# APPENDIX D

# BPA AREA ON-ROAD EMISSIONS INVENTORIES FOR SIP SUBMISSION - 2005, 2011, 2014, 2017, AND 2021, TTI REPORT, FEBRUARY 2012

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

# BPA Area On-Road Emissions Inventories for SIP Submission - 2005, 2011, 2014, 2017, and 2021

*Prepared by the* Texas Transportation Institute

February 2012

# DEVELOPMENT OF 2005, 2011, 2014, 2017, AND 2021 BEAUMONT/PORT ARTHUR AREA ON-ROAD EMISSIONS INVENTORIES FOR STATE IMPLEMENTATION PLAN (SIP) MAINTENANCE SUBMISSION

**TECHNICAL REPORT**

**FINAL**

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## EXECUTIVE SUMMARY

The Motor Vehicle Emission Simulator (MOVES) model was officially released for production of on-road emissions inventories (EIs) to be included with future State Implementation Plan (SIP) submissions, by the U.S. Environmental Protection Agency (EPA) on March 2, 2010. The Texas Commission on Environmental Quality (TCEQ) will submit SIP revisions to the EPA, as required under the eight-hour ozone standard, using the MOVES model. As part of the eight-hour SIP process, areas such as Beaumont/Port Arthur (BPA) that have recently come into compliance with the eight-hour ozone standard must demonstrate how they will maintain that standard for at least 10 years after officially being designated attainment by EPA.

To support the analysis required for the BPA maintenance SIP, on-road mobile source EIs of oxides of nitrogen ($NO_x$) and volatile organic compounds (VOC) are needed for a 2005 base year, 2011, 2014, and 2017 interim years, and the 2021 horizon year. The Texas Transportation Institute (TTI) developed the required link-based on-road inventories including VOC and $NO_x$ using the MOVES model for the three-county Beaumont/Port Arthur (BPA) area, which comprises Hardin, Jefferson, and Orange counties. The EIs used the latest planning assumptions to assure that motor vehicle emissions budgets set by the SIP will be consistent with transportation conformity analysis assumptions.

TTI used the travel demand model (TDM) link-based, MOVES "rates-per-activity" EI method to produce hourly, ozone season weekday EIs for the three BPA area counties. The level of detail produced was hourly and 24-hour periods, by MOVES source use type (SUT) and fuel type, pollutant process, and TDM roadway class. Estimates were included of carbon monoxide (CO), carbon dioxide ($CO_2$), particulate matter (PM) with aerodynamic diameters equal to or less than 10 microns ($PM_{10}$), and PM with aerodynamic diameters equal to or less than 2.5 microns ($PM_{2.5}$), as well as the VOC and $NO_x$. The process employs methods consistent with the EPA guidance on the use of MOVES for EI preparation in SIPs and Transportation Conformity.

Table 1 summarizes the BPA area ozone season weekday inventories. A more detailed summary is provided in the following sections, along with the details of the modeling methods and input parameter development and usage.

**Table 1. BPA Area Ozone Season Weekday On-Road Mobile Emissions Inventories (Tons).**

| Year | VMT | Speed[1] | VOC | CO | $NO_X$ | $CO_2$ | $PM_{10}$[2] | $PM_{2.5}$[2] |
|---|---|---|---|---|---|---|---|---|
| 2005 | 12,766,328 | 45.9 | 11.3 | 150.5 | 44.5 | 8,572.9 | 2.0 | 1.8 |
| 2011 | 13,221,528 | 46.0 | 8.3 | 92.3 | 26.6 | 8,857.9 | 1.3 | 1.0 |
| 2014 | 13,691,363 | 45.7 | 6.3 | 74.0 | 18.6 | 9,063.7 | 0.9 | 0.7 |
| 2017 | 14,178,111 | 45.8 | 5.0 | 64.3 | 13.5 | 9,130.6 | 0.7 | 0.5 |
| 2021 | 14,854,487 | 45.5 | 3.9 | 58.7 | 9.7 | 9,204.4 | 0.6 | 0.3 |

[1] Miles-per-hour (mph).

[2] Particulate matter estimates are direct vehicle emissions consisting of exhaust, brakewear, and tirewear.

## PURPOSE

The accuracy of $NO_x$ and VOC emissions estimates are critical for SIP modeling and control strategy development. The purpose of this project was to develop 2005, 2011, 2014, 2017, and 2021 link-based on-road EIs for the three-county BPA area. These on-road inventories were developed for inclusion in a SIP revision that will continue to show how the BPA area will demonstrate maintenance of the EPA's 1997 eight-hour ozone standard out to 2021. This project is part of the ongoing effort to ensure that accurate and detailed mobile source EIs are produced on a schedule to ensure availability of all inventories required to support SIP development and overall TCEQ planning activities.

## BACKGROUND

TCEQ works with local planning districts, the Texas Department of Transportation (TxDOT), and TTI to provide on-road mobile source EIs of air quality pollutants. TxDOT typically funds transportation conformity determinations required under 40 CFR Part 93. TCEQ funds mobile source inventory work in support of the Federal Clean Air Act (CAA) requirements, such as attainment of the National Ambient Air Quality Standards (NAAQS) 42 USCA 7409, and the study and control of hazardous air pollutants (HAPs), including those from motor vehicles and/or motor vehicle fuels (as mandated under CAA sections 202 and 211).

TCEQ EI development activities include inventory production, methodology updates, data gathering, analysis and assessment, and planning for future requirements. In addition to meeting the basic inventory production requirements, Texas has consistently used state-of-the-art methodologies and up-to-date data sets to produce highly detailed on-road mobile SIP inventories. This level of commitment requires a constant update of EI and control strategy reduction estimates to include the latest methodologies and data.

Although maintenance inventories were previously developed to support a BPA Maintenance SIP, those inventory estimates were developed using MOBILE6.2.03. At the time, MOBILE6.2.03 was the newest version of the EPA's on-road mobile emissions factor model. In March 2010, the EPA released a new mobile source emissions model, MOVES. To incorporate MOVES, the BPA Maintenance SIP inventories will need to be updated. The inventory updates will also include the latest planning assumptions to assure the motor vehicle emissions budgets set by the SIP will be consistent with transportation conformity analysis assumptions.

TCEQ is continuing its progress toward meeting the requirements of EPA's eight-hour ozone standard. As part of the eight-hour SIP planning and development process, areas such as the BPA that have recently come into compliance with the eight-hour ozone standard must demonstrate how they will maintain that standard for at least 10 years after officially being designated attainment by EPA. To support the analysis required for the maintenance SIP, on-road mobile source EIs are needed for 2005, 2011, 2014, 2017, and 2021. TTI produced the 2005, 2011, 2014, 2017, and 2021 on-road mobile link-based EIs for the three BPA counties. This work was conducted in accordance with, and completed consistent with the list of references.

**Development of On-Road Mobile Source Emissions Inventories for the BPA Counties with a Base Year of 2005, Interim Years of 2011, 2014, 2017, and the Horizon Year of 2021**

TTI developed hourly, link-based on-road mobile EI estimates for the three BPA counties for 2005, 2011, 2014, 2017, and 2021. For the inventories to be consistent with inventory development for other SIP analyses, the most recent activity information, based on current travel demand modeling, and the newest version of the EPA's MOVES on-road mobile emissions model were used. The inventories were produced based on methods agreed upon in consultation with the TCEQ Project Manager. The methods used to produce the inventories were consistent with EPA guidance on the production of emissions inventories.

TTI conformed to the following:

- The emissions factor model used in developing inventories was the newest version of MOVES, MOVES2010a, released in August 2010.
- The pollutants included in the inventories are VOC, CO, $NO_x$, $CO_2$, $PM_{10}$, and $PM_{2.5}$.
- The day type for all the inventories was the ozone-season weekday. Activity levels were adjusted for the summer season (June through August) and for the average weekday, Monday through Friday.
- The temperatures were consistent with the eight-hour, ozone season temperatures as determined using EPA guidance and provided by TCEQ.
- The humidity input was developed using the same methodology as the ozone season temperatures and was provided by TCEQ.
- The vehicle miles traveled (VMT) mixes were consistent with the EPA MOVES source use types. The most current VMT mix for the BPA area was used.
- The most recent year vehicle registration distributions developed from the TxDOT registration data was used as input for locality specific MOVES age distributions for the future analysis years.
- A link-based, time-of-day emissions analysis methodology, using the latest available BPA regional travel models, was used for all of the referenced counties.
- Control program parameters, including Reid Vapor Pressure (RVP) and fuel settings was determined based upon BPA control strategies in effect for each analysis year. The control program parameters and fuel settings used by TTI for this analysis were developed in consultation with TCEQ.
- Year-specific Texas Low Emissions Diesel (TxLED) adjustment factors developed using the established method were used. These factors were developed and provided by TCEQ (based on the benefit information described in the EPA *Memorandum on Texas Low Emission Diesel Fuel Benefits*, and the method as documented in previous Texas on-road inventory development reports).

To achieve maximum flexibility for subsequent analyses and use of the on-road mobile source inventories produced under this task, TTI provided the detailed, link-based inventories summarized for each county and analysis year in the most recent tab-delimited EI summary file format provided by TTI to TCEQ; and in a format compatible for uploading to TCEQ's Texas Air Emissions Repository (TexAER). TexAER has recently been updated to be compatible with the most recent version of the EPA's National Emission Inventory Format, the Consolidated Emissions Reporting Schema (CERS) written in Extensible Markup Language (XML). MOVES source use types are not consistent with the EPAs source classification code (SCC) system for reporting inventories in CERS. A mapping of the MOVES source use types to the EPAs SCCs will need to be established. TCEQ will work with the EPA to establish the methodology to incorporate MOVES-based inventories into the SCCs and the CERS XML format. The methodology is to be provided to TTI. The schedule for completion of the XML files is contingent upon when TTI receives the required mapping information from TCEQ. This deliverable can be completed within two months after receipt of the mapping information.

The following activities were completed:

- Prepared county-level hourly and 24-hour day tables that provide roadway and source use type summaries of VMT, vehicle hours traveled (VHT), average speed, source hours parked (SHP), vehicle starts, extended idle hours (SHI), and totals for the pollutants VOC, CO, $NO_x$, $CO_2$, $PM_{10}$, and $PM_{2.5}$ by associated emissions processes. These files are tab-delimited for ease of loading into spreadsheet software such as Microsoft® Excel.
- Prepared TexAER ready formatted inventory files (these are to be provided within two months subsequent to TTI's receipt of the needed mapping convention from TCEQ for use in conversion of MOVES-based EIs to CERS XML format).
- Prepared documentation, complete and self contained, including electronic data files.

TTI will maintain a record of all electronic files developed or used in conjunction with the completion of this project. All pertinent data relating to project activities were submitted to TCEQ in the specified electronic format, in conjunction with supporting electronic document files, and copies of the this report. The electronic file submission is described in Appendix A – Electronic Data Submittal.

**Acknowledgments**

Dennis Perkinson, Ph.D., L.D. White, Gary Lobaugh, and Martin Boardman, all of TTI, contributed to the development of the MOVES link-based emissions estimates. Dr. Perkinson produced the VMT mixes used to divide fleet VMT activity into MOVES SUTs by fuel type category, county VMT control totals and hourly VMT factors. TxDOT provided the BPA regional travel model data sets. White processed roadway based activity (VMT and speeds) and off-network vehicle activity estimates (and vehicle population estimates) needed for the emissions calculations. Lobaugh and Boardman produced MOVES model and MOVES output post-processor set-ups, and Boardman produced MOVES-based emissions factors with adjustments for TxLED fuel. Boardman prepared MOVES model county input databases and performed the emissions runs. Chris Kite of TCEQ provided the TxLED fuel adjustment factors and Kritika Thapa provided meteorological input data. Lobaugh was responsible for editing, design, and production of this Technical Report. Each member of the assigned TTI staff contributed to the quality assurance of the EI elements. Dr. Perkinson was the principle

investigator for this project. This work was performed by TTI under contract to TCEQ. Kritika Thapa was the TCEQ project technical manager.

The discussion is organized in the following sections: Summary of Results, Overview of Methodology, Development of SUT/Fuel Type VMT Mix, Estimation of VMT, Estimation of Link Speeds, Estimation of Off-Network Activity, Estimation of Emissions Factors, Emissions Calculations, and Quality Assurance.

## SUMMARY OF RESULTS

Table 2 summarizes the ozone season weekday inventories of county total emissions with VMT and average speed for the BPA area.

**Table 2. BPA Ozone Season Weekday On-Road Mobile Source Emissions Inventories (Tons).**

| Year | County | VMT | Speed[1] | VOC | CO | $NO_X$ | $CO_2$ | $PM_{10}$[2] | $PM_{2.5}$[2] |
|---|---|---|---|---|---|---|---|---|---|
| 2005 | Hardin | 1,739,251 | 43.7 | 1.5 | 20.7 | 5.6 | 1,142.4 | 0.2 | 0.0 |
| | Jefferson | 7,769,291 | 45.4 | 6.8 | 91.2 | 26.1 | 5,135.6 | 1.0 | 0.1 |
| | Orange | 3,257,786 | 48.6 | 3.0 | 38.6 | 12.8 | 2,294.8 | 0.5 | 0.0 |
| 2011 | Hardin | 2,079,909 | 43.0 | 1.4 | 15.0 | 3.9 | 1,375.3 | 0.2 | 0.0 |
| | Jefferson | 7,701,489 | 45.4 | 4.8 | 53.7 | 14.8 | 5,062.2 | 0.6 | 0.1 |
| | Orange | 3,440,131 | 49.3 | 2.2 | 23.7 | 7.8 | 2,420.4 | 0.3 | 0.0 |
| 2014 | Hardin | 2,163,678 | 42.6 | 1.1 | 12.1 | 2.7 | 1,412.6 | 0.1 | 0.0 |
| | Jefferson | 7,948,748 | 45.2 | 3.6 | 42.9 | 10.3 | 5,161.6 | 0.4 | 0.1 |
| | Orange | 3,578,937 | 49.1 | 1.7 | 19.1 | 5.6 | 2,489.4 | 0.2 | 0.0 |
| 2017 | Hardin | 2,250,822 | 42.5 | 0.8 | 10.6 | 2.0 | 1,426.8 | 0.1 | 0.0 |
| | Jefferson | 8,203,946 | 45.2 | 2.8 | 37.1 | 7.3 | 5,165.5 | 0.3 | 0.1 |
| | Orange | 3,723,343 | 49.7 | 1.3 | 16.7 | 4.2 | 2,538.3 | 0.1 | 0.0 |
| 2021 | Hardin | 2,372,498 | 42.0 | 0.7 | 9.8 | 1.4 | 1,446.4 | 0.0 | 0.0 |
| | Jefferson | 8,557,001 | 44.9 | 2.2 | 33.7 | 5.1 | 5,177.7 | 0.1 | 0.1 |
| | Orange | 3,924,988 | 49.4 | 1.1 | 15.3 | 3.1 | 2,580.2 | 0.1 | 0.1 |

[1] Miles-per-hour (mph).
[2] Particulate matter is direct vehicle emissions estimate consisting of exhaust, brakewear, and tirewear.

## OVERVIEW OF METHODOLOGY

A detailed, hourly, TDM link-based, MOVES "rates-per-activity"-based EI method was used to produce the hourly emissions estimates by MOVES SUT/fuel type (see Table 3), pollutant and emission process (see Table 4) for each county and year.

This method is an adaptation of the previous TDM link-based EI method used with MOBILE6. In addition to the VMT-based emissions calculations for roadway-based emissions processes, it now uses off-network activity measures (i.e., starts, source hours parked [SHP], extended idling hours [SHI]) with MOVES model-based emissions rates in these off-network activity units (*Update of On-Road Inventory Development Methodologies for MOVES Model Compatibility*, TTI, July 2011). "Rates-per-activity" is emphasized because the standard MOVES off-network emissions rate look-up table output for external emissions calculations provides rates in terms of pollutant mass per vehicle. However, the TTI method requires post-processing of MOVES output into rate tables that include all emissions rates based in units of activity. This method was first implemented by TTI in the development of link-based emissions inventories as documented in *Development and Production of 2006 Base Case and 2008 Baseline On-road Mobile Source Emissions Inventories for the HGB Nonattainment Area* (TTI, July 2011).

**Table 3. MOVES Source Use Type/Fuel Types.**

| Source Use Type ID | Source Use Type Description | Source Use Type Abbreviation[1] |
|---|---|---|
| 11 | Motorcycle | MC |
| 21 | Passenger Car | PC |
| 31 | Passenger Truck | PT |
| 32 | Light Commercial Truck | LCT |
| 41 | Intercity Bus | IBus |
| 42 | Transit Bus | TBus |
| 43 | School Bus | SBus |
| 51 | Refuse Truck | RT |
| 52 | Single Unit Short-Haul Truck | SUShT |
| 53 | Single Unit Long-Haul Truck | SULhT |
| 54 | Motor Home | MH |
| 61 | Combination Short-Haul Truck | CShT |
| 62 | Combination Long-Haul Truck | CLhT |

[1] The SUT/fuel type labels are the SUT abbreviation and fuel type names separated by an underscore, e.g., MC_Gas, RT_Diesel, and SBus_Gas are motorcycles, diesel-powered refuse trucks, and gasoline-powered school buses.

**Table 4. MOVES Model Emissions Processes.**

| Process ID | Process Name |
|---|---|
| 1 | Running Exhaust |
| 2 | Start Exhaust |
| 9 | Brake Wear |
| 10 | Tire Wear |
| 11 | Evaporative Permeation |
| 12 | Evaporative Fuel Vapor Venting |
| 13 | Evaporative Fuel Leaks |
| 15 | Crankcase Running Exhaust |
| 16 | Crankcase Start Exhaust |
| 17 | Crankcase Extended Idle Exhaust |
| 18[1] | Refueling Displacement Vapor Loss |
| 19[1] | Refueling Spillage Loss |
| 90 | Extended Idle Exhaust |
| 99[1] | Well-to-Pump |

[1] Not subject to on-road mobile emissions analysis.

With TTI's MOVES link-based emissions estimation utility, in addition to VMT for roadway-based emissions processes, either vehicle populations (numbers of vehicles) or off-network activity measures are needed to estimate emissions for the off-network emissions processes. The method of choice required rates-per-activity as opposed to rates-per-vehicle. The major difference is that this "rates-per-activity" method requires: 1) estimation of the associated off-network activity, rather than just numbers of vehicles, and 2) post-processing of MOVES output into rate tables that include the off-network process emissions rates based in units of activity, rather than the MOVES "per vehicle" type of rates. Table 5 shows the emission rate units with associated processes and activity factors used in this MOVES "rates-per-activity"-based analysis.

**Table 5. Emissions Rates by Process and Activity Factor.**

| Emissions Process | Activity Factor[1] | Emissions Rate Units |
|---|---|---|
| Running Exhaust | VMT | grams/mile (g/mi) |
| Brakewear | VMT | g/mi |
| Tirewear | VMT | g/mi |
| Evaporative Permeation | VMT; SHP | g/mi; g/shp |
| Evaporative Fuel Vapor Venting | VMT; SHP | g/mi; g/shp |
| Evaporative Fuel Leaks | VMT; SHP | g/mi; g/shp |
| Crankcase Running Exhaust | VMT | g/mi |
| Start Exhaust | Starts | g/start |
| Crankcase Start Exhaust | Starts | g/start |
| Crankcase Extended Idle Exhaust | SHI | g/shi |
| Extended Idle Exhaust | SHI | g/shi |

[1] The amount of travel on roads (VMT), SHP, vehicle starts, and SHI are the basic activity factors. SHI is for Combination Long-Haul Trucks only. Note that the evaporative emissions processes of permeation, fuel vapor venting, and fuel leaks may occur both when the vehicle is parked, and when the vehicle is operating on roads.

### Major EI Process Components

The county EI estimation process requires development of the following major inventory components. All are inputs to the emissions calculations, except for vehicle populations, which are intermediate inputs needed for calculating the activity estimates of SHP and vehicle starts.

- Area SUT/fuel type VMT mix;
- County, hourly link fleet VMT and average speeds;
- County SUT/fuel type vehicle populations;
- County, hourly SUT/fuel type SHP;
- County, hourly SUT/fuel type starts;
- County, hourly SUT/fuel type SHI; and
- County, hourly SUT/fuel type emissions rates: g/mi, g/SHP, g/start, g/SHI.

### VMT Mix

The VMT mix designates the SUT/fuel types included in the analysis, and specifies the fraction of on-road fleet VMT attributable to each SUT/fuel type by MOVES road type.

The SUT/fuel type VMT mixes were estimated using TTI's SUT/fuel type VMT mix method (*Methodologies for Conversion of Data Sets for MOVES Model Compatibility*, TTI, August 2009). The VMT mix method sets Texas vehicle registration category aggregations for the MOVES SUT categories to be used in developing the VMT mix estimates, as well as for developing other fleet parameter inputs needed in the process (e.g., SUT age distributions). The current VMT mix method produced a set of 24-hour average SUT/fuel type VMT allocations by MOVES road type, estimated for the TxDOT Beaumont District, for use by analysis year. The data sources used were recent, multi-year TxDOT vehicle classification counts, year-end TxDOT/Texas Department of Motor Vehicles (TxDMV) registration data, along with MOVES default data where needed.

**On-Road Fleet Link-VMT and Speeds**

The TDM link-based method (as used in the prior, recent MOBILE6 analysis) was used to estimate fleet VMT and speed inputs to the roadway-based emissions calculations (product of "mass per mile" emissions factors and VMT).

TTI post-processed non-directional, 24-hour, TDM network traffic assignments and trip matrix data provided by the TxDOT to produce the hourly, directional, link VMT (consistent with Highway Performance Monitoring System [HPMS] VMT estimates for each year) and associated average fleet speed estimates, reflective of the ozone season weekday (i.e., average Monday through Friday during the June through August period). The seasonal period, day type, and hourly distributions used were based on factors developed with TxDOT Automatic Traffic Recorder (ATR) data from the Beaumont area. The hourly average operational fleet speeds were estimated corresponding to the link VMT estimates using the TTI's speed model, which estimates delay (as function of volume-to-capacity [V/C]) on each link, and applies it to the link's estimated free-flow speed.

**Vehicle Population and Off-Network Vehicle Activity Estimates**

The non-roadway travel-related emissions estimates (e.g., from vehicle starts, parked vehicle evaporative permeation and tank vapor venting, extended idling) were calculated as the product of the amount of associated activity and the pollutant mass per unit of activity (rate units as shown in Table 5). To estimate the SHP and vehicle starts, SUT/fuel type category population estimates were needed, whereas SHI was based on BPA county-specific actual estimates (*Heavy-Duty Vehicle Idle Activity and Emissions Characterization Study* (ERG, August 2004).

***SUT/Fuel Type Populations***: TTI based vehicle population estimates on registration data aggregations, SUT/fuel type VMT mix-based vehicle population factors, and, for future years, VMT-based growth estimates. For historical years, the SUT/fuel type vehicle population estimates were based solely on mid-year TxDOT (or TxDMV) county registrations data and regional, all roads-weekday SUT/fuel type VMT mix-based population factors for the analysis year. For future years, SUT/fuel type populations were estimated as a function of base (e.g., latest available, mid-year) registrations, grown to a future value (growth as a function of base and future VMT), and all roads-weekday SUT/fuel type VMT mix-based population factors applicable to the analysis year.

***SHP*:** The SHP was estimated as a function of total hours (hours a vehicle exists) minus its hours of operation on roads (SHO, which is the same as VHT). For historical years, the SUT/fuel type SHP estimates were based on VMT mix, link VMT and speeds, and the vehicle population estimates. The VMT mix was applied to the link VMT to produce SUT/fuel type-specific VMT estimates. Link VMT was divided by the associated speed to produce SHO estimates, which were subtracted from source hours resulting in SHP estimates. This was performed for each county by year and hour. For the future years, the SUT/fuel type SHP was estimated in the same manner as for historical years, except using the future year link VMT and speeds, VMT mix, and the vehicle population estimates.

***Starts***: Engine starts were based on the MOVES national default starts per vehicle, and the local, county SUT/fuel type vehicle population estimates. MOVES default weekday starts per vehicle were used for this ozone season weekday analysis. The starts were calculated as the product of starts/vehicle from MOVES, and the local, county SUT/fuel type population estimates.

***SHI***: The SHI (for Combination Long-Haul Trucks) was estimated based on information from a TCEQ extended idling study, and additional scaling factors developed by TTI. The 2004 idle activity study produced 2004 summer weekday SHI estimates by Texas county. TTI used the BPA county summer weekday 24-hour 2004 base year SHI estimates from this study in combination with 2004 base year and analysis year link VMT and SUT/fuel type VMT mixes (for producing the SHI scaling factors) to estimate county, hourly extended idling activity for each analysis year summer weekday. SHI hourly factors (estimated as the inverse of the hourly VMT factors) were used to allocate the 24-hour SHI to each hour of the day.

**MOVES Emissions Factors**

TTI post-processed the MOVES (emissions and activity) output to calculate the emissions rates in the needed activity units (as summarized in Table 5).

Basic to the rates-per-activity emissions rates modeling method, the activity inputs used in MOVES are essentially MOVES defaults, which are later divided out (to unity) in the production of emissions rates, via post-processing of the MOVES activity and emissions output (i.e., emissions divided by activity). The actual local, year and scenario-specific activity estimates for each county are then used in the EI calculations outside of MOVES.

Look-up tables of MOVES emissions factors were developed (post-processed from “emission rate calculation type” MOVES output, which produces speed bin-indexed emissions and activity data) by pollutant, process, speed (for roadway-based processes), hour, road type, and average SUT/fuel type. MOVES outputs were post-processed in two ways: 1) to calculate the emissions rates from emissions and activity output, and 2) to extract the rates for only those pollutants needed in the emissions calculations, and apply TxLED adjustments (for all analysis years except for 2005) to each county’s diesel vehicle $NO_x$ emissions rates.

County-level emissions factors were developed for each evaluation year. Local emissions factor modeling input parameters were developed and used to produce emissions factors reflective of the local scenario conditions (e.g., weather and fleet characteristics, fuel properties), and the TxLED $NO_x$ adjustment factors used were analysis year and SUT specific.

### Emissions Calculations

Emissions were calculated for each county and year using the major inputs as described previously, and summarized here: TxDOT district-level 24-hour SUT/fuel type VMT mix by MOVES road type; county, hourly link on-road fleet VMT and speed estimates; county hourly off-network activity estimates by SUT/fuel type of SHP, starts, and SHI; and the county-level look-up tables of activity-based hourly emissions rates by SUT/fuel type and emissions process.

For the VMT-based calculations, a MOVES road type to TDM network road type/area type designation was used to match the appropriate VMT mixes and link VMT. The VMT mixes by MOVES road type were multiplied by the link fleet VMT to distribute each link's VMT to the SUT/fuel types. Emissions rates for each link's average speed were interpolated (see procedure in Appendix B) from the set of look-up table rates and corresponding index speeds (i.e., the average bin speeds of 2.5, 5.0, 10.0, 15.0, … 75.0 mph), bounding the link's average speed. For link speeds below or above the minimum and maximum average bin speeds of 2.5 and 75 mph, the rates for those bounding speeds were used. The estimated SUT/fuel type/MOVES road type/link speed-specific emissions factors for each pollutant process were then multiplied by the associated VMT to produce the link-based emissions estimates. This process was executed for each hour.

For the off-network emissions calculations, which are county level, the emissions factors by SUT/fuel type were multiplied by the appropriate county total activity estimate, as determined by the pollutant process. This process was executed for each hour.

The emissions estimates are organized in a tab-delimited output file for the specified county by pollutant/process, roadway type, and SUT/fuel type combination for each hour, and for the 24-hour period. This tab-delimited file also includes hourly and 24-hour summaries of the off-network activity, VMT, VHT, and speed by roadway (Appendix A lists more detailed output definitions and specifications).

TTI developed and maintains a series of computer utilities to calculate and summarize detailed on-road mobile source EIs in various formats, such as those used in this analysis. Appendix B describes these applications, and includes a process flow diagram.

## DEVELOPMENT OF SUT/FUEL TYPE VMT MIX

The SUT/fuel type VMT mix is a major input to the MOVES link-based emissions estimation process. It is an estimate 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 SUT/fuel type. These hourly VMT estimates by SUT/fuel type are combined with the appropriate emissions factors in the link-emissions calculations.

TxDOT district-level, 24-hour average, weekday SUT/fuel type VMT mixes (for gasoline-powered and diesel-powered vehicles) were estimated by the four MOVES road-type categories following the methodology detailed in the report entitled, *Methodologies for Conversion of Data Sets for MOVES Model Compatibility*, TTI, August 2009. This methodology characterizes VMT by SUT/fuel type for a region (or district) as follows.

- TxDOT Classification Counts by County and TxDOT District — This is the standard TxDOT classification data assembled and used for determining the in-use road fleet mix (e.g., VMT mix under MOBILE).
- Redefine Roadway Functional Classifications from Federal Highway Administration (FHWA)/TxDOT to MOVES types — A straightforward transposition of FHWA/TxDOT roadway functional classifications in the classification count data into the five MOVES road types.
- Define MOVES vehicle categories.  For example, PV21 – Passenger vehicles equivalent to FHWA C minus .001 for MCs.
- Define MOVES vehicle categories - Passenger and Light Commercial Trucks — Separates FHWA light-truck category (P) into passenger trucks and light commercial vehicles using approximate (rounded) MOVES default values.  Note this disaggregation is similar to the MOBILE6 distinction between the two primary LDT categories (LDT12 and LDT34).
- Define MOVES vehicle categories – Single-Unit Trucks RTF51 — These are refuse trucks.  These are currently assigned a nominal default value (.001) taken from the combined FHWA single-unit truck category total (SU2, SU3, and SU4).  To be modified as improved or locally-specific data become available.
- Define MOVES vehicle categories – Single-Unit Trucks Short-Haul versus Long-Haul (SUSH52 and SULH53) per SUT_SSHX — Separates single-unit trucks into short-haul and long-haul based on local (TxDOT district) registrations versus observed vehicles from the classification counts.  District allocations verified against statewide allocation.
- Define MOVES vehicle categories – Single-Unit Trucks MH54 — These are motor homes/recreational vehicles.  These are currently assigned a nominal default value (.001) taken from the combined FHWA single-unit truck category total (SU2, SU3, and SU4).  To be modified as improved or locally-specific data become available.
- Define MOVES vehicle categories - Buses (approximate MOBILE6 defaults) — To be modified as improved or locally-specific data become available.
- Define MOVES vehicle categories - Combination Trucks Short-Haul versus Long-Haul (CSH61 and CLH62) per SUT_HDX9 and SUT_CSHX — Separates combination trucks into short-haul and long-haul based on local (TxDOT district) registrations versus observed vehicles from the classification counts.  District allocations verified against statewide allocation.
- Define MOVES vehicle categories - MCs — Nominal default value taken from passenger cars (FHWA C).  To be modified as improved or locally-specific data become available.
- Fuel Type Allocation - PV and LDT fuel type allocation per TxDOT registration data and MOVES defaults (21, 31, and 32) per AgeReg9X and MF_Fuel — Other fuel types currently treated as *de minimus*.  Additional fuel types can be incorporated as local or regional data become available, or from the MOVES national default database (though this latter option is not recommended).  Note allocation of fuel type varies with analysis year.

- Fuel Type Allocation - Single Unit and Combination Trucks per TxDOT registration data per SUT_HDV9 — As with PV and LDT, other fuel types currently treated as *de minimus*.
- Aggregate and Calculate MOVES SUTs and apply day-of-week factors from urban area classification count data (Friday, Saturday, and Sunday).

TxDOT district-level weekday SUT/fuel type VMT mixes by MOVES road-type category (included in Appendix C) were produced based on recent multi-year vehicle classification counts and appropriate end-of-year TxDOT vehicle registrations data. Using the same data sets and a similar procedure, aggregate (i.e., all road-type categories) TxDOT district-level weekday SUT/fuel type VMT mixes (used in the vehicle population estimation) were also produced and included in Appendix C. To ensure general applicability and consistency across all study areas, all VMT mixes were developed in five-year increments beginning with the year 2000 and applied to the analysis years based on Table 6.

**Table 6. VMT Mix Year/Analysis Year Correlations.**

| VMT Mix Year | Analysis Years |
|---|---|
| 2000 | 1998 through 2002 |
| 2005 | 2003 through 2007 |
| 2010 | 2008 through 2012 |
| 2015 | 2013 through 2017 |
| 2020 | 2018 through 2022 |

## ESTIMATION OF VMT

The detailed, hourly, link-based emissions process requires VMT estimates by hour and direction for each link in the TDMs. This analysis also required that VMT be adjusted for HPMS consistency and to reflect estimated levels characteristic of a typical summer ozone season (June through August) weekday (Monday through Friday). The TRANSVMT utility (see Appendix B for a description of the utility), the latest available BPA 2002, 2011, and 2021 TDMs, and post-processing factors developed from several other data sources, were used to produce this hourly VMT by direction. The hourly and 24-hour VMT and VHT summaries by county and road type were provided electronically to TCEQ (see Appendix A for electronic data descriptions).

### Data Sources

The latest available BPA 2002 (dated December 7, 2010), 2011 (dated December 3, 2010), and 2021 (dated December 3, 2010) TDMs were used to estimate the directional link VMT and speeds by hour. Since intrazonal VMT are not accounted for in the TDMs, the intrazonal VMT was estimated using the TDM’s trip matrix and zonal radii.

Several other data sources were used to adjust the VMT for HPMS consistency and for seasonality (i.e., ozone season summer weekday). The first data source is HPMS VMT estimates, which are based on traffic count data collected according to a statistical sampling procedure specified by the FHWA designed to estimate VMT. The county total HPMS Annual Average Daily Traffic (AADT) VMT was used to ensure the travel model VMT was consistent with the HPMS VMT estimates. (EPA and FHWA have endorsed HPMS as the appropriate source of VMT and require that VMT used to construct on-road mobile source emissions estimates be consistent with that reported through HPMS.)

The second data source is ATR vehicle counts, which are collected by TxDOT at selected locations throughout Texas on a continuous basis. These vehicle counts are collected on a continuous basis and are available by season, month, and weekday, as well as on an annual average daily basis (i.e., AADT). The counts are very well suited for making seasonal, day-of-week, and time-of-day comparisons (e.g., seasonal adjustment and hourly allocation factors), even though there may be relatively few ATR data collection locations in any given area.

Multiple years (2000 through 2010) of data from the ATR stations were grouped for this analysis at different aggregation levels, depending upon the purpose. This data source was used to produce the day-type-specific adjustment factor, in which the data from the ATR stations within the Beaumont TxDOT District were combined for use with all three counties. This data source was also used to product the time-of-day (hourly) allocation factors, in which the data from the ATR stations within the three-county region was combined.

### VMT Adjustments

For each analysis year, the designated TDM VMT (see Table 7) was adjusted for HPMS consistency and for seasonality (i.e., ozone season summer weekday). For 2005, which by definition is a historical year (i.e., HPMS VMT data exists for those years), county-level VMT control totals were used. For the remaining analysis years (2011, 2014, 2017, and 2021), which are considered future years (i.e., HPMS VMT data does not exist), a regional HPMS factor and a seasonal weekday factor were used. However, a TDM does not exist for 2014 and 2017. For 2014 and 2017, intermediate year factors were developed using the bounding TDMs (i.e., 2011 and 2021) and applied to the analysis year's respective TDM VMT. Hourly travel factors were also applied to distribute this adjusted VMT over each hour of the day.

