texas Low Emission Diesel [LED] Fuel Benefits, September 27, 2001.

Table 15. Estimated TxLED Fuel NOx Reductions and Adjustments.

Diesel Fuel Source Use Type	NOx Reduction			NOx Adjustment		
	2017	2025	2032+	2017	2025	2032+
Passenger Car	5.16%	4.84%	4.80%	0.9484	0.9516	0.9520
Passenger Truck	5.23%	4.92%	4.80%	0.9477	0.9508	0.9520
Light Commercial Truck	5.55%	5.15%	4.80%	0.9445	0.9485	0.9520
Intercity Bus	5.78%	5.40%	4.80%	0.9422	0.9460	0.9520
Transit Bus	5.71%	5.31%	4.80%	0.9429	0.9469	0.9520
School Bus	5.75%	5.36%	4.80%	0.9425	0.9464	0.9520
Refuse Truck	5.42%	5.00%	4.80%	0.9458	0.9500	0.9520
Single Unit Short-Haul Truck	4.97%	4.82%	4.80%	0.9503	0.9518	0.9520
Single Unit Long-Haul Truck	4.97%	4.83%	4.80%	0.9503	0.9517	0.9520
Motor Home	5.44%	5.09%	4.80%	0.9456	0.9491	0.9520
Combination Short-Haul Truck	5.18%	4.90%	4.80%	0.9482	0.9510	0.9520
Combination Long-Haul Truck	5.23%	4.89%	4.80%	0.9477	0.9511	0.9520

TTI, November 2020 – produced using TCEQ procedure available at: ftp://amdaftp.tceq.texas.gov/pub/EI/onroad/txled/ with Texas statewide age distributions and fuel fractions inputs to MOVES2014b based on latest available (2018) TxDMV statewide registrations data.

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

Bexar County (48029) 2018 Age Distribution Inputs to MOVES (used for 2017, 2025, 2035, and 2045)

