CHAPTER 6: ESTIMATION OF OFF-NETWORK ACTIVITY

To estimate the off-network (or parked vehicle) emissions using the mass per activity emissions rates, county-level analysis years 2018, 2020, 2028, 2037, and 2045 weekday estimates of the source hours parked (SHP), starts, source hours idling (SHI), and auxiliary power units (APU) hours are required by hour and vehicle (SHI and APU hours are for diesel combination long-haul trucks only). One of the main components of the SHP and starts off-network activity estimation is the analysis year county-level vehicle population. Appendix 12.21 contains the vehicle population and hourly SHP, starts, SHI, and APU hours.

Texas Transportation Institute's (TTI) MOVESpopulationBuild module is used to convert Motor Vehicle Emissions Simulator version 2014a (MOVES2014a) based Texas Department of Motor Vehicles registration data for each county into 13 MOVES2014a source use type (SUT) population (or vehicle population). The county-level SHP, starts, SHI, and APU hours of off- network activity were developed using the "OffNetActCalc" utility and methodology provided by TTI.

6.1 Estimation of SHP
The first activity measure needed to estimate the off-network emissions using the mass per activity emissions rates are county-level analysis year weekday estimates of SHP by hour and vehicle type. For each hour, the county-level vehicle type SHP was calculated by taking the difference between the vehicle type total available hours minus the vehicle type vehicle hours travelled (VHT). Since this calculation was performed at the hourly level, the vehicle type total available hours was set equal to the vehicle type population. The Source Hours Operating (SHO) was calculated using the link vehicle miles of travel (VMT) and speeds and the VMT mixes by MOVES road-type category. Appendix 12.21 includes the 24-hour summaries of the county-level weekday estimates of SHP by hour and vehicle type for all analysis years.

6.1.1 Vehicle Type Total Available Hours
The vehicle type total available hours is typically calculated as the vehicle type population times the number of hours in the time period. Since this calculation was performed at the hourly level, the vehicle type total available hours was set equal to the vehicle type vehicle.

6.1.2 Vehicle Type VHT
To calculate the VHT for a given link, the VMT was allocated to each vehicle type using the Texas Department of Transportation district-level vehicle type VMT mixes by MOVES road-type category, which was then divided by the link speed to calculate the link vehicle type VHT. These VMT mixes are the same VMT mixes used to estimate emissions in the emissions estimation process. This SHO calculation was performed for each link in a given hour, aggregating the VHT to one value per vehicle type per hour.

6.2 Estimation of Starts
The second activity measure needed to estimate the off-network emissions using the mass per activity emissions rates are county-level analysis year weekday estimates of starts by hour and vehicle type. The vehicle type hourly default starts per vehicle were multiplied by the analysis year county-level vehicle type vehicle population to estimate the county-level vehicle type starts by hour. Appendix 12.21 includes the 24-hour summaries of the county-level vehicle type starts by hour for each analysis year.

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 run by dividing the MOVES start

output by the MOVES vehicle population output. These MOVES national default starts per vehicle do not vary by year, only by MOVES day type. For this weekday analysis, the MOVES national default "weekday" starts per vehicle were used.

6.3 Estimation of SHI and APU Hours

The remaining activity measures needed to estimate the off-network emissions using the mass per activity emissions rates are the hourly, county-level analysis year weekday heavy-duty diesel truck (SUT 62, fuel type 2 [CLhT_Diesel]) SHI and APU hours (hotelling activity). During hotelling, the truck's main engine is assumed to be in idling mode or its APU is in use. To calculate the SHI and APU hours activity, the hotelling hours activity were calculated, which was then allocated to the SHI and APU hours components.