**Table 7. Analysis Year/TDM Year Designation.**

| Analysis Year | TDM Year |
|---|---|
| 2005 | 2002 |
| 2011 | 2011 |
| 2014 | 2011 |
| 2017 | 2021 |
| 2021 | 2021 |

*Historical Year Analyses – VMT Control Totals and VMT Adjustments*

To estimate the 2005 HPMS-consistent ozone season summer weekday VMT, county-level VMT control totals were used to develop county-level VMT adjustment factors. The VMT control totals are comprised of two key components: the 2005 county-level HPMS AADT VMT and an ozone season summer day-of-week (i.e., weekday) adjustment factor.

The ozone season summer weekday adjustment factor was developed using aggregated ATR data from the Beaumont TxDOT district for the years 2000 through 2010. This regional factor was calculated by dividing the average day-of-week count by the AADT traffic count. For this analysis, the VMT control total ozone season summer weekday adjustment factor was 1.08998.

The VMT control totals were then developed by multiplying the 2005 HPMS AADT VMT for each county by the VMT control total ozone season summer weekday adjustment factor to produce three 2005 VMT control totals (one for each county). To develop the county-level VMT adjustment factors, each county's respective control total was divided by the total VMT (TDM assignment VMT plus intrazonal VMT estimate) from the 2002 TDM to produce three county-level 2005 VMT adjustment factors. For each link in the TDM, the volume was multiplied by the corresponding VMT adjustment factor (based on the county where the link is located). The adjusted link volumes were then multiplied by the associated link lengths to produce the 2005 link-level HPMS consistent, period day-type-specific VMT estimates. Table 8 shows the weekday VMT control totals, the total TDM VMT, and the VMT adjustment factors for the 2005 analysis year.

**Table 8. BPA 2005 Weekday VMT Control Totals and VMT Adjustment Factors.**

| County | VMT Control Total | TDM VMT[1] | VMT Adjustment Factor |
|---|---|---|---|
| Jefferson | 7,769,291 | 6,469,636 | 1.200885343 |
| Orange | 3,257,786 | 2,838,521 | 1.147705466 |
| Hardin | 1,739,251 | 1,594,167 | 1.091009187 |

[1] 2002 TDM, including intrazonal VMT.

*Future Year Analyses – HPMS Adjustment Factor*

For the future year analyses, an HPMS adjustment factor was used to adjust the total VMT (TDM assignment VMT plus intrazonal VMT estimate) for HPMS consistency for each TDM. These factors were developed using the county-specific total VMT from the 2002 travel model validation, the 2002 county-level HPMS VMT reported by TxDOT, and the county-specific 2001 ATR data (to produce the average non-summer weekday traffic [ANSWT] adjustment factors for the first equation, following). The 2001 ATR data was used instead of 2002 because of missing data in Jefferson County for 2002. The formula for the HPMS factor calculation, as applied for each BPA county is:

County HPMS VMT (AADT) × ANSWT Adjustment Factor = County HPMS VMT (ANSWT)

Region HPMS VMT (ANSWT) / Region Model VMT (ANSWT) = HPMS Factor

Applying the ANSWT adjustment to the HPMS AADT VMT (i.e., conversion from AADT to ANSWT) produces seasonal, day-of-week consistency between the TDM VMT and HPMS VMT components of the HPMS factor. The actual values for the county HPMS factors are:

Hardin: 1,431,413.355 × 1.0323127 = 1,477,666.185 (HPMS ANSWT VMT);

Jefferson: 6,705,065.686 × 1.0285808 = 6,896,701.827 (HPMS ANSWT VMT);

Orange: 2,833,063.158 × 1.0325609 = 2,925,310.244 (HPMS ANSWT VMT); and

Region: 11,299,678.257 / 10,902,324.045 = 1.036446744 (HPMS Factor).

*Future Year Analyses – Seasonal Adjustment Factor*

For the future year analyses, a seasonal adjustment factor was used to adjust the TDM and estimated intrazonal VMT to ozone season summer weekday VMT. The seasonal adjustment factor was developed using aggregated ATR data from the Beaumont TxDOT district for the years 2000 – 2010. One factor was calculated by dividing the average day-of-week (weekday) count by the ANSWT traffic count and applied to each county and analysis year. The seasonal adjustment factor for this analysis was 1.06428.

*Future Year Analyses – Intermediate Year Adjustment Factors*

For those analysis years where a TDM does not currently exist (i.e., 2014 and 2017), intermediate year adjustment factors were used to estimate the analysis year VMT from an existing TDM. These adjustment factors were developed using the bounding year TDMs (2011 and 2021) and applied to the TDM as specified in Table 7. The intermediate year adjustment factors were based on the annually compounded growth rates between the 2011 and 2021 TDM, as shown in Table 9.

**Table 9. Annually Compounded Growth Rates.**

| County | 2011 TDM VMT[1] | 2021 TDM VMT[1] | Growth Rate |
|---|---|---|---|
| Jefferson | 6,981,870 | 7,757,444 | 1.01058928 |
| Orange | 3,118,689 | 3,558,242 | 1.01327268 |
| Hardin | 1,885,564 | 2,150,815 | 1.01324895 |

[1] Includes the estimated intrazonal VMT.

The annual growth rates were then converted into the intermediate year adjustment factors using the following equation:

$$\text{Intermediate Year Adj. Factor} = \text{Growth Rate}^{\text{Target Year - Base Year}}$$

Where:

Target Year = the desired intermediate year;
Base Year = the year of the TDM used for estimating the VMT; and
Growth Rate = the annual growth rate from the range of TDM years encompassing the Target Year.

The intermediate year adjustment factors were calculated for each county and analysis year, producing six adjustment factors. The intermediate adjustment factors were applied to each link in the designated base TDM (including the intrazonal VMT) in addition to the VMT adjustments discussed in the previous sections to estimate the analysis year VMT. Table 10 shows the intermediate year adjustment factors.

**Table 10. Intermediate Year Adjustment Factors.**

| County | 2014[1] | 2017[2] |
|---|---|---|
| Jefferson | 1.032105439 | 0.958740877 |
| Orange | 1.040348874 | 0.948625215 |
| Hardin | 1.040275770 | 0.948714101 |

[1] Applied to 2011 TDM VMT (including intrazonal VMT) to estimate analysis year VMT.
[2] Applied to 2021 TDM VMT (including intrazonal VMT) to estimate analysis year VMT.

*Future Year Analyses – VMT Summary*

For each future year (i.e., 2011, 2014, 2017, and 2021), the final HPMS-consistent, day-type-specific VMT is comprised of two parts – the link-level VMT and the estimated intrazonal VMT. The volume for each link was multiplied by the HPMS factor, the seasonal adjustment factor, and the link's respective length to estimate the link-level VMT (hourly factors were applied to distribute the resulting VMT over each hour of the day, discussed in a later section). The HPMS and seasonal adjustment factors (as well as the hourly factors mentioned previously) were also applied to the estimated intrazonal VMT. For those future years where TDMs do not exist (i.e., 2014 and 2017), the appropriate intermediate year VMT adjustment factors were applied to the volume for each link prior to the VMT calculation and to the estimated intrazonal VMT. Table 11 and Table 12 show the TDM and ozone season weekday VMT summaries.

**Table 11. BPA 2011 and 2014 VMT Summary.**

| County | 2011 | | 2014[1] | |
|---|---|---|---|---|
| | TDM | Weekday | TDM | Weekday |
| Jefferson | 6,981,870 | 7,701,489 | 6,981,870 | 7,948,748 |
| Orange | 3,118,689 | 3,440,131 | 3,118,689 | 3,578,937 |
| Hardin | 1,885,564 | 2,079,909 | 1,885,564 | 2,163,678 |

[1] Based on 2011 TDM with intermediate year VMT factors.

**Table 12. BPA 2017 and 2021 VMT Summary.**

| County | 2017[1] | | 2021 | |
|---|---|---|---|---|
| | TDM | Weekday | TDM | Weekday |
| Jefferson | 7,757,444 | 8,203,946 | 7,757,444 | 8,557,001 |
| Orange | 3,558,242 | 3,723,343 | 3,558,242 | 3,924,988 |
| Hardin | 2,150,815 | 2,250,822 | 2,150,815 | 2,372,498 |

[1] Based on 2021 TDM with intermediate year VMT factors.

### Hourly Travel Factors

Hourly travel factors were used to distribute the TDM and intrazonal VMT to each hour of the day. These hourly travel factors were developed using multi-year (2000 through 2010) aggregated ATR station data for the three-county BPA area. Each factor (i.e., 24, or one for each hour of the day) was then multiplied by the link volume (in addition to the other VMT adjustment factors). These adjusted link volumes were then multiplied by their respective link lengths to estimate the link level, ozone season summer weekday VMT estimates for each analysis year. These factors were also multiplied by the estimated intrazonal VMT to produce the final hourly-adjusted VMT. Table 13 shows the weekday hourly travel factors.

**Table 13. Weekday Hourly Travel Factors.**

| Hour | Weekday |
|---|---|
| 12:00 a.m. | 0.011109 |
| 1:00 a.m. | 0.008287 |
| 2:00 a.m. | 0.007323 |
| 3:00 a.m. | 0.007374 |
| 4:00 a.m. | 0.012088 |
| 5:00 a.m. | 0.027261 |
| 6:00 a.m. | 0.045726 |
| 7:00 a.m. | 0.058822 |
| 8:00 a.m. | 0.050728 |
| 9:00 a.m. | 0.048863 |
| 10:00 a.m. | 0.052146 |
| 11:00 a.m. | 0.056893 |
| 12:00 p.m. | 0.059840 |
| 1:00 p.m. | 0.061044 |
| 2:00 p.m. | 0.062801 |
| 3:00 p.m. | 0.068873 |
| 4:00 p.m. | 0.072972 |
| 5:00 p.m. | 0.075035 |
| 6:00 p.m. | 0.057294 |
| 7:00 p.m. | 0.044919 |
| 8:00 p.m. | 0.037733 |
| 9:00 p.m. | 0.031814 |
| 10:00 p.m. | 0.023652 |
| 11:00 p.m. | 0.017403 |

### Time-of-Day Directional Split Factors

The TDMs for the BPA area are also non-directional (i.e., speed and volume are only listed for the link, not in both directions). Directional split factors were used to produce the VMT and speeds by direction. These factors were multiplied by the link volume to estimate the volume of travel in each direction, one record containing the estimated volume in the peak (or dominant) direction, and the second record containing the estimated volume in the opposite direction. These directional volume estimates were used not only to estimate the VMT in each direction, but also to estimate the directional speeds (discussed in the next section).

The directional split factors were developed for application by time-of-day period (Table 14), at the facility type (Table 15), and area type level (Table 16).

**Table 14. BPA Time-of-Day Travel Periods.**

| Period | Hours |
| --- | --- |
| AM Peak | 6 a.m. - 9 a.m. |
| Mid-Day | 9 a.m. – 4 p.m. |
| PM Peak | 4 p.m. – 7 p.m. |
| Overnight | 7 p.m. - 6 a.m. |

**Table 15. BPA Network Facility Types.**

| Facility Type Code | Facility Type Description |
|---|---|
| 1 | Radial IH Freeways - Mainlanes Only |
| 2 | Radial IH Freeways - Mainlanes and Frontage Roads |
| 3 | Circumferential IH Freeways (Loops) - Mainlanes Only |
| 4 | Circumferential IH Freeways (Loops) - Mainlanes and Frontage Roads |
| 5 | Radial Other Freeways - Mainlanes Only |
| 6 | Radial Other Freeways - Mainlanes and Frontage Roads |
| 7 | Circumferential Other Freeways (Loops) - Mainlanes Only |
| 8 | Circumferential Other Freeways (Loops) - Mainlanes and Frontage Roads |
| 9 | Radial Expressways[1] |
| 10 | Circumferential Expressways (Loops)[1] |
| 11 | Principal Arterial - Divided |
| 12 | Principal Arterial - Continuous Left Turn Lane |
| 13 | Principal Arterial - Undivided |
| 14 | Minor Arterial - Divided |
| 15 | Minor Arterial - Continuous Left Turn Lane |
| 16 | Minor Arterial - Undivided |
| 17 | Collector - Divided |
| 18 | Collector - Continuous Left Turn Lane |
| 19 | Collector - Undivided |
| 20 | Frontage Road |
| 21 | Ramp (Between Frontage Road and Mainlanes) |
| 22 | Interchange Ramp (Freeway-to-Freeway Interchange Ramps) |
| 0 | Centroid Connector |

[1] Directional split factors not used – facility types not in any of the models.

**Table 16. BPA Network Area Types.**

| Area Type Code | Area Type Description |
|---|---|
| 1 | CBD |
| 2 | CBD Fringe |
| 3 | Urban |
| 4 | Suburban |
| 5 | Rural |

These time-of-day directional split factors were taken from the Technical Note, *1996 Jefferson, Orange, and Hardin Counties Periodic Emissions Inventory*, TTI, November 26, 1997. These data were provided by TxDOT's Transportation Planning and Programming Division after collaboration with TxDOT's Beaumont District and the Beaumont/Port Arthur Metropolitan Planning Organization. The directional split factors were initially based on functional class and not facility type. A correlation table was developed to relate the functional-class-based directional splits to the facility types listed in the model. Appendix D (Directional Split Estimates) contains the directional splits and the correlation table relating the functional class descriptions in the original directional split data to the facility types used in the BPA TDM.

## ESTIMATION OF LINK SPEEDS

To estimate link operational (congested) speeds, a speed model involving both the link estimated free-flow speed and estimated directional delay (as a function of volume and capacity) was used. This model was used to estimate the hourly, directional, congested speed for each link, except for the TDM centroid connectors and added intrazonal links. The congested speed was calculated using the following formula:

$$Congested\ Speed = \frac{60}{\frac{60}{Freeflow\ Speed} + Delay}$$

Free-flow speed factors were used to convert TDM speeds (which are by definition level of service [LOS] C) to LOS A speeds (free flow). For each facility type and area type combination, the free-flow speed factors were calculated by dividing the free-flow speed by the corresponding speed from the speed/capacity look-up table used for the TDM. The free-flow speeds were determined using the Highway Capacity Manual (HCM), using suitable assumptions to relate the HCM data to the facility types used in the TDMs. Appendix E (Capacity Factors and Speed Factors) shows the free-flow speed factors used by area-type/functional-class combination.

The second component of the speed model used to calculate the congested speed is the estimated directional delay. The directional delay (in minutes per mile) due to congestion was calculated using the following volume/delay equation:

$$Delay = Min\left[ A\,e^{B(\frac{V}{C})}, M \right]$$

Where:

Delay = congestion delay (in minutes/mile);
A & B = volume/delay equation coefficients;
M = maximum minutes of delay per mile; and
V/C = time-of-day directional V/C ratio.

The delay model parameters (A, B, and M) were developed for the Dallas/Fort Worth area and verified by application in other Texas urban areas. Table 17 shows these parameters, followed by
Table 18, which lists the facility types used in the TDMs and their capacity category (except for centroid connector and intrazonal, which do not use capacity data).

**Table 17. Volume/Delay Equation Parameters.**

| **Facility Category** | **A** | **B** | **M** |
|---|---|---|---|
| High-Capacity Facilities | 0.015 | 3.5 | 5 |
| Low-Capacity Facilities | 0.050 | 3.0 | 10 |

**Table 18. Facility Type Categories for Applying Delay Parameters.**

| Category | TDM Facility Type Code | TDM Facility Type Description |
|---|---|---|
| High-Capacity | 1 | Radial IH Freeways - Mainlanes Only |
| | 2 | Radial IH Freeways - Mainlanes and Frontage Roads |
| | 3 | Circumferential IH Freeways (Loops) - Mainlanes Only |
| | 4 | Circumferential IH Freeways (Loops) - Mainlanes and Frontage Roads |
| | 5 | Radial Other Freeways - Mainlanes Only |
| | 6 | Radial Other Freeways - Mainlanes and Frontage Roads |
| | 7 | Circumferential Other Freeways (Loops) - Mainlanes Only |
| | 8 | Circumferential Other Freeways (Loops) - Mainlanes and Frontage Roads |
| Low-Capacity | 11 | Principal Arterial - Divided |
| | 12 | Principal Arterial - Continuous Left Turn Lane |
| | 13 | Principal Arterial - Undivided |
| | 14 | Minor Arterial - Divided |
| | 15 | Minor Arterial - Continuous Left Turn Lane |
| | 16 | Minor Arterial - Undivided |
| | 17 | Collector - Divided |
| | 18 | Collector - Continuous Left Turn Lane |
| | 19 | Collector - Undivided |
| | 20 | Frontage Road |
| | 21 | Ramp (Between Frontage Road and Mainlanes) |
| | 22 | Interchange Ramp (Freeway-to-Freeway Interchange Ramps)[1] |

[1] For delay parameter purposes, interchange ramps were considered to have characteristics (i.e., link speeds and capacities) closer to the low-capacity category than that of the high-capacity category.

The time-of-day directional V/C ratios were estimated using the directional volume (from the VMT estimation) and the time-of-day directional capacity. However, the 24-hour user equilibrium assignments were performed using non-directional 24-hour capacities. To estimate the time-of-day directional capacity, the directional split for capacity was assumed at 50/50 and capacity factors were multiplied by the non-directional capacity for each link. Appendix E (Capacity Factors and Speed Factors) summarizes the capacity factors for the BPA region TDMs by area type/facility type combination. Capacity factors were calculated using the following formula:

$$\textit{Capacity Factor} = \frac{\textit{(Hourly Capacity per Lane) (Length of the Time Period)}}{\textit{24 - Hour Capacity per Lane}}$$

Capacity data are not used, however, for the centroid connector links and the added intrazonal links (added specifically for air emissions analyses). The centroid connector traffic assignment input speeds were used as the centroid connector operational speeds estimates. Operational speeds for the intrazonal trips category were estimated by zone as the average of the zone's centroid connector speeds.

## ESTIMATION OF OFF-NETWORK ACTIVITY

To estimate the off-network (or parked vehicle) emissions using the grams per activity emissions rates (i.e., grams per SHP, grams per start, and grams per SHI), county-level estimates of the SHP, starts, and SHI are required by hour and SUT/fuel type for each analysis year. One of the main components of the SHP and starts off-network activity estimation is the county-level vehicle population for each analysis year. Appendix F includes summaries of the vehicle population and 24-hour SHP, starts, and SHI off-network activity. Hourly SHP, starts, and SHI activity estimates are included with the detailed EI data provided (see inventory data file descriptions in Appendix A).

The county-level vehicle population estimates were developed using the MOVESpopulationBuild utility. The county-level SHP and starts by hour and SUT/fuel type estimates were developed using the ShpExtIdleStartActBld utility. The county-level SHI by hour and SUT/fuel type estimates were developed using the ExtIdleHrsCalc utility. Appendix B contains a description of the utilities.

### Estimation of Vehicle Population

The vehicle population estimates (by SUT/fuel type) are needed to estimate the SHP and starts off-network activity. The vehicle population estimates (included as Appendix F) were produced for each county and analysis year. The vehicle population estimates are a function of vehicle registration data (TxDOT registration data sets), population scaling factors (where applicable), and SUT/fuel type VMT mix.

For estimating vehicle populations, a historical analysis year is defined as any year where actual TxDOT registration data and HPMS VMT data (used in developing population scaling factors) exists. Therefore, the 2005 analysis year was considered a historical year and the vehicle population estimates were based on the TxDOT registration data for the analysis year. Since the 2011 HPMS VMT data was not available, the 2011 analysis year (along with the 2014, 2017, and 2021 analysis years) were considered future analysis years (i.e., TxDOT registration data does not exist). For the future analysis years, the vehicle population estimates were based on the most recent year (2010) TxDOT registration data set for which HPMS VMT data exists and analysis year population scaling factors.

The VMT mix used to estimate the vehicle population is the aggregate (i.e., all road-type categories) TxDOT district-level weekday SUT/fuel type VMT mixes. The development of these VMT mixes are described in more detail in the "Development of SUT/Fuel Type VMT Mix" section and included as Appendix C.

*Historical Vehicle Population Estimates*

The county-level vehicle population estimates for the 2005 historical analysis year were calculated using the 2005 county-level, mid-year TxDOT vehicle registrations and the assigned aggregate SUT/fuel type VMT mix (see Table 6 and Appendix C). The vehicle population estimation process assumes that all of the non-long-haul SUT category populations for a county are represented in the county vehicle registrations data. This process also estimates the long-haul category populations as an expansion of the county registrations. There are three main steps in the vehicle estimation process: registration data category aggregation, calculation of the SUT/fuel type population factors, and estimation of the county-level vehicle population by SUT/fuel type.

The first step in the vehicle estimation process is the registration data category aggregation. For each county, the analysis year vehicle registrations were aggregated into five categories. Table 19 shows these five categories.

**Table 19. Registration Data Categories.**

| Registration Data Category | Vehicle Registration Aggregation |
|---|---|
| 1 | Motorcycles |
| 2 | Passenger Cars (PC) |
| 3 | Trucks <= 8.5 K gross vehicle weight rating (GVWR) (pounds) |
| 4 | Trucks > 8.5 and <= 19.5 K GVWR |
| 5 | Trucks > 19.5 K GVWR |

The second step is calculating the SUT/fuel type population factors. Using the assigned aggregate SUT/fuel type VMT mix, SUT/fuel type population factors were calculated for each SUT/fuel type combination. For the non-long-haul SUT categories, the SUT/fuel population factors were calculated by dividing the SUT/fuel type VMT mix by the summed total of the SUT/fuel type VMT mix fractions in its associated vehicle registration data category. For example, the LCT_Diesel population factor using the VMT mix is LCT_Diesel/(PT_Gas + PT_Diesel + LCT_Gas + LCT_Diesel). For the long-haul SUTs, the SUT/fuel type population factors were calculated by taking the ratio of the long-haul and short-haul VMT mix values. For example, the SULhT_Gas population factor using SUT mix fractions is

SULhT_Gas/SUShT_Gas. Table 20 shows the vehicle registration aggregations and their associated MOVES SUT/fuel types.

**Table 20. TxDOT Vehicle Registration Aggregations and Associated SUT/Fuel Types for Estimating SUT/Fuel Type Populations.**

| Vehicle Registration[1] Aggregation | Associated MOVES SUT/Fuel Type[2] |
|---|---|
| Motorcycles | MC_Gas |
| Passenger Cars (PC) | PC_Gas; PC_Diesel |
| Trucks <= 8.5 K GVWR (pounds) | PT_Gas; PT_Diesel;<br>LCT_Gas; LCT_Diesel |
| Trucks > 8.5 and <= 19.5 K GVWR | RT_Gas; RT_Diesel<br>SUShT_Gas; SUShT_Diesel<br>MH_Gas; MH_Diesel<br>IBus_Diesel<br>TBus_Gas; TBus_Diesel<br>SBus_Gas; SBus_Diesel |
| Trucks > 19.5 K GVWR | CShT_Gas; CShT_Diesel |
| NA[1] | SULhT_Gas; SULhT_Diesel<br>CLhT_Gas; CLhT_Diesel |

[1] The four long-haul SUT/fuel type populations are estimated using a long-haul-to-short-haul weekday SUT VMT mix ratio applied to the short-haul SUT population estimate.
[2] The mid-year TxDOT county registrations data extracts were used (i.e., the three-file data set consisting of: 1 - light-duty cars, trucks, and motorcycles; 2 - heavy-duty diesel trucks; and 3 - heavy-duty gasoline trucks) for estimating the vehicle populations.

The third step is the estimation of the county-level vehicle population by SUT/fuel type. The non-long-haul SUT/fuel type vehicle populations were estimated by applying their SUT/fuel type population factors to the appropriate registration data category. For the CLht_Gas type, the vehicle population was set to 0. For the remaining three long-haul SUT/fuel types (SULhT_Gas, SULhT_Diesel, and CLhT_Diesel), the vehicle populations were calculated as the product of the corresponding short-haul category vehicle population and the associated long-haul population factor (e.g., SULhT_Gas vehicle population = SUShT_Gas vehicle population x [SULhT_Gas SUT mix fraction/ SUShT_Gas SUT mix fraction]).

*Future Vehicle Population Estimates*

The process for estimating the county-level vehicle population estimates for the future analysis years (2011, 2014, 2017, and 2021) is very similar to the historical vehicle population estimates except that instead of using the analysis year registration data sets, the most recent (2010) mid-year TxDOT registration data sets for which HPMS VMT data exists were used. Using these registration data sets and the assigned VMT mix, the base SUT/fuel type population for 2010 was calculated. To estimate the future analysis year county-level vehicle populations, future year county-level vehicle population scaling factors were applied to the base SUT/fuel type population for 2010. These future year county-level vehicle population scaling factors were calculated as the ratio of the county-level weekday VMT for the analysis year to the county-level weekday VMT for the year of the registration data (i.e., vehicle population increases linearly with VMT).

## Estimation of SHP

The first activity measure needed to estimate the off-network emissions using the grams per activity emissions rates are county-level weekday estimates of SHP by hour and SUT/fuel type for each analysis year, season, and day type. For each hour, the county-level SHP by SUT/fuel type was calculated by taking the difference between the total available hours minus the SHO by SUT/fuel type. Since this calculation was performed at the hourly level, the total available hours by SUT/fuel type is the same as the vehicle population by SUT/fuel type. The SHO was calculated using the link VMT and speeds and the TxDOT district-level SUT/fuel type VMT mixes by MOVES road-type category (see the "Development of SUT/Fuel Type VMT Mix" section for more details). Appendix F includes the 24-hour summaries of the county-level weekday estimates of SHP by hour and SUT/fuel type for each analysis year (hourly summaries were provided electronically to TCEQ; see Appendix A for electronic data descriptions).

### *Total Available Hours by SUT/Fuel Type*

The total available hours by SUT/fuel type is typically calculated as the vehicle population times the number of hours in the time period. Since this calculation was performed at the hourly level, the total available hours by SUT/fuel type for each analysis year was set equal to the vehicle population by SUT/fuel type for the analysis year.

### *SHO by SUT/Fuel Type*

To calculate the VHT (or SHO) for a given link, the VMT was allocated to each SUT/fuel type using the TxDOT district-level SUT/fuel type VMT mixes by MOVES road-type category, which was then divided by the link speed to calculate the link SHO by SUT/fuel type. These VMT mixes are the same VMT mixes used to estimate emissions in the emissions estimation process (see Table 6 and Appendix C). This SHO calculation was performed for each link in a given hour, aggregating the SHO to one value per SUT/fuel type per hour.

## Estimation of Starts

The second activity measure needed to estimate the off-network emissions using the grams per activity emissions rates are county-level estimates of starts by hour and SUT/fuel type for each analysis year, season, and day type. The hourly default starts per vehicle by SUT/fuel type were multiplied by the analysis year county-level vehicle population by SUT/fuel type to estimate the county-level starts by hour and SUT/fuel type. Appendix F includes the 24-hour summaries of the county-level starts by hour and SUT/fuel type for each analysis year (hourly summaries were provided electronically to TCEQ; see Appendix A for electronic data descriptions).

For the hourly default starts per vehicle, the MOVES defaults were used. The MOVES activity output was used to estimate the hourly starts per vehicle for a MOVES weekday and MOVES weekend run by dividing the MOVES start output by the MOVES vehicle population output. These MOVES default starts per vehicle do not vary by year or geography (i.e., county), only by MOVES day type. Since the emissions inventories are for weekday, only the MOVES weekday default starts per vehicle were used.

## Estimation of SHI

The third activity measure needed to estimate the off-network emissions using the grams per activity emissions rates are county-level estimate of SHI by hour and SUT/fuel type for each analysis year, season, and day type. These SHI estimates were for source type 62, fuel type 2 (CLhT_Diesel) only. The SHI was based on information from a TCEQ extended idling study, which produced 2004 summer weekday SHI estimates for each Texas county. SHI scaling factors (by analysis) were applied to the base 2004 summer weekday SHI values from the study to estimate the 24-hour SHI by analysis year. SHI hourly factors were then applied to allocate the 24-hour SHI by analysis year to each hour of the day. To ensure valid hourly SHI values are used in the emissions estimation, the hourly SHI was compared to the CLhT_Diesel hourly SHP (i.e., hourly SHI values cannot exceed the hourly SHP values). Appendix F includes the 24-hour summaries of the county-level estimates of SHI by hour and SUT/fuel type for each analysis year (hourly summaries were provided electronically to TCEQ; see Appendix A for electronic data descriptions).

### *SHI Scaling Factors*

To estimate the county-level 24-hour SHI by analysis year, county-level SHI scaling factors were developed using county-level 2004 summer weekday link-level VMT and speeds, the TxDOT district-level base weekday SUT/fuel type VMT mix (by MOVES road type), the county-level analysis year weekday link-level VMT and speeds, and the TxDOT district-level analysis year SUT/fuel type VMT mix (by MOVES road type). The 2004 summer weekday link-level VMT and speeds were developed using a similar to process as the historical analysis year (2005) analysis year weekday link-level VMT speeds using the BPA 2002 TDM and 2004 summer weekday VMT control totals. The SUT/fuel type VMT mixes were the same VMT mixes used to estimate emissions in the emissions estimation process (see Table 6 and Appendix C). For the base weekday SUT/fuel type VMT mix, the 2005 weekday SUT/fuel type VMT mix was used.

For each link in the 2004 summer weekday link-level VMT and speeds, the link VMT was allocated to CLhT_Diesel using the base weekday SUT/fuel type VMT mix. This VMT allocation was performed for each link and hour in the 2004 summer weekday link-level VMT and speeds, with the individual link VMT aggregated by hour to produce the CLhT_Diesel hourly and 24-hour 2004 summer weekday VMT. Using a similar allocation process, the analysis year CLhT_Diesel hourly and 24-hour VMT was calculated using the analysis year weekday link-level VMT and speeds and the analysis year SUT/fuel type VMT mix. The county-level 24-hour SHI scaling factors by analysis year were calculated by divding the analysis year and day type CLhT_Diesel 24-hour VMT by the CLhT_Diesel 24-hour 2004 summer weekday VMT.

### *SHI Hourly Factors*

To allocate the analysis year and weekday county-level 24-hour SHI to each hour of the day, SHI hourly factors were used. These SHI hourly factors were calculated as the inverse of the analysis year weekday CLhT_Diesel hourly VMT fractions. The analysis year weekday CLhT_Diesel hourly VMT fractions were calculated using the analysis year weekday CLhT_Diesel hourly VMT. The analysis year weekday CLhT_Diesel hourly VMT were converted to hourly fractions, therefore creating analysis year weekday CLhT_Diesel hourly VMT fractions. The inverse of these hourly VMT fractions were calculated and the inverse for each hour was divided by the sum of the inverse hourly VMT fractions across all hours to calculate the county-level analysis year weekday SHI hourly factors.

*County-Level CLhT_Diesel SHI by Hour Estimation*

The base analysis year weekday CLhT_Diesel SHI by hour was calculated by multiplying the 24-hour 2004 summer weekday SHI by the SHI scaling factor and by the SHI hourly factors. For each hour, the base analysis year weekday CLhT_Diesel SHI was then compared to the analysis year weekday CLhT_Diesel SHP to estimate the final analysis year weekday CLhT_Diesel SHI by hour. If the base analysis year weekday CLhT_Diesel SHI value was greater than the analysis year weekday CLhT_Diesel SHP value, then the final analysis year weekday CLhT_Diesel SHI for that hour was set to the analysis year weekday CLhT_Diesel SHP value. Otherwise, the final analysis year weekday CLhT_Diesel SHI for that hour was set to the base analysis year weekday CLhT_Diesel SHI value. All calculations (scaling factors, SHI hourly factors, and SHI by hour calculations) were performed by county and analysis year (i.e., three SHI scaling factors were calculated per analysis year).

## ESTIMATION OF EMISSIONS FACTORS

TTI developed emissions factors using MOVES2010a (software and database released in EPA's MOVES2010a Installation Suite, revised September 23, 2010, downloadable from http://www.epa.gov/otaq/models/moves/index.htm). The emissions factors were developed based on the current MOVES guidance as documented in *Technical Guidance on the Use of MOVES2010 for Emission Inventory Preparation in State Implementation Plans and Transportation Conformity*, EPA, April 2010. This MOVES EI *Technical Guidance* along with *Motor Vehicle Emission Simulator (MOVES) User Guide for MOVES1010a*, EPA, August 2010; and *Update Of On-Road Inventory Development Methodologies For Motor Vehicle Emissions Simulator (Moves) Model Compatibility Technical Report*, TTI, July 2011 (MOVES output post-processing utilities used are summarized in Appendix B of this Technical Report), are the main references where additional detail may be found.

The detailed link-based EI method of analysis requires emissions rates by speed in look-up table form; the MOVES Emission Rate (as opposed to Inventory) mode was thus selected to direct MOVES to output emission rates, emissions, and activity data by MOVES speed bin average speed (2.5, 5, 10….. 75 mph). The EI method required that all rates be in terms of mass/activity (as opposed to the off-network rates in terms of mass/vehicle as output by MOVES) for the external emissions calculations. TTI post processed the MOVES emissions and activity output to produce all emissions rates in mass/activity terms (see Table 21, which was included in a previous section, but is provided again here for convenience).

**Table 21. Emissions Rates by Process and Activity Factor.**

| Emissions Process | Activity[1] | Emissions Rate Units |
|---|---|---|
| Running Exhaust | VMT | grams/mile (g/mi) |
| Brakewear | VMT | g/mi |
| Tirewear | VMT | g/mi |
| Evaporative Permeation | VMT; SHP | g/mi; g/SHP |
| Evaporative Fuel Vapor Venting | VMT; SHP | g/mi; g/SHP |
| Evaporative Fuel Leaks | VMT; SHP | g/mi; g/SHP |
| Crankcase Running Exhaust | VMT | g/mi |
| Start Exhaust | starts | g/start |
| Crankcase Start Exhaust | starts | g/start |
| Crankcase Extended Idle Exhaust | SHI | g/SHI |
| Extended Idle Exhaust | SHI | g/SHI |

[1] The amount of travel on roads (VMT), SHP, vehicle starts, and SHI are the basic activity factors. SHI is for Combination Long-Haul Trucks only.

The MOVES model is equipped with default modeling values for the range of conditions that affect emissions factors. MOVES defaults may be replaced by alternate input data sets that better reflect local scenario conditions. Where local data were available, MOVES defaults were replaced by local input values, via the MOVES Run Specifications file (RunSpec or MRS) and MOVES CDB (county input database). (The MOVES RunSpecs, CDBs, and MOVES default database provide the data for each local scenario model run.) Local inputs were developed and used to produce emissions factors characteristic of local June through August period peak ozone season weather conditions, summer fuel properties, vehicle fleet characteristics, and emissions control programs. In the case of the activity input data to MOVES, the MOVES defaults were in general used, which is basic to the method (default activity is divided out to unity in the rates calculation, and local activity estimates are applied later in the external emissions calculations). Since MOVES does not model TxLED fuel, diesel vehicle $NO_x$ emissions rates were post-processed to include TxLED effects.