Age	MC	PC	PT	LCT	IBus	TBus	SBus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.06007	0.08795	0.07475	0.07475	0.05774	0.05773	0.05776	0.06524	0.11234	0.10895	0.06536	0.08348	0.06883
1	0.06062	0.08749	0.06405	0.06405	0.05719	0.05714	0.05722	0.06513	0.10424	0.10365	0.06552	0.06590	0.05954
2	0.05987	0.07491	0.05070	0.05070	0.05503	0.05496	0.05506	0.06331	0.10744	0.11127	0.06402	0.06127	0.04790
3	0.06532	0.07736	0.04968	0.04968	0.05443	0.05438	0.05447	0.06248	0.08692	0.08575	0.06340	0.06257	0.06068
4	0.05997	0.08077	0.04703	0.04703	0.05235	0.05232	0.05240	0.05980	0.10273	0.10245	0.06087	0.08722	0.07197
5	0.05722	0.06867	0.04968	0.04968	0.04769	0.04775	0.04773	0.05441	0.05953	0.05603	0.05552	0.06229	0.05726
6	0.05612	0.06455	0.04200	0.04200	0.04218	0.04224	0.04222	0.04799	0.04840	0.05081	0.04899	0.05274	0.05812
7	0.04761	0.05473	0.03676	0.03676	0.03844	0.03850	0.03848	0.04332	0.07074	0.07144	0.04423	0.05392	0.06003
8	0.03771	0.04372	0.03631	0.03631	0.03469	0.04576	0.02683	0.02294	0.04736	0.04883	0.03220	0.02615	0.03087
9	0.02681	0.03951	0.03362	0.03362	0.03020	0.02762	0.02892	0.01783	0.01624	0.01704	0.02789	0.01636	0.02000
10	0.05782	0.03146	0.02432	0.02432	0.02495	0.02784	0.03395	0.02325	0.01598	0.01619	0.02298	0.02562	0.02743
11	0.05677	0.04348	0.04374	0.04374	0.03178	0.03853	0.03673	0.01764	0.04028	0.04138	0.02915	0.02306	0.02481
12	0.06672	0.04200	0.04641	0.04641	0.04110	0.03694	0.03756	0.06061	0.02678	0.02706	0.03745	0.07329	0.07872
13	0.05657	0.03475	0.04257	0.04257	0.04143	0.02614	0.04332	0.04432	0.02953	0.03020	0.03745	0.04889	0.05090
14	0.04266	0.03168	0.03942	0.03942	0.04227	0.04032	0.03809	0.04107	0.02711	0.02570	0.03805	0.04535	0.04309
15	0.02991	0.02696	0.04421	0.04421	0.04070	0.03276	0.03718	0.02430	0.02078	0.01923	0.03642	0.02274	0.02442
16	0.03486	0.02344	0.04336	0.04336	0.03709	0.03156	0.03148	0.02336	0.01556	0.01579	0.03303	0.02140	0.02162
17	0.02706	0.01939	0.04132	0.04132	0.03428	0.03157	0.03263	0.01665	0.01461	0.01349	0.03042	0.01632	0.01686
18	0.01736	0.01547	0.03825	0.03825	0.03234	0.03568	0.02921	0.02000	0.01249	0.01353	0.02847	0.01896	0.02354
19	0.01340	0.01261	0.02848	0.02848	0.03035	0.02382	0.03136	0.02685	0.00928	0.00983	0.02660	0.02790	0.03223
20	0.01305	0.00954	0.02300	0.02300	0.02901	0.02271	0.02854	0.03757	0.00903	0.00937	0.02519	0.02079	0.02437
21	0.00765	0.00634	0.01648	0.01648	0.02162	0.02620	0.02214	0.03381	0.00477	0.00451	0.01450	0.01584	0.01839
22	0.00595	0.00488	0.01635	0.01635	0.01739	0.02367	0.02039	0.01611	0.00454	0.00468	0.02200	0.01129	0.01267
23	0.00560	0.00320	0.01106	0.01106	0.01413	0.02143	0.01728	0.02044	0.00206	0.00232	0.01328	0.01096	0.01238
24	0.00350	0.00286	0.01082	0.01082	0.01812	0.01733	0.02178	0.02578	0.00225	0.00239	0.01541	0.01031	0.01177
25	0.00365	0.00195	0.00963	0.00963	0.01379	0.01493	0.01039	0.01786	0.00123	0.00141	0.01445	0.00707	0.00808
26	0.00250	0.00146	0.00632	0.00632	0.01119	0.01222	0.01224	0.00798	0.00114	0.00107	0.00976	0.00512	0.00627
27	0.00235	0.00108	0.00467	0.00467	0.00815	0.01049	0.00976	0.00700	0.00085	0.00071	0.00840	0.00333	0.00387
28	0.00125	0.00098	0.00331	0.00331	0.00913	0.01049	0.01232	0.01080	0.00097	0.00073	0.00617	0.00329	0.00364
29	0.00145	0.00073	0.00291	0.00291	0.01011	0.01514	0.01372	0.00752	0.00074	0.00065	0.00793	0.00353	0.00349
30	0.01861	0.00605	0.01877	0.01877	0.02115	0.02184	0.01884	0.01462	0.00409	0.00352	0.01492	0.01303	0.01626