The hotelling activity was based on information from a Texas Commission on Environmental Quality extended idling study, which produced 2004 weekday extended idling estimates for each Texas County and hotelling activity data from MOVES. Hotelling scaling factors (by analysis year) were applied to the base 2004 weekday hotelling values from the study to estimate the 24-hour hotelling by analysis year. Hotelling hourly factors were then applied to allocate the 24-hour hotelling by analysis year to each hour of the day. To ensure that valid hourly hotelling values are used, the hourly hotelling activity was compared to the CLhT_Diesel hourly SHP (i.e., hourly hotelling values cannot exceed the hourly SHP values). SHI and APU hours factors were then applied to the hotelling hours to produce the hourly SHI and APU hours of activity. Appendix 12.21 incudes the 24-hour summaries of the county-level estimates of hotelling hours, SHI, and APU hours for each analysis year.

6.3.1 Hotelling Activity Scaling Factors

To estimate the analysis year county-level 24-hour hotelling activity, county-level hotelling activity scaling factors were developed using the county-level 2004 weekday link-level VMT and speeds, the VMT mix (by MOVES road type), the county-level analysis year weekday link-level VMT and speeds, and the VMT mix (by MOVES road type). The 2004 weekday link-level VMT and speeds were developed using a process similar to the 2018, 2020, 2028, 2037, and 2045 weekday link-level VMT speed estimation. The vehicle type VMT mixes were the same VMT mixes used to estimate emissions in the emissions estimation process. For the base weekday vehicle type VMT mix, the 2006 weekday vehicle type VMT mix was used.

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

6.3.2 Hotelling Activity Hourly Factors

To allocate the analysis year weekday county-level 24-hour hotelling activity to each hour of the day, hotelling activity hourly factors were used. These hotelling activity hourly factors were calculated as the inverse of the analysis year weekday CLhT_Diesel hourly VHT fractions. The analysis year weekday CLhT_Diesel hourly VHT fractions were calculated using the hourly analysis year weekday CLhT_Diesel VHT. The hourly analysis year weekday CLhT_Diesel VHT was converted to hourly fractions, therefore creating analysis year weekday CLhT_Diesel hourly VHT fractions. The inverse of these hourly VHT

fractions were calculated and the inverse for each hour was divided by the sum of the inverse hourly VHT fractions across all hours to calculate the county-level analysis year weekday hotelling activity hourly factors for each analysis year.

6.3.3 County-Level CLhT_Diesel Hotelling Activity by Hour Estimation

The four analysis years' weekday CLhT_Diesel hotelling activity by hour was calculated by multiplying the 24-hour 2004 weekday hotelling hours by the analysis year hotelling activity scaling factor and by the analysis year hotelling activity hourly factors. For each hour, the analysis year weekday hotelling activity was then compared to the analysis year weekday CLhT_Diesel SHP to estimate the final analysis year weekday hotelling activity by hour. If the analysis year weekday hotelling activity value was greater than the analysis year weekday SHP value, then the final analysis year weekday hotelling activity for that hour was set to the analysis year weekday CLhT_Diesel SHP value. Otherwise, the final analysis year weekday hotelling activity for that hour was set to the base analysis year weekday hotelling activity value. All calculations (scaling factors, hotelling activity hourly factors, and hotelling activity by hour calculations) were performed by county and analysis year (i.e., 10 hotelling activity scaling factors were calculated per analysis year).

6.3.4 County-Level CLhT_Diesel SHI and APU Hours Estimation

Weekday hourly county-level hotelling activity for all analysis years was then allocated to SHI and APU hours activity components using the aggregate extended idle mode and APU mode fractions. For each hour, the analysis year weekday hotelling activity was multiplied by the SHI fraction to calculate the analysis year weekday hourly SHI activity and by the APU fraction to calculate the analysis year weekday hourly APU activity.

The aggregate SHI and the APU fractions were estimated using model year travel fractions (based on source type age distribution and relative mileage accumulation rates used in the MOVES runs) and the MOVES default hotelling activity distribution (i.e., a bi-modal distribution of 1.0 SHI prior to the 2010 model year and a 0.7/0.3 SHI/APU activity allocation for 2010 and later model years). The associated travel fractions were applied to the appropriate extended idle and APU operating mode fractions (of the hotelling operating mode distribution) by model year and summed within each mode to estimate the aggregate (across model years) individual SHI and APU fractions (which sum to 1.0).

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