## MOVES Inputs, Outputs and Post-Processing

There is one RunSpec required per county and year, and a corresponding number of CDBs and output databases. Thus, for three counties and five years, there are 15 each of MOVES RunSpecs, MOVES CDBs, and MOVES output databases. Correspondingly, there are 15 each of the post-processing utility runs, MOVESRatesCalc (for calculating the rates-per-activity rate tables) and MOVESRatesAdj (for $NO_x$ TxLED effect adjustments, and for extracting and storing only the rates for the inventoried pollutants in a separate, smaller database for input to the emissions runs). See the utility descriptions and the process flow diagram in Appendix B.

### Summary of Control Programs Modeled

Other than the TxLED fuel post-processing, all control programs were modeled via the MOVES model and associated local input. Table 22 shows the control measures modeled in the analysis.

**Table 22. Control Measure Modeling by RFP Control Scenario.**

| Strategy[1] | Approach |
|---|---|
| Federal Motor Vehicle Control Program Standards | MOVES defaults. |
| Federal Low Emissions Heavy-Duty Diesel Engines Rebuild Program | MOVES defaults. |
| Federal Heavy-Duty 2004 Pull-Ahead Program | MOVES defaults. |
| Conventional Gasoline | Locality-specific inputs to MOVES developed by TTI in consultation with TCEQ, based on Beaumont area sample data from TCEQ summer 2005 and 2011 retail outlet fuel surveys, MOVES defaults, and regulated limits or allowables, as needed for future years. |
| Diesel Fuel | Locality-specific sulfur content inputs to MOVES, put together by TTI in consultation with TCEQ, based on actual, local survey data (i.e., Beaumont area sample data from TCEQ summer 2005 and 2011 retail outlet fuel surveys), and for future years, based on MOVES defaults. |
| | Post-process diesel vehicle $NO_x$ emissions rates for TxLED effects. TTI post-processed the 2011 and later analysis year diesel vehicle $NO_x$ emissions factors for all counties using evaluation-year-specific average $NO_x$ reduction factors provided by TCEQ (based on 4.8% and 6.2% reductions for 2002 and later, and 2001 and earlier model years, respectively).[1] |

[1] TCEQ's TxLED factor analysis spreadsheet by year is located in "mvs10a-statewide-txled-2011-analysis-11-14-17-18-19-21.zip," available at ftp://amdaftp.tceq.texas.gov/pub/mobile_EI/statewide/mvs/txled.

### MOVES Emissions Factor Aggregation Levels

The MOVES emissions factors for the analysis are produced at the following levels. The summer weekday emissions factor look-up tables provide the emission rates by:

- Up to 13 source types (i.e., vehicle types);
- Up to 4 fuel types;
- Up to 5 road types (four actual MOVES road categories and "off-network");
- Each of the 24 hours in a day;
- 16 speed bins (i.e., 2.5, 5, 10, 15,…. 75 mph) (only included in miles-based rate tables);

- Up to 38 pollutants; and
- Up to 13 emissions processes.

The vehicle fleet was assumed to be powered only by the predominant on-road fuels of gasoline or diesel. The five road type categories in MOVES are Off-Network (not actually a road type), Rural Restricted Access, Rural Unrestricted Access, Urban Restricted Access, and Urban Unrestricted Access. Of the two rate tables produced (by post-processing) for input to the emissions calculations: one rate table contains off-network rates, and the other includes rates for each of the actual four MOVES road types, indexed by 16 speeds. The speeds index corresponds to the 16 MOVES speed bin average speeds: 2.5, 5, 10, 15,…. 75 mph.

**MOVES Run Specifications**

The MRS (XML file) defines the place, time, vehicle, road, fuel, emissions producing process, and pollutant parameters for the modeling scenario. TTI developed the analysis MRS files by first creating an MRS template for each year using the MOVES Graphical User Interface (GUI), then looping through the templates with a basic file-building utility to create one MRS for each county and year. This process was used to produce the 15 MRSs for the analysis.

Table 23 describes the MRS selections TTI used in producing the MOVES emissions and activity output for calculating the emissions rates.

## Table 23. BPA Area County MRS Selections by GUI Panel.

<table>
<tr><th>Navigation Panel</th><th>Detail Panel</th><th colspan="3">Selection</th></tr>
<tr><td>Scale[1]</td><td>Domain/Scale;<br>Calculation Type</td><td colspan="3">County;<br>Emissions Rates</td></tr>
<tr><td>Time Spans[1]</td><td>Time Aggregation Level;<br>Years – Months – Days – Hours</td><td colspan="3">Hour;<br>2005 (2011, 2014, 2017, 2021) - July - Weekday - All</td></tr>
<tr><td>Geographic Bounds[1]</td><td>Region;<br>Selections;<br>Domain Input Database</td><td colspan="3">Zone and Link;<br>Hardin (Jefferson, Orange);<br><database name for county/year scenario></td></tr>
<tr><td rowspan="14">On-Road Vehicle Equipment</td><td rowspan="14">SUT/fuel combinations</td><td>SUT</td><td>Gasoline</td><td>Diesel</td></tr>
<tr><td>Motorcycle</td><td>X</td><td>-</td></tr>
<tr><td>Passenger Car</td><td>X</td><td>X</td></tr>
<tr><td>Passenger Truck</td><td>X</td><td>X</td></tr>
<tr><td>Light Commercial Truck</td><td>X</td><td>X</td></tr>
<tr><td>Intercity Bus</td><td>-</td><td>X</td></tr>
<tr><td>Transit Bus</td><td>-</td><td>X</td></tr>
<tr><td>School Bus</td><td>X</td><td>X</td></tr>
<tr><td>Refuse Truck</td><td>X</td><td>X</td></tr>
<tr><td>Single Unit Short-Haul Truck</td><td>X</td><td>X</td></tr>
<tr><td>Single Unit Long-Haul Truck</td><td>X</td><td>X</td></tr>
<tr><td>Motor Home</td><td>X</td><td>X</td></tr>
<tr><td>Combination Short-Haul Truck</td><td>X</td><td>X</td></tr>
<tr><td>Combination Long-Haul Truck</td><td>-</td><td>X</td></tr>
<tr><td>Road Type</td><td>Selected Road Types</td><td colspan="3">Off-Network –<br>Rural Restricted Access – Rural Unrestricted Access –<br>Urban Restricted Access – Urban Unrestricted Access</td></tr>
<tr><td>Pollutants and Processes[2]</td><td>VOC; CO; $NO_x$; Atmospheric $CO_2$; $PM_{10}$; $PM_{2.5}$</td><td colspan="3">Depending on pollutant, processes may include:<br>Running Exhaust, Start Exhaust, Extended Idle Exhaust, Crankcase Running Exhaust, Crankcase Start Exhaust, Crankcase Extended Idle Exhaust, Evap Permeation, Fuel Vapor Venting, Fuel Leaks, Brake Wear, Tire Wear</td></tr>
<tr><td>Manage Input Data Sets</td><td>Additional input database selections</td><td colspan="3">None</td></tr>
<tr><td>Strategies</td><td>Alternate Vehicle Fuels Technologies (AVFT)</td><td colspan="3">“New” button is grayed out, which means that an AVFT data set (local fuel fractions) was imported to the Runspec</td></tr>
<tr><td>General Output</td><td>Output Database;<br>Units;<br>Activity</td><td colspan="3"><database name for county/year/ scenario>;<br>Pounds, KiloJoules, Miles;<br>Distance Traveled, Source Hours, Source Hours Idling, Source Hours Operating, Source Hours Parked, Population, Starts</td></tr>
<tr><td>Output Emissions Detail</td><td>Always;<br>For All Vehicles/Equipment;<br>On Road</td><td colspan="3">Time: Hour – Location: Link – Pollutant;<br>Fuel Type, Emissions Process;<br>Source Use Type</td></tr>
<tr><td>Advanced Performance Measures</td><td>Aggregation and Data Handling</td><td colspan="3">All check boxes were “un-checked”</td></tr>
</table>

[1] County scale allows one county and year per run – all counties and years are listed for reference.

[2] Chained pollutants require other pollutant selections, not listed (e.g., VOC requires Total Gaseous Hydrocarbons and Non-Methane Hydrocarbons; $CO_2$ requires Total Energy Consumption). PM pollutants included: Primary Exhaust $PM_{10}$ - Total; Primary $PM_{10}$: Organic Carbon, Elemental Carbon, and Sulfate; Primary Exhaust $PM_{2.5}$ - Total; Primary $PM_{2.5}$: Organic Carbon, Elemental Carbon, Sulfate; Primary $PM_{10}$ - Brakewear; Primary $PM_{2.5}$ - Brakewear; Primary $PM_{10}$ - Tirewear; and Primary $PM_{2.5}$ - Tirewear.

*Scale, Time Spans, and Geographic Bounds*

The MOVES "County Domain/Scale" was selected as is required for SIP EI analyses. The MOVES Calculation Type "Emissions Rates" was selected (with other required selections) for MOVES to produce the activity and emissions output needed for input to the post-processing algorithms (see MOVESratescalc utility description in Appendix B) that calculate the emissions rate look-up tables with speed bin indexing, as needed for the detailed link-based emissions estimation process.

The Time Spans parameters were specified to provide the most detail available, which is the hourly aggregation level, for all hours of the day. One analysis year per run was selected, as MOVES allows only one "Years" selection for the County Domain Scale. For TTI's MOVES-based link emissions estimation process, which is for a single day, one "Months" (July for this analysis) and one "Days" (Weekdays) selection was made.

Under Geographic Bounds for the County Domain Scale, only one county may be selected. The user-produced CDB containing the scenario-specific input data for the county was specified as the County Domain Input Database, and under Region, "Zone & Link" was selected as required for the emissions rates calculation type. With these required set-ups, only one county, one year, and one day type was modeled per run.

*On-Road Vehicle Equipment and Road Type*

All of the SUTs associated with gasoline and diesel fuels were specified. Note that for this analysis, the MOVES default fuel/engine fractions were replaced with local inputs, which showed no compressed natural gas (CNG) vehicles in the fleet (the MOVES default fuel/engine fractions database includes some CNG Transit Buses), and no gasoline Transit Buses. (The local SUT/fuel type VMT mixes developed for the study define the SUT/fuel type combinations that were included in the MOVES runs.) For emissions rate calculations, all five MOVES road type categories were selected.

*Pollutants and Processes*

In MOVES, VOC is a "chained" pollutant, meaning that it is calculated based on one or more other pollutants that must also be calculated. In addition to the pollutants called for in this analysis, Total Gaseous Hydrocarbons (THC) and Non-Methane Hydrocarbons (NMHC) were additionally required for MOVES to produce the VOC emissions rates. Additionally, Total Energy Consumption (TEC) was required for MOVES to calculate $CO_2$ and sulfate particulate rates. All of the associated processes available by the selected pollutants were included, except for the two refueling emissions processes.

*Manage Input Data Sets and Strategies*

The Manage Input Datasets feature allows alternate inputs other than those included in the CDB. No additional inputs were included via Manage Input Datasets panel.

The Strategies, Alternative Vehicle Fuels & Technologies feature was used to import the local fuel/engine fractions (i.e., equivalent of diesel fractions inputs to MOBILE6) into the MOVES MRS. A year-specific fuel/engine fractions data set (e.g., year of local vehicle registration data extract used – 2005, and latest available 2011, for this analysis) was imported to each of two year-specific MRS templates (i.e., 2005 for 2005 analysis year, and 2011 for subsequent analysis years), prior to creating the individual scenario RunSpecs for each year.

*Output*

The output units were pounds (converted in a later step to grams), kilojoules, and miles. All of the activity categories were chosen for inclusion in the output database. The activity output was needed along with the emissions output to calculate the rates/activity emissions rates look-up tables via post-processing. The output detail level was by hour, link (i.e., county/road type/speed bin combination), pollutant, process, SUT, and fuel type.

Appendix A lists the electronic data files provided in support of this analysis, which includes the MOVES RunSpecs used.

**MOVES County Input Databases**

Most of the locality-specific input data for County scale runs are entered through the CDB (the exception is the alternate or local fuel/engine fractions which are input via the MRS). Additional user input data may be entered through separate databases via the Manage Input Datasets feature, although this feature was not used.

TTI developed procedures to facilitate building and checking CDBs for large scale EI projects. The basic procedure was to write a CDB builder MySQL script that was then converted to a template by replacing particular scenario-specific values (e.g., year, input file paths, county name/FIPS) with variables. The template was looped through for each scenario (in this case for each year and county) to produce the MySQL scripts needed to create all of the required CDBs. After executing the scripts to build the CDBs, a CDB checker utility was run on each CDB to verify that the 18 required tables (listed in Table 24) were built in the CDB and populated as intended.

To build all of the CDBs needed for the analysis, the required data were first prepared and organized. The input data for populating the CDBs includes local data from prepared text files and databases (e.g., for local fuels and weather data), and MOVES default data from MOVESDB20100830 (e.g., for default activity data), and some values provided directly in the CDB builder MySQL script.

Table 24 provides an outline and brief description of the CDBs, followed by discussion of the development of the local data and the defaults contained therein. Unless otherwise stated, the CDB table data applies to all counties and years.

**Table 24. MOVES CDB Input Tables.**

| Input Table[1] | Category | Notes |
|---|---|---|
| Year | Time | Designated analysis year as a base year (i.e., specifies that local activity inputs were supplied rather than forecast by the model). |
| State | Geography | Identified the state (Texas) for the analysis. |
| County | Geography/ Meteorology | Identified county of analysis. Contains local altitude and barometric pressure (TCEQ, October 2011). |
| Zonemonthhour | Meteorology | Hourly temperature and relative humidity (TCEQ, October 2011). |
| Roadtype[2] | Activity | Lists the MOVES road types and associated ramp activity fractions. Road type ramp fractions were set to 0. |
| Hpmsvtypeyear[3] | Activity (Defaults) | **Used MOVES defaults** – 1999 national annual VMT by HPMS vehicle category, except yearID was set to analysis year. |
| roadtypedistribution[3] | | **Used MOVES default** road type VMT fractions. |
| monthvmtfraction[3] | | **Used MOVES default** month VMT fractions. |
| dayvmtfraction[3] | | **Used MOVES default** day VMT fractions. |
| Hourvmtfraction[3] | | **Used MOVES default** hour VMT fractions. |
| Avgspeeddistribution[3] | | **Used MOVES default** average speed distributions. |
| sourcetypeyear[3] | Fleet (Defaults) | **Used MOVES default** – 1999 national SUT populations, except yearID was set equal to the analysis year value. |
| sourcetypeage-distribution | Fleet | TTI estimated SUT age fractions using mid-year TxDOT/TxDMV vehicle registration data and MOVES defaults, as needed. Analysis year-specific registration data were used for historical years and latest available for future years. |
| Fuelengfraction (text file import) | Fleet | TTI estimated SUT fuel fractions using TxDOT/TxDMV vehicle registration data and defaults where needed. Analysis year-specific registration data were used for historical years and latest available for future years. |
| Zone | Activity | Start, idle, 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 | Contains market share information for analysis year-specific summer gasoline and diesel formulations, developed by TTI in consultation with TCEQ. |
| fuelformulation | Fuel | Contains locality and analysis-year-specific summer gasoline and diesel fuel formulations developed by TTI in consultation with TCEQ. |
| imcoverage | I/M | Not applicable (empty table is included in CDB). |

[1] All of these datasets are CDB tables except for the fuel/engine fractions, which are imported to RunSpecs.
[2] MOVES does not produce "ramp road type" rates in a single run with the other road types. To calculate emissions for particular travel model ramp links, MOVES unrestricted access road type rates were used.
[3] Use of default activity and population inputs to MOVES is basic to the inventory method. It allows simultaneous development of emissions factors and local activity parameters required in the external emissions calculations. The MOVES default activity is normalized in the emissions rates calculation post-processing procedure (i.e., emissions/activity), and the actual local activity estimates are used in the external emissions calculations.

## User Inputs to MOVES via CDB – Locality Specific Inputs and Defaults Used

All inputs discussed in the following are input via the CDB unless otherwise noted (e.g., fuel/engine fractions). Unless otherwise stated, the inputs apply to all counties and analysis years.

*Year, State, and County Inputs to MOVES*

The year, state, and county tables are populated with data identifying the subject year, state and county of the run.

The yearID field of the "year" table was populated with the analysis year value, which was set as a base year (specifies that particular user-input fleet and activity data were to be used, rather than forecast by MOVES). StateID "48" (Texas) was inserted in the state table. The county table identifies the county of analysis and contains barometric pressure and altitude information (discussed further with other meteorological inputs). The county data was selected from a prepared local "meteorology" database containing tables of weather data records (i.e., "county" and "zonemonthhour" tables) for the analysis.

*Roadtype Table Inputs to MOVES*

Currently the MOVES model contains "ramp" emissions rates, but not a road type for ramps specifically. In the roadtype table, MOVES provides a field "rampFraction" for including a fraction of estimated ramp activity as a fraction of SHO on each of the MOVES road types. For this analysis, the MOVES default roadtype table data were used, but with the ramp fractions set to zero (i.e., 100% of activity on each MOVES road type was based on the road type drive cycles assigned to that road type by MOVES, exclusive of ramp activity; currently the MOVES Unrestricted Access road type rates are used with activity for particular ramp links in the external emissions calculations). The treatment of ramps for subsequent EI development projects will be updated to incorporate use of ramp rates.

*Default Activity and Population CDB Inputs to MOVES*

The vehicle activity and vehicle population inputs under the methodology use the MOVES defaults. The subject tables are: hpmsvtypeyear, roadtpyedistribution, monthvmtfaction, dayvmtfraction, hourvmtfraction, avgspeeddistribution, and sourcetypeyear. Data for all of these tables were selected and inserted from the MOVES default database. For the two tables dependent on year (i.e., hpmsvtypeyear and sourcetypeyear include the yearID field), the 1999 default data were used, and the yearID value was updated by setting it to the analysis year value.

The zone and zoneroadtype tables contain zonal sub-allocation activity factors. For county scale analyses, county is equal to zone, thus these allocation factors were set to 1.0.

*Local Fleet Age Distributions and Fuel Fractions Inputs to MOVES*

The locality-specific fleet inputs to MOVES consist of age distributions and diesel fractions (or fuel/engine fractions). The age distributions and fuel fractions inputs were calculated and written to text files in preparation for loading the data into the appropriate model input files or tables. The MOVESfleetInputBuild utility was used to produce these fleet inputs to MOVES in the required formats (see utility description in Appendix B).

One statewide level fuel fractions data set was produced for the 2005 historical year and imported to its particular year-specific MRS template prior to creation of all of the MRS files for 2005. For the "2011 and all future analysis years" MRS template, the latest available (2011) local dataset was used. The county-level SUT age distribution inputs for each year were loaded into the appropriate county scenario CDB sourcetypeagedistribution tables via the CDB builder MySQL scripts.

The age distributions and fuel/engine fractions were based on TxDOT mid-year county registrations data and MOVES model defaults, as needed. The fuel/enhine fractions were developed consistent with the SUT/fuel types in the VMT mix (e.g., no CNG vehicles are in the SUT/fuel type VMT mix resulting in fuel/engine fractions for CNG of zero). Locality-specific age distributions were produced based on the TxDOT county vehicle registration category aggregations consistent with the vehicle registration category aggregations used in estimating the SUT/fuel type VMT mix (see Appendix B). See age distributions and diesel fractions summaries in Appendix G.

Table 25 summarizes the data sources and aggregation levels used to estimate the BPA county sourcetypeagedistributions and fuel/engine fractions.

**Table 25. Data Sources and Aggregations for SUT Age Distributions and Fuel/Engine Fractions.**

<table>
<tr><th>SUT Name</th><th>SUT ID</th><th>TxDOT Category[1] Aggregations for Age Distributions and Fuel/Engine Fractions</th><th>Geographic Aggregation for Age Distributions</th><th>Geographic Aggregation for Fuel/Engine Fractions[2]</th></tr>
<tr><td>Motorcycle</td><td>11</td><td>Motorcycles</td><td>County</td><td>NA – 100 percent gas, no Fuel/Engine Fractions</td></tr>
<tr><td>Passenger Car</td><td>21</td><td>Passenger</td><td>County</td><td>MOVES default</td></tr>
<tr><td>Passenger Truck</td><td>31</td><td>Total Trucks<=8500</td><td>County</td><td>MOVES default</td></tr>
<tr><td>Light Commercial Truck</td><td>32</td><td>Total Trucks<=8500</td><td>County</td><td>MOVES default</td></tr>
<tr><td>Single-Unit Short-Haul Truck</td><td>52</td><td>>8500+ >10000+ >14000+>16000</td><td>BPA Region</td><td>Texas Statewide</td></tr>
<tr><td>Single-Unit Long-Haul Truck</td><td>53</td><td>>8500+ >10000+ >14000+>16000</td><td>Texas Statewide</td><td>Texas Statewide</td></tr>
<tr><td>Refuse Truck</td><td>51</td><td rowspan="5" colspan="3">MOVES default</td></tr>
<tr><td>Motor Home</td><td>54</td></tr>
<tr><td>Intercity Bus</td><td>41</td></tr>
<tr><td>Transit Bus[2]</td><td>42</td></tr>
<tr><td>School Bus</td><td>43</td></tr>
<tr><td>Combination Short-Haul Truck</td><td>61</td><td>>19500+ >26000+ >33000+ >60000</td><td>BPA Region</td><td>Texas Statewide</td></tr>
<tr><td>Combination Long-Haul Truck</td><td>62</td><td>>19500+ >26000+ >33000+ >60000</td><td>Texas statewide</td><td>NA – 100 percent diesel, no Fuel/Engine Fractions</td></tr>
</table>

[1] TxDOT mid-year 2005 and 2011county vehicle registrations data (i.e., three-file data set: composite fuel light-duty categories; heavy-duty gas by eight weight categories; and heavy-duty diesel by eight weight categories) were used for developing local inputs for 2005 and 2011 (and future years), respectively (weights are GVWR in units of lbs.). Based on the current MOVES model and database, TTI updated the MOVES default age distributions from EPA's MOVES tools webpage, http://www.epa.gov/otaq/models/moves/tools.htm (which were based on the previous MOVES version), and used the updates in this analysis.

[2] MOVES default fuel/engine fractions for transit buses were revised to exclude the CNG and gasoline-fueled components, consistent with the local SUT/fuel type VMT mixes.

*Local Meteorological (County and Zonemonthhour Table) Inputs to MOVES*

The TCEQ provided the local meteorological input values (October 2011), which TTI shifted into local time form (to Central Daylight Time from Central Standard Time) and into MOVES input format, and loaded into the "county" (barometric pressure) and "zonemonthhour" (temperature and relative humidity) tables. These input data were developed by TCEQ as one set of "peak ozone season" hourly temperature and relative humidity, and 24-hour barometric pressure averages for the BPA region, using recent multiple year (2008 through 2011), June through August hourly weather station data from the Southeast Texas Regional Airport. Low altitude was designated for all counties. Table 26 summarizes the temperatures, relative humidity and barometric pressure input values.

**Table 26. Meteorological Inputs to MOVES.**

| Hour | Temperature[1] (Degrees Fahrenheit) | Relative Humidity[1] (Percent) | 24-Hour Average Barometric Pressure[1] (Inches of Mercury) |
|---|---|---|---|
| 1 | 78.27 | 89.51 | 29.93 |
| 2 | 77.81 | 90.39 | |
| 3 | 77.56 | 91.06 | |
| 4 | 77.18 | 91.87 | |
| 5 | 76.96 | 92.19 | |
| 6 | 76.68 | 92.55 | |
| 7 | 76.86 | 92.60 | |
| 8 | 80.01 | 86.61 | |
| 9 | 82.95 | 78.14 | |
| 10 | 85.40 | 70.55 | |
| 11 | 87.34 | 64.68 | |
| 12 | 88.78 | 60.71 | |
| 13 | 89.74 | 58.25 | |
| 14 | 90.40 | 56.74 | |
| 15 | 90.35 | 57.12 | |
| 16 | 90.27 | 57.38 | |
| 17 | 89.54 | 58.68 | |
| 18 | 88.06 | 61.99 | |
| 19 | 86.08 | 66.68 | |
| 20 | 83.23 | 74.05 | |
| 21 | 80.87 | 81.14 | |
| 22 | 79.92 | 84.55 | |
| 23 | 79.27 | 86.85 | |
| 24 | 78.65 | 88.58 | |

[1] Based on multi-year (2008 through 2011), June through August weather station data from the Southeast Texas Regional Airport (TCEQ, October 2011).

*Fuels Inputs to MOVES*

The local fuels inputs to MOVES are input via the CDB in the fuelsupply and fuelformulation tables (see Table 27 for fuelformulation fields and values). TTI prepared the BPA area level input data for each year and saved the input data to text files in MOVES-required format. These data were then imported to the fuelsupply and fuelformulation tables in the appropriate MOVES scenario CDBs. The following describes the procedure used to populate the fuels tables.

- Selected and inserted into the CDB fuelsupply table all MOVES default fuelsupply records associated with the scenario (i.e., for the countyID, fuelyearID, monthgroupID) and set their marketshare field values to zero (to prevent MOVES from applying the default fuels data in addition to the desired local fuels input data).
- Loaded all local fuel formulations from the specified local fuels inputs text files into the CDB fuelformulation table (these were given fuelformulationIDs different than the set of IDs used as MOVES defaults).
- Loaded the subject scenario (i.e., for the subject countyID, fuelyearID, monthgroupID) local fuel supply records (i.e., the market shares of the specified fuel formulations) from the input data text files into the CDB fuelsupply table.

**Data Sources –** TTI produced the fuel parameter input records to MOVES for developing the BPA 2005, 2011, 2014, 2017, and 2021 summer season emissions rates using information from the following sources: TCEQ's 2005 and 2011 summer season retail outlet fuel survey studies; regulatory limits or allowables, and MOVES fuel formulation defaults. In the case of 2005 and 2011 summer gasoline, the TCEQ Beaumont survey data were the main source of the fuel property inputs.

For 2005 all of the fuel property input values are directly from Table 2 and Table 5 (for gasoline and diesel, respectively, under Beaumont Region) found in *Sampling and Laboratory Analysis of Retail Gasoline and Diesel Fuel for Selected Texas Cities – Summer 2005* (Prepared for TCEQ by ERG, August 31, 2005), except for the E200 and E300 values. For the 2005 E200 and E300, which were not included in the TCEQ study, the MOVES defaults (consistent with a subject county, month and year) were used. The Beaumont Region average fuel properties from the TCEQ 2005 fuel study were based on fuel samples all taken within the BPA three-county area.

For 2011, the source of all the fuel input parameter values was *Sampling and Laboratory Analysis of Retail Gasoline and Diesel Fuel for Selected Texas Cities – Summer 2011* (Prepared for TCEQ by ERG, August 31, 2011), with some additional processing of the gasoline sample data. TTI re-processed the sample data to produce fuel property inputs based solely on conventional gasoline samples typical of the subject BPA area, i.e., excluded reformulated gasoline (RFG) sample data that was included in the original Beaumont Region summary averages. TTI additionally processed the gasoline data to produce the appropriate units needed for input to MOVES (i.e., percent by volume as opposed to percent by weight as is used in the TCEQ report Table 3 for some gasoline property values, namely, MOVES aromaticContent, olefinContent, and benzeneContent field values). The 2011 diesel sulfur input value was taken directly from Table 5 in the TCEQ 2011 fuel survey report.

For the future year fuel inputs a combination of latest available local values, MOVES defaults, and a regulated limit was used. For gasoline the latest available local input values, based on TCEQ Summer 2011 fuel study Beaumont data (re-processed by TTI as previously mentioned), were used for E200 and E300 values, for aromatic and olefin volumes; and for MTBE, ETBE, and TAME oxygenate volumes. For sulfur level (both gasoline and diesel), ethanol oxygenate volume and benzene volume, MOVES defaults were used. The future year RVP, per MOVES EI Technical Guidance (EPA, April 2010), is the RVP limit plus the 1.0 pounds-per-square inch waiver for 10 volume percent ethanol (under 40 CFR 80.27).

**Methodology –** TTI re-calculated the summer 2011 Beaumont average gasoline fuel properties using the same methodology as used in the original TCEQ summer 2011 study for the Beaumont Region, except using only the conventional gasoline samples. This simply entailed dropping the RFG sample data, recalculating the average fuel properties for each of the three fuel grades, and weighting each fuel property across grades using the same fuel sales volumes by grade from the TCEQ Study (i.e., 0.878 regular, 0.065 mid-grade, 0.057 premium). The sample data used was from "Summer2011_Gasoline_Workup1.xlsm," Attachment 5A to the TCEQ Summer 2011 Fuel Study Report (the data available in the report attachment were all in the appropriate units for input to MOVES, unlike the values summarized in Table 3 of the TCEQ Summer 2011 Fuels report). Note that since TTI re-calculated the summer 2011 Beaumont average gasoline fuel properties after dropping the RFG sample, these re-calculated input values (shown in Table 27) are different than the Beaumont region values summarized.

**Table 27. MOVES Fuel Formulation Inputs – Beaumont Summer 2005, 2011 and Future Years.**

| MOVES fuelformulation Table Field (Units) | Gasoline[1] | | | Diesel[1] | | |
|---|---|---|---|---|---|---|
| | 2005 | 2011 | Future Years | 2005 | 2011 | Future Years |
| fuelFormulationID | 10001 | 10002 | 10003 | 30268 | 30006 | 30011 |
| fuelSubtypeID | 10 | 13 | 12 | 20 | 20 | 20 |
| RVP (psi) | 7.45 | 7.42 | 8.8 | 0 | 0 | 0 |
| sulfurLevel (ppm) | 113.9 | 32.45 | 22.9132 | 268 | 6.36 | 11 |
| ETOHVolume (volume %) | 0 | 8.90 | 10 | 0 | 0 | 0 |
| MTBEVolume (volume %) | 0.43 | 0 | 0 | 0 | 0 | 0 |
| ETBEVolume (volume %) | 2.22 | 0 | 0 | 0 | 0 | 0 |
| TAMEVolume (volume %) | 0 | 0 | 0 | 0 | 0 | 0 |
| aromaticContent (volume %) | 33.94 | 30.77 | 30.77 | 0 | 0 | 0 |
| olefinContent (volume %) | 11.13 | 8.09 | 8.09 | 0 | 0 | 0 |
| benzeneContent (volume %) | 1.39 | 1.375 | 0.6615 | 0 | 0 | 0 |
| e200 (vapor %) | 45.21 | 49.361 | 49.361 | 0 | 0 | 0 |
| e300 (vapor %) | 80.89 | 80.629 | 80.629 | 0 | 0 | 0 |
| volToWtPercentOxy | 0.1533 | 0.3488 | 0.3488 | 0 | 0 | 0 |
| BioDieselEsterVolume (volume %) | \N | \N | \N | \N | \N | \N |
| CetaneIndex | \N | \N | \N | \N | \N | \N |
| PAHContent (volume %) | \N | \N | \N | \N | \N | \N |

[1] Data sources by number are: 1) TCEQ Summer 2005 fuel survey; 2) TCEQ Summer 2011 fuel survey data (BPA gasoline values recalculated excluding RFG samples included in original values; 3) Regulated limit with ethanol RVP waiver (under 40 CFR 80.27); and 4) MOVES default. The 2005 gasoline input values are all from source "1," except for e200 and e300 which are from source "4." The 2011 input values are all from source "2." Future Year gasoline values: RVP is from source "3;" sulfurLevel, ETOHVolume, and benzeneContent are from source "4;" and all other inputs are from source "2." Future Year diesel sulfur is from source "4." The last three fields are not currently used in MOVES2010a.

The fuel supply, or market share, value for each fuel formulation used was 1.0, meaning that for each modeling scenario, there was only one diesel and one gasoline fuel formulation used. The MOVES user-input, locality-specific CDBs containing the actual fuelformulation and fuelsupply input tables used were provided as a part of the electronic data submittal.

*Local I/M Inputs to MOVES*

There is not an I/M program in the BPA area counties. The CDBs do, however, include "imcoverage" tables as a part of the CDB 18-table input dataset. For the BPA counties, these imcoverage tables are empty, thus no I/M program was modeled. The MOVES input files (MRSs and CDBs) were provided as a part of the electronic data submittal (Appendix A) of this Technical Note.

## Checks and Runs

After completing the input data preparation, the CDBs were checked to verify that all 18 tables were in the appropriate CDBs and the tables were populated with data as intended. The MOVES RunSpecs were executed in batches using the MOVES commandline tool. The batches were set up to write each MOVES run log to a text file for later access. After completion, TTI searched the MOVES run logs for error and warning messages, for which none were found.

Post-processing utilities run on the MOVES output also checked output for errors, e.g., negative values, and also summarized run information from the movesrun output tables – no errors were found. The MOVES run summaries are included as Appendix H.

## Post-Processing Runs

- *Rates Per Activity*: Using the MOVESratescalc utility, TTI calculated "rates-per-activity" for each county from the MOVES output (i.e., emissions divided by activity, using the movesoutput [emissions] and movesactivityoutput [activity] tables). The process created two emissions rate tables (per run) that were added to the MOVES output database: "ttirateperdistance" containing mass/mile emissions rates, and "ttirateperactivity" containing mass/SHP, mass/SHI, and mass/start emissions rates. This was performed for each county. See MOVESratescalc utility description in Appendix B for more details.
- *Rates Adjustments*: From the two calculated rate tables output from each MOVESratescalc run, emissions rates were extracted for only those pollutants needed in the emissions calculations. For 2011 and later years, TxLED adjustments were applied to all diesel vehicle $NO_x$ emissions rates, and the extracted and adjusted rate tables for each county and year were placed in a separate individual databases for input to the emissions calculations. Table 28 shows the TxLED factors used (provided by TCEQ). TCEQ produced these average diesel SUT $NO_x$ adjustments using 4.8% and 6.2% reductions for 2002 and later, and 2001 and earlier model years, respectively. More details on TCEQ's TxLED factors analysis may be found at, ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/Statewide/mvs/TxLED/, in the file:

  – *mvs10a-statewide-txled-2011-analysis-11-14-17-18-19-21.zip.*

  These TxLED $NO_x$ adjustment factors provided by TCEQ were based on the most current mid-year (2011) TxDMV vehicle registration data.

**Table 28. Analysis Year TxLED Adjustment Factor Summary.**

| Diesel Fuel Source Use Type | 2011 | 2014 | 2017 | 2021 |
|---|---|---|---|---|
| Passenger Car | 0.9494 | 0.9509 | 0.9515 | 0.9518 |
| Passenger Truck | 0.9456 | 0.9479 | 0.9492 | 0.9502 |
| Light Commercial Truck | 0.9460 | 0.9479 | 0.9488 | 0.9500 |
| Intercity Bus | 0.9418 | 0.9426 | 0.9433 | 0.9445 |
| Transit Bus | 0.9422 | 0.9428 | 0.9442 | 0.9459 |
| School Bus | 0.9423 | 0.9430 | 0.9438 | 0.9451 |
| Refuse Truck | 0.9431 | 0.9438 | 0.9451 | 0.9472 |
| Single Unit Short-Haul Truck | 0.9491 | 0.9503 | 0.9508 | 0.9514 |
| Single Unit Long-Haul Truck | 0.9487 | 0.9499 | 0.9505 | 0.9512 |
| Motor Home | 0.9445 | 0.9454 | 0.9462 | 0.9472 |
| Combination Short-Haul Truck | 0.9445 | 0.9462 | 0.9476 | 0.9495 |
| Combination Long-Haul Truck | 0.9445 | 0.9465 | 0.9481 | 0.9500 |

Source: TCEQ, Fall 2011. See ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/Statewide/mvs/TxLED/ for TCEQ's TxLED analysis spreadsheets and other information.