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	0.499	0.490	0.443	0.400	0.421	0.275	0.284	0.332	0.383	0.331	0.272	0.273	0.249	0.257	0.251	0.275
SUShT	Diesel	0.501	0.510	0.557	0.600	0.579	0.725	0.716	0.668	0.617	0.669	0.728	0.727	0.751	0.743	0.749	0.725
SULhT	Gas	0.499	0.490	0.443	0.400	0.421	0.275	0.284	0.332	0.383	0.331	0.272	0.273	0.249	0.257	0.251	0.275
SULhT	Diesel	0.501	0.510	0.557	0.600	0.579	0.725	0.716	0.668	0.617	0.669	0.728	0.727	0.751	0.743	0.749	0.725
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	0.106	0.093	0.073	0.098	0.087	0.081	0.065	0.077	0.077	0.079	0.054	0.065	0.061	0.077	0.086	0.093
CShT	Diesel	0.894	0.907	0.927	0.902	0.913	0.919	0.935	0.923	0.923	0.921	0.946	0.935	0.939	0.923	0.914	0.907
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	0.302	0.363	0.325	0.413	0.415	0.383	0.623	0.502	0.490	0.494	0.507	0.545	0.782	0.782	0.782
SUShT	Diesel	0.698	0.637	0.675	0.587	0.585	0.617	0.377	0.498	0.510	0.506	0.493	0.455	0.218	0.218	0.218
SULhT	Gas	0.302	0.363	0.325	0.413	0.415	0.383	0.623	0.502	0.490	0.494	0.507	0.545	0.782	0.782	0.782
SULhT	Diesel	0.698	0.637	0.675	0.587	0.585	0.617	0.377	0.498	0.510	0.506	0.493	0.455	0.218	0.218	0.218
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	0.096	0.110	0.110	0.109	0.122	0.119	0.208	0.100	0.104	0.116	0.142	0.137	0.256	0.256	0.256
CShT	Diesel	0.904	0.890	0.890	0.891	0.878	0.881	0.792	0.900	0.896	0.884	0.858	0.863	0.744	0.744	0.744
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 2025 Fuel Engine Fractions Summary[1]

SUT	Fuel Type	Model Year															
		2025	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	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	0.990
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	0.012	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	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	0.020	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	0.947	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	0.053	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	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	0.002
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	0.997	0.998
SUShT	Gas	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.474	0.499	0.490	0.443	0.400	0.421	0.275	0.284	0.332
SUShT	Diesel	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.526	0.501	0.510	0.557	0.600	0.579	0.725	0.716	0.668
SULhT	Gas	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.474	0.499	0.490	0.443	0.400	0.421	0.275	0.284	0.332
SULhT	Diesel	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.526	0.501	0.510	0.557	0.600	0.579	0.725	0.716	0.668
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	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.091	0.106	0.093	0.073	0.098	0.087	0.081	0.065	0.077
CShT	Diesel	0.919	0.919	0.919	0.919	0.919	0.919	0.919	0.909	0.894	0.907	0.927	0.902	0.913	0.919	0.935	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 2025 Fuel Engine Fractions Summary[1] - (Continued)