Appendix A describes the electronic data submittal for this inventory analysis, which, in addition to the MOVES model set-ups (MRS files and CDBs), includes the TxLED factor files used in the MOVESratesAdj utility runs, that produced the final emissions rate look-up table inputs to the emissions calculations.

## EMISSIONS CALCULATIONS

TTI calculated hourly, ozone season weekday, link-based EIs by county for each analysis year using the MOVESemscalc utility. Under the link-based inventory method with MOVES, the emissions calculations fall into two categories: VMT-based (or on-network) emissions calculations and off-network emissions calculations. The VMT-based calculations use the TDM VMT and speeds to estimate emissions at the link (or roadway segment) level. The off-network emissions process calculations use off-network activity (SHP, starts, and SHI) to estimate emissions at the county level.

### Hourly Link-Based Emissions Calculations

The link-based hourly ozone season weekday inventories for each county and analysis year were calculated with the MOVESemscalc utility using the following major inputs:

- VMT mix – TxDOT district-level SUT/fuel type VMT mix by MOVES roadway type;
- VMT and speeds – TDM link and intrazonal link VMT and speeds estimates, which contain the link-specific, hourly, directional, operational VMT and speed estimates as developed by the TRANSVMT utility to include: A-node, B-node, county number, TDM road type (functional class) code, link length, congested (operational) speed, VMT, and TDM area type code;
- VMT-based emissions factors – MOVES-based "ttirateperdistance" table emissions factors by pollutant, process, hour, speed, MOVES roadway type, SUT, and fuel type;
- Road type associations – TDM road type/area type to MOVES road type designations;
- Off-network activity – County-level hourly SUT/fuel type off-network activity estimates (SHP, starts, and SHI); and
- Off-network activity-based emissions factors – MOVES-based "ttirateperactivity" table off-network process emissions factors by pollutant, process, hour, SUT, and fuel type.

The VMT-based emissions were calculated for each hour using the TxDOT district-level SUT/fuel type VMT mix, the TDM link and intrazonal link VMT and speeds estimates, the MOVES-based "on-network" emissions factors, and the TDM road type/area type to MOVES road type designations. Each link was assigned a MOVES road type based on the link's road type and area type (Table 29). The link VMT was then allocated to each SUT/fuel type using the VMT mix, based on the link's designated MOVES road type and its associated TxDOT district.

Emissions factors for each SUT/fuel type were selected based on the link's MOVES road type and the link speed from the ttirateperdistance rates table. For link speeds falling between MOVES speed bin average speeds, emissions factors were interpolated from bounding speeds (see example in Appendix B). For link speeds falling outside of the MOVES speed range (less than 2.5 mph and greater than 75 mph), the emissions factors for the associated bounding speeds were used. The g/mi rates were multiplied by the link SUT/fuel type VMT producing the link-level emissions estimates.

### Table 29. BPA TDM Road Type/Area Type to MOVES Road Type Designations.

| TDM Road Type (Code - Name) | TDM Area Type (Code - Name) | MOVES Road Type (Code - Name) |
|---|---|---|
| 1 - Radial IH Freeways - Mainlanes Only<br>2 - Radial IH Freeways - Mainlanes and Frontage Roads<br>3 - Circumferential IH Freeways (Loops) - Mainlanes Only<br>4 - Circ - IH Freeways - Mainlanes and Frontage Roads<br>5 - Radial Other Freeways - Mainlanes Only<br>6 - Radial Other Freeways - Mainlanes and Frontage Roads<br>7 - Circ - Other Freeways - Mainlanes Only<br>8 - Circ - Other Freeways - Mainlanes and Frontage Roads<br>22 - Interchange Ramp (Freeway-to-Freeway) | 5 - Rural | 2 - Rural Restricted Access |
| 11 - Principal Arterial - Divided<br>12 - Principal Arterial - Continuous Left Turn Lane<br>13 - Principal Arterial - Undivided<br>14 - Minor Arterial - Divided<br>15 - Minor Arterial - Continuous Left Turn Lane<br>16 - Minor Arterial - Undivided<br>17 - Collector - Divided<br>18 - Collector - Continuous Left Turn Lane<br>19 - Collector - Undivided<br>20 - Frontage Road<br>21 - Ramp (Between Frontage Road and Mainlanes)<br>0 - Centroid Connector[1] | 5 - Rural | 3 - Rural Unrestricted Access |
| 1 - Radial IH Freeways - Mainlanes Only<br>2 - Radial IH Freeways - Mainlanes and Frontage Roads<br>3 - Circumferential IH Freeways (Loops) - Mainlanes Only<br>4 - Circ - IH Freeways - Mainlanes and Frontage Roads<br>5 - Radial Other Freeways - Mainlanes Only<br>6 - Radial Other Freeways - Mainlanes and Frontage Roads<br>7 - Circ - Other Freeways - Mainlanes Only<br>8 - Circ - Other Freeways - Mainlanes and Frontage Roads<br>22 - Interchange Ramp (Freeway-to-Freeway) | 1 - CBD;<br>2 - CBD Fringe;<br>3 - Urban;<br>4 - Suburban | 4 - Urban Restricted Access |
| 21 - Ramp (Between Frontage Road and Mainlanes)<br>11 - Principal Arterial - Divided<br>12 - Principal Arterial - Continuous Left Turn Lane<br>13 - Principal Arterial - Undivided<br>14 - Minor Arterial - Divided<br>15 - Minor Arterial - Continuous Left Turn Lane<br>16 - Minor Arterial - Undivided<br>20 - Frontage Road<br>17 - Collector - Divided<br>18 - Collector - Continuous Left Turn Lane<br>19 - Collector - Undivided<br>0 - Centroid Connector[1] | 1 - CBD;<br>2 - CBD Fringe;<br>3 - Urban;<br>4 - Suburban | 5 - Urban Unrestricted Access |
| 40 – Intrazonal[1, 2] | Local (Intrazonal) | |

[1] Emissions estimates for centroid connector and intrazonal links comprise the local road type estimate.
[2] Special links added for application of the intrazonal VMT estimate.

The off-network emissions were calculated at the county level by multiplying the hourly MOVES-based off-network emissions factors from the ttirateperactivity rates table by the appropriate county-level hourly SUT/fuel type off-network activity, which was determined by the pollutant emissions process/activity association.

The MOVESemscalc utility output for each EI run (15 county-level EIs for the analysis) consisted of a listing file (summarizing all pertinent information regarding the execution of the utility), and a tab-delimited emissions report summary file including both hourly and 24-hour activity and emissions estimates by SUT/fuel type and TDM road type. The tab-delimited EI summary output files each contain 92 tables per time period (four activity tables and 88 pollutant/process tables), or 2,300 total inventory data tables. Each inventory data table is composed of mostly roadway type rows (i.e., the TDM road types plus an “Off-network” labeled row for the off-network emissions processes) and of SUT columns (i.e., the SUT/Fuel Types as listed in the VMT mix), with an additional row and column for totals. The tables are grouped by time period and ordered sequentially, beginning with the first hour as midnight to 1:00 a.m., and ending with the 24-hour total tables (calculated as the sum of the hourly results).

The four activity tables included in the output are: VMT, VHT, Speed (VMT/VHT), and Other Activity Inputs. While the VMT, VHT, and Speed table rows are TDM roadway types, the Other Activity Inputs table rows are off-network activity input (i.e., SHP, Extended Idle Hours, and Starts).

Table 30 lists the 16 pollutants and the associated emissions processes included in the MOVESemscalc tab-delimited EI summary report output.

**Table 30. BPA Maintenance EI Pollutants and Associated Emissions Processes.**

| **Pollutant** | **Emissions Process**[1] |
|---|---|
| VOC,<br>CO,<br>NOx,<br>Primary Exhaust $PM_{10}$ – Total<br>Primary $PM_{10}$ – Organic Carbon<br>Primaary $PM_{10}$ – Elemental Carbon<br>Primary $PM_{10}$ – Sulfate Particulate<br>Primary Exhaust $PM_{2.5}$ – Total<br>Primary $PM_{2.5}$ – Organic Carbon<br>Primaary $PM_{2.5}$ – Elemental Carbon<br>Primary $PM_{2.5}$ – Sulfate Particulate | Running Exhaust<br>Start Exhaust<br>Extended Idle Exhaust<br>Crankcase Running Exhaust<br>Crankcase Start Exhaust<br>Crankcase Extended Idle Exhaust<br><br>(***and for VOC only***:<br>Evaporative Permeation,<br>Evaporative Fuel Vapor Venting,<br>Evaporative Fuel Leaks) |
| Primary $PM_{10}$ – Brakewear Particulate<br>Primary $PM_{2.5}$ – Brakewear Particulate | Brakewear |
| Primary $PM_{10}$ – Tirewear Particulate<br>Primary $PM_{2.5}$ – Tirewear Particulate | Tirewear |
| Atmospheric $CO_2$ | Running Exhaust<br>Start Exhaust<br>Extended Idle Exhaust |

[1] The pollutant "composite" category was additionally included in emissions output, which is the aggregate sum of a pollutant's emissions from all associated processes.

TTI additionally produced 24-hour data extracts from the MOVESemscalc tab-delimited output for each year for use in summarizing results, including county totals by pollutant and process, and county totals by pollutant, process, and SUT/fuel type.

See Appendix A (Electronic Data Submittal) for the listing of EI data files submitted as a part of this project report. See Appendix B for additional MOVESemscalc utility information and the emissions calculation process flow diagram.

## QUALITY ASSURANCE

Analyses and results were subjected to appropriate internal review and QA/QC procedures, including independent verification and reasonableness checks. All work was completed consistent with applicable elements of ANSI/ASQ E4-2004: *Specifications and Guidelines for Quality Systems for Environmental Data Collection and Technology Programs* and the TCEQ Quality Management Plan.

Quality Assurance Project Plan (QAPP) Category II (Modeling for NAAQS Compliance) is the QAPP category that most closely matches these objectives and establishes QAPP requirements for projects involving applied research or technology evaluations. Internal review and quality control measures consistent with applicable NRML QAPP requirements, along with appropriate audits or assessments of data and reporting of findings, were employed. These include, but are not limited to, the elements outlined in the following description.

### A. Project Management

The project management was as listed previously in the Acknowledgments section.

The definition and background of the problem addressed by this project, the project/task description, and project documents and records produced are as described previously in the Purpose, Background, Project Reporting, and Project Electronic Data sections. No special training or certifications were required. The TTI project manager assured that the appropriate project personnel had and used the most current, approved version of the QAPP.

After receiving the Notice to Commence (NTC) from TCEQ, the TTI project manager provided a detailed pre-analysis plan to the TCEQ project manager for review and concurrence. Upon concurrence of the pre-analysis plan, the TTI project manager distributed the pre-analysis plan to the TTI inventory developers for use in both the inventory development and QA review process. TTI maintains records of the project QA checks as a part of the project archive, for at least five years.

The objective was to produce the emissions inventory product of the quality suited to its purpose as specified (e.g., inventories to be processed for input to a photochemical model, for use in an attainment demonstration SIP revision, from which a motor vehicle emissions budget will be produced for transportation conformity purposes), in accordance with the appropriate guidance and methods documents as referenced, as detailed in the pre-analysis plan, and in consultation with the TCEQ project manager.

Basic criteria were used to assure that the acceptable quality of the product was met – product developers verified that the process and product were as specified, to include:

- The product met the purpose of the emissions analysis (e.g., photochemical modeling, reasonable further progress, transportation conformity, model comparison);
- The full extent of the modeling domain (e.g., analysis years, geographic coverage, seasonal periods, days, sources, pollutants) was included;
- Agreed methods, models, tools, and data were used (e.g., as listed in the Grant Activities Description, and as listed in the more detailed pre-analysis plan – any change from this plan, if needed, was made in consultation with the TCEQ Project Manager);
- The required output data sets were produced in the appropriate formats in accordance with the pre-analysis plan; and
- Any deficiencies found during development and end-product quality checks (as discussed in QAPP Section D) were corrected.

### B. Data Generation and Acquisition

Note that no sampling of data was involved in the emissions inventory development, thus only existing data (non-direct measurements) were used for this project.

The data needed for project implementation were in the categories needed for development of emissions rate model inputs and adjustment factors, and development of the activity inputs for external emissions calculations. These emissions factor model inputs and activity inputs were developed using data sources as outlined previously and/or methods and procedures as detailed in the references listed, and as provided in the pre-analysis plan.

All data used either as direct input or to produce inputs (e.g., to the MOVES model or to TTI's emissions inventory development utilities used, which were listed in the pre-analysis plan) were reviewed by TTI for suitability before use. The data sets for the project were provided by TxDOT, a Metropolitan Planning Organization (MPO) or Council of Governments (COG), TCEQ, and/or the EPA, and in most cases were QA'd by the providing agency. The data needed may include: HPMS data (from TxDOT's Roadway Inventory Functional Classification Record [RIFCREC] report); regional travel demand model data; speed model data; vehicle registration data; ATR data; vehicle classification count data; meteorological data; fuels data; MOVES emissions model data; extended idling activity data; and vehicle I/M program design data.

Any significant problems found during data review, verification, and/or validation (see QA criteria and methods discussion in section D) were to be corrected, and the QA procedure was repeated until satisfied. No significant problems were found.

**Data Management:** TTI emissions inventory data developers work as a closely coordinated team. The assigned staff used the same electronic project folder structure on their individual workstations. As various scripts, inputs, and outputs were developed in the emissions inventory development process, data were shared within the team for crosschecking via an intra-net, flash drive, or external hard drive. To perform the MOVES model runs, a computer cluster, or multiple computer configurations, was used. After input data were QA'd, depending on the size of the data set, the data sets were backed up and stored in compressed files. These activities were performed throughout the process until the final products were produced.

For MOVES model runs to produce emissions factor look-up tables for the emissions inventories, all run files (MOVES model inputs and batch files) were produced on an individual workstation. After the MOVES input data and batch files (i.e., Run Files) were QA'd, they were copied (via external hard drive) to the cluster's Master computer. Upon execution, completion, and error checking, the MOVES output databases and run log text files were copied to an individual workstation, archived, and processed further in preparation for input to the emissions calculations.

After the final product was completed, all the project data archives were compiled on a set of optical data discs (CD-ROM or DVD, depending on size), or on an external drive for very large project data sets. A complete archive of the project data is kept by TTI (the computer models and emissions inventory development utilities used in the process are included). An electronic data submittal package (containing the project deliverables as listed in Appendix A) was produced along with data description (on CD-ROM, DVDs, or external hard drive, depending on needed storage space) and delivered to TCEQ.

## C. Assessment and Oversight

The following assessments were performed.

- Verified that the overall scope was met (consistent with the intended purpose, for specified temporal resolution and geographic coverage, for specified sources, pollutants, and emissions processes).
- Checked that input data preparation, and model or utility execution instructions (e.g., run specifications, scripts, JCFs, command files) were prepared according to the plan; and
- Checked that correct output data were produced (includes interim output [output that becomes input to a subsequent step in the inventory development process], as well as the final product). Records were kept of the checks performed.

If any inconsistencies or deficiencies were found, the issue was directly communicated to the responsible staff for corrections (or the outside agency staff involved, if provided from outside of TTI, if needed). After a correction was made, the QA checks were performed again to ensure that the additional work resulted in the intended quality assured result, and the correction was noted in the QA record (process was performed until QA check was satisfied).

Any major problem was reported to the project manager and communicated to the project team as needed, as well as when the various data elements in the process passed QA checks and were ready for further processing according to the project pre-analysis plan. The project manager ensured that all of the QA checks performed were compiled, and maintained in the project archives.

In addition, technical systems audits were performed as appropriate. Audits of data quality at the requisite 25% level were performed for any data collected or produced as part of this study. QA findings were reported in both the draft and the final reports.

## D. Data Validation and Usability

Development of the detailed on-road mobile source emissions estimates is a multi-staged process that involves many data sets and data processing steps. In the interest of product quality and process efficiency, thorough quality assurance checks are performed during emissions inventory development.

Data for the project, whether provided for direct use or processed by TTI, were reviewed, verified, and validated to ensure that they conform to their particular specifications and TCEQ's requirements for the intended use. The data specifications and requirements where not stated specifically, are included in the documents listed in the "References" section, or are outlined or referenced in the detailed pre-analysis plan.

The criteria for passing quality checks and the checks typically performed on each major inventory input component (i.e., estimates of source activity, activity distributions, and emissions factors) as well as on the resulting emissions estimates, are summarized in the following. These

QA guidelines are used to ensure the development of emissions inventory estimates that are as accurate as possible and meet the requirements of TCEQ's intended use.

Verified that the overall scope of the emissions analysis has been met as prescribed in the pre-analysis plan, to include:

- Purpose of the emissions analysis (e.g., photochemical modeling, reasonable further progress, transportation conformity, model comparison);
- Extent of the modeling domain (e.g., analysis years, geographic coverage, seasonal periods, days, sources, pollutants);
- Methods, models, and data used (e.g., default versus local input data sources); and
- Procedures and tools used and all required emissions output data sets were produced.

Performed checks on input data preparation, model or utility execution instructions (e.g., run specifications, scripts, JCFs, command files), and output, as appropriate to the component:

- Input data preparation checks:
    - Verified the basis of input data sets against the pre-analysis plan: Actual historical or latest available data, validated model, expected values or regulated limits, regulatory program design, model defaults, surrogates, professional judgment; check aggregation levels.
    - Data development: Depending on the procedure and particular input data set, calculations were verified (e.g., re-calculated independently and compared with originally prepared values – if spot-checking a series of results, included extremes and intermediate values).
    - Completeness: Verified that input data sets were within the required dimensions, and all required fields were populated and properly coded or labeled.
    - Format: Verified that formats were within required specifications (e.g., field positions, data types and formats, and file formats), if any.
    - Reasonability checks: (discussed in the next section).
    - Ensured that any inputs provided from external sources were quality assured, as listed previously.
- Checked the model or utility execution instructions:
    - Verified that the correct number of utility or model run specifications were prepared for each application (e.g., by year, county, season, day type).
    - Verified that each utility or model run script included the correct modeling specifications (e.g., commands, input values, input and output file paths, output options) for the application per applicable user guide.
- Checked for the successful completion of model and utility executions:
    - Verified that the correct number of each type of output file was produced by the particular model or utility.

- Checked for any unusual output file sizes.
- Searched output (e.g., utility listing files or model execution logs that contain error and warning records) for warnings/errors.
- Checked the summary information provided in output listing files for any unusual results.

Performed further checks for consistency, completeness, and reasonability of data output from model or utility applications:

- Verified that the data distributions and allocation factors produced or used sum to 1.0, as appropriate (e.g., hourly travel factors within a time period, proportion of travel by vehicle categories on a particular roadway category).
- Verified that the required data fields were present, populated, and properly coded or labeled; verified that data and file formats were within specifications.
- Verified that any activity, emissions rate, or emissions adjustments were performed as intended (e.g., seasonal activity factor, emissions control program adjustment).
- For data sets prepared with temporal or geographic variation (e.g., activity distributions between weekends/weekdays, vehicle mix, or average speeds between road types or time periods), compared and noted whether directional differences were as expected.
- Checked for consistency between data sets (e.g., compared detailed spatially and temporally disaggregated activity estimates [e.g., link VMT] to original aggregate totals, activity total summaries between utility applications [e.g., link-VMT producer and emissions calculator], and input hourly distributions versus hourly summaries from the link activity output data).
- Calculated county, 24-hour, aggregate emissions rates (from aggregate VMT and emissions output) and compared the rates between counties examining the results for outliers while assessing the reasonability of any relative and directional differences (e.g., qualify based on activity distributions by road type and speed, mix of vehicles by road type, meteorological variation, control program coverage). Compared the results to results from previous emissions analyses if available.
- Calculated county, 24-hour aggregate rates by vehicle class and compared between vehicle classes. Examined the results for consistent patterns, e.g., between gasoline versus diesel, heavy versus light.
- Verified summed link emissions output against tabular emissions output summaries – differences should be within rounding error.

Any additional data products required for the emissions analysis were subjected to the appropriate QA checks previously listed. Any issues found needing resolution were corrected and appropriate QA checks were performed until satisfied.

## REFERENCES

Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations, EPA-454/R-05-001. Issued By: Emissions Inventory Group, Emissions, Monitoring and Analysis Division, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711, August 2005.

Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources. EPA420-R-92-009. U.S. Environmental Protection Agency, Emission Planning and Strategies Division, Office of Mobile Sources and Technical Support Division, Office of Air Quality Planning and Standards, December 1992.

Draft Motor Vehicle Emission Simulator (MOVES) 2009, Software Design and Reference Manual. Assessment and Standards Division Office of Transportation and Air Quality U.S. Environmental Protection Agency, EPA420-B-09-007, March 2009.

Motor Vehicle Emissions Simulator (MOVES) User Guide for MOVES2010a. Assessment and Standards Division, Office of Transportation and Air Quality, U.S. Environmental Protection Agency, EPA420-B-10-036, August 2010.

Technical Guidance on the Use of MOVES2010 for Emission Inventory Preparation in State Implementation Plans and Transportation Conformity, Transportation and Regional Programs. Division, Office of Transportation and Air Quality, U.S. Environmental Protection Agency, EPA420-B-10-023, April 2010.

Update Of On-Road Inventory Development Methodologies for Motor Vehicle Emissions Simulator (Moves) Model Compatibility Technical Report. Texas Transportation Institute, The Texas A&M University System, College Station, TX, July 2011.

Sampling and Laboratory Analysis of Retail Gasoline and Diesel Fuel for Selected Texas Cities – Summer 2005. Prepared for the Texas Commission on Environmental Quality by ERG, August 31, 2005.

Sampling and Laboratory Analysis of Retail Gasoline and Diesel Fuel for Selected Texas Cities – Summer 2011. Prepared for the Texas Commission on Environmental Quality by ERG, August 31, 2011.

Development and Production of 2006 Base Case and 2008 Baseline On-road Mobile Source Emissions Inventories for the HGB Nonattainment Area. Texas Transportation Institute, The Texas A&M University System, College Station, TX, July 2011.

Methodologies for Conversion of Data Sets for MOVES Model Compatibility. Texas Transportation Institute, The Texas A&M University System, College Station, TX, August 2009.

Heavy-Duty Vehicle Idle Activity and Emissions Characterization Study. ERG, August 2004.

Specifications and Guidelines for Quality Systems for Environmental Data Collection and Technology Programs.  ANSI/ASQ E4-2004.

EPA Memorandum on Texas Low Emission Diesel Fuel Benefits.

1996 Jefferson, Orange, and Hardin Counties Periodic Emissions Inventory.  Texas Transportation Institute, The Texas A&M University System, College Station, TX, November 26, 1997.

TxLED Factor Analysis Spreadsheet.  Available at ftp://amdaftp.tceq.texas.gov/pub/mobile_EI/statewide/mvs/txled.  Texas Commission on Environmental Quality.

# APPENDIX A:
# BPA MAINTENANCE ON-ROAD INVENTORIES ELECTRONIC DATA SUBMITTAL

**BPA Maintenance MOVES-Based, County-Level, EIs – Electronic Data Submittal**

This appendix (electronic data set and description) contains a description of the electronic data package that TTI submitted to TCEQ, per Proposal for Grant No. 582-11-11226-FY12-07.

The MOVES rates-per-activity, TDM link-based method was used to produce 15 ozone season weekday county level EIs, i.e., three per year for 2005, 2011, 2014, 2017, and 2021. The following table lists the pollutants and associated emissions processes included in the EIs, in MOVES nomenclature.

| Pollutant | Emissions Process[1] |
|---|---|
| VOC,<br>CO,<br>NOx,<br>Primary Exhaust $PM_{10}$ – Total<br>Primary $PM_{10}$ – Organic Carbon<br>Primary $PM_{10}$ – Elemental Carbon<br>Primary $PM_{10}$ – Sulfate Particulate<br>Primary Exhaust $PM_{2.5}$ – Total<br>Primary $PM_{2.5}$ – Organic Carbon<br>Primary $PM_{2.5}$ – Elemental Carbon<br>Primary $PM_{2.5}$ – Sulfate Particulate | Running Exhaust<br>Start Exhaust<br>Extended Idle Exhaust<br>Crankcase Running Exhaust<br>Crankcase Start Exhaust<br>Crankcase Extended Idle Exhaust<br><br>(***and for VOC only***:<br>Evaporative Permeation,<br>Evaporative Fuel Vapor Venting,<br>Evaporative Fuel Leaks) |
| Primary $PM_{10}$ – Brakewear Particulate<br>Primary $PM_{2.5}$ – Brakewear Particulate | Brakewear |
| Primary $PM_{10}$ – Tirewear Particulate<br>Primary $PM_{2.5}$ – Tirewear Particulate | Tirewear |
| Atmospheric $CO_2$ | Running Exhaust<br>Start Exhaust<br>Extended Idle Exhaust |

[1] The pollutant "composite" category was additionally included in the emissions output, which is the aggregate sum of a pollutant's emissions from all associated processes.

## Electronic Media

The electronic data submittal data files and databases, summarized in the following, were compressed into about 208 megabytes of memory space, and were submitted on one CD-ROM, entitled:

"*BPA Maintenance MOVES-Based On-Road Mobile Source EIs – TTI FY2012.*"

- Emissions Files:
  - Hourly and 24-hour EI summary tables – MOVESemscalc utility tab-delimited, county-level EI report summary files;
  - 24-Hour EI report extracts – 24-hour totals summaries extracted from MOVESemscalc EI data files listed in previous bullet.

- Emission Factors:
  - MOVES inputs (run specifications [MRS] and county domain input databases [CDB]); and
  - TTI MOVES post processor utility-produced emissions factors (emissions factor database inputs to the emissions calculations), and TxLED adjustment factor files.

**File-Naming Conventions**
The following file naming conventions were used:

- ***YYYY*** is for analysis year (2002, 2008, 2011, 2014, 2017, 2018, 2019); and
- ***CCCC*** is county FIPS code (48199, 48245, 48361).

Note: databases are MySQL databases. Each MySQL database consists of one "db.opt" file and a set of tables, where each table is composed of three files of the type: *.frm, *.MYD, and *.MYI.

**Emissions Data Files**
*Hourly and 24-Hour EIs* – Five MOVESemscalc utility EI runs per county. Each run produced two file types (compressed in "BPAmaint_mvs10a_5EIs.zip"):

- "BPAmaint_mvs10a_***YYYY***swkd_***CCCC***_ems.TAB" (15): tab-delimited county EI data summary report including hourly and 24-hour activity and emissions tables. For roadway-based processes by roadway and vehicle type (SUT/Fuel Type) – VMT, VHT (vehicle hours traveled), average speed (VMT/VHT), and pollutant/process emissions totals; for off-network-based processes by vehicle type – SHP, SHI, starts, and pollutant/process emissions totals (SHI for combination long-haul trucks only).
- "BPAmaint_mvs10a_***YYYY***swkd_***CCCC***_ems.LST" (15): list of execution times; run script; file locations; data descriptions; and varied data summaries including hourly and 24-hour activity, pollutant/process emissions totals, and average speed (VMT/VHT).

*24-Hour EI Extracts* – 24-hour EI totals by SUT/fuel type extracted from the MOVESemscalc tab-file output, used for emissions summaries. There were 10 EI extracts provided (compressed in "BPAmaint_mvs10a_5EIs.zip"):

- "BPAmaint_mvs10a_***YYYY***swkd_tabtots_ST.tab" (5): tab-delimited text file of 24-hour EI data summaries for three counties, by SUT/fuel type, pollutant, and process.
- "BPAmaint_mvs10a_***YYYY***swkd_tabtots.tab" (5): tab-delimited text file of 24-hour EI data summaries for three counties, by pollutant and process.

*Spreadsheet Summary Tables* – 24-hour EI data extracts were summarized in spreadsheets. The spreadsheet file is compressed in "BPAmaint_mvs10a_5EIs.zip." The file name is:

- "BPAmaint_mvs10a 24Hr EI Summaries.xls" (1): regional and county level EI summaries.

**Emissions Factor Files**

*MOVES Input Files for BPA EIs* – There were 15 MOVES runs performed – one per county and year. The MOVES RunSpec and CDB inputs used were provided (the MOVES model current default input database used, MOVESDB20100830, is available at EPA's MOVES model website: http://www.epa.gov/otaq/models/moves/index.htm):

- "MVS10A_BPAmaint_***YYYY***SWKD_***CCCC***_ER.MRS" (15): MRSs are compressed in "BPAmaint_mvs10a_MRSs.zip;" and
- "MVS10A_BPAmaint_***YYYY***SWKD_***CCCC***_ER_CDB_IN" (15 MySQL database folders containing 825 total files): The CDBs are compressed in "BPAmaint_mvs10a_CDBs.zip."

*Final MOVES-Based, Emissions Factor Look-Up Tables*: The MOVESratesAdj utility-adjusted (i.e., $NO_x$ TxLED effects for 2011 and later years), final emissions rate look-up table inputs to the emissions calculations are MySQL databases containing two emissions rate look-up tables: ttirateperdistance for roadway-based emissions processes, and ttirateperactivity for the "off-network" processes. The ttirateperactivity table fields are: pollutantID, processID, hourID, sourceTypeID, fuelTypeID, rateperactivity. The ttirateperdistance table fields are: pollutantID, avgSpeedBinID, processID, hourID, roadTypeID, sourceTypeID, fuelTypeID, ratePerDistance.

- "mvs10a_BPAmaint_ ***YYYY***SWKD_***CCCC***_er_outratesadj" (15 MySQL database folders containing 105 total files). The set of rates database look-up tables, for all counties and years, used in the five BPA EIs. Each database contains the ttirateperdistance and ttirateperactivity emissions rate look-up tables used in the emissions calculations for one county/year. They are compressed in "BPAmaint_mvs10a_ratesadj_outdbs.zip."
- "tx_mvs10a_***YYYY***_txled_facts.txt" (four TxLED adjustment factor files, for 2008 and later analysis years), compressed in "BPAmaint_mvs10a_adjfacts.zip."

Note: the MOVES output databases were post-processed in two main steps to calculate the final emissions rates used in the external emissions calculations:

1) <u>Rate Calculations</u>: Using the TTI's MOVESratesCalc utility, TTI calculated "rates-per-activity" as "emissions/activity" from the movesoutput (emissions) and movesactivityoutput (activity) tables, performed unit conversions, and added two new tables to the original MOVES output database: "ttirateperdistance" with grams/mile rates, and "ttirateperactivity" with grams/SHP, grams/SHI, and grams/start rates.

2) Final Rates Adjustments: Using TTI's MOVESratesAdj utility, TTI-calculated rates were extracted for only those pollutants needed in the emissions calculations. TxLED adjustments were applied to diesel vehicle $NO_x$ rates for analysis years 2011 and later (2005 was prior to TxLED implementation), and the extracted and adjusted rate tables were placed in a separate database (by county and year) for input to the emissions calculations.

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

## TTI EMISSIONS ESTIMATION UTILITIES FOR MOVES-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. 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 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, MOVESactivityInputBuild, MOVESpopulationBuild, MOVESfleetInputBuild, MOVESratesCalc, MOVESratesAdj, ShpExtIdleStartActBld, ExtIdleHrsCalc, MOVESemscalc, and MOVEStabcomb. The TRANSVMT and VirtualLinkVMT prepare the link VMT and speeds activity input. The MOVESactivityInputBuild, MOVESpopulationBuild, and MOVESfleetInputBuild utilities build inputs used in MOVES. The MOVESratesCalc utility calculates the emissions rates from the MOVES output in terms of grams per activity, rather than the grams per vehicle emissions rates produced by MOVES. The MOVESratesadj utility makes special adjustments to the emissions rates when required. The ShpExtIdleStartActBld utility builds the SHP and starts activity required to estimate emissions using the grams per activity emissions rates produced by the MOVESratesCalc utility. The ExtIdleHrsCalc utility builds the SHI activity required to estimate emissions using the grams per activity emissions rates produced by the MOVESratesCalc utility. The MOVESemscalc utility calculates emissions by hourly time periods, producing a tab-delimited summary file (including 24-hour totals) and hourly link emissions output files (optional). The MOVEStabcomb utility combines multiple MOVESemscalc tab-delimited output files into one regional tab-delimited output file.

A process flow diagram follows the utility descriptions.

### TRANSVMT

The TRANSVMT utility post-processes TDMs to produce hourly, on-road vehicle, seasonal and day-of-week specific, directional link VMT, and speed estimates. The TRANSVMT utility processes a travel demand model (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.

### VirtualLinkVMT

The VirtualLinkVMT utility post-processes county HPMS AADT VMT, centerline miles, and lane miles by functional classification and area type (from TxDOT's annual RIFCREC report) 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 EI 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 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 V/C-derived directional delay (minutes/mile) applied to the estimated freeflow speeds for each link. The virtual link VMT and speeds produced using the VirtualLinkVMT utility are an input to the emissions calculation utility, EMSCALC.

**MOVESactivityInputBuild**

The MOVESactivityInputBuild utility builds the roadtypedistribution, hourvmtfraction, avgspeeddistribution, roadtype, hpmsvtypeyear, year, state, zone, zoneroadtype, monthvmtfraction, and dayvmtfraction 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 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;
- Link/MOVES roadway type designations, which lists associations of the link roadway types/area type combination to the MOVES roadway types (same as used with the MOVESemscalc utility);
- VMT mix by MOVES roadway type, MOVES source type, and MOVES fuel type (same as used with the MOVESemscalc 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, and
- MOVES default database.

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, then the VHT is also saved in the ramp segment of the road type VHT array.

A MOVES roadway type array (by MOVES roadway type) is also formed using the data in the VMT summary array and the link/MOVES roadway type designations. An hourly VMT array (by MOVES SUT, MOVES roadway type, and hour) is formed using the data in the VMT summary array, the link/MOVES roadway type designations, and the VMT mix. 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 hour VMT array is aggregated by hour to produce the roadway type distribution array by MOVES SUT and MOVES roadway type. This VMT is then 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. Using the appropriate MySQL code, the roadtypedistribution database table is written. A tab-delimited version is also written (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. Using the appropriate MySQL code, the hourvmtfraction database table is written. 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. A tab-delimited version is also written (optional).

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. Using the appropriate MySQL code, the avgspeeddistribution database table is written. 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. A tab-delimited version is also written (optional).

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. Using the appropriate MySQL code, the road type database table is written using the proportions from the road type VHT array. A tab-delimited version is also written (optional).

The VMT in the hourly VMT array is aggregated to form the HPMS vehicle type VMT array. Each SUT is assigned an HPMS vehicle type (SUT 11 is HPMS vehicle type 10; SUT 21 is HPMS vehicle type 20; SUTs 31 and 32 are HPMS vehicle type 30; 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). Using the appropriate MySQL code, the hpmsvtypeyear database table is written using the VMT from the HPMS vehicle type VMT array, along with the user supplied year ID, the VMT growth factor (automatically set to "Null"), and the base year Off-Network VMT (automatically set to 0). A tab-delimited version is also written (optional).

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

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 outputs five other database tables (state, zone, zoneroadtype, monthvmtfraction, and dayvmtfraction) using the appropriate MySQL code and the user-supplied inputs. For the state database table, a new state database table is created and the data from the MOVES default state database table is copied to the new table for the state ID of 48. For the zone database table, a new zone database table is created and the data from the MOVES default zone data base table is copied to the new table for the county ID greater than 48000 and county ID less than 49000. The start allocation factors, idle allocation factors, and SHP allocation factors are all then replaced with values of 1 in the new table.

For the zoneroadtype database table, a new zoneroadtype database table is created and the data from the MOVES default zoneroadtype data base table is copied to the new table for the zone ID greater than 480000 and zone ID less than 490000. The SHO allocation factors are all then replaced with values of 1 in the new table. For the monthvmtfraction database table, a new monthvmtfraction database table is created and the data from the MOVES default monthvmtfraction database table is copied to the new database table and the month VMT fraction is set to 1 for the user-supplied month ID and 0 for all other months. For the dayvmtfraction database table, a new dayvmtfraction database table is created and the data from the MOVES default dayvmtfraction database table is copied to the new and the day VMT fraction is set to 1 for the user-supplied day ID and 0 for all other months.

**MOVESpopulationBuild**

The MOVESpopulationBuild utility builds the sourcetypeyear MOVES input database table and the source type/fuel type population input file used with the MOVESemscalc utility to estimate emissions using the VMT mix and the TxDOT registration data sets. 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:

- 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 source type, 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 (a total of seven categories for 31 years of data and the total) using the combinations in Table 31.

**Table 31. 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 everything except the 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 32 shows the SUTs and their associated registration category in the registration category data array.

**Table 32. 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 SUTs42, 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 source type 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 source type/fuel type population input file used with the MOVESemscalc utility is written using the SUT population array.

**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 souretypeagedistribution 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 keeps 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 form the registration category data array (a total of seven categories for 31 years of data and the total) using the combinations in Table 31 (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 33 shows the source types and their corresponding registration categories.

**Table 33. 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 34 shows the SUTs and their corresponding registration categories.

**Table 34. 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.

**MOVESratesCalc**

The MOVESratesCalc utility estimates emissions rates in terms of grams per activity (i.e., grams per mile, grams per SHP, grams per start, and grams per SHI) using the data in the movesoutput (emissions output) and movesactivityoutput (activity output) database tables produced by a MOVES emissions rate run. The utility also has the option of calculating the SHP, starts, and SHI activity per vehicle using the movesactivityoutput database table. If not specified, emissions rates are calculated for each pollutant and process combination (excluding total energy) in the movesoutput database table. The utility also uses the movesrun database table to determine the units of the emissions in the movesoutput table, which will then be converted to grams per activity during the emissions rate calculations; therefore allowing 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 35 shows.

**Table 35. MOVES2010a Emissions Process and Corresponding Activity for Grams per Activity Emissions Rates.**

| MOVES2010a Emissions Process | Activity | Emissions Rate Units |
|---|---|---|
| Running Exhaust | Miles Traveled | Grams/Mile |
| Crankcase Running Exhaust | Miles Traveled | Grams/Mile |
| Start Exhaust | Starts | Grams/Start |
| Crankcase Start Exhaust | Starts | Grams/Start |
| Extended Idle Exhaust | Extended Idle Hours | Grams/Extended Idle Hour |
| Crankcase Extended Idle Exhaust | Extended Idle Hours | Grams/Extended Idle Hour |
| Evaporative Permeation | Miles Traveled<br>Source Hours Parked | Grams/Mile<br>Grams/ Source Hour Parked |
| Evaporative Fuel Vapor Venting | Miles Traveled<br>Source Hours Parked | Grams/Mile<br>Grams/ Source Hour Parked |
| Evaporative Fuel Leaks | Miles Traveled<br>Source Hours Parked | Grams/Mile<br>Grams/ Source Hour Parked |
| Brake Wear | Miles Traveled | Grams/Mile |
| Tire Wear | Miles Traveled | Grams/Mile |

For the distance based emissions rates (i.e., grams per mile), the utility extracts the emissions data (by pollutant, pollutant process, roadway type, average speed bin, SUT, and fuel type) from the movesoutput database for the specified pollutants (or all of the pollutants if not specified) and the corresponding miles traveled activity (MOVES activityTypeID = 1) from the movesactivityoutput database table. The utility divides the emissions data by the corresponding activity data, applies the appropriate units conversion factor and saves the emissions rates in the ttirateperdistance database table.

For the off-network emissions rates (i.e., grams per SHP, grams per start, and grams per SHI) the utility calculates the emissions rates based on the pollutant process. For processID = 12 (evaporative fuel vapor venting), the utility extracts the emissions data (by hour, pollutant, pollutant process, source type, and fuel type) from the movesoutput database table for the specified pollutants pollutants (or all of the pollutants if not specified) where roadTypeID = 1 (“off-network” emissions) and the corresponding SHP activity (activityTypeID = 5) from the movesactivityoutput database table. The utility divides the emissions data by the corresponding activity data, applies the appropriate units conversion factor and saves the emissions rates in the ttirateperactivity database table.

Using the same calculation process, the utility also calcutes the emissions rates for processID = 17 (crankcase extended idle exhaust) and processID = 90 (extended idle exhaust) using the corresponding SHI activity (activityTypeID = 3), for processID = 11 (evaporative permeation) and processID = 13 (evaporative fuel leaks) using the corresponding SHP activity (activityTypeID = 5), and for processID = 2 (start exhaust) and processID = 16 (crankcase start exhaust) using the corresponding starts activity (activityTypeID = 7).

For the SHP, starts, and SHI activity per vehicle, the utility extracts the SHP, starts, SHI, and population activity data (by hour, SUT, and fuel type) from the movesactivityoutput database table. The utility divides the SHP activity by the population and saves the SHP per vehicle in the ttiactpervehicle database table. Using the same calculation process, the utility also calculates the starts per vehicle and SHI per vehicle using the starts and SHI activity data.

**MOVESratesAdj**

The MOVESratesAdj utility applies emissions rate adjustments to an emissions rate database table produced by MOVES (rateperdistance, ratepervehicle, rateperprofile), the MOVESratesCalc utility (ttirateperdistance, ttirateperactivity) 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. Otherwise, all of the pollutants in the input emissions rate database table will be in the new emissions rate database table. The utility also has the option for combining multiple emissions rate database tables into one new emissions rate database table, provided that 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 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. A tab-delimited form of this database table may also be output that includes the text description of the pollutant, process, and roadway type instead of the MOVES codes that are included in the database tables.

**ShpExtIdleStartActBld**

The ShpExtIdleStartActBld utility calculates the SHP and starts activity by hour, SUT, and fuel type used to estimate emissions using the MOVESratesCalc emissions rates. The SHP is calculated using the either the TDM or virtual link based link VMT and speeds (same as used in the distance-based emissions estimation), the VMT mix (by roadway type), and the SUT/fuel type population (from the MOVESpopulationBuild). The starts activity is calculated using the SUT/fuel type population and the starts per vehicle (typically from the ttiactpervehicle database table created by the MOVESratesCalc utility). The utility also has the option of calculating the SHI activity used to estimate emissions using the MOVESratesCalc emissions rates. However, this method of estimating the extended idle hours is a direct function of the SHO and does not consider the availability of locations where extended idling may occur. The suggested method for estimating the SHI is discussed in the "ExtIdleHrsCalc" section.

For each link in the first VMT and speeds input with the desired county code, the utility applies the appropriate VMT mix to distribute 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 VMT and speeds input; therefore producing 24-hourly values for VMT by SUT/fuel type and for VHT by SUT/fuel type.

The hourly SUT/fuel type speed, total hours (or source hours), and SHP are then calclulaed. 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 by are calculated subtracting the hourly SUT/fuel type VHT (or SHO) from the hourly SUT/fuel type total hours.

The hourly SUT/fuel type starts are calculated using the hourly starts per vehicle and the SUT/fuel type population. For each hour, the hourly SUT/fuel type starts are calculated by multiplying the hourly starts per vehicle by the SUT/fuel type population.

The hourly SUT/fuel type SHIs are calculated for source type 62, fuel type 2 (CLhT_Diesel) only. The CLhT_Diesel 24-hour SHI is calculated by multiplying the CLhT_Diesel 24-hour VHT (from the SHP calculation process) by the user-supplied extended idle factor, which represents the amount of extended idle time that must occur per SHO. The hourly CLhT_Diesel VHT (from the SHP calculation process) is converted to hourly VHT fractions. The hourly SHI fractions are calculated as the inverse of the hourly VHT fractions. The hourly SHI fractions are then applied to the CLhT_Diesel 24-hour SHI to calculate the hourly SUT/fuel type SHI.

**ExtIdleHrsCalc**

The ExtIdleHrsCalc utility calculates the SHI activity by hour for SUT 62, fuel type 2 (CLhT_Diesel) used to estimate emissions using the MOVESratesCalc emissions rates. This hourly SHI is calculated using a 24-hour base SHI for a specific year and day type, base link

VMT and speeds, base VMT mix, future link VMT and speeds, future VMT mix, and the future tab-delimited hourly SHP by SUT/fuel type.  All of the base data should be from the same year and day-type.  Although the term future data is used, the future data can be a year previous to the base data (i.e., historical year) and should be from the same year and day type.  The tab-delimited hourly SHP by SUT/fuel type is typically the output from the ShpExtIdleStartActBld utility.

For each link in the first base VMT and speeds input with the desired county code, the utility applies the appropriate base VMT mix for CLhT_Diesel to the link VMT to calculate the link CLhT_Diesel VMT, which is added to the hourly CLhT_Diesel VMT.  The link CLhT_Diesel VMT is divided by the link speed to calculate the link CLhT_Diesel VHT, which is added to the hourly CLhT_Diesel VHT.  This calculation process is repeated for each base VMT and speeds input; therefore producing 24-hourly values for base CLhT_Diesel VMT and for base CLhT_Diesel VHT by SUT/fuel type.  The same calculation process is performed for the future data (future VMT and speeds, future VMT mix) to calculate the hourly future CLhT_Diesel VMT and the hourly future CLhT_Diesel VHT.

The 24-hour future SHI is calculated using the 24-hour base CLhT_Diesel VMT, the 24-hour future CLhT_Diesel VMT, and the 24-hour base SHI.  The scaling factor is calculated by the dividing the 24-hour future CLhT_Diesel VMT by the 24-hour base CLhT_Diesel VMT.  The scaling factor is multiplied by the 24-hour base SHI to estimate the 24-hour future SHI.

The 24-hour future SHI is distributed to each hour using SHI hourly factors.  The SHI hourly factors are calculated using the hourly CLhT_Diesel VMT.  The hourly CLhT_Diesel VMT is converted hourly CLhT_Diesel VMT fractions.  The SHI hourly factors are calculated by taking the inverse of the hourly CLhT_Diesel VMT fractions (i.e., more VMT implies less SHI).  The SHI hourly factors are applied to the 24-hour future SHI to calculate the initial hourly future SHI, therefore distributing the 24-hour future SHI to each hour of the day.

To form the final SHI activity by hour, the initial hourly future SHI is compared to the hourly CLhT_Diesel SHP.  If the initial hourly future SHI is greater than the hourly CLhT_Diesel SHP, then the final SHI activity for that hour is set to the hourly CLhT_Diesel SHP.  Otherwise, the final SHI activity for that hour is set to the initial hourly future SHI.  This comparison is performed for each hour.

**MOVESemscalc**

The MOVESemscalc utility estimates the hourly link emissions for one user-specified county using the emissions factors (either from MOVES, MOVES ratesCalc or MOVESratesAdj), the VMT mix, the hourly link VMT and speeds activity estimates (either from TRANSVMT or VirtualLinkVMT), and the off-network activity (either vehicle population or 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 MOVESemscalc are:

- Emissions factors from MOVES, MOVES ratesCalc or MOVESratesAdj;
- Link-based hourly VMT and speeds developed with the TRANSVMT or VirtualLinkVMT utility.  For each link, the following information is input to

MOVESemscalc: link start node, link end node, link county number, link roadway type number, link area type number, link VMT, and link operational speed estimate;

- VMT mix by MOVES roadway type, MOVES SUT, and MOVES fuel type;
- Off-network activity. If the emissions factors are in the MOVES format, vehicle population by SUT/fuel type is required. If the emissions factors are in the MOVESratesCalc format, the SHP, starts, and SHI by hour and SUT/fuel type are required; and
- Link/MOVES roadway type designations, which associates the link roadway/area type combination to the appropriate MOVES roadway type.

The emissions estimation can be categorized by two basic types based on the type of emissions factors: the VMT-based emissions and the off-network emissions. For the VMT-based emissions (rateperdistance or ttirateperdistance emissions factors), the VMT for each link is distributed to each of the SUT/fuel type combinations listed in the VMT mix by MOVES roadway type (as designated in the link/MOVES roadway type designations). The emissions factors are selected based on the MOVES roadway type 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.

The off-network emissions calculation depends on the format of the input emissions factors. If the emissions factors are in the MOVES format (rateperprofile and ratepervehicle), the emissions factors by SUT/fuel type are multiplied by their associated vehicle population to estimate emissions. If the emissions factors are in the MOVESratesCalc format, the emissions factors by SUT/fuel type are multiplied by the appropriate activity, which is determined by the pollutant process (see Table 35).

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, 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. This tab-delimited file also includes hourly and 24-hour summaries of the off-network activity and VMT, VHT, and speed by roadway. Link emissions may also be output by county, pollutant, process, and each SUT/fuel type combination.

*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:

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

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.

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

$$EF_{Interp} = 0.7413 \text{ g/mi} - (0.26214) \times (0.7413 \text{ g/mi} - 0.7274 \text{ g/mi});$$

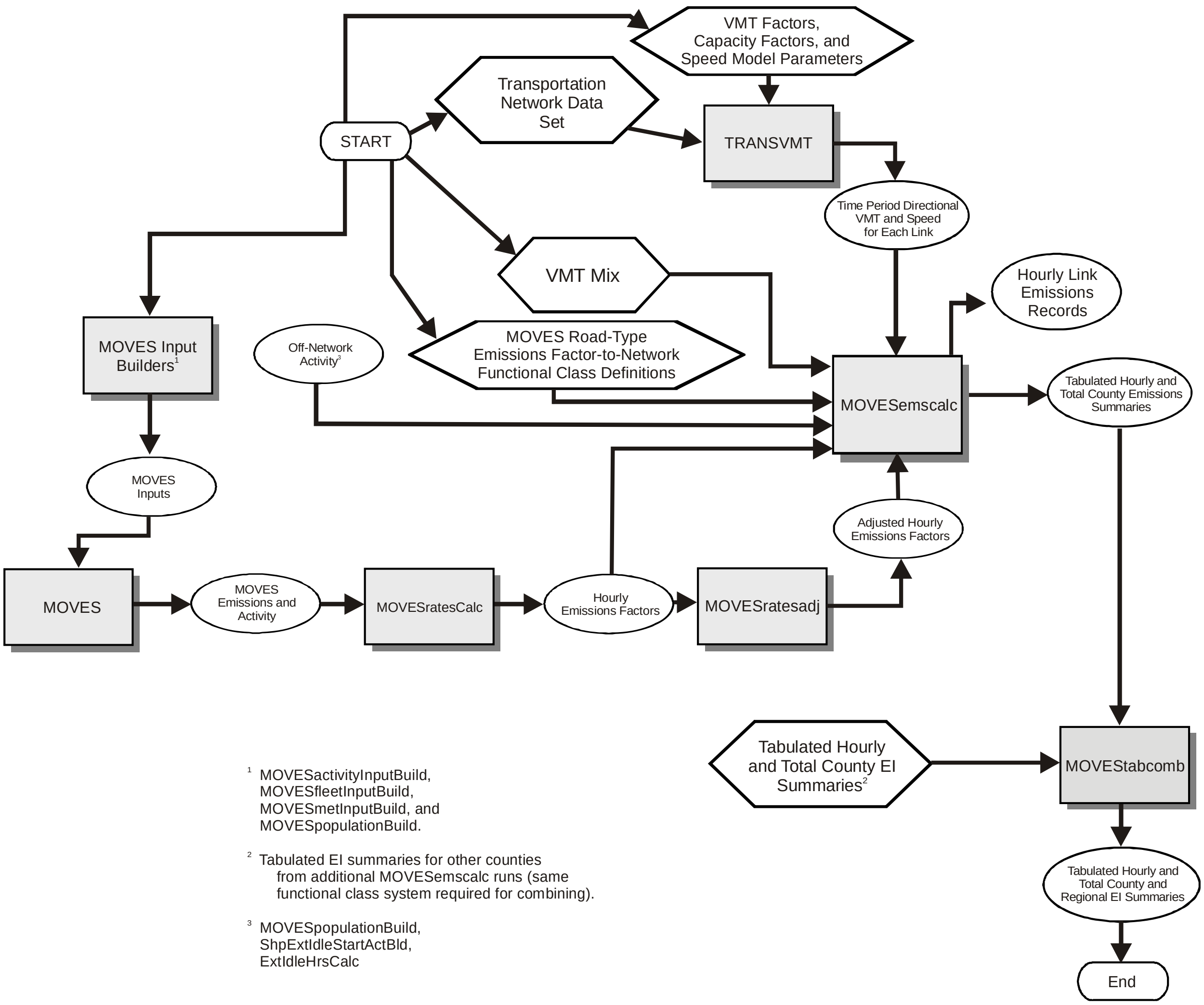
$$= 0.7377 \text{ g/mi.}$$

**MOVEStabcomb**

The MOVEStabcomb utility combines the tab-delimited output from multiple runs of the MOVESemscac utility to produce a regional summary of the VMT, VHT, speed (VMT/VHT), off-network activity, and emissions for each hour along with a 24-hour summary. A maximum of 1,000 tab files can be combined in one run of the MOVEStabcomb utility. However, each tab file must have the same roadway types or the utility will not function properly.

The new regional tab-delimited file is in the same form as the individual county files taken as input, except that each time period includes the individual county data summaries plus the regional summary. The individual county summaries are taken directly from the input tab-delimited files. The regional data summaries are summations of the county data except for "speed," which is calculated as regional VMT/regional VHT.

# Travel Demand Model Network Link-Based Hourly MOVES Emissions Estimates




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

[2] Tabulated EI summaries for other counties from additional MOVESemscalc runs (same functional class system required for combining).

[3] MOVESpopulationBuild, ShpExtIdleStartActBld, ExtIdleHrsCalc

# APPENDIX C: TXDOT DISTRICT VMT MIX BY DAY OF WEEK AND AGGREGATE WEEKDAY VMT MIX

**VMT Mix Year/Analysis Year Correlations**

| VMT Mix Year | Analysis Years |
|---|---|
| 2000 | 1998 through 2002 |
| 2005 | 2003 through 2007 |
| 2010 | 2008 through 2012 |
| 2015 | 2013 through 2017 |
| 2020 | 2018 through 2022 |

## 2005 and 2010 Weekday VMT Mix for the Beaumont TxDOT District

| SUT/FT | 2005[1] | | | | 2010[2] | | | |
|---|---|---|---|---|---|---|---|---|
| | RT2 | RT3 | RT4 | RT5 | RT2 | RT3 | RT4 | RT5 |
| 21_D | 0.00109 | 0.00114 | 0.00116 | 0.00129 | 0.00055 | 0.00057 | 0.00058 | 0.00064 |
| 21_G | 0.54421 | 0.56823 | 0.57804 | 0.64318 | 0.54475 | 0.56880 | 0.57862 | 0.64382 |
| 31_D | 0.00325 | 0.00430 | 0.00345 | 0.00437 | 0.00495 | 0.00655 | 0.00526 | 0.00666 |
| 31_G | 0.15146 | 0.20039 | 0.16093 | 0.20373 | 0.14976 | 0.19814 | 0.15912 | 0.20144 |
| 32_D | 0.00423 | 0.00559 | 0.00449 | 0.00569 | 0.00340 | 0.00450 | 0.00362 | 0.00458 |
| 32_G | 0.04734 | 0.06263 | 0.05030 | 0.06368 | 0.04817 | 0.06373 | 0.05118 | 0.06479 |
| 51_D | 0.00094 | 0.00112 | 0.00084 | 0.00080 | 0.00065 | 0.00078 | 0.00058 | 0.00056 |
| 51_G | 0.00024 | 0.00029 | 0.00022 | 0.00020 | 0.00017 | 0.00020 | 0.00015 | 0.00014 |
| 52_D | 0.03619 | 0.04335 | 0.03239 | 0.03077 | 0.03650 | 0.04372 | 0.03267 | 0.03103 |
| 52_G | 0.00927 | 0.01111 | 0.00830 | 0.00788 | 0.00935 | 0.01121 | 0.00837 | 0.00795 |
| 53_D | 0.00174 | 0.00209 | 0.00156 | 0.00148 | 0.00176 | 0.00211 | 0.00158 | 0.00150 |
| 53_G | 0.00045 | 0.00054 | 0.00040 | 0.00038 | 0.00045 | 0.00054 | 0.00040 | 0.00038 |
| 54_D | 0.00196 | 0.00235 | 0.00175 | 0.00167 | 0.00192 | 0.00230 | 0.00172 | 0.00163 |
| 54_G | 0.00050 | 0.00060 | 0.00045 | 0.00043 | 0.00049 | 0.00059 | 0.00044 | 0.00042 |
| 41_D | 0.00192 | 0.00180 | 0.00167 | 0.00131 | 0.00196 | 0.00183 | 0.00170 | 0.00133 |
| 42_D | 0.00065 | 0.00061 | 0.00057 | 0.00045 | 0.00061 | 0.00057 | 0.00053 | 0.00042 |
| 42_G | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 43_D | 0.00218 | 0.00204 | 0.00190 | 0.00148 | 0.00218 | 0.00204 | 0.00190 | 0.00149 |
| 43_G | 0.00002 | 0.00002 | 0.00002 | 0.00001 | 0.00002 | 0.00002 | 0.00002 | 0.00002 |
| 61_D | 0.06570 | 0.03125 | 0.05171 | 0.01047 | 0.06570 | 0.03125 | 0.05171 | 0.01047 |
| 61_G | 0.00738 | 0.00351 | 0.00581 | 0.00118 | 0.00738 | 0.00351 | 0.00581 | 0.00118 |
| 62_D | 0.11873 | 0.05647 | 0.09345 | 0.01891 | 0.11873 | 0.05647 | 0.09345 | 0.01891 |
| 62_G | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 11_G | 0.00055 | 0.00057 | 0.00058 | 0.00065 | 0.00055 | 0.00057 | 0.00058 | 0.00065 |

[1] 2005 analysis year.
[2] 2011 analysis year.

## 2015 and 2020 Weekday VMT Mix for the Beaumont TxDOT District

| SUT/FT | 2015[1] | | | | 2020[2] | | | |
|---|---|---|---|---|---|---|---|---|
| | RT2 | RT3 | RT4 | RT5 | RT2 | RT3 | RT4 | RT5 |
| 21_D | 0.00055 | 0.00057 | 0.00058 | 0.00064 | 0.00164 | 0.00171 | 0.00174 | 0.00193 |
| 21_G | 0.54475 | 0.56880 | 0.57862 | 0.64382 | 0.54366 | 0.56766 | 0.57746 | 0.64254 |
| 31_D | 0.00696 | 0.00921 | 0.00740 | 0.00936 | 0.00866 | 0.01146 | 0.00921 | 0.01165 |
| 31_G | 0.14775 | 0.19548 | 0.15698 | 0.19874 | 0.14604 | 0.19323 | 0.15517 | 0.19645 |
| 32_D | 0.00315 | 0.00416 | 0.00334 | 0.00423 | 0.00346 | 0.00457 | 0.00367 | 0.00465 |
| 32_G | 0.04842 | 0.06407 | 0.05145 | 0.06514 | 0.04811 | 0.06366 | 0.05112 | 0.06472 |
| 51_D | 0.00049 | 0.00059 | 0.00044 | 0.00042 | 0.00037 | 0.00044 | 0.00033 | 0.00031 |
| 51_G | 0.00013 | 0.00015 | 0.00011 | 0.00011 | 0.00009 | 0.00011 | 0.00008 | 0.00008 |
| 52_D | 0.03665 | 0.04391 | 0.03281 | 0.03116 | 0.03681 | 0.04410 | 0.03295 | 0.03130 |
| 52_G | 0.00939 | 0.01125 | 0.00841 | 0.00799 | 0.00943 | 0.01130 | 0.00844 | 0.00802 |
| 53_D | 0.00177 | 0.00212 | 0.00158 | 0.00150 | 0.00177 | 0.00213 | 0.00159 | 0.00151 |
| 53_G | 0.00045 | 0.00054 | 0.00041 | 0.00039 | 0.00045 | 0.00054 | 0.00041 | 0.00039 |
| 54_D | 0.00192 | 0.00230 | 0.00172 | 0.00163 | 0.00188 | 0.00225 | 0.00168 | 0.00160 |
| 54_G | 0.00049 | 0.00059 | 0.00044 | 0.00042 | 0.00048 | 0.00058 | 0.00043 | 0.00041 |
| 41_D | 0.00198 | 0.00186 | 0.00172 | 0.00135 | 0.00199 | 0.00186 | 0.00173 | 0.00136 |
| 42_D | 0.00059 | 0.00055 | 0.00051 | 0.00040 | 0.00057 | 0.00054 | 0.00050 | 0.00039 |
| 42_G | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 43_D | 0.00218 | 0.00204 | 0.00190 | 0.00149 | 0.00219 | 0.00205 | 0.00191 | 0.00149 |
| 43_G | 0.00002 | 0.00002 | 0.00002 | 0.00002 | 0.00002 | 0.00002 | 0.00002 | 0.00002 |
| 61_D | 0.06570 | 0.03125 | 0.05171 | 0.01047 | 0.06570 | 0.03125 | 0.05171 | 0.01047 |
| 61_G | 0.00738 | 0.00351 | 0.00581 | 0.00118 | 0.00738 | 0.00351 | 0.00581 | 0.00118 |
| 62_D | 0.11873 | 0.05647 | 0.09345 | 0.01891 | 0.11873 | 0.05647 | 0.09345 | 0.01891 |
| 62_G | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 11_G | 0.00055 | 0.00057 | 0.00058 | 0.00065 | 0.00055 | 0.00057 | 0.00058 | 0.00065 |

[1] 2014 and 2017 analysis years.
[2] 2021 analysis year.

## Aggregate Weekday VMT Mix for the Beaumont TxDOT District

| SUT/FT | 2005[1] | 2010[2] | 2015[3] | 2020[4] |
|---|---|---|---|---|
| 21_D | 0.001140 | 0.000570 | 0.000570 | 0.001710 |
| 21_G | 0.569900 | 0.570470 | 0.570470 | 0.569330 |
| 31_D | 0.003700 | 0.005630 | 0.007920 | 0.009860 |
| 31_G | 0.172360 | 0.170420 | 0.168130 | 0.166190 |
| 32_D | 0.004810 | 0.003870 | 0.003580 | 0.003930 |
| 32_G | 0.053870 | 0.054810 | 0.055100 | 0.054750 |
| 51_D | 0.000950 | 0.000660 | 0.000490 | 0.000370 |
| 51_G | 0.000240 | 0.000170 | 0.000130 | 0.000090 |
| 52_D | 0.036500 | 0.036820 | 0.036970 | 0.037130 |
| 52_G | 0.009350 | 0.009440 | 0.009480 | 0.009520 |
| 53_D | 0.001760 | 0.001780 | 0.001780 | 0.001790 |
| 53_G | 0.000450 | 0.000450 | 0.000460 | 0.000460 |
| 54_D | 0.001980 | 0.001940 | 0.001940 | 0.001890 |
| 54_G | 0.000510 | 0.000500 | 0.000500 | 0.000490 |
| 41_D | 0.001760 | 0.001790 | 0.001810 | 0.001820 |
| 42_D | 0.000600 | 0.000560 | 0.000540 | 0.000520 |
| 42_G | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 43_D | 0.001990 | 0.002000 | 0.002000 | 0.002000 |
| 43_G | 0.000020 | 0.000020 | 0.000020 | 0.000020 |
| 61_D | 0.047110 | 0.047110 | 0.047110 | 0.047110 |
| 61_G | 0.005290 | 0.005290 | 0.005290 | 0.005290 |
| 62_D | 0.085140 | 0.085140 | 0.085140 | 0.085140 |
| 62_G | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 11_G | 0.000570 | 0.000570 | 0.000570 | 0.000570 |

[1] 2005 analysis year.
[2] 2011 analysis year.
[3] 2014 and 2017 analysis years.
[4] 2021 analysis year.

# APPENDIX D:
# DIRECTIONAL SPLIT ESTIMATES

## AM Peak-Period Directional Split Estimates for BPA

| Area Types | Functional Classification Groups | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Centroid Connector | IH and Freeway | Principal Arterial Divided | Principal Arterial Undivided | Minor Arterial Divided | Minor Arterial Undivided | Collector | Frontage Road | Ramp |
| CBD | 54.0 | 50.0 | 65.0 | 65.0 | 58.0 | 58.0 | 64.5 | 50.0 | 50.0 |
| CBD Fringe | 87.0 | 50.0 | 60.0 | 60.0 | 59.0 | 59.0 | 63.0 | 50.0 | 50.0 |
| Urban | 85.0 | 60.0 | 62.0 | 62.0 | 58.0 | 58.0 | 53.0 | 60.0 | 60.0 |
| Suburban | 72.0 | 61.0 | 65.0 | 65.0 | 64.0 | 64.0 | 64.5 | 61.0 | 61.0 |
| Rural | 78.0 | 70.0 | 71.0 | 71.0 | 68.0 | 68.0 | 75.0 | 70.0 | 70.0 |

## Mid-Day and Overnight (Off-Peak) Directional Split Estimates for BPA

| Area Types | Functional Classification Groups | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Centroid Connector | IH and Freeway | Principal Arterial Divided | Principal Arterial Undivided | Minor Arterial Divided | Minor Arterial Undivided | Collector | Frontage Road | Ramp |
| CBD | 54.0 | 51.0 | 55.0 | 55.0 | 55.0 | 55.0 | 54.5 | 51.0 | 51.0 |
| CBD Fringe | 54.0 | 51.0 | 54.0 | 54.0 | 55.0 | 55.0 | 53.0 | 51.0 | 51.0 |
| Urban | 55.0 | 53.0 | 50.0 | 50.0 | 52.0 | 52.0 | 52.0 | 53.0 | 53.0 |
| Suburban | 55.0 | 51.0 | 57.0 | 57.0 | 56.0 | 56.0 | 57.0 | 51.0 | 51.0 |
| Rural | 52.0 | 53.0 | 55.0 | 55.0 | 58.0 | 58.0 | 54.0 | 53.0 | 53.0 |

## PM Peak-Period Directional Split Estimates for BPA

| Area Types | Functional Classification Groups | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Centroid Connector** | **IH and Freeway** | **Principal Arterial Divided** | **Principal Arterial Undivided** | **Minor Arterial Divided** | **Minor Arterial Undivided** | **Collector** | **Frontage Road** | **Ramp** |
| CBD | 55.0 | 54.0 | 62.0 | 62.0 | 52.0 | 52.0 | 57.5 | 54.0 | 54.0 |
| CBD Fringe | 72.0 | 54.0 | 59.0 | 59.0 | 53.0 | 53.0 | 64.5 | 54.0 | 54.0 |
| Urban | 72.0 | 56.0 | 57.0 | 57.0 | 64.0 | 64.0 | 68.0 | 56.0 | 56.0 |
| Suburban | 72.0 | 67.0 | 60.0 | 60.0 | 65.0 | 65.0 | 62.5 | 67.0 | 67.0 |
| Rural | 71.0 | 65.0 | 66.0 | 66.0 | 63.0 | 63.0 | 70.0 | 65.0 | 65 |

Note: Time-of-day directional splits for area type and facility type were provided by TxDOT's Transportation Planning and Programming Division after collaboration with TxDOT's Beaumont/Port Arthur District and the Beaumont/Port Arthur Metropolitan Planning Organization. The tables are taken from TTI report, *1996 Jefferson, Orange, and Hardin Counties Periodic Emission Inventory*, December 3, 1997. The functional classification groups-to-facility type correlation is shown at the end of this appendix.