SUT	Fuel Type	Model Year														
		2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995
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	0.993	0.999	1.000	0.993	0.995	0.997	0.996	0.996	0.997	0.997	0.998	0.998	0.999	0.999	0.999
PC	Diesel	0.007	0.001	0.000	0.007	0.005	0.003	0.004	0.004	0.003	0.003	0.002	0.002	0.001	0.001	0.001
PT	Gas	0.985	0.977	0.981	0.975	0.979	0.982	0.982	0.983	0.989	0.992	0.981	0.993	0.992	0.981	0.995
PT	Diesel	0.015	0.023	0.019	0.025	0.021	0.018	0.018	0.017	0.011	0.008	0.019	0.007	0.008	0.019	0.005
LCT	Gas	0.955	0.941	0.948	0.938	0.946	0.951	0.951	0.956	0.908	0.949	0.929	0.950	0.927	0.971	0.932
LCT	Diesel	0.045	0.059	0.052	0.062	0.054	0.049	0.049	0.044	0.092	0.051	0.071	0.050	0.073	0.029	0.068
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	0.042	0.114
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	0.958	0.886
RT	Gas	0.002	0.005	0.001	0.003	0.003	0.005	0.004	0.005	0.006	0.002	0.169	0.404	0.019	0.012	0.010
RT	Diesel	0.998	0.995	0.999	0.997	0.997	0.995	0.996	0.995	0.994	0.998	0.831	0.596	0.981	0.988	0.990
SUShT	Gas	0.383	0.331	0.272	0.273	0.249	0.257	0.251	0.275	0.302	0.363	0.325	0.413	0.415	0.383	0.623
SUShT	Diesel	0.617	0.669	0.728	0.727	0.751	0.743	0.749	0.725	0.698	0.637	0.675	0.587	0.585	0.617	0.377
SULhT	Gas	0.383	0.331	0.272	0.273	0.249	0.257	0.251	0.275	0.302	0.363	0.325	0.413	0.415	0.383	0.623
SULhT	Diesel	0.617	0.669	0.728	0.727	0.751	0.743	0.749	0.725	0.698	0.637	0.675	0.587	0.585	0.617	0.377
MH	Gas	0.500	0.510	0.530	0.540	0.560	0.570	0.590	0.600	0.630	0.660	0.680	0.710	0.740	0.770	0.790
MH	Diesel	0.500	0.490	0.470	0.460	0.440	0.430	0.410	0.400	0.370	0.340	0.320	0.290	0.260	0.230	0.210
CShT	Gas	0.077	0.079	0.054	0.065	0.061	0.077	0.086	0.093	0.096	0.110	0.110	0.109	0.122	0.119	0.208
CShT	Diesel	0.923	0.921	0.946	0.935	0.939	0.923	0.914	0.907	0.904	0.890	0.890	0.891	0.878	0.881	0.792
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 2035 Fuel Engine Fractions Summary[1]

SUT	Fuel Type	Model Year															
		2035	2034	2033	2032	2031	2030	2029	2028	2027	2026	2025	2024	2023	2022	2021	2020
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	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519
SUShT	Diesel	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481
SULhT	Gas	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519
SULhT	Diesel	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481
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	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081
CShT	Diesel	0.919	0.919	0.919	0.919	0.919	0.919	0.919	0.919	0.919	0.919	0.919	0.919	0.919	0.919	0.919	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	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2035 Fuel Engine Fractions Summary[1] - (Continued)

SUT	Fuel Type	Model Year														
		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
PC	Gas	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	0.010	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	0.987	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	0.013	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	0.962	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	0.038	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
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	0.002	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	0.998	0.998	0.995	0.999	0.997	0.997
SUShT	Gas	0.519	0.474	0.499	0.490	0.443	0.400	0.421	0.275	0.284	0.332	0.383	0.331	0.272	0.273	0.249
SUShT	Diesel	0.481	0.526	0.501	0.510	0.557	0.600	0.579	0.725	0.716	0.668	0.617	0.669	0.728	0.727	0.751
SULhT	Gas	0.519	0.474	0.499	0.490	0.443	0.400	0.421	0.275	0.284	0.332	0.383	0.331	0.272	0.273	0.249
SULhT	Diesel	0.481	0.526	0.501	0.510	0.557	0.600	0.579	0.725	0.716	0.668	0.617	0.669	0.728	0.727	0.751
MH	Gas	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.510	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	0.490	0.470	0.460	0.440
CShT	Gas	0.081	0.091	0.106	0.093	0.073	0.098	0.087	0.081	0.065	0.077	0.077	0.079	0.054	0.065	0.061
CShT	Diesel	0.919	0.909	0.894	0.907	0.927	0.902	0.913	0.919	0.935	0.923	0.923	0.921	0.946	0.935	0.939
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	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519
SUShT	Diesel	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481
SULhT	Gas	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519
SULhT	Diesel	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481
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	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081
CShT	Diesel	0.919	0.919	0.919	0.919	0.919	0.919	0.919	0.919	0.919	0.919	0.919	0.919	0.919	0.919	0.919	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	1.000

[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	0.012
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
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	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.474	0.499	0.490	0.443
SUShT	Diesel	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.526	0.501	0.510	0.557
SULhT	Gas	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.519	0.474	0.499	0.490	0.443
SULhT	Diesel	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.526	0.501	0.510	0.557
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	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.091	0.106	0.093	0.073
CShT	Diesel	0.919	0.919	0.919	0.919	0.919	0.919	0.919	0.919	0.919	0.919	0.919	0.909	0.894	0.907	0.927
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.