**BPA Network Facility Types Correlated to Functional Classification Groups**

| Functional Classification Groups | Facility Type Code | Facility Type Name |
|---|---|---|
| IH and Freeway | 1 | Radial IH Freeways - Mainlanes Only |
| | 2 | Radial IH Freeways - Mainlanes and Frontage Roads |
| | 3 | Circumferential IH Freeways (Loops) - Mainlanes Only |
| | 4 | Circumferential IH Freeways (Loops) - Mainlanes and Frontage Roads |
| | 5 | Radial Other Freeways - Mainlanes Only |
| | 6 | Radial Other Freeways - Mainlanes and Frontage Roads |
| | 7 | Circumferential Other Freeways (Loops) - Mainlanes Only |
| | 8 | Circumferential Other Freeways (Loops) - Mainlanes and Frontage Roads |
| | 22 | Interchange Ramp (Freeway-to-freeway Interchange Ramps) |
| Principle Arterial Divided | 11 | Principal Arterial – Divided |
| Principle Arterial Undivided | 12 | Principal Arterial - Continuous Left Turn Lane |
| | 13 | Principal Arterial – Undivided |
| Minor Arterial Divided | 14 | Minor Arterial – Divided |
| Minor Arterial Undivided | 15 | Minor Arterial - Continuous Left Turn Lane |
| | 16 | Minor Arterial – Undivided |
| Collector | 17 | Collector – Divided |
| | 18 | Collector - Continuous Left Turn Lane |
| | 19 | Collector - Undivided |
| Frontage Road | 20 | Frontage Road |
| Ramp | 21 | Ramp (Between Frontage Road and Mainlanes) |
| Centroid Connector | 0 | Centroid Connector |

# APPENDIX E:
# CAPACITY FACTORS AND SPEED FACTORS

## BPA TDM Capacity Factors

| Facility Type | Area Type | | | | |
|---|---|---|---|---|---|
| | CBD | CBD Fringe | Urban | Suburban | Rural |
| 1 | 0.0938 | 0.0979 | 0.0987 | 0.1121 | 0.1266 |
| 2 | 0.0938 | 0.0979 | 0.0987 | 0.1121 | 0.1266 |
| 3 | 0.0938 | 0.0939 | 0.0933 | 0.1032 | 0.1117 |
| 4 | 0.0938 | 0.0939 | 0.0933 | 0.1032 | 0.1117 |
| 5 | 0.0938 | 0.0979 | 0.0987 | 0.1121 | 0.1266 |
| 6 | 0.0938 | 0.0979 | 0.0987 | 0.1121 | 0.1266 |
| 7 | 0.0938 | 0.0939 | 0.0933 | 0.1032 | 0.1117 |
| 8 | 0.0938 | 0.0939 | 0.0933 | 0.1032 | 0.1117 |
| 9 | 0.0918 | 0.0964 | 0.1020 | 0.1204 | 0.1370 |
| 10 | 0.0918 | 0.0925 | 0.0938 | 0.1060 | 0.1176 |
| 11 | 0.0733 | 0.0811 | 0.0915 | 0.1133 | 0.1404 |
| 12 | 0.0733 | 0.0811 | 0.0915 | 0.1133 | 0.1404 |
| 13 | 0.0746 | 0.0833 | 0.0938 | 0.1184 | 0.1422 |
| 14 | 0.0846 | 0.0938 | 0.1025 | 0.1273 | 0.1531 |
| 15 | 0.0846 | 0.0938 | 0.1025 | 0.1273 | 0.1531 |
| 16 | 0.0847 | 0.0948 | 0.1027 | 0.1225 | 0.1467 |
| 17 | 0.0800 | 0.0867 | 0.0957 | 0.1163 | 0.1382 |
| 18 | 0.0800 | 0.0867 | 0.0957 | 0.1163 | 0.1382 |
| 19 | 0.0875 | 0.0938 | 0.1053 | 0.1324 | 0.1532 |
| 20 | 0.0846 | 0.0938 | 0.1025 | 0.1273 | 0.1480 |
| 21 | 0.0733 | 0.0800 | 0.0833 | 0.0933 | 0.1000 |
| 22 | 0.0733 | 0.0800 | 0.0833 | 0.0933 | 0.1000 |

## BPA TDM Free Flow (Volume = 1) Speed Factors

| Facility Type | Area Type | | | | |
|---|---|---|---|---|---|
| | CBD | CBD Fringe | Urban | Suburban | Rural |
| 1 | 1.441300 | 1.398264 | 1.278228 | 1.292247 | 1.325758 |
| 2 | 1.441300 | 1.398264 | 1.278228 | 1.292247 | 1.325758 |
| 3 | 1.528202 | 1.451451 | 1.346499 | 1.368997 | 1.412714 |
| 4 | 1.528202 | 1.451451 | 1.346499 | 1.368997 | 1.412714 |
| 5 | 1.441300 | 1.398264 | 1.278228 | 1.292247 | 1.325758 |
| 6 | 1.441300 | 1.398264 | 1.278228 | 1.292247 | 1.325758 |
| 7 | 1.528202 | 1.451451 | 1.346499 | 1.368997 | 1.412714 |
| 8 | 1.528202 | 1.451451 | 1.346499 | 1.368997 | 1.412714 |
| 9 | 1.573427 | 1.522843 | 1.321702 | 1.281753 | 1.283422 |
| 10 | 1.616960 | 1.551891 | 1.355381 | 1.321163 | 1.325967 |
| 11 | 1.687764 | 1.644989 | 1.383338 | 1.289324 | 1.282948 |
| 12 | 1.687764 | 1.644989 | 1.383338 | 1.289324 | 1.282948 |
| 13 | 1.603376 | 1.530222 | 1.383338 | 1.289324 | 1.282948 |
| 14 | 1.654064 | 1.517572 | 1.274291 | 1.217532 | 1.209190 |
| 15 | 1.654064 | 1.517572 | 1.274291 | 1.217532 | 1.209190 |
| 16 | 1.559546 | 1.397764 | 1.274291 | 1.217532 | 1.209190 |
| 17 | 1.603421 | 1.469933 | 1.204819 | 1.127714 | 1.143583 |
| 18 | 1.603421 | 1.469933 | 1.204819 | 1.127714 | 1.143583 |
| 19 | 1.496526 | 1.336303 | 1.204819 | 1.127714 | 1.143583 |
| 20 | 1.765225 | 1.667313 | 1.368613 | 1.274210 | 1.282948 |
| 21 | 1.544572 | 1.550989 | 1.368613 | 1.274210 | 1.282948 |
| 22 | 1.544572 | 1.550989 | 1.368613 | 1.274210 | 1.282948 |

# APPENDIX F:
# VEHICLE POPULATION ESTIMATES AND 24-HOUR SHP, STARTS, AND SHI SUMMARIES

## 2005 and 2011 Vehicle Population Estimates

| SUT/FT | 2005 | | | 2011 | | |
|---|---|---|---|---|---|---|
| | Hardin | Jefferson | Orange | Hardin | Jefferson | Orange |
| 21_D | 38 | 194 | 65 | 26 | 98 | 35 |
| 21_G | 18,760 | 96,814 | 32,438 | 26,077 | 98,263 | 35,301 |
| 31_D | 275 | 927 | 408 | 550 | 1,446 | 688 |
| 31_G | 12,822 | 43,182 | 19,010 | 16,649 | 43,758 | 20,827 |
| 32_D | 358 | 1,205 | 531 | 378 | 994 | 473 |
| 32_G | 4,008 | 13,496 | 5,941 | 5,355 | 14,073 | 6,698 |
| 51_D | 9 | 33 | 11 | 16 | 37 | 16 |
| 51_G | 2 | 8 | 3 | 4 | 10 | 4 |
| 52_D | 354 | 1,264 | 437 | 893 | 2,075 | 866 |
| 52_G | 91 | 324 | 112 | 229 | 532 | 222 |
| 53_D | 17 | 61 | 21 | 43 | 100 | 42 |
| 53_G | 4 | 16 | 5 | 11 | 25 | 11 |
| 54_D | 19 | 69 | 24 | 47 | 109 | 46 |
| 54_G | 5 | 18 | 6 | 12 | 28 | 12 |
| 41_D | 17 | 61 | 21 | 43 | 101 | 42 |
| 42_D | 6 | 21 | 7 | 14 | 32 | 13 |
| 42_G | 0 | 0 | 0 | 0 | 0 | 0 |
| 43_D | 19 | 69 | 24 | 48 | 113 | 47 |
| 43_G | 0 | 1 | 0 | 0 | 1 | 0 |
| 61_D | 154 | 940 | 240 | 233 | 1,209 | 252 |
| 61_G | 17 | 106 | 27 | 26 | 136 | 28 |
| 62_D | 278 | 1,700 | 434 | 422 | 2,185 | 455 |
| 62_G | 0 | 0 | 0 | 0 | 0 | 0 |
| 11_G | 960 | 3,145 | 1,426 | 1,646 | 3,921 | 2,161 |

**2014 and 2017 Vehicle Population Estimates**

| SUT/FT | 2014 | | | 2017 | | |
|---|---|---|---|---|---|---|
| | Hardin | Jefferson | Orange | Hardin | Jefferson | Orange |
| 21_D | 27 | 101 | 37 | 28 | 105 | 38 |
| 21_G | 27,128 | 101,418 | 36,725 | 28,220 | 104,674 | 38,207 |
| 31_D | 805 | 2,099 | 1,007 | 837 | 2,166 | 1,048 |
| 31_G | 17,087 | 44,556 | 21,376 | 17,775 | 45,987 | 22,239 |
| 32_D | 364 | 949 | 455 | 378 | 979 | 474 |
| 32_G | 5,600 | 14,602 | 7,005 | 5,825 | 15,071 | 7,288 |
| 51_D | 12 | 29 | 12 | 13 | 29 | 12 |
| 51_G | 3 | 8 | 3 | 3 | 8 | 3 |
| 52_D | 933 | 2,151 | 905 | 970 | 2,220 | 941 |
| 52_G | 239 | 552 | 232 | 249 | 569 | 241 |
| 53_D | 45 | 104 | 44 | 47 | 107 | 45 |
| 53_G | 12 | 27 | 11 | 12 | 28 | 12 |
| 54_D | 49 | 113 | 47 | 51 | 116 | 49 |
| 54_G | 13 | 29 | 12 | 13 | 30 | 13 |
| 41_D | 46 | 105 | 44 | 48 | 109 | 46 |
| 42_D | 14 | 31 | 13 | 14 | 32 | 14 |
| 42_G | 0 | 0 | 0 | 0 | 0 | 0 |
| 43_D | 50 | 116 | 49 | 52 | 120 | 51 |
| 43_G | 1 | 1 | 0 | 1 | 1 | 1 |
| 61_D | 243 | 1,248 | 262 | 253 | 1,288 | 272 |
| 61_G | 27 | 140 | 29 | 28 | 145 | 31 |
| 62_D | 439 | 2,255 | 473 | 456 | 2,327 | 492 |
| 62_G | 0 | 0 | 0 | 0 | 0 | 0 |
| 11_G | 1,712 | 4,047 | 2,248 | 1,781 | 4,177 | 2,339 |

## 2021 Vehicle Population Estimates

| SUT/FT | 2021 | | |
|---|---|---|---|
| | Hardin | Jefferson | Orange |
| 21_D | 89 | 327 | 121 |
| 21_G | 29,686 | 108,961 | 40,196 |
| 31_D | 1,099 | 2,813 | 1,375 |
| 31_G | 18,520 | 47,412 | 23,172 |
| 32_D | 438 | 1,121 | 548 |
| 32_G | 6,101 | 15,620 | 7,634 |
| 51_D | 10 | 23 | 10 |
| 51_G | 2 | 6 | 2 |
| 52_D | 1,028 | 2,327 | 997 |
| 52_G | 264 | 597 | 256 |
| 53_D | 50 | 112 | 48 |
| 53_G | 13 | 29 | 12 |
| 54_D | 52 | 118 | 51 |
| 54_G | 14 | 31 | 13 |
| 41_D | 50 | 114 | 49 |
| 42_D | 14 | 33 | 14 |
| 42_G | 0 | 0 | 0 |
| 43_D | 55 | 125 | 54 |
| 43_G | 1 | 1 | 1 |
| 61_D | 266 | 1,343 | 287 |
| 61_G | 30 | 151 | 32 |
| 62_D | 481 | 2,427 | 519 |
| 62_G | 0 | 0 | 0 |
| 11_G | 1,878 | 4,357 | 2,465 |

## 2005 and 2011 24-Hour Weekday SHP Summaries

| SUT/FT | 2005 | | | 2011 | | |
|---|---|---|---|---|---|---|
| | Hardin | Jefferson | Orange | Hardin | Jefferson | Orange |
| 21_D | 854 | 4,441 | 1,479 | 597 | 2,254 | 806 |
| 21_G | 426,902 | 2,220,200 | 739,505 | 597,473 | 2,255,438 | 806,475 |
| 31_D | 6,437 | 21,553 | 9,527 | 12,886 | 33,650 | 16,092 |
| 31_G | 299,851 | 1,003,993 | 443,800 | 390,072 | 1,018,611 | 487,117 |
| 32_D | 8,368 | 28,018 | 12,385 | 8,858 | 23,130 | 11,062 |
| 32_G | 93,716 | 313,791 | 138,707 | 125,454 | 327,602 | 156,665 |
| 51_D | 181 | 637 | 208 | 349 | 789 | 326 |
| 51_G | 45 | 161 | 52 | 90 | 204 | 84 |
| 52_D | 6,928 | 24,457 | 7,974 | 19,481 | 44,019 | 18,176 |
| 52_G | 1,775 | 6,265 | 2,043 | 4,995 | 11,287 | 4,660 |
| 53_D | 334 | 1,180 | 385 | 942 | 2,128 | 879 |
| 53_G | 85 | 301 | 98 | 238 | 538 | 222 |
| 54_D | 376 | 1,327 | 433 | 1,027 | 2,320 | 958 |
| 54_G | 97 | 342 | 112 | 265 | 598 | 247 |
| 41_D | 343 | 1,198 | 392 | 959 | 2,157 | 890 |
| 42_D | 117 | 408 | 134 | 300 | 675 | 279 |
| 42_G | 0 | 0 | 0 | 0 | 0 | 0 |
| 43_D | 388 | 1,354 | 443 | 1,071 | 2,409 | 995 |
| 43_G | 4 | 14 | 5 | 11 | 24 | 10 |
| 61_D | 2,583 | 17,626 | 3,324 | 4,244 | 24,159 | 3,477 |
| 61_G | 290 | 1,979 | 373 | 476 | 2,712 | 390 |
| 62_D | 4,668 | 31,857 | 6,008 | 7,670 | 43,664 | 6,285 |
| 62_G | 0 | 0 | 0 | 0 | 0 | 0 |
| 11_G | 23,017 | 75,376 | 34,185 | 39,478 | 94,010 | 51,819 |

## 2014 and 2017 24-Hour Weekday SHP Summaries

| SUT/FT | 2014 | | | 2017 | | |
|---|---|---|---|---|---|---|
| | Hardin | Jefferson | Orange | Hardin | Jefferson | Orange |
| 21_D | 621 | 2,326 | 838 | 646 | 2,400 | 872 |
| 21_G | 621,309 | 2,327,404 | 838,803 | 646,222 | 2,401,927 | 873,279 |
| 31_D | 18,855 | 48,852 | 23,548 | 19,612 | 50,417 | 24,508 |
| 31_G | 400,255 | 1,037,053 | 499,896 | 416,339 | 1,070,289 | 520,276 |
| 32_D | 8,523 | 22,082 | 10,644 | 8,865 | 22,790 | 11,078 |
| 32_G | 131,172 | 339,865 | 163,827 | 136,443 | 350,757 | 170,506 |
| 51_D | 269 | 603 | 251 | 280 | 623 | 262 |
| 51_G | 72 | 161 | 67 | 75 | 166 | 70 |
| 52_D | 20,341 | 45,612 | 18,980 | 21,150 | 47,073 | 19,781 |
| 52_G | 5,216 | 11,697 | 4,867 | 5,424 | 12,071 | 5,073 |
| 53_D | 979 | 2,196 | 914 | 1,018 | 2,266 | 952 |
| 53_G | 253 | 568 | 236 | 263 | 586 | 246 |
| 54_D | 1,068 | 2,394 | 996 | 1,110 | 2,471 | 1,038 |
| 54_G | 275 | 617 | 257 | 286 | 637 | 268 |
| 41_D | 1,008 | 2,250 | 936 | 1,048 | 2,322 | 975 |
| 42_D | 301 | 672 | 279 | 313 | 693 | 291 |
| 42_G | 0 | 0 | 0 | 0 | 0 | 0 |
| 43_D | 1,114 | 2,487 | 1,035 | 1,158 | 2,566 | 1,078 |
| 43_G | 11 | 24 | 10 | 12 | 25 | 11 |
| 61_D | 4,405 | 24,914 | 3,604 | 4,571 | 25,728 | 3,752 |
| 61_G | 495 | 2,797 | 404 | 513 | 2,888 | 421 |
| 62_D | 7,962 | 45,028 | 6,513 | 8,262 | 46,499 | 6,781 |
| 62_G | 0 | 0 | 0 | 0 | 0 | 0 |
| 11_G | 41,068 | 97,028 | 53,910 | 42,722 | 100,143 | 56,086 |

## 2021 24-Hour Weekday SHP Summaries

| SUT/FT | 2021 | | |
|---|---|---|---|
| | Hardin | Jefferson | Orange |
| 21_D | 2,040 | 7,507 | 2,758 |
| 21_G | 679,388 | 2,499,599 | 918,430 |
| 31_D | 25,729 | 65,457 | 32,159 |
| 31_G | 433,650 | 1,103,264 | 542,030 |
| 32_D | 10,255 | 26,089 | 12,817 |
| 32_G | 142,862 | 363,462 | 178,568 |
| 51_D | 223 | 491 | 209 |
| 51_G | 54 | 119 | 51 |
| 52_D | 22,377 | 49,305 | 20,935 |
| 52_G | 5,738 | 12,643 | 5,368 |
| 53_D | 1,079 | 2,377 | 1,009 |
| 53_G | 277 | 611 | 260 |
| 54_D | 1,139 | 2,509 | 1,065 |
| 54_G | 295 | 651 | 277 |
| 41_D | 1,111 | 2,435 | 1,034 |
| 42_D | 317 | 695 | 295 |
| 42_G | 0 | 0 | 0 |
| 43_D | 1,220 | 2,676 | 1,136 |
| 43_G | 12 | 26 | 11 |
| 61_D | 4,802 | 26,802 | 3,936 |
| 61_G | 539 | 3,009 | 442 |
| 62_D | 8,678 | 48,440 | 7,113 |
| 62_G | 0 | 0 | 0 |
| 11_G | 45,031 | 104,452 | 59,123 |

## 2005 and 2011 24-Hour Weekday Starts Summaries

| SUT/FT | 2005 | | | 2011 | | |
|---|---|---|---|---|---|---|
| | Hardin | Jefferson | Orange | Hardin | Jefferson | Orange |
| 21_D | 220 | 1,137 | 381 | 153 | 576 | 207 |
| 21_G | 110,143 | 568,398 | 190,444 | 153,100 | 576,905 | 207,252 |
| 31_D | 1,588 | 5,349 | 2,355 | 3,174 | 8,342 | 3,970 |
| 31_G | 73,991 | 249,179 | 109,696 | 96,072 | 252,505 | 120,181 |
| 32_D | 2,153 | 7,251 | 3,192 | 2,275 | 5,979 | 2,846 |
| 32_G | 24,113 | 81,204 | 35,749 | 32,217 | 84,677 | 40,302 |
| 51_D | 35 | 123 | 43 | 60 | 139 | 58 |
| 51_G | 9 | 31 | 11 | 15 | 36 | 15 |
| 52_D | 2,476 | 8,839 | 3,054 | 6,241 | 14,504 | 6,052 |
| 52_G | 634 | 2,264 | 782 | 1,600 | 3,719 | 1,552 |
| 53_D | 73 | 261 | 90 | 185 | 430 | 179 |
| 53_G | 19 | 67 | 23 | 47 | 109 | 45 |
| 54_D | 11 | 39 | 13 | 27 | 62 | 26 |
| 54_G | 3 | 10 | 3 | 7 | 16 | 7 |
| 41_D | 47 | 169 | 58 | 120 | 279 | 116 |
| 42_D | 27 | 95 | 33 | 62 | 144 | 60 |
| 42_G | 0 | 0 | 0 | 0 | 0 | 0 |
| 43_D | 111 | 396 | 137 | 279 | 648 | 270 |
| 43_G | 1 | 4 | 1 | 3 | 6 | 3 |
| 61_D | 912 | 5,577 | 1,424 | 1,384 | 7,168 | 1,492 |
| 61_G | 102 | 626 | 160 | 155 | 805 | 168 |
| 62_D | 1,191 | 7,286 | 1,860 | 1,808 | 9,365 | 1,950 |
| 62_G | 0 | 0 | 0 | 0 | 0 | 0 |
| 11_G | 427 | 1,399 | 634 | 732 | 1,745 | 961 |

**2014 and 2017 24-Hour Weekday Starts Summaries**

| SUT/FT | 2014 | | | 2017 | | |
|---|---|---|---|---|---|---|
| | Hardin | Jefferson | Orange | Hardin | Jefferson | Orange |
| 21_D | 159 | 595 | 215 | 166 | 614 | 224 |
| 21_G | 159,267 | 595,427 | 215,614 | 165,681 | 614,543 | 224,314 |
| 31_D | 4,645 | 12,112 | 5,811 | 4,832 | 12,500 | 6,045 |
| 31_G | 98,598 | 257,110 | 123,350 | 102,569 | 265,364 | 128,327 |
| 32_D | 2,189 | 5,708 | 2,739 | 2,277 | 5,892 | 2,849 |
| 32_G | 33,692 | 87,858 | 42,150 | 35,049 | 90,679 | 43,851 |
| 51_D | 46 | 107 | 45 | 48 | 110 | 47 |
| 51_G | 12 | 28 | 12 | 13 | 29 | 12 |
| 52_D | 6,521 | 15,036 | 6,324 | 6,783 | 15,519 | 6,579 |
| 52_G | 1,672 | 3,856 | 1,622 | 1,739 | 3,979 | 1,687 |
| 53_D | 193 | 444 | 187 | 200 | 458 | 194 |
| 53_G | 50 | 115 | 48 | 52 | 118 | 50 |
| 54_D | 28 | 64 | 27 | 29 | 66 | 28 |
| 54_G | 7 | 16 | 7 | 7 | 17 | 7 |
| 41_D | 126 | 291 | 123 | 131 | 301 | 127 |
| 42_D | 62 | 144 | 60 | 65 | 148 | 63 |
| 42_G | 0 | 0 | 0 | 0 | 0 | 0 |
| 43_D | 290 | 669 | 281 | 302 | 690 | 293 |
| 43_G | 3 | 7 | 3 | 3 | 7 | 3 |
| 61_D | 1,440 | 7,398 | 1,552 | 1,498 | 7,636 | 1,615 |
| 61_G | 162 | 831 | 174 | 168 | 857 | 181 |
| 62_D | 1,881 | 9,666 | 2,028 | 1,957 | 9,976 | 2,110 |
| 62_G | 0 | 0 | 0 | 0 | 0 | 0 |
| 11_G | 762 | 1,801 | 1,000 | 793 | 1,858 | 1,040 |

## 2021 24-Hour Weekday Starts Summaries

| SUT/FT | 2021 | | |
|---|---|---|---|
| | Hardin | Jefferson | Orange |
| 21_D | 523 | 1,921 | 709 |
| 21_G | 174,289 | 639,709 | 235,989 |
| 31_D | 6,340 | 16,232 | 7,933 |
| 31_G | 106,866 | 273,591 | 133,716 |
| 32_D | 2,635 | 6,746 | 3,297 |
| 32_G | 36,709 | 93,980 | 45,932 |
| 51_D | 38 | 87 | 37 |
| 51_G | 9 | 21 | 9 |
| 52_D | 7,185 | 16,266 | 6,969 |
| 52_G | 1,842 | 4,171 | 1,787 |
| 53_D | 212 | 481 | 206 |
| 53_G | 55 | 124 | 53 |
| 54_D | 30 | 67 | 29 |
| 54_G | 8 | 17 | 7 |
| 41_D | 139 | 316 | 135 |
| 42_D | 66 | 149 | 64 |
| 42_G | 0 | 0 | 0 |
| 43_D | 318 | 720 | 309 |
| 43_G | 3 | 7 | 3 |
| 61_D | 1,579 | 7,965 | 1,703 |
| 61_G | 177 | 894 | 191 |
| 62_D | 2,062 | 10,405 | 2,224 |
| 62_G | 0 | 0 | 0 |
| 11_G | 835 | 1,938 | 1,097 |

**24-Hour Weekday SHI Summaries (CLhT_Diesel Only)**

| County | 2005 | 2011 | 2014 | 2017 | 2021 |
| --- | --- | --- | --- | --- | --- |
| Hardin | 121 | 145 | 150 | 157 | 166 |
| Jefferson | 1,995 | 1,965 | 2,028 | 2,082 | 2,172 |
| Orange | 3,546 | 3,764 | 3,916 | 4,110 | 4,332 |

# APPENDIX G:
# SOURCE TYPE AGE AND FUEL/ENGINE FRACTIONS INPUTS TO MOVES

# Hardin County 2005 Age Distributions Inputs to MOVES

| Age | MC | PC | PT | LCT | IBus | TBus | SBus | RT | SUShT | SULhT | MH | CShT | CLhT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.106250 | 0.053197 | 0.034129 | 0.034129 | 0.087667 | 0.071149 | 0.083693 | 0.045293 | 0.138386 | 0.148124 | 0.080959 | 0.055256 | 0.049622 |
| 1 | 0.090625 | 0.074157 | 0.089504 | 0.089504 | 0.070787 | 0.057450 | 0.067579 | 0.036817 | 0.110049 | 0.127905 | 0.065371 | 0.028976 | 0.042585 |
| 2 | 0.135417 | 0.081338 | 0.099410 | 0.099410 | 0.057447 | 0.046623 | 0.054843 | 0.027679 | 0.121582 | 0.107832 | 0.053051 | 0.063342 | 0.039452 |
| 3 | 0.107292 | 0.078679 | 0.094886 | 0.094886 | 0.050912 | 0.041320 | 0.048605 | 0.028474 | 0.088962 | 0.086095 | 0.047017 | 0.042453 | 0.039805 |
| 4 | 0.098958 | 0.075327 | 0.090019 | 0.090019 | 0.059298 | 0.048125 | 0.056610 | 0.030418 | 0.100824 | 0.092264 | 0.054761 | 0.069407 | 0.057684 |
| 5 | 0.094792 | 0.086020 | 0.066999 | 0.066999 | 0.064452 | 0.052308 | 0.061530 | 0.043044 | 0.071829 | 0.079009 | 0.059520 | 0.047170 | 0.075243 |
| 6 | 0.050000 | 0.070593 | 0.064422 | 0.064422 | 0.064457 | 0.052312 | 0.061535 | 0.049361 | 0.079407 | 0.072285 | 0.059525 | 0.070755 | 0.075916 |
| 7 | 0.039583 | 0.065486 | 0.055431 | 0.055431 | 0.049875 | 0.062687 | 0.049583 | 0.038194 | 0.039209 | 0.035096 | 0.035731 | 0.045148 | 0.063342 |
| 8 | 0.035417 | 0.063198 | 0.057665 | 0.057665 | 0.041435 | 0.058484 | 0.047161 | 0.031731 | 0.047117 | 0.044590 | 0.056172 | 0.037736 | 0.047923 |
| 9 | 0.031250 | 0.050484 | 0.047014 | 0.047014 | 0.035351 | 0.055590 | 0.041969 | 0.069335 | 0.027677 | 0.024611 | 0.035891 | 0.036388 | 0.049225 |
| 10 | 0.029167 | 0.054527 | 0.045239 | 0.045239 | 0.046922 | 0.046526 | 0.054752 | 0.081187 | 0.032290 | 0.031250 | 0.043248 | 0.045148 | 0.063684 |
| 11 | 0.018750 | 0.044952 | 0.043349 | 0.043349 | 0.037294 | 0.041881 | 0.027275 | 0.051853 | 0.017133 | 0.020910 | 0.042568 | 0.047170 | 0.044151 |
| 12 | 0.014583 | 0.036653 | 0.033328 | 0.033328 | 0.031359 | 0.035485 | 0.033271 | 0.045241 | 0.014498 | 0.016043 | 0.029923 | 0.057278 | 0.041548 |
| 13 | 0.008333 | 0.031333 | 0.028288 | 0.028288 | 0.023852 | 0.031812 | 0.027711 | 0.019801 | 0.011862 | 0.012141 | 0.027105 | 0.033019 | 0.029669 |
| 14 | 0.007292 | 0.025535 | 0.024738 | 0.024738 | 0.027910 | 0.033227 | 0.036526 | 0.055555 | 0.014827 | 0.011783 | 0.020820 | 0.042453 | 0.035372 |
| 15 | 0.008333 | 0.023673 | 0.019871 | 0.019871 | 0.032003 | 0.049689 | 0.042153 | 0.048335 | 0.009226 | 0.011426 | 0.027863 | 0.045822 | 0.033640 |
| 16 | 0.009375 | 0.017502 | 0.021188 | 0.021188 | 0.032788 | 0.039048 | 0.024843 | 0.038969 | 0.009885 | 0.009653 | 0.037181 | 0.030997 | 0.028202 |
| 17 | 0.006250 | 0.014576 | 0.015118 | 0.015118 | 0.031176 | 0.031415 | 0.030190 | 0.053591 | 0.010873 | 0.008605 | 0.033702 | 0.026954 | 0.023945 |
| 18 | 0.008333 | 0.009203 | 0.010479 | 0.010479 | 0.033118 | 0.029702 | 0.031254 | 0.043859 | 0.007249 | 0.005953 | 0.033641 | 0.026280 | 0.021397 |
| 19 | 0.007292 | 0.007235 | 0.011224 | 0.011224 | 0.028398 | 0.025578 | 0.027885 | 0.055361 | 0.005601 | 0.008177 | 0.025355 | 0.017520 | 0.019445 |
| 20 | 0.008333 | 0.006490 | 0.008933 | 0.008933 | 0.025354 | 0.022437 | 0.024474 | 0.029765 | 0.004942 | 0.007486 | 0.027516 | 0.023585 | 0.021585 |
| 21 | 0.007292 | 0.005320 | 0.008361 | 0.008361 | 0.020393 | 0.017879 | 0.019319 | 0.031594 | 0.004613 | 0.005464 | 0.028532 | 0.016846 | 0.017096 |
| 22 | 0.009375 | 0.003671 | 0.004810 | 0.004810 | 0.008229 | 0.017336 | 0.007216 | 0.009257 | 0.001977 | 0.002958 | 0.018899 | 0.008760 | 0.007798 |
| 23 | 0.010417 | 0.001968 | 0.005497 | 0.005497 | 0.007091 | 0.009559 | 0.005403 | 0.010539 | 0.004283 | 0.004951 | 0.011281 | 0.014825 | 0.011890 |
| 24 | 0.010417 | 0.001862 | 0.003665 | 0.003665 | 0.006296 | 0.004243 | 0.006485 | 0.009548 | 0.004613 | 0.003564 | 0.006341 | 0.014151 | 0.012110 |
| 25 | 0.009375 | 0.001649 | 0.002176 | 0.002176 | 0.008295 | 0.011663 | 0.006449 | 0.002420 | 0.003295 | 0.002591 | 0.000845 | 0.013477 | 0.009243 |
| 26 | 0.005147 | 0.001850 | 0.002509 | 0.002509 | 0.005046 | 0.003492 | 0.005389 | 0.002524 | 0.002164 | 0.002229 | 0.006603 | 0.006878 | 0.004976 |
| 27 | 0.007353 | 0.000983 | 0.001868 | 0.001868 | 0.003996 | 0.001542 | 0.004649 | 0.002482 | 0.002153 | 0.002167 | 0.008892 | 0.005244 | 0.004117 |
| 28 | 0.002941 | 0.000983 | 0.001363 | 0.001363 | 0.004286 | 0.000308 | 0.004675 | 0.000000 | 0.001450 | 0.001686 | 0.012184 | 0.004976 | 0.004505 |
| 29 | 0.002941 | 0.000867 | 0.001123 | 0.001123 | 0.001623 | 0.000587 | 0.003125 | 0.005045 | 0.001829 | 0.001340 | 0.007556 | 0.003553 | 0.003794 |
| 30 | 0.019118 | 0.010692 | 0.007395 | 0.007395 | 0.002891 | 0.000544 | 0.003849 | 0.002729 | 0.010198 | 0.011815 | 0.001945 | 0.018433 | 0.021035 |

## Hardin County 2011 Age Distributions Inputs to MOVES (2011, 2014, 2017, and 2021 Analysis Years)

| Age | MC | PC | PT | LCT | IBus | TBus | SBus | RT | SUShT | SULhT | MH | CShT | CLhT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.026886 | 0.049799 | 0.027331 | 0.027331 | 0.069073 | 0.061049 | 0.067376 | 0.028802 | 0.094013 | 0.104789 | 0.066877 | 0.007752 | 0.021517 |
| 1 | 0.028379 | 0.064267 | 0.043485 | 0.043485 | 0.063576 | 0.056190 | 0.062014 | 0.027620 | 0.053221 | 0.054592 | 0.061554 | 0.012522 | 0.018938 |
| 2 | 0.095594 | 0.061784 | 0.044703 | 0.044703 | 0.061072 | 0.053977 | 0.059571 | 0.027681 | 0.055147 | 0.051380 | 0.059130 | 0.029219 | 0.033960 |
| 3 | 0.089619 | 0.094156 | 0.082213 | 0.082213 | 0.067253 | 0.059440 | 0.065601 | 0.031074 | 0.183123 | 0.148094 | 0.065115 | 0.048301 | 0.047549 |
| 4 | 0.113518 | 0.089715 | 0.078506 | 0.078506 | 0.068818 | 0.060823 | 0.067127 | 0.032867 | 0.091737 | 0.091287 | 0.066630 | 0.119261 | 0.100800 |
| 5 | 0.118745 | 0.083126 | 0.071701 | 0.071701 | 0.068082 | 0.060172 | 0.066409 | 0.054654 | 0.109244 | 0.100234 | 0.065917 | 0.098986 | 0.075154 |
| 6 | 0.073189 | 0.074102 | 0.055657 | 0.055657 | 0.067348 | 0.059523 | 0.065693 | 0.048848 | 0.087885 | 0.091233 | 0.065206 | 0.072749 | 0.065321 |
| 7 | 0.056012 | 0.057534 | 0.069433 | 0.069433 | 0.052749 | 0.046621 | 0.051452 | 0.038516 | 0.054272 | 0.063794 | 0.051071 | 0.033989 | 0.044275 |
| 8 | 0.071695 | 0.055577 | 0.074855 | 0.074855 | 0.041523 | 0.036699 | 0.040503 | 0.028087 | 0.055147 | 0.051239 | 0.040203 | 0.030411 | 0.037609 |
| 9 | 0.049291 | 0.054144 | 0.068050 | 0.068050 | 0.035696 | 0.031549 | 0.034819 | 0.028027 | 0.041492 | 0.040653 | 0.034561 | 0.038163 | 0.037406 |
| 10 | 0.063480 | 0.046171 | 0.066058 | 0.066058 | 0.040316 | 0.035632 | 0.039325 | 0.029033 | 0.043768 | 0.042649 | 0.039034 | 0.051282 | 0.052107 |
| 11 | 0.036594 | 0.049417 | 0.046141 | 0.046141 | 0.042925 | 0.037938 | 0.041871 | 0.040246 | 0.029062 | 0.034783 | 0.041560 | 0.059630 | 0.064101 |
| 12 | 0.031367 | 0.040871 | 0.043209 | 0.043209 | 0.041615 | 0.036780 | 0.040592 | 0.044739 | 0.029237 | 0.031295 | 0.040292 | 0.045915 | 0.056536 |
| 13 | 0.019417 | 0.034234 | 0.035076 | 0.035076 | 0.031537 | 0.043166 | 0.032034 | 0.033904 | 0.010679 | 0.014618 | 0.023687 | 0.041741 | 0.046019 |
| 14 | 0.023898 | 0.028839 | 0.033527 | 0.033527 | 0.025659 | 0.039441 | 0.029841 | 0.027586 | 0.015581 | 0.016614 | 0.036470 | 0.033989 | 0.035234 |
| 15 | 0.010456 | 0.020865 | 0.026335 | 0.026335 | 0.021215 | 0.036330 | 0.025734 | 0.058414 | 0.008228 | 0.009689 | 0.022582 | 0.023852 | 0.032591 |
| 16 | 0.011202 | 0.020961 | 0.025118 | 0.025118 | 0.027572 | 0.029773 | 0.032872 | 0.066975 | 0.008929 | 0.010658 | 0.026644 | 0.031604 | 0.040969 |
| 17 | 0.008962 | 0.014658 | 0.023513 | 0.023513 | 0.021230 | 0.025963 | 0.015864 | 0.041439 | 0.004552 | 0.006977 | 0.025405 | 0.032200 | 0.026449 |
| 18 | 0.004481 | 0.011984 | 0.016598 | 0.016598 | 0.017475 | 0.021535 | 0.018944 | 0.035394 | 0.002976 | 0.005036 | 0.017483 | 0.028623 | 0.024074 |
| 19 | 0.002987 | 0.009549 | 0.012946 | 0.012946 | 0.012872 | 0.018696 | 0.015280 | 0.015002 | 0.002101 | 0.003477 | 0.015336 | 0.019082 | 0.017590 |
| 20 | 0.002987 | 0.006255 | 0.010788 | 0.010788 | 0.014586 | 0.018911 | 0.019505 | 0.040761 | 0.004202 | 0.003744 | 0.011408 | 0.023852 | 0.019591 |
| 21 | 0.002987 | 0.006350 | 0.008907 | 0.008907 | 0.016370 | 0.027679 | 0.022031 | 0.034709 | 0.002451 | 0.003655 | 0.014943 | 0.023256 | 0.017397 |
| 22 | 0.004481 | 0.004202 | 0.007524 | 0.007524 | 0.016236 | 0.021057 | 0.012570 | 0.027090 | 0.001225 | 0.003071 | 0.019303 | 0.013715 | 0.013278 |
| 23 | 0.002987 | 0.002865 | 0.005643 | 0.005643 | 0.015106 | 0.016577 | 0.014946 | 0.036454 | 0.002451 | 0.002499 | 0.017121 | 0.017889 | 0.010967 |
| 24 | 0.003734 | 0.002483 | 0.003928 | 0.003928 | 0.015702 | 0.015336 | 0.015140 | 0.029193 | 0.001751 | 0.001536 | 0.016722 | 0.011330 | 0.009105 |
| 25 | 0.002987 | 0.001862 | 0.003596 | 0.003596 | 0.013171 | 0.012919 | 0.013214 | 0.036047 | 0.001050 | 0.001835 | 0.012329 | 0.010137 | 0.008763 |
| 26 | 0.003734 | 0.001767 | 0.002822 | 0.002822 | 0.011504 | 0.011086 | 0.011346 | 0.018960 | 0.001225 | 0.001467 | 0.013089 | 0.010733 | 0.008281 |
| 27 | 0.006721 | 0.001671 | 0.002988 | 0.002988 | 0.009052 | 0.008642 | 0.008761 | 0.019687 | 0.000175 | 0.001153 | 0.013278 | 0.005367 | 0.006291 |
| 28 | 0.003734 | 0.001003 | 0.001715 | 0.001715 | 0.003572 | 0.008196 | 0.003201 | 0.005641 | 0.000175 | 0.000748 | 0.008601 | 0.004174 | 0.002814 |
| 29 | 0.004481 | 0.001050 | 0.001383 | 0.001383 | 0.003011 | 0.004420 | 0.002344 | 0.006282 | 0.000875 | 0.001073 | 0.005022 | 0.002982 | 0.004440 |
| 30 | 0.025392 | 0.008738 | 0.006252 | 0.006252 | 0.004084 | 0.003881 | 0.004023 | 0.006268 | 0.004027 | 0.006131 | 0.003427 | 0.017293 | 0.020875 |