Attachment 4:
Electronic Data Submittal

INTRODUCTION

This section describes input and output files generated during the emissions inventory analysis. The files are provided as electronic files in a separate folder titled "electronicDataSubmittal_san21tip_mvs14b_AUG_2021".

MOVES2014b-based Emission Rates Files

Emission rates were estimated using TTI's rates-per-activity method. The method uses TTI's RatesCalc and RatesAdj utilities to assemble all emission rates for specified MOVES pollutant-processes in rates-per-activity form (and to calculate the rate-per-SHP form of evaporative rates which are not directly available from MOVES), for input to the EmsCalc utility emissions calculations. The process accommodates simultaneous preparation of local link-based (on-network) and off-network activity and emission rates inputs needed for the detailed disaggregate external emissions calculations by using MOVES county scale emission rate mode set-ups with a combination of local input data (e.g., fuels, temperatures, age distributions, fuel fractions) and MOVES default input data (e.g., VMT, vehicle populations, various activity factors). Emission rate data files are provided in the form of MySQL database files and ASCII text files.

MOVES Files

Due to their large size (e.g., MOVES output rateperdistance tables with more than one million records) the emission rate input and output files are provided in electronic format. Included are MOVES2014b (EPA, August 2018) run specification (MRS) input files and county input databases (CDBs), MOVES output databases and log files. (The MOVES default database used - "movesdb20181022" - is available with the MOVES2014b model for download: https://www.epa.gov/moves.)[19]

There are five counties (48029, 48091, 48187, 48259 and 48493: Bexar, Comal, Guadalupe, Kendall, and Wilson County FIPS codes, respectively) within the San Antonio travel network domain. Activity and emissions were analyzed under this task for four analysis years (2017, 2025, 2035, and 2045). As this analysis was only for Bexar County, only the Bexar County files were produced and provided. These files consist of four county scale emission rates mode MRS (XML) files and four MySQL CDBs.

MVS14B_SAN21TIP_2017SWKD_48029_ER.MRS
MVS14B_SAN21TIP_2025SWKD_48029_ER.MRS

[19] On November 16, 2020 EPA released MOVES3, EPA's latest official version of its on-road emissions model. With its release EPA intends to establish a two-year grace period before MOVES3 is considered the latest, official emissions model for use in transportation conformity. Employing this grace period, MOVES2014b (released August 2018) is considered the latest, official release of MOVES, for transportation conformity purposes. TTI used MOVES2014b in this analysis.

MVS14B_SAN21TIP_2035SWKD_48029_ER.MRS
MVS14B_SAN21TIP_2045SWKD_48029_ER.MRS

mvs14b_san21tip_2017swkd_48029_er_cdb_in
mvs14b_san21tip_2025swkd_48029_er_cdb_in
mvs14b_san21tip_2035swkd_48029_er_cdb_in
mvs14b_san21tip_2045swkd_48029_er_cdb_in

(Provided in "san21tip_Bexar_MRSs.zip" and "san21tip_Bexar_CDBs.zip".)

Each CDB contains the following input tables: avft, avgspeeddistribution, county, countyyear, dayvmtfraction, fuelformulation, fuelsupply, hotellingactivitydistribution, hourvmtfraction, hpmsvtypeyear, imcoverage, monthvmtfraction, roadtype, roadtypedistribution, sourcetypeagedistribution, sourcetypeyear, state, year, zone, zonemonthhour, and zoneroadtype.[20]

Correspondingly there are four MOVES emissions rates output MySQL databases (interim output for input to RatesCalc) and four MOVES log files:

mvs14b_san21mtp_2017swkd_48029_er_out
mvs14b_san21mtp_2025swkd_48029_er_out
mvs14b_san21mtp_2035swkd_48029_er_out
mvs14b_san21mtp_2045swkd_48029_er_out

mvs14b_san21mtp_2017swkd_48029_er_log.txt
mvs14b_san21mtp_2025swkd_48029_er_log.txt
mvs14b_san21mtp_2035swkd_48029_er_log.txt
mvs14b_san21mtp_2045swkd_48029_er_log.txt

(Provided in "san21tip_Bexar_MOVESOutput.zip".)

These 17 MySQL database tables are included in each MOVES output database: activitytype, baserateoutput, baserateunits, bundletracking, movesactivityoutput, moveserror, moveseventlog, movesoutput, movesrun, movestablesused, movesworkersused, rateperdistance, rateperhour, rateperprofile, rateperstart, ratepervehicle, startspervehicle. There are other MOVES pollutantIDs included in this rates output, in addition to the required VOC and NO_X. Other pollutants are prerequisites for VOC or were optionally included.

[20] Note that the rates-per-activity link-based inventory method uses MOVES default activity inputs in the emission rates development, while the actual locality-specific activity estimates are combined with the emissions rates external to MOVES. Since the activity tables in each CDB contain MOVES defaults specifically for rates-mode runs, these CDBs should not be used for MOVES inventory calculation-type runs.

RatesCalc Utility Files

RatesCalc calculates parked vehicle evaporative rates in terms of rate-per-SHP as a conversion of MOVES rate-per-vehicle output. Using data from the MOVES CDB and MOVES database, RatesCalc replicates the MOVES vehicle population and SHP calculation process. Vehicle population-to-SHP ratios are multiplied by the parked vehicle evaporative rates output from the MOVES ratepervehicle and rateperprofile tables yielding rateperSHP. RatesCalc produced four emission rates databases (interim output for input to RatesAdj).

mvs14b_san21mtp_2017swkd_48029_er_outratescalc
mvs14b_san21mtp_2025swkd_48029_er_outratescalc
mvs14b_san21mtp_2035swkd_48029_er_outratescalc
mvs14b_san21mtp_2045swkd_48029_er_outratescalc

(Provided in "san21tip_Bexar_RatesCalcOutDBs.zip".)

The following six MySQL database tables are included in each database: ratescalcrun (lists basic utility execution information including the MOVES rates output database name), ttiactivity (includes distance, population, SHP and SHO activity), ttirateperdistance (copy of MOVES rateperdistance rates for specified pollutants), ttirateperhour (copy of MOVES rateperhour rates), ttiratepershp (parked vehicle rate-per-SHP rates calculated by RatesCalc), and ttirateperstart (copy of MOVES rateperstart rates).

RatesAdj Utility Files

The RatesCalc output is input to RatesAdj and further processed into final form for input to the EmsCalc utility. RatesAdj extracted emissions rates from the RatesCalc rate tables for only those pollutants desired in the emissions calculations (VOC, NOx, and CO). This step applied TxLED adjustments to the diesel vehicle NOx emissions rates. The extracted and adjusted rate tables were placed in "outRatesAdj" databases (one each per run) for subsequent input to the on-road mobile source emissions calculator, EmsCalc. The RatesAdj output databases contain five MySQL database tables: the four emission rates lookup tables (as also contained in the interim RatesCalc output databases), and a ratesadjrun table (listing the basic utility execution information). RatesAdj produced four final emission rates databases (inputs to EmsCalc).

mvs14b_san21mtp_2017swkd_48029_er_outRatesadj
mvs14b_san21mtp_2025swkd_48029_er_outRatesadj
mvs14b_san21mtp_2035swkd_48029_er_outRatesadj
mvs14b_san21mtp_2045swkd_48029_er_outRatesadj

(Provided in "san21tip_Bexar_RatesAdjOutDBs.zip".)