# Jefferson County 2005 Age Distribution Inputs to MOVES

| Age | MC | PC | PT | LCT | IBus | TBus | SBus | RT | SUShT | SULhT | MH | CShT | CLhT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.097933 | 0.049243 | 0.040911 | 0.040911 | 0.087667 | 0.071149 | 0.083693 | 0.045293 | 0.138386 | 0.148124 | 0.080959 | 0.055256 | 0.049622 |
| 1 | 0.095072 | 0.068283 | 0.084969 | 0.084969 | 0.070787 | 0.057450 | 0.067579 | 0.036817 | 0.110049 | 0.127905 | 0.065371 | 0.028976 | 0.042585 |
| 2 | 0.117965 | 0.069767 | 0.096463 | 0.096463 | 0.057447 | 0.046623 | 0.054843 | 0.027679 | 0.121582 | 0.107832 | 0.053051 | 0.063342 | 0.039452 |
| 3 | 0.106836 | 0.076623 | 0.097177 | 0.097177 | 0.050912 | 0.041320 | 0.048605 | 0.028474 | 0.088962 | 0.086095 | 0.047017 | 0.042453 | 0.039805 |
| 4 | 0.106836 | 0.075757 | 0.081687 | 0.081687 | 0.059298 | 0.048125 | 0.056610 | 0.030418 | 0.100824 | 0.092264 | 0.054761 | 0.069407 | 0.057684 |
| 5 | 0.096979 | 0.081993 | 0.066298 | 0.066298 | 0.064452 | 0.052308 | 0.061530 | 0.043044 | 0.071829 | 0.079009 | 0.059520 | 0.047170 | 0.075243 |
| 6 | 0.060731 | 0.070293 | 0.069427 | 0.069427 | 0.064457 | 0.052312 | 0.061535 | 0.049361 | 0.079407 | 0.072285 | 0.059525 | 0.070755 | 0.075916 |
| 7 | 0.045151 | 0.063191 | 0.053171 | 0.053171 | 0.049875 | 0.062687 | 0.049583 | 0.038194 | 0.039209 | 0.035096 | 0.035731 | 0.045148 | 0.063342 |
| 8 | 0.038792 | 0.059902 | 0.056725 | 0.056725 | 0.041435 | 0.058484 | 0.047161 | 0.031731 | 0.047117 | 0.044590 | 0.056172 | 0.037736 | 0.047923 |
| 9 | 0.033386 | 0.054769 | 0.047169 | 0.047169 | 0.035351 | 0.055590 | 0.041969 | 0.069335 | 0.027677 | 0.024611 | 0.035891 | 0.036388 | 0.049225 |
| 10 | 0.022576 | 0.056212 | 0.045996 | 0.045996 | 0.046922 | 0.046526 | 0.054752 | 0.081187 | 0.032290 | 0.031250 | 0.043248 | 0.045148 | 0.063684 |
| 11 | 0.019078 | 0.046677 | 0.044737 | 0.044737 | 0.037294 | 0.041881 | 0.027275 | 0.051853 | 0.017133 | 0.020910 | 0.042568 | 0.047170 | 0.044151 |
| 12 | 0.015580 | 0.041378 | 0.033124 | 0.033124 | 0.031359 | 0.035485 | 0.033271 | 0.045241 | 0.014498 | 0.016043 | 0.029923 | 0.057278 | 0.041548 |
| 13 | 0.010175 | 0.035214 | 0.027733 | 0.027733 | 0.023852 | 0.031812 | 0.027711 | 0.019801 | 0.011862 | 0.012141 | 0.027105 | 0.033019 | 0.029669 |
| 14 | 0.007313 | 0.030740 | 0.025285 | 0.025285 | 0.027910 | 0.033227 | 0.036526 | 0.055555 | 0.014827 | 0.011783 | 0.020820 | 0.042453 | 0.035372 |
| 15 | 0.006041 | 0.025060 | 0.020065 | 0.020065 | 0.032003 | 0.049689 | 0.042153 | 0.048335 | 0.009226 | 0.011426 | 0.027863 | 0.045822 | 0.033640 |
| 16 | 0.009221 | 0.020895 | 0.020252 | 0.020252 | 0.032788 | 0.039048 | 0.024843 | 0.038969 | 0.009885 | 0.009653 | 0.037181 | 0.030997 | 0.028202 |
| 17 | 0.006359 | 0.014473 | 0.015525 | 0.015525 | 0.031176 | 0.031415 | 0.030190 | 0.053591 | 0.010873 | 0.008605 | 0.033702 | 0.026954 | 0.023945 |
| 18 | 0.010493 | 0.011566 | 0.010576 | 0.010576 | 0.033118 | 0.029702 | 0.031254 | 0.043859 | 0.007249 | 0.005953 | 0.033641 | 0.026280 | 0.021397 |
| 19 | 0.010175 | 0.009113 | 0.011172 | 0.011172 | 0.028398 | 0.025578 | 0.027885 | 0.055361 | 0.005601 | 0.008177 | 0.025355 | 0.017520 | 0.019445 |
| 20 | 0.009221 | 0.008845 | 0.009743 | 0.009743 | 0.025354 | 0.022437 | 0.024474 | 0.029765 | 0.004942 | 0.007486 | 0.027516 | 0.023585 | 0.021585 |
| 21 | 0.008903 | 0.006824 | 0.008621 | 0.008621 | 0.020393 | 0.017879 | 0.019319 | 0.031594 | 0.004613 | 0.005464 | 0.028532 | 0.016846 | 0.017096 |
| 22 | 0.006995 | 0.003886 | 0.005679 | 0.005679 | 0.008229 | 0.017336 | 0.007216 | 0.009257 | 0.001977 | 0.002958 | 0.018899 | 0.008760 | 0.007798 |
| 23 | 0.008585 | 0.002526 | 0.006104 | 0.006104 | 0.007091 | 0.009559 | 0.005403 | 0.010539 | 0.004283 | 0.004951 | 0.011281 | 0.014825 | 0.011890 |
| 24 | 0.008585 | 0.001835 | 0.004795 | 0.004795 | 0.006296 | 0.004243 | 0.006485 | 0.009548 | 0.004613 | 0.003564 | 0.006341 | 0.014151 | 0.012110 |
| 25 | 0.006995 | 0.001598 | 0.002449 | 0.002449 | 0.008295 | 0.011663 | 0.006449 | 0.002420 | 0.003295 | 0.002591 | 0.000845 | 0.013477 | 0.009243 |
| 26 | 0.003712 | 0.001414 | 0.002375 | 0.002375 | 0.005046 | 0.003492 | 0.005389 | 0.002524 | 0.002164 | 0.002229 | 0.006603 | 0.006878 | 0.004976 |
| 27 | 0.003712 | 0.001132 | 0.002578 | 0.002578 | 0.003996 | 0.001542 | 0.004649 | 0.002482 | 0.002153 | 0.002167 | 0.008892 | 0.005244 | 0.004117 |
| 28 | 0.004639 | 0.001044 | 0.002053 | 0.002053 | 0.004286 | 0.000308 | 0.004675 | 0.000000 | 0.001450 | 0.001686 | 0.012184 | 0.004976 | 0.004505 |
| 29 | 0.003402 | 0.000740 | 0.000807 | 0.000807 | 0.001623 | 0.000587 | 0.003125 | 0.005045 | 0.001829 | 0.001340 | 0.007556 | 0.003553 | 0.003794 |
| 30 | 0.018558 | 0.009009 | 0.006335 | 0.006335 | 0.002891 | 0.000544 | 0.003849 | 0.002729 | 0.010198 | 0.011815 | 0.001945 | 0.018433 | 0.021035 |

# Jefferson County 2011 Age Distributions Inputs to MOVES (2011, 2014, 2017, and 2021 Analysis Years)

| Age | MC | PC | PT | LCT | IBus | TBus | SBus | RT | SUShT | SULhT | MH | CShT | CLhT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.029877 | 0.037592 | 0.024015 | 0.024015 | 0.069073 | 0.061049 | 0.067376 | 0.028802 | 0.094013 | 0.104789 | 0.066877 | 0.007752 | 0.021517 |
| 1 | 0.039506 | 0.051928 | 0.041085 | 0.041085 | 0.063576 | 0.056190 | 0.062014 | 0.027620 | 0.053221 | 0.054592 | 0.061554 | 0.012522 | 0.018938 |
| 2 | 0.105679 | 0.052893 | 0.041637 | 0.041637 | 0.061072 | 0.053977 | 0.059571 | 0.027681 | 0.055147 | 0.051380 | 0.059130 | 0.029219 | 0.033960 |
| 3 | 0.099259 | 0.079005 | 0.080824 | 0.080824 | 0.067253 | 0.059440 | 0.065601 | 0.031074 | 0.183123 | 0.148094 | 0.065115 | 0.048301 | 0.047549 |
| 4 | 0.099506 | 0.081260 | 0.082333 | 0.082333 | 0.068818 | 0.060823 | 0.067127 | 0.032867 | 0.091737 | 0.091287 | 0.066630 | 0.119261 | 0.100800 |
| 5 | 0.095309 | 0.079045 | 0.073619 | 0.073619 | 0.068082 | 0.060172 | 0.066409 | 0.054654 | 0.109244 | 0.100234 | 0.065917 | 0.098986 | 0.075154 |
| 6 | 0.081975 | 0.069907 | 0.055721 | 0.055721 | 0.067348 | 0.059523 | 0.065693 | 0.048848 | 0.087885 | 0.091233 | 0.065206 | 0.072749 | 0.065321 |
| 7 | 0.056543 | 0.060396 | 0.068378 | 0.068378 | 0.052749 | 0.046621 | 0.051452 | 0.038516 | 0.054272 | 0.063794 | 0.051071 | 0.033989 | 0.044275 |
| 8 | 0.061235 | 0.058338 | 0.072175 | 0.072175 | 0.041523 | 0.036699 | 0.040503 | 0.028087 | 0.055147 | 0.051239 | 0.040203 | 0.030411 | 0.037609 |
| 9 | 0.059506 | 0.060022 | 0.072938 | 0.072938 | 0.035696 | 0.031549 | 0.034819 | 0.028027 | 0.041492 | 0.040653 | 0.034561 | 0.038163 | 0.037406 |
| 10 | 0.053333 | 0.056556 | 0.061969 | 0.061969 | 0.040316 | 0.035632 | 0.039325 | 0.029033 | 0.043768 | 0.042649 | 0.039034 | 0.051282 | 0.052107 |
| 11 | 0.040000 | 0.058053 | 0.047754 | 0.047754 | 0.042925 | 0.037938 | 0.041871 | 0.040246 | 0.029062 | 0.034783 | 0.041560 | 0.059630 | 0.064101 |
| 12 | 0.032099 | 0.048157 | 0.044931 | 0.044931 | 0.041615 | 0.036780 | 0.040592 | 0.044739 | 0.029237 | 0.031295 | 0.040292 | 0.045915 | 0.056536 |
| 13 | 0.020988 | 0.038626 | 0.033913 | 0.033913 | 0.031537 | 0.043166 | 0.032034 | 0.033904 | 0.010679 | 0.014618 | 0.023687 | 0.041741 | 0.046019 |
| 14 | 0.019506 | 0.032020 | 0.034919 | 0.034919 | 0.025659 | 0.039441 | 0.029841 | 0.027586 | 0.015581 | 0.016614 | 0.036470 | 0.033989 | 0.035234 |
| 15 | 0.019012 | 0.025482 | 0.026968 | 0.026968 | 0.021215 | 0.036330 | 0.025734 | 0.058414 | 0.008228 | 0.009689 | 0.022582 | 0.023852 | 0.032591 |
| 16 | 0.011358 | 0.024290 | 0.024794 | 0.024794 | 0.027572 | 0.029773 | 0.032872 | 0.066975 | 0.008929 | 0.010658 | 0.026644 | 0.031604 | 0.040969 |
| 17 | 0.009136 | 0.017753 | 0.023901 | 0.023901 | 0.021230 | 0.025963 | 0.015864 | 0.041439 | 0.004552 | 0.006977 | 0.025405 | 0.032200 | 0.026449 |
| 18 | 0.007407 | 0.013578 | 0.015691 | 0.015691 | 0.017475 | 0.021535 | 0.018944 | 0.035394 | 0.002976 | 0.005036 | 0.017483 | 0.028623 | 0.024074 |
| 19 | 0.007160 | 0.011205 | 0.012332 | 0.012332 | 0.012872 | 0.018696 | 0.015280 | 0.015002 | 0.002101 | 0.003477 | 0.015336 | 0.019082 | 0.017590 |
| 20 | 0.003210 | 0.009078 | 0.011001 | 0.011001 | 0.014586 | 0.018911 | 0.019505 | 0.040761 | 0.004202 | 0.003744 | 0.011408 | 0.023852 | 0.019591 |
| 21 | 0.000741 | 0.007227 | 0.009006 | 0.009006 | 0.016370 | 0.027679 | 0.022031 | 0.034709 | 0.002451 | 0.003655 | 0.014943 | 0.023256 | 0.017397 |
| 22 | 0.003951 | 0.005346 | 0.008292 | 0.008292 | 0.016236 | 0.021057 | 0.012570 | 0.027090 | 0.001225 | 0.003071 | 0.019303 | 0.013715 | 0.013278 |
| 23 | 0.001728 | 0.003535 | 0.005955 | 0.005955 | 0.015106 | 0.016577 | 0.014946 | 0.036454 | 0.002451 | 0.002499 | 0.017121 | 0.017889 | 0.010967 |
| 24 | 0.002716 | 0.002905 | 0.003618 | 0.003618 | 0.015702 | 0.015336 | 0.015140 | 0.029193 | 0.001751 | 0.001536 | 0.016722 | 0.011330 | 0.009105 |
| 25 | 0.006420 | 0.002215 | 0.003959 | 0.003959 | 0.013171 | 0.012919 | 0.013214 | 0.036047 | 0.001050 | 0.001835 | 0.012329 | 0.010137 | 0.008763 |
| 26 | 0.002716 | 0.002146 | 0.003408 | 0.003408 | 0.011504 | 0.011086 | 0.011346 | 0.018960 | 0.001225 | 0.001467 | 0.013089 | 0.010733 | 0.008281 |
| 27 | 0.004691 | 0.001920 | 0.002742 | 0.002742 | 0.009052 | 0.008642 | 0.008761 | 0.019687 | 0.000175 | 0.001153 | 0.013278 | 0.005367 | 0.006291 |
| 28 | 0.002469 | 0.001054 | 0.002174 | 0.002174 | 0.003572 | 0.008196 | 0.003201 | 0.005641 | 0.000175 | 0.000748 | 0.008601 | 0.004174 | 0.002814 |
| 29 | 0.003210 | 0.000827 | 0.002109 | 0.002109 | 0.003011 | 0.004420 | 0.002344 | 0.006282 | 0.000875 | 0.001073 | 0.005022 | 0.002982 | 0.004440 |
| 30 | 0.019753 | 0.007641 | 0.007837 | 0.007837 | 0.004084 | 0.003881 | 0.004023 | 0.006268 | 0.004027 | 0.006131 | 0.003427 | 0.017293 | 0.020875 |

# Orange County 2005 Age Distributions Inputs to MOVES

| Age | MC | PC | PT | LCT | IBus | TBus | SBus | RT | SUShT | SULhT | MH | CShT | CLhT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.090463 | 0.048303 | 0.034067 | 0.034067 | 0.087667 | 0.071149 | 0.083693 | 0.045293 | 0.138386 | 0.148124 | 0.080959 | 0.055256 | 0.049622 |
| 1 | 0.082749 | 0.068394 | 0.076207 | 0.076207 | 0.070787 | 0.057450 | 0.067579 | 0.036817 | 0.110049 | 0.127905 | 0.065371 | 0.028976 | 0.042585 |
| 2 | 0.134642 | 0.073132 | 0.086559 | 0.086559 | 0.057447 | 0.046623 | 0.054843 | 0.027679 | 0.121582 | 0.107832 | 0.053051 | 0.063342 | 0.039452 |
| 3 | 0.119916 | 0.080116 | 0.085825 | 0.085825 | 0.050912 | 0.041320 | 0.048605 | 0.028474 | 0.088962 | 0.086095 | 0.047017 | 0.042453 | 0.039805 |
| 4 | 0.103787 | 0.073378 | 0.080572 | 0.080572 | 0.059298 | 0.048125 | 0.056610 | 0.030418 | 0.100824 | 0.092264 | 0.054761 | 0.069407 | 0.057684 |
| 5 | 0.068724 | 0.081039 | 0.065469 | 0.065469 | 0.064452 | 0.052308 | 0.061530 | 0.043044 | 0.071829 | 0.079009 | 0.059520 | 0.047170 | 0.075243 |
| 6 | 0.065217 | 0.070547 | 0.069061 | 0.069061 | 0.064457 | 0.052312 | 0.061535 | 0.049361 | 0.079407 | 0.072285 | 0.059525 | 0.070755 | 0.075916 |
| 7 | 0.034362 | 0.064948 | 0.055388 | 0.055388 | 0.049875 | 0.062687 | 0.049583 | 0.038194 | 0.039209 | 0.035096 | 0.035731 | 0.045148 | 0.063342 |
| 8 | 0.029453 | 0.061102 | 0.059367 | 0.059367 | 0.041435 | 0.058484 | 0.047161 | 0.031731 | 0.047117 | 0.044590 | 0.056172 | 0.037736 | 0.047923 |
| 9 | 0.036466 | 0.055072 | 0.051062 | 0.051062 | 0.035351 | 0.055590 | 0.041969 | 0.069335 | 0.027677 | 0.024611 | 0.035891 | 0.036388 | 0.049225 |
| 10 | 0.028050 | 0.055995 | 0.051101 | 0.051101 | 0.046922 | 0.046526 | 0.054752 | 0.081187 | 0.032290 | 0.031250 | 0.043248 | 0.045148 | 0.063684 |
| 11 | 0.018233 | 0.045565 | 0.048783 | 0.048783 | 0.037294 | 0.041881 | 0.027275 | 0.051853 | 0.017133 | 0.020910 | 0.042568 | 0.047170 | 0.044151 |
| 12 | 0.018233 | 0.039812 | 0.034376 | 0.034376 | 0.031359 | 0.035485 | 0.033271 | 0.045241 | 0.014498 | 0.016043 | 0.029923 | 0.057278 | 0.041548 |
| 13 | 0.014727 | 0.034612 | 0.029625 | 0.029625 | 0.023852 | 0.031812 | 0.027711 | 0.019801 | 0.011862 | 0.012141 | 0.027105 | 0.033019 | 0.029669 |
| 14 | 0.007013 | 0.027351 | 0.028776 | 0.028776 | 0.027910 | 0.033227 | 0.036526 | 0.055555 | 0.014827 | 0.011783 | 0.020820 | 0.042453 | 0.035372 |
| 15 | 0.008415 | 0.025075 | 0.023986 | 0.023986 | 0.032003 | 0.049689 | 0.042153 | 0.048335 | 0.009226 | 0.011426 | 0.027863 | 0.045822 | 0.033640 |
| 16 | 0.005610 | 0.020183 | 0.023716 | 0.023716 | 0.032788 | 0.039048 | 0.024843 | 0.038969 | 0.009885 | 0.009653 | 0.037181 | 0.030997 | 0.028202 |
| 17 | 0.005610 | 0.016860 | 0.018888 | 0.018888 | 0.031176 | 0.031415 | 0.030190 | 0.053591 | 0.010873 | 0.008605 | 0.033702 | 0.026954 | 0.023945 |
| 18 | 0.006311 | 0.011414 | 0.011047 | 0.011047 | 0.033118 | 0.029702 | 0.031254 | 0.043859 | 0.007249 | 0.005953 | 0.033641 | 0.026280 | 0.021397 |
| 19 | 0.016830 | 0.009599 | 0.011510 | 0.011510 | 0.028398 | 0.025578 | 0.027885 | 0.055361 | 0.005601 | 0.008177 | 0.025355 | 0.017520 | 0.019445 |
| 20 | 0.013324 | 0.007538 | 0.010429 | 0.010429 | 0.025354 | 0.022437 | 0.024474 | 0.029765 | 0.004942 | 0.007486 | 0.027516 | 0.023585 | 0.021585 |
| 21 | 0.011921 | 0.006861 | 0.009540 | 0.009540 | 0.020393 | 0.017879 | 0.019319 | 0.031594 | 0.004613 | 0.005464 | 0.028532 | 0.016846 | 0.017096 |
| 22 | 0.009818 | 0.003384 | 0.006759 | 0.006759 | 0.008229 | 0.017336 | 0.007216 | 0.009257 | 0.001977 | 0.002958 | 0.018899 | 0.008760 | 0.007798 |
| 23 | 0.009116 | 0.002707 | 0.006605 | 0.006605 | 0.007091 | 0.009559 | 0.005403 | 0.010539 | 0.004283 | 0.004951 | 0.011281 | 0.014825 | 0.011890 |
| 24 | 0.010519 | 0.002123 | 0.004867 | 0.004867 | 0.006296 | 0.004243 | 0.006485 | 0.009548 | 0.004613 | 0.003564 | 0.006341 | 0.014151 | 0.012110 |
| 25 | 0.010519 | 0.001477 | 0.002008 | 0.002008 | 0.008295 | 0.011663 | 0.006449 | 0.002420 | 0.003295 | 0.002591 | 0.000845 | 0.013477 | 0.009243 |
| 26 | 0.008690 | 0.001338 | 0.002232 | 0.002232 | 0.005046 | 0.003492 | 0.005389 | 0.002524 | 0.002164 | 0.002229 | 0.006603 | 0.006878 | 0.004976 |
| 27 | 0.001738 | 0.001085 | 0.002576 | 0.002576 | 0.003996 | 0.001542 | 0.004649 | 0.002482 | 0.002153 | 0.002167 | 0.008892 | 0.005244 | 0.004117 |
| 28 | 0.004634 | 0.001193 | 0.001993 | 0.001993 | 0.004286 | 0.000308 | 0.004675 | 0.000000 | 0.001450 | 0.001686 | 0.012184 | 0.004976 | 0.004505 |
| 29 | 0.005793 | 0.000832 | 0.000558 | 0.000558 | 0.001623 | 0.000587 | 0.003125 | 0.005045 | 0.001829 | 0.001340 | 0.007556 | 0.003553 | 0.003794 |
| 30 | 0.019117 | 0.008967 | 0.007047 | 0.007047 | 0.002891 | 0.000544 | 0.003849 | 0.002729 | 0.010198 | 0.011815 | 0.001945 | 0.018433 | 0.021035 |

## Orange County 2011 Age Distributions Inputs to MOVES (2011, 2014, 2017, and 2021 Analysis Years)

| Age | MC | PC | PT | LCT | IBus | TBus | SBus | RT | SUShT | SULhT | MH | CShT | CLhT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.023973 | 0.038537 | 0.019508 | 0.019508 | 0.069073 | 0.061049 | 0.067376 | 0.028802 | 0.094013 | 0.104789 | 0.066877 | 0.007752 | 0.021517 |
| 1 | 0.029843 | 0.056795 | 0.036910 | 0.036910 | 0.063576 | 0.056190 | 0.062014 | 0.027620 | 0.053221 | 0.054592 | 0.061554 | 0.012522 | 0.018938 |
| 2 | 0.104697 | 0.065066 | 0.039719 | 0.039719 | 0.061072 | 0.053977 | 0.059571 | 0.027681 | 0.055147 | 0.051380 | 0.059130 | 0.029219 | 0.033960 |
| 3 | 0.097847 | 0.088378 | 0.081233 | 0.081233 | 0.067253 | 0.059440 | 0.065601 | 0.031074 | 0.183123 | 0.148094 | 0.065115 | 0.048301 | 0.047549 |
| 4 | 0.122309 | 0.083262 | 0.075380 | 0.075380 | 0.068818 | 0.060823 | 0.067127 | 0.032867 | 0.091737 | 0.091287 | 0.066630 | 0.119261 | 0.100800 |
| 5 | 0.111546 | 0.080352 | 0.074561 | 0.074561 | 0.068082 | 0.060172 | 0.066409 | 0.054654 | 0.109244 | 0.100234 | 0.065917 | 0.098986 | 0.075154 |
| 6 | 0.080235 | 0.072264 | 0.056847 | 0.056847 | 0.067348 | 0.059523 | 0.065693 | 0.048848 | 0.087885 | 0.091233 | 0.065206 | 0.072749 | 0.065321 |
| 7 | 0.045988 | 0.062278 | 0.069177 | 0.069177 | 0.052749 | 0.046621 | 0.051452 | 0.038516 | 0.054272 | 0.063794 | 0.051071 | 0.033989 | 0.044275 |
| 8 | 0.064090 | 0.059306 | 0.070113 | 0.070113 | 0.041523 | 0.036699 | 0.040503 | 0.028087 | 0.055147 | 0.051239 | 0.040203 | 0.030411 | 0.037609 |
| 9 | 0.058708 | 0.057499 | 0.069567 | 0.069567 | 0.035696 | 0.031549 | 0.034819 | 0.028027 | 0.041492 | 0.040653 | 0.034561 | 0.038163 | 0.037406 |
| 10 | 0.048924 | 0.052322 | 0.064066 | 0.064066 | 0.040316 | 0.035632 | 0.039325 | 0.029033 | 0.043768 | 0.042649 | 0.039034 | 0.051282 | 0.052107 |
| 11 | 0.038160 | 0.052383 | 0.049551 | 0.049551 | 0.042925 | 0.037938 | 0.041871 | 0.040246 | 0.029062 | 0.034783 | 0.041560 | 0.059630 | 0.064101 |
| 12 | 0.028376 | 0.041907 | 0.045572 | 0.045572 | 0.041615 | 0.036780 | 0.040592 | 0.044739 | 0.029237 | 0.031295 | 0.040292 | 0.045915 | 0.056536 |
| 13 | 0.017613 | 0.034983 | 0.034179 | 0.034179 | 0.031537 | 0.043166 | 0.032034 | 0.033904 | 0.010679 | 0.014618 | 0.023687 | 0.041741 | 0.046019 |
| 14 | 0.013699 | 0.028704 | 0.034842 | 0.034842 | 0.025659 | 0.039441 | 0.029841 | 0.027586 | 0.015581 | 0.016614 | 0.036470 | 0.033989 | 0.035234 |
| 15 | 0.021037 | 0.022393 | 0.029653 | 0.029653 | 0.021215 | 0.036330 | 0.025734 | 0.058414 | 0.008228 | 0.009689 | 0.022582 | 0.023852 | 0.032591 |
| 16 | 0.008806 | 0.021872 | 0.027663 | 0.027663 | 0.027572 | 0.029773 | 0.032872 | 0.066975 | 0.008929 | 0.010658 | 0.026644 | 0.031604 | 0.040969 |
| 17 | 0.009785 | 0.016113 | 0.025829 | 0.025829 | 0.021230 | 0.025963 | 0.015864 | 0.041439 | 0.004552 | 0.006977 | 0.025405 | 0.032200 | 0.026449 |
| 18 | 0.006849 | 0.012805 | 0.015256 | 0.015256 | 0.017475 | 0.021535 | 0.018944 | 0.035394 | 0.002976 | 0.005036 | 0.017483 | 0.028623 | 0.024074 |
| 19 | 0.009295 | 0.010354 | 0.014787 | 0.014787 | 0.012872 | 0.018696 | 0.015280 | 0.015002 | 0.002101 | 0.003477 | 0.015336 | 0.019082 | 0.017590 |
| 20 | 0.003425 | 0.007505 | 0.012993 | 0.012993 | 0.014586 | 0.018911 | 0.019505 | 0.040761 | 0.004202 | 0.003744 | 0.011408 | 0.023852 | 0.019591 |
| 21 | 0.004403 | 0.007076 | 0.011120 | 0.011120 | 0.016370 | 0.027679 | 0.022031 | 0.034709 | 0.002451 | 0.003655 | 0.014943 | 0.023256 | 0.017397 |
| 22 | 0.002446 | 0.005361 | 0.010378 | 0.010378 | 0.016236 | 0.021057 | 0.012570 | 0.027090 | 0.001225 | 0.003071 | 0.019303 | 0.013715 | 0.013278 |
| 23 | 0.002446 | 0.004136 | 0.006360 | 0.006360 | 0.015106 | 0.016577 | 0.014946 | 0.036454 | 0.002451 | 0.002499 | 0.017121 | 0.017889 | 0.010967 |
| 24 | 0.005382 | 0.002573 | 0.003043 | 0.003043 | 0.015702 | 0.015336 | 0.015140 | 0.029193 | 0.001751 | 0.001536 | 0.016722 | 0.011330 | 0.009105 |
| 25 | 0.004403 | 0.002634 | 0.004253 | 0.004253 | 0.013171 | 0.012919 | 0.013214 | 0.036047 | 0.001050 | 0.001835 | 0.012329 | 0.010137 | 0.008763 |
| 26 | 0.001957 | 0.001961 | 0.003746 | 0.003746 | 0.011504 | 0.011086 | 0.011346 | 0.018960 | 0.001225 | 0.001467 | 0.013089 | 0.010733 | 0.008281 |
| 27 | 0.002935 | 0.001715 | 0.003394 | 0.003394 | 0.009052 | 0.008642 | 0.008761 | 0.019687 | 0.000175 | 0.001153 | 0.013278 | 0.005367 | 0.006291 |
| 28 | 0.006360 | 0.000796 | 0.001678 | 0.001678 | 0.003572 | 0.008196 | 0.003201 | 0.005641 | 0.000175 | 0.000748 | 0.008601 | 0.004174 | 0.002814 |
| 29 | 0.004403 | 0.000705 | 0.001483 | 0.001483 | 0.003011 | 0.004420 | 0.002344 | 0.006282 | 0.000875 | 0.001073 | 0.005022 | 0.002982 | 0.004440 |
| 30 | 0.020059 | 0.007965 | 0.007140 | 0.007140 | 0.004084 | 0.003881 | 0.004023 | 0.006268 | 0.004027 | 0.006131 | 0.003427 | 0.017293 | 0.020875 |