MOVES2014b-based Emissions Files

EmsCalc Output

There are two output files from each EmsCalc MOVES2014b-based emissions calculation utility run which are relatively large: an LST file (run execution listing text file) and a TAB file (tab-delimited emissions and activity results summaries text file). As with the emissions rate files, these files are available only in electronic format. Runs are by county and year. There were four runs for Bexar County (i.e., one per analysis year) resulting in eight output files. The emissions inventory summary output files and associated output LST files provided are:

san21tip_mvs14b_48029_2017swkd_ems.tab
san21tip_mvs14b_48029_2025swkd_ems.tab
san21tip_mvs14b_48029_2035swkd_ems.tab
san21tip_mvs14b_48029_2045swkd_ems.tab

san21tip_mvs14b_48029_2017swkd_ems.LST
san21tip_mvs14b_48029_2025swkd_ems.LST
san21tip_mvs14b_48029_2035swkd_ems.LST
san21tip_mvs14b_48029_2045swkd_ems.LST

(Provided in "san21tip_Bexar_EmsCalcOutput.zip".)

EmsCalc TAB files are tab-delimited files for listing summaries of the VMT, VHT, calculated speed (VMT/VHT), off-network activity (SHP, starts, extended idle hours, and APU hours), and the specified MOVES pollutant-process emissions in units of pounds by roadway type (TDM link road types, MOVES off-network road type, and total) for each fuel type (gasoline and diesel) and source type combination in the VMT mix. The summaries are included for each hour and for the 24-hour period. The pollutants included are VOC, NOx, and CO. The emission processes included are running exhaust, crankcase running exhaust, start exhaust, crankcase start exhaust, extended idling exhaust, crankcase extended idling exhaust, evaporative permeation, evaporative vapor venting, and evaporative liquid leaks. The pollutant totals for each MOVES pollutant ID are also included.

EmsCalc LST files are space-delimited text files listing utility execution information including execution date/time, compilation date, run instructions (JCF file), input and output file paths, input summaries including header file, county code, road type codes, TDM road type and area type code designations (for VMT mix road type, rates road type, and MOVES road type), hourly time period designations (by peak and off-peak periods), VMT mix summaries (for the four peak/off-peak time periods), off-network activity summaries, pollutant-process-units list, summary information on each of the four emission rate tables used (i.e., ttiratperdistance, ttirateperstart, ttiratepershp, and ttirateperhour), link data input files summary statistics (count comparison of links with and without VMT, and between hours), roadway-based activity and emissions summary totals by hour and 24-hour, and various warning messages.

TabFileTotals Output

Also provided are EmsCalc activity and emissions results (by pollutant and process) that were extracted from the EmsCalc TAB-file output for each year, summarized at seven different aggregation levels, and output in a separate set of tab-delimited emissions and activity summary files. Using 2045 summer weekday as an example (with "*" as a wildcard), the additional summary files for each year are:

*2045swkd_tabtots.lst	(tabfiletotals utility execution log file)
*2045swkd_tabtots.tab	(24-hour totals)
*2045swkd_tabtots_Hr.tab	(hourly totals)
*2045swkd_tabtots_ST.tab	(24-hour SUT/fuel type totals)
*2045swkd_tabtots_RdType.tab	(hourly, road type totals)
*2045swkd_tabtots_RdTypeST.tab	(hourly, road type, SUT/fuel type totals)
*2045swkd_tabtots_24hourRdTypeST.tab	(24-hour, road type, SUT/fuel type totals)
*2045swkd_tabtots_HrST.tab	(hourly, SUT/fuel type totals)

(Provided in "san21tip_Bexar_TabFileTotals.zip".)

This set of extracts (seven TAB-delimited summary files) and the associated LST were produced for each analysis year.