## Texas Statewide 2005 Fuel/Engine Fractions Summary[1]

| SUT | Fuel Type | Model Year | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2005 | 2004 | 2003 | 2002 | 2001 | 2000 | 1999 | 1998 | 1997 | 1996 | 1995 | 1994 | 1993 | 1992 | 1991 | 1990 |
| PC | Gas | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| PC | Diesel | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| PT | Gas | 0.987 | 0.987 | 0.987 | 0.987 | 0.987 | 0.977 | 0.977 | 0.990 | 0.981 | 0.980 | 0.985 | 0.982 | 0.979 | 0.979 | 0.980 | 0.987 |
| PT | Diesel | 0.013 | 0.013 | 0.013 | 0.013 | 0.013 | 0.023 | 0.023 | 0.010 | 0.019 | 0.020 | 0.015 | 0.018 | 0.021 | 0.021 | 0.020 | 0.013 |
| PT | Gas | 0.987 | 0.987 | 0.987 | 0.987 | 0.987 | 0.977 | 0.977 | 0.990 | 0.981 | 0.980 | 0.985 | 0.982 | 0.979 | 0.979 | 0.980 | 0.987 |
| PT | Diesel | 0.013 | 0.013 | 0.013 | 0.013 | 0.013 | 0.023 | 0.023 | 0.010 | 0.019 | 0.020 | 0.015 | 0.018 | 0.021 | 0.021 | 0.020 | 0.013 |
| LCT | Gas | 0.891 | 0.819 | 0.867 | 0.843 | 0.827 | 0.877 | 0.833 | 0.962 | 0.864 | 0.911 | 0.881 | 0.898 | 0.915 | 0.930 | 0.932 | 0.916 |
| LCT | Diesel | 0.109 | 0.181 | 0.133 | 0.157 | 0.173 | 0.123 | 0.167 | 0.038 | 0.136 | 0.089 | 0.119 | 0.102 | 0.085 | 0.070 | 0.068 | 0.084 |
| LCT | Gas | 0.891 | 0.819 | 0.867 | 0.843 | 0.827 | 0.877 | 0.833 | 0.962 | 0.864 | 0.911 | 0.881 | 0.898 | 0.915 | 0.930 | 0.932 | 0.916 |
| LCT | Diesel | 0.109 | 0.181 | 0.133 | 0.157 | 0.173 | 0.123 | 0.167 | 0.038 | 0.136 | 0.089 | 0.119 | 0.102 | 0.085 | 0.070 | 0.068 | 0.084 |
| 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 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.114 | 0.147 | 0.121 | 0.010 | 0.090 | 0.124 |
| SBus | Diesel | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.886 | 0.853 | 0.879 | 0.990 | 0.910 | 0.876 |
| RT | Gas | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 |
| RT | Diesel | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 |
| SUShT | Gas | 0.196 | 0.162 | 0.224 | 0.256 | 0.298 | 0.372 | 0.357 | 0.452 | 0.466 | 0.468 | 0.699 | 0.506 | 0.505 | 0.498 | 0.509 | 0.542 |
| SUShT | Diesel | 0.804 | 0.838 | 0.776 | 0.744 | 0.702 | 0.628 | 0.643 | 0.548 | 0.534 | 0.532 | 0.301 | 0.494 | 0.495 | 0.502 | 0.491 | 0.458 |
| SULhT | Gas | 0.196 | 0.162 | 0.224 | 0.256 | 0.298 | 0.372 | 0.357 | 0.452 | 0.466 | 0.468 | 0.699 | 0.506 | 0.505 | 0.498 | 0.509 | 0.542 |
| SULhT | Diesel | 0.804 | 0.838 | 0.776 | 0.744 | 0.702 | 0.628 | 0.643 | 0.548 | 0.534 | 0.532 | 0.301 | 0.494 | 0.495 | 0.502 | 0.491 | 0.458 |
| MH | Gas | 0.560 | 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 | 0.440 | 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 | 0.067 | 0.078 | 0.058 | 0.073 | 0.092 | 0.097 | 0.113 | 0.140 | 0.168 | 0.134 | 0.338 | 0.112 | 0.120 | 0.180 | 0.158 | 0.146 |
| CShT | Diesel | 0.933 | 0.922 | 0.942 | 0.927 | 0.908 | 0.903 | 0.887 | 0.860 | 0.832 | 0.866 | 0.662 | 0.888 | 0.880 | 0.820 | 0.842 | 0.854 |
| 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 2005 Fuel/Engine Fractions Summary[1] (Continued)

| SUT | Fuel Type | Model Year | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1989 | 1988 | 1987 | 1986 | 1985 | 1984 | 1983 | 1982 | 1981 | 1980 | 1979 | 1978 | 1977 | 1976 | 1975 |
| PC | Gas | 1.000 | 1.000 | 1.000 | 1.000 | 0.988 | 0.981 | 0.969 | 0.939 | 0.924 | 0.953 | 0.969 | 0.985 | 0.987 | 0.983 | 0.982 |
| PC | Diesel | 0.000 | 0.000 | 0.000 | 0.000 | 0.012 | 0.019 | 0.031 | 0.061 | 0.076 | 0.047 | 0.031 | 0.015 | 0.013 | 0.017 | 0.018 |
| PT | Gas | 0.992 | 0.995 | 0.990 | 0.978 | 0.983 | 0.985 | 0.979 | 0.960 | 0.982 | 0.988 | 0.986 | 0.986 | 0.986 | 0.986 | 0.986 |
| PT | Diesel | 0.008 | 0.005 | 0.010 | 0.022 | 0.017 | 0.015 | 0.021 | 0.040 | 0.018 | 0.012 | 0.014 | 0.014 | 0.014 | 0.014 | 0.014 |
| PT | Gas | 0.992 | 0.995 | 0.990 | 0.978 | 0.983 | 0.985 | 0.979 | 0.960 | 0.982 | 0.988 | 0.986 | 0.986 | 0.986 | 0.986 | 0.986 |
| PT | Diesel | 0.008 | 0.005 | 0.010 | 0.022 | 0.017 | 0.015 | 0.021 | 0.040 | 0.018 | 0.012 | 0.014 | 0.014 | 0.014 | 0.014 | 0.014 |
| LCT | Gas | 0.907 | 0.923 | 0.939 | 0.919 | 0.900 | 0.852 | 0.795 | 0.780 | 0.929 | 0.893 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 |
| LCT | Diesel | 0.093 | 0.077 | 0.061 | 0.081 | 0.100 | 0.148 | 0.205 | 0.220 | 0.071 | 0.107 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 |
| LCT | Gas | 0.907 | 0.923 | 0.939 | 0.919 | 0.900 | 0.852 | 0.795 | 0.780 | 0.929 | 0.893 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 |
| LCT | Diesel | 0.093 | 0.077 | 0.061 | 0.081 | 0.100 | 0.148 | 0.205 | 0.220 | 0.071 | 0.107 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 |
| 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 | 0.229 | 0.250 | 0.266 | 0.327 | 0.485 | 0.615 | 0.676 | 0.674 | 0.736 | 0.941 | 0.954 | 0.971 | 0.976 | 0.991 | 0.991 |
| SBus | Diesel | 0.771 | 0.750 | 0.734 | 0.673 | 0.515 | 0.385 | 0.324 | 0.326 | 0.264 | 0.059 | 0.046 | 0.029 | 0.024 | 0.009 | 0.009 |
| RT | Gas | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 |
| RT | Diesel | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 |
| SUShT | Gas | 0.575 | 0.725 | 0.761 | 0.787 | 0.817 | 0.789 | 0.804 | 0.855 | 0.930 | 0.971 | 0.938 | 0.982 | 0.983 | 0.994 | 0.996 |
| SUShT | Diesel | 0.425 | 0.275 | 0.239 | 0.213 | 0.183 | 0.211 | 0.196 | 0.145 | 0.070 | 0.029 | 0.062 | 0.018 | 0.017 | 0.006 | 0.004 |
| SULhT | Gas | 0.575 | 0.725 | 0.761 | 0.787 | 0.817 | 0.789 | 0.804 | 0.855 | 0.930 | 0.971 | 0.938 | 0.982 | 0.983 | 0.994 | 0.996 |
| SULhT | Diesel | 0.425 | 0.275 | 0.239 | 0.213 | 0.183 | 0.211 | 0.196 | 0.145 | 0.070 | 0.029 | 0.062 | 0.018 | 0.017 | 0.006 | 0.004 |
| MH | Gas | 0.850 | 0.850 | 0.850 | 0.850 | 0.850 | 0.850 | 0.850 | 0.850 | 0.850 | 0.850 | 0.850 | 0.850 | 0.850 | 0.850 | 0.850 |
| MH | Diesel | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 |
| CShT | Gas | 0.122 | 0.185 | 0.170 | 0.239 | 0.258 | 0.274 | 0.354 | 0.326 | 0.285 | 0.557 | 0.634 | 0.457 | 0.427 | 0.698 | 0.828 |
| CShT | Diesel | 0.878 | 0.815 | 0.830 | 0.761 | 0.742 | 0.726 | 0.646 | 0.674 | 0.715 | 0.443 | 0.366 | 0.543 | 0.573 | 0.302 | 0.172 |
| 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 2011 Fuel/Engine Fractions Summary[1]

| SUT | Fuel Type | Model Year | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2011 | 2010 | 2009 | 2008 | 2007 | 2006 | 2005 | 2004 | 2003 | 2002 | 2001 | 2000 | 1999 | 1998 | 1997 | 1996 |
| PC | Gas | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| PC | Diesel | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| PT | Gas | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.987 | 0.987 | 0.987 | 0.987 | 0.987 | 0.977 | 0.977 | 0.990 | 0.981 | 0.980 |
| PT | Diesel | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.013 | 0.013 | 0.013 | 0.013 | 0.013 | 0.023 | 0.023 | 0.010 | 0.019 | 0.020 |
| PT | Gas | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.987 | 0.987 | 0.987 | 0.987 | 0.987 | 0.977 | 0.977 | 0.990 | 0.981 | 0.980 |
| PT | Diesel | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.013 | 0.013 | 0.013 | 0.013 | 0.013 | 0.023 | 0.023 | 0.010 | 0.019 | 0.020 |
| LCT | Gas | 0.895 | 0.895 | 0.895 | 0.895 | 0.913 | 0.921 | 0.891 | 0.819 | 0.867 | 0.843 | 0.827 | 0.877 | 0.833 | 0.962 | 0.864 | 0.911 |
| LCT | Diesel | 0.105 | 0.105 | 0.105 | 0.105 | 0.087 | 0.079 | 0.109 | 0.181 | 0.133 | 0.157 | 0.173 | 0.123 | 0.167 | 0.038 | 0.136 | 0.089 |
| LCT | Gas | 0.895 | 0.895 | 0.895 | 0.895 | 0.913 | 0.921 | 0.891 | 0.819 | 0.867 | 0.843 | 0.827 | 0.877 | 0.833 | 0.962 | 0.864 | 0.911 |
| LCT | Diesel | 0.105 | 0.105 | 0.105 | 0.105 | 0.087 | 0.079 | 0.109 | 0.181 | 0.133 | 0.157 | 0.173 | 0.123 | 0.167 | 0.038 | 0.136 | 0.089 |
| 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 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 |
| SBus | Diesel | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 |
| RT | Gas | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 |
| RT | Diesel | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 |
| SUShT | Gas | 0.211 | 0.221 | 0.307 | 0.256 | 0.238 | 0.219 | 0.211 | 0.229 | 0.250 | 0.266 | 0.312 | 0.348 | 0.359 | 0.426 | 0.423 | 0.435 |
| SUShT | Diesel | 0.789 | 0.779 | 0.693 | 0.744 | 0.762 | 0.781 | 0.789 | 0.771 | 0.750 | 0.734 | 0.688 | 0.652 | 0.641 | 0.574 | 0.577 | 0.565 |
| SULhT | Gas | 0.211 | 0.221 | 0.307 | 0.256 | 0.238 | 0.219 | 0.211 | 0.229 | 0.250 | 0.266 | 0.312 | 0.348 | 0.359 | 0.426 | 0.423 | 0.435 |
| SULhT | Diesel | 0.789 | 0.779 | 0.693 | 0.744 | 0.762 | 0.781 | 0.789 | 0.771 | 0.750 | 0.734 | 0.688 | 0.652 | 0.641 | 0.574 | 0.577 | 0.565 |
| MH | Gas | 0.500 | 0.500 | 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 |
| MH | Diesel | 0.500 | 0.500 | 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 |
| CShT | Gas | 0.046 | 0.071 | 0.047 | 0.053 | 0.026 | 0.059 | 0.048 | 0.050 | 0.050 | 0.078 | 0.077 | 0.083 | 0.102 | 0.131 | 0.152 | 0.146 |
| CShT | Diesel | 0.954 | 0.929 | 0.953 | 0.947 | 0.974 | 0.941 | 0.952 | 0.950 | 0.950 | 0.922 | 0.923 | 0.917 | 0.898 | 0.869 | 0.848 | 0.854 |
| 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 2011 Fuel/Engine Fractions Summary[1] (Continued)

| SUT | Fuel Type | Model Year | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1995 | 1994 | 1993 | 1992 | 1991 | 1990 | 1989 | 1988 | 1987 | 1986 | 1985 | 1984 | 1983 | 1982 | 1981 |
| PC | Gas | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.988 | 0.981 | 0.969 | 0.939 | 0.924 |
| PC | Diesel | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.012 | 0.019 | 0.031 | 0.061 | 0.076 |
| PT | Gas | 0.985 | 0.982 | 0.979 | 0.979 | 0.980 | 0.987 | 0.992 | 0.995 | 0.990 | 0.978 | 0.983 | 0.985 | 0.979 | 0.960 | 0.982 |
| PT | Diesel | 0.015 | 0.018 | 0.021 | 0.021 | 0.020 | 0.013 | 0.008 | 0.005 | 0.010 | 0.022 | 0.017 | 0.015 | 0.021 | 0.040 | 0.018 |
| PT | Gas | 0.985 | 0.982 | 0.979 | 0.979 | 0.980 | 0.987 | 0.992 | 0.995 | 0.990 | 0.978 | 0.983 | 0.985 | 0.979 | 0.960 | 0.982 |
| PT | Diesel | 0.015 | 0.018 | 0.021 | 0.021 | 0.020 | 0.013 | 0.008 | 0.005 | 0.010 | 0.022 | 0.017 | 0.015 | 0.021 | 0.040 | 0.018 |
| LCT | Gas | 0.881 | 0.898 | 0.915 | 0.930 | 0.932 | 0.916 | 0.907 | 0.923 | 0.939 | 0.919 | 0.900 | 0.852 | 0.795 | 0.780 | 0.929 |
| LCT | Diesel | 0.119 | 0.102 | 0.085 | 0.070 | 0.068 | 0.084 | 0.093 | 0.077 | 0.061 | 0.081 | 0.100 | 0.148 | 0.205 | 0.220 | 0.071 |
| LCT | Gas | 0.881 | 0.898 | 0.915 | 0.930 | 0.932 | 0.916 | 0.907 | 0.923 | 0.939 | 0.919 | 0.900 | 0.852 | 0.795 | 0.780 | 0.929 |
| LCT | Diesel | 0.119 | 0.102 | 0.085 | 0.070 | 0.068 | 0.084 | 0.093 | 0.077 | 0.061 | 0.081 | 0.100 | 0.148 | 0.205 | 0.220 | 0.071 |
| 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 | 0.114 | 0.147 | 0.121 | 0.010 | 0.090 | 0.124 | 0.229 | 0.250 | 0.266 | 0.327 | 0.485 | 0.615 | 0.676 | 0.674 | 0.736 |
| SBus | Diesel | 0.886 | 0.853 | 0.879 | 0.990 | 0.910 | 0.876 | 0.771 | 0.750 | 0.734 | 0.673 | 0.515 | 0.385 | 0.324 | 0.326 | 0.264 |
| RT | Gas | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 |
| RT | Diesel | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 |
| SUShT | Gas | 0.674 | 0.516 | 0.523 | 0.515 | 0.497 | 0.530 | 0.540 | 0.658 | 0.719 | 0.768 | 0.767 | 0.825 | 0.773 | 0.847 | 0.976 |
| SUShT | Diesel | 0.326 | 0.484 | 0.477 | 0.485 | 0.503 | 0.470 | 0.460 | 0.342 | 0.281 | 0.232 | 0.233 | 0.175 | 0.227 | 0.153 | 0.024 |
| SULhT | Gas | 0.674 | 0.516 | 0.523 | 0.515 | 0.497 | 0.530 | 0.540 | 0.658 | 0.719 | 0.768 | 0.767 | 0.825 | 0.773 | 0.847 | 0.976 |
| SULhT | Diesel | 0.326 | 0.484 | 0.477 | 0.485 | 0.503 | 0.470 | 0.460 | 0.342 | 0.281 | 0.232 | 0.233 | 0.175 | 0.227 | 0.153 | 0.024 |
| MH | Gas | 0.790 | 0.820 | 0.850 | 0.850 | 0.850 | 0.850 | 0.850 | 0.850 | 0.850 | 0.850 | 0.850 | 0.850 | 0.850 | 0.850 | 0.850 |
| MH | Diesel | 0.210 | 0.180 | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 |
| CShT | Gas | 0.306 | 0.112 | 0.123 | 0.164 | 0.161 | 0.153 | 0.124 | 0.170 | 0.148 | 0.250 | 0.239 | 0.284 | 0.384 | 0.311 | 0.626 |
| CShT | Diesel | 0.694 | 0.888 | 0.877 | 0.836 | 0.839 | 0.847 | 0.876 | 0.830 | 0.852 | 0.750 | 0.761 | 0.716 | 0.616 | 0.689 | 0.374 |
| 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 2014 Fuel/Engine Fractions Summary[1]

| SUT | Fuel Type | Model Year | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2014 | 2013 | 2012 | 2011 | 2010 | 2009 | 2008 | 2007 | 2006 | 2005 | 2004 | 2003 | 2002 | 2001 | 2000 | 1999 |
| PC | Gas | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 1.000 | 1.000 |
| PC | Diesel | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.000 | 0.000 |
| PT | Gas | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.987 | 0.987 | 0.987 | 0.987 | 0.987 | 0.977 | 0.977 |
| PT | Diesel | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.013 | 0.013 | 0.013 | 0.013 | 0.013 | 0.023 | 0.023 |
| PT | Gas | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.987 | 0.987 | 0.987 | 0.987 | 0.987 | 0.977 | 0.977 |
| PT | Diesel | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.013 | 0.013 | 0.013 | 0.013 | 0.013 | 0.023 | 0.023 |
| LCT | Gas | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.913 | 0.921 | 0.891 | 0.819 | 0.867 | 0.843 | 0.827 | 0.877 | 0.833 |
| LCT | Diesel | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.087 | 0.079 | 0.109 | 0.181 | 0.133 | 0.157 | 0.173 | 0.123 | 0.167 |
| LCT | Gas | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.913 | 0.921 | 0.891 | 0.819 | 0.867 | 0.843 | 0.827 | 0.877 | 0.833 |
| LCT | Diesel | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.087 | 0.079 | 0.109 | 0.181 | 0.133 | 0.157 | 0.173 | 0.123 | 0.167 |
| 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 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 |
| SBus | Diesel | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 |
| RT | Gas | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 |
| RT | Diesel | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 |
| SUShT | Gas | 0.211 | 0.211 | 0.211 | 0.211 | 0.221 | 0.307 | 0.256 | 0.238 | 0.219 | 0.211 | 0.229 | 0.250 | 0.266 | 0.312 | 0.348 | 0.359 |
| SUShT | Diesel | 0.789 | 0.789 | 0.789 | 0.789 | 0.779 | 0.693 | 0.744 | 0.762 | 0.781 | 0.789 | 0.771 | 0.750 | 0.734 | 0.688 | 0.652 | 0.641 |
| SULhT | Gas | 0.211 | 0.211 | 0.211 | 0.211 | 0.221 | 0.307 | 0.256 | 0.238 | 0.219 | 0.211 | 0.229 | 0.250 | 0.266 | 0.312 | 0.348 | 0.359 |
| SULhT | Diesel | 0.789 | 0.789 | 0.789 | 0.789 | 0.779 | 0.693 | 0.744 | 0.762 | 0.781 | 0.789 | 0.771 | 0.750 | 0.734 | 0.688 | 0.652 | 0.641 |
| 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 | 0.680 |
| 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 | 0.320 |
| CShT | Gas | 0.046 | 0.046 | 0.046 | 0.046 | 0.071 | 0.047 | 0.053 | 0.026 | 0.059 | 0.048 | 0.050 | 0.050 | 0.078 | 0.077 | 0.083 | 0.102 |
| CShT | Diesel | 0.954 | 0.954 | 0.954 | 0.954 | 0.929 | 0.953 | 0.947 | 0.974 | 0.941 | 0.952 | 0.950 | 0.950 | 0.922 | 0.923 | 0.917 | 0.898 |
| 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 2014 Fuel/Engine Fractions Summary[1] (Continued)

| SUT | Fuel Type | Model Year | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1998 | 1997 | 1996 | 1995 | 1994 | 1993 | 1992 | 1991 | 1990 | 1989 | 1988 | 1987 | 1986 | 1985 | 1984 |
| PC | 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 | 0.988 | 0.981 |
| PC | Diesel | 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 | 0.012 | 0.019 |
| PT | Gas | 0.990 | 0.981 | 0.980 | 0.985 | 0.982 | 0.979 | 0.979 | 0.980 | 0.987 | 0.992 | 0.995 | 0.990 | 0.978 | 0.983 | 0.985 |
| PT | Diesel | 0.010 | 0.019 | 0.020 | 0.015 | 0.018 | 0.021 | 0.021 | 0.020 | 0.013 | 0.008 | 0.005 | 0.010 | 0.022 | 0.017 | 0.015 |
| PT | Gas | 0.990 | 0.981 | 0.980 | 0.985 | 0.982 | 0.979 | 0.979 | 0.980 | 0.987 | 0.992 | 0.995 | 0.990 | 0.978 | 0.983 | 0.985 |
| PT | Diesel | 0.010 | 0.019 | 0.020 | 0.015 | 0.018 | 0.021 | 0.021 | 0.020 | 0.013 | 0.008 | 0.005 | 0.010 | 0.022 | 0.017 | 0.015 |
| LCT | Gas | 0.962 | 0.864 | 0.911 | 0.881 | 0.898 | 0.915 | 0.930 | 0.932 | 0.916 | 0.907 | 0.923 | 0.939 | 0.919 | 0.900 | 0.852 |
| LCT | Diesel | 0.038 | 0.136 | 0.089 | 0.119 | 0.102 | 0.085 | 0.070 | 0.068 | 0.084 | 0.093 | 0.077 | 0.061 | 0.081 | 0.100 | 0.148 |
| LCT | Gas | 0.962 | 0.864 | 0.911 | 0.881 | 0.898 | 0.915 | 0.930 | 0.932 | 0.916 | 0.907 | 0.923 | 0.939 | 0.919 | 0.900 | 0.852 |
| LCT | Diesel | 0.038 | 0.136 | 0.089 | 0.119 | 0.102 | 0.085 | 0.070 | 0.068 | 0.084 | 0.093 | 0.077 | 0.061 | 0.081 | 0.100 | 0.148 |
| 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 | 0.042 | 0.042 | 0.042 | 0.114 | 0.147 | 0.121 | 0.010 | 0.090 | 0.124 | 0.229 | 0.250 | 0.266 | 0.327 | 0.485 | 0.615 |
| SBus | Diesel | 0.958 | 0.958 | 0.958 | 0.886 | 0.853 | 0.879 | 0.990 | 0.910 | 0.876 | 0.771 | 0.750 | 0.734 | 0.673 | 0.515 | 0.385 |
| RT | Gas | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 |
| RT | Diesel | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 |
| SUShT | Gas | 0.426 | 0.423 | 0.435 | 0.674 | 0.516 | 0.523 | 0.515 | 0.497 | 0.530 | 0.540 | 0.658 | 0.719 | 0.768 | 0.767 | 0.825 |
| SUShT | Diesel | 0.574 | 0.577 | 0.565 | 0.326 | 0.484 | 0.477 | 0.485 | 0.503 | 0.470 | 0.460 | 0.342 | 0.281 | 0.232 | 0.233 | 0.175 |
| SULhT | Gas | 0.426 | 0.423 | 0.435 | 0.674 | 0.516 | 0.523 | 0.515 | 0.497 | 0.530 | 0.540 | 0.658 | 0.719 | 0.768 | 0.767 | 0.825 |
| SULhT | Diesel | 0.574 | 0.577 | 0.565 | 0.326 | 0.484 | 0.477 | 0.485 | 0.503 | 0.470 | 0.460 | 0.342 | 0.281 | 0.232 | 0.233 | 0.175 |
| MH | Gas | 0.710 | 0.740 | 0.770 | 0.790 | 0.820 | 0.850 | 0.850 | 0.850 | 0.850 | 0.850 | 0.850 | 0.850 | 0.850 | 0.850 | 0.850 |
| MH | Diesel | 0.290 | 0.260 | 0.230 | 0.210 | 0.180 | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 |
| CShT | Gas | 0.131 | 0.152 | 0.146 | 0.306 | 0.112 | 0.123 | 0.164 | 0.161 | 0.153 | 0.124 | 0.170 | 0.148 | 0.250 | 0.239 | 0.284 |
| CShT | Diesel | 0.869 | 0.848 | 0.854 | 0.694 | 0.888 | 0.877 | 0.836 | 0.839 | 0.847 | 0.876 | 0.830 | 0.852 | 0.750 | 0.761 | 0.716 |
| 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 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 |
| PC | Gas | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 |
| PC | Diesel | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 |
| PT | Gas | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.987 | 0.987 | 0.987 | 0.987 |
| PT | Diesel | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.013 | 0.013 | 0.013 | 0.013 |
| PT | Gas | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.987 | 0.987 | 0.987 | 0.987 |
| PT | Diesel | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.013 | 0.013 | 0.013 | 0.013 |
| LCT | Gas | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.913 | 0.921 | 0.891 | 0.819 | 0.867 | 0.843 |
| LCT | Diesel | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.087 | 0.079 | 0.109 | 0.181 | 0.133 | 0.157 |
| LCT | Gas | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.913 | 0.921 | 0.891 | 0.819 | 0.867 | 0.843 |
| LCT | Diesel | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.087 | 0.079 | 0.109 | 0.181 | 0.133 | 0.157 |
| 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 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 |
| SBus | Diesel | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 |
| RT | Gas | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 |
| RT | Diesel | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 |
| SUShT | Gas | 0.211 | 0.211 | 0.211 | 0.211 | 0.211 | 0.211 | 0.211 | 0.221 | 0.307 | 0.256 | 0.238 | 0.219 | 0.211 | 0.229 | 0.250 | 0.266 |
| SUShT | Diesel | 0.789 | 0.789 | 0.789 | 0.789 | 0.789 | 0.789 | 0.789 | 0.779 | 0.693 | 0.744 | 0.762 | 0.781 | 0.789 | 0.771 | 0.750 | 0.734 |
| SULhT | Gas | 0.211 | 0.211 | 0.211 | 0.211 | 0.211 | 0.211 | 0.211 | 0.221 | 0.307 | 0.256 | 0.238 | 0.219 | 0.211 | 0.229 | 0.250 | 0.266 |
| SULhT | Diesel | 0.789 | 0.789 | 0.789 | 0.789 | 0.789 | 0.789 | 0.789 | 0.779 | 0.693 | 0.744 | 0.762 | 0.781 | 0.789 | 0.771 | 0.750 | 0.734 |
| 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 | 0.046 | 0.046 | 0.046 | 0.046 | 0.046 | 0.046 | 0.046 | 0.071 | 0.047 | 0.053 | 0.026 | 0.059 | 0.048 | 0.050 | 0.050 | 0.078 |
| CShT | Diesel | 0.954 | 0.954 | 0.954 | 0.954 | 0.954 | 0.954 | 0.954 | 0.929 | 0.953 | 0.947 | 0.974 | 0.941 | 0.952 | 0.950 | 0.950 | 0.922 |
| 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 |
| PC | Gas | 0.996 | 1.000 | 1.000 | 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 | Diesel | 0.004 | 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 |
| PT | Gas | 0.987 | 0.977 | 0.977 | 0.990 | 0.981 | 0.980 | 0.985 | 0.982 | 0.979 | 0.979 | 0.980 | 0.987 | 0.992 | 0.995 | 0.990 |
| PT | Diesel | 0.013 | 0.023 | 0.023 | 0.010 | 0.019 | 0.020 | 0.015 | 0.018 | 0.021 | 0.021 | 0.020 | 0.013 | 0.008 | 0.005 | 0.010 |
| PT | Gas | 0.987 | 0.977 | 0.977 | 0.990 | 0.981 | 0.980 | 0.985 | 0.982 | 0.979 | 0.979 | 0.980 | 0.987 | 0.992 | 0.995 | 0.990 |
| PT | Diesel | 0.013 | 0.023 | 0.023 | 0.010 | 0.019 | 0.020 | 0.015 | 0.018 | 0.021 | 0.021 | 0.020 | 0.013 | 0.008 | 0.005 | 0.010 |
| LCT | Gas | 0.827 | 0.877 | 0.833 | 0.962 | 0.864 | 0.911 | 0.881 | 0.898 | 0.915 | 0.930 | 0.932 | 0.916 | 0.907 | 0.923 | 0.939 |
| LCT | Diesel | 0.173 | 0.123 | 0.167 | 0.038 | 0.136 | 0.089 | 0.119 | 0.102 | 0.085 | 0.070 | 0.068 | 0.084 | 0.093 | 0.077 | 0.061 |
| LCT | Gas | 0.827 | 0.877 | 0.833 | 0.962 | 0.864 | 0.911 | 0.881 | 0.898 | 0.915 | 0.930 | 0.932 | 0.916 | 0.907 | 0.923 | 0.939 |
| LCT | Diesel | 0.173 | 0.123 | 0.167 | 0.038 | 0.136 | 0.089 | 0.119 | 0.102 | 0.085 | 0.070 | 0.068 | 0.084 | 0.093 | 0.077 | 0.061 |
| 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 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.114 | 0.147 | 0.121 | 0.010 | 0.090 | 0.124 | 0.229 | 0.250 | 0.266 |
| SBus | Diesel | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.886 | 0.853 | 0.879 | 0.990 | 0.910 | 0.876 | 0.771 | 0.750 | 0.734 |
| RT | Gas | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 |
| RT | Diesel | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 |
| SUShT | Gas | 0.312 | 0.348 | 0.359 | 0.426 | 0.423 | 0.435 | 0.674 | 0.516 | 0.523 | 0.515 | 0.497 | 0.530 | 0.540 | 0.658 | 0.719 |
| SUShT | Diesel | 0.688 | 0.652 | 0.641 | 0.574 | 0.577 | 0.565 | 0.326 | 0.484 | 0.477 | 0.485 | 0.503 | 0.470 | 0.460 | 0.342 | 0.281 |
| SULhT | Gas | 0.312 | 0.348 | 0.359 | 0.426 | 0.423 | 0.435 | 0.674 | 0.516 | 0.523 | 0.515 | 0.497 | 0.530 | 0.540 | 0.658 | 0.719 |
| SULhT | Diesel | 0.688 | 0.652 | 0.641 | 0.574 | 0.577 | 0.565 | 0.326 | 0.484 | 0.477 | 0.485 | 0.503 | 0.470 | 0.460 | 0.342 | 0.281 |
| 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 | 0.077 | 0.083 | 0.102 | 0.131 | 0.152 | 0.146 | 0.306 | 0.112 | 0.123 | 0.164 | 0.161 | 0.153 | 0.124 | 0.170 | 0.148 |
| CShT | Diesel | 0.923 | 0.917 | 0.898 | 0.869 | 0.848 | 0.854 | 0.694 | 0.888 | 0.877 | 0.836 | 0.839 | 0.847 | 0.876 | 0.830 | 0.852 |
| 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 2021 Fuel/Engine Fractions Summary[1]

| SUT | Fuel Type | Model Year | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2021 | 2020 | 2019 | 2018 | 2017 | 2016 | 2015 | 2014 | 2013 | 2012 | 2011 | 2010 | 2009 | 2008 | 2007 | 2006 |
| PC | Gas | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 |
| PC | Diesel | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 |
| PT | Gas | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 |
| PT | Diesel | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 |
| PT | Gas | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 | 0.977 |
| PT | Diesel | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 |
| LCT | Gas | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.913 | 0.921 |
| LCT | Diesel | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.087 | 0.079 |
| LCT | Gas | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.913 | 0.921 |
| LCT | Diesel | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.087 | 0.079 |
| 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 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 |
| SBus | Diesel | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 |
| RT | Gas | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 |
| RT | Diesel | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 |
| SUShT | Gas | 0.211 | 0.211 | 0.211 | 0.211 | 0.211 | 0.211 | 0.211 | 0.211 | 0.211 | 0.211 | 0.211 | 0.221 | 0.307 | 0.256 | 0.238 | 0.219 |
| SUShT | Diesel | 0.789 | 0.789 | 0.789 | 0.789 | 0.789 | 0.789 | 0.789 | 0.789 | 0.789 | 0.789 | 0.789 | 0.779 | 0.693 | 0.744 | 0.762 | 0.781 |
| SULhT | Gas | 0.211 | 0.211 | 0.211 | 0.211 | 0.211 | 0.211 | 0.211 | 0.211 | 0.211 | 0.211 | 0.211 | 0.221 | 0.307 | 0.256 | 0.238 | 0.219 |
| SULhT | Diesel | 0.789 | 0.789 | 0.789 | 0.789 | 0.789 | 0.789 | 0.789 | 0.789 | 0.789 | 0.789 | 0.789 | 0.779 | 0.693 | 0.744 | 0.762 | 0.781 |
| 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 | 0.510 | 0.530 | 0.540 |
| 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 | 0.490 | 0.470 | 0.460 |
| CShT | Gas | 0.046 | 0.046 | 0.046 | 0.046 | 0.046 | 0.046 | 0.046 | 0.046 | 0.046 | 0.046 | 0.046 | 0.071 | 0.047 | 0.053 | 0.026 | 0.059 |
| CShT | Diesel | 0.954 | 0.954 | 0.954 | 0.954 | 0.954 | 0.954 | 0.954 | 0.954 | 0.954 | 0.954 | 0.954 | 0.929 | 0.953 | 0.947 | 0.974 | 0.941 |
| 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 2021 Fuel/Engine Fractions Summary[1] (Continued)

| SUT | Fuel Type | Model Year | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2005 | 2004 | 2003 | 2002 | 2001 | 2000 | 1999 | 1998 | 1997 | 1996 | 1995 | 1994 | 1993 | 1992 | 1991 |
| PC | Gas | 0.996 | 0.996 | 0.996 | 0.996 | 0.996 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| PC | Diesel | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| PT | Gas | 0.987 | 0.987 | 0.987 | 0.987 | 0.987 | 0.977 | 0.977 | 0.990 | 0.981 | 0.980 | 0.985 | 0.982 | 0.979 | 0.979 | 0.980 |
| PT | Diesel | 0.013 | 0.013 | 0.013 | 0.013 | 0.013 | 0.023 | 0.023 | 0.010 | 0.019 | 0.020 | 0.015 | 0.018 | 0.021 | 0.021 | 0.020 |
| PT | Gas | 0.987 | 0.987 | 0.987 | 0.987 | 0.987 | 0.977 | 0.977 | 0.990 | 0.981 | 0.980 | 0.985 | 0.982 | 0.979 | 0.979 | 0.980 |
| PT | Diesel | 0.013 | 0.013 | 0.013 | 0.013 | 0.013 | 0.023 | 0.023 | 0.010 | 0.019 | 0.020 | 0.015 | 0.018 | 0.021 | 0.021 | 0.020 |
| LCT | Gas | 0.891 | 0.819 | 0.867 | 0.843 | 0.827 | 0.877 | 0.833 | 0.962 | 0.864 | 0.911 | 0.881 | 0.898 | 0.915 | 0.930 | 0.932 |
| LCT | Diesel | 0.109 | 0.181 | 0.133 | 0.157 | 0.173 | 0.123 | 0.167 | 0.038 | 0.136 | 0.089 | 0.119 | 0.102 | 0.085 | 0.070 | 0.068 |
| LCT | Gas | 0.891 | 0.819 | 0.867 | 0.843 | 0.827 | 0.877 | 0.833 | 0.962 | 0.864 | 0.911 | 0.881 | 0.898 | 0.915 | 0.930 | 0.932 |
| LCT | Diesel | 0.109 | 0.181 | 0.133 | 0.157 | 0.173 | 0.123 | 0.167 | 0.038 | 0.136 | 0.089 | 0.119 | 0.102 | 0.085 | 0.070 | 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 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.114 | 0.147 | 0.121 | 0.010 | 0.090 |
| SBus | Diesel | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.958 | 0.886 | 0.853 | 0.879 | 0.990 | 0.910 |
| RT | Gas | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 |
| RT | Diesel | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 |
| SUShT | Gas | 0.211 | 0.229 | 0.250 | 0.266 | 0.312 | 0.348 | 0.359 | 0.426 | 0.423 | 0.435 | 0.674 | 0.516 | 0.523 | 0.515 | 0.497 |
| SUShT | Diesel | 0.789 | 0.771 | 0.750 | 0.734 | 0.688 | 0.652 | 0.641 | 0.574 | 0.577 | 0.565 | 0.326 | 0.484 | 0.477 | 0.485 | 0.503 |
| SULhT | Gas | 0.211 | 0.229 | 0.250 | 0.266 | 0.312 | 0.348 | 0.359 | 0.426 | 0.423 | 0.435 | 0.674 | 0.516 | 0.523 | 0.515 | 0.497 |
| SULhT | Diesel | 0.789 | 0.771 | 0.750 | 0.734 | 0.688 | 0.652 | 0.641 | 0.574 | 0.577 | 0.565 | 0.326 | 0.484 | 0.477 | 0.485 | 0.503 |
| MH | Gas | 0.560 | 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 |
| MH | Diesel | 0.440 | 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 |
| CShT | Gas | 0.048 | 0.050 | 0.050 | 0.078 | 0.077 | 0.083 | 0.102 | 0.131 | 0.152 | 0.146 | 0.306 | 0.112 | 0.123 | 0.164 | 0.161 |
| CShT | Diesel | 0.952 | 0.950 | 0.950 | 0.922 | 0.923 | 0.917 | 0.898 | 0.869 | 0.848 | 0.854 | 0.694 | 0.888 | 0.877 | 0.836 | 0.839 |
| 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 H:
# MOVES RUN SUMMARIES

Appendix H is being transmitted electronically.