# Appendix 5

## Post Process
*Source: TTI, 2004*

**Post-Process Adjustments**
The following adjustment steps were done to the post-process output of SUMALL for all counties. These adjustments were applied in the SIP using a combination of EPS2, a photochemical preprocessor, and SAS code. The following steps apply the same adjustment methodology to the SUMALL output as was applied in the SIP.

**NOXTEMPFACT**
The NOXTEMPFACT program is used to calculate the county-specific hourly temperature/humidity adjustment factors for the light-duty diesel, heavy-duty diesel, and heavy-duty gasoline vehicle types. The three primary inputs to NOXTEMPFACT are:

- Climate data consisting of the hourly temperature, barometric pressure, and relative humidity for each county;

- Temperature (AC) correction data consisting of temperatures and their corresponding emission factors;

- NOx emissions contribution percentages by vehicle age group (2003-and-older for the first group and 2004-and-newer for the second group for heavy-duty gasoline vehicle types and 1993-and-older for the first group and 1994-and-newer for the second group for the heavy-duty diesel vehicle types) for each of the light-duty diesel, heavy-duty diesel, and heavy-duty gasoline vehicle types.

The adjustment factors for each vehicle age group and vehicle type (i.e., gas and diesel) are calculated by hour using the climate data and four adjustment factor equations (one for each vehicle age group for heavy-duty gasoline vehicle types and one for each vehicle age group for the heavy-duty diesel vehicle types). The adjustment factor equations used are Equation #2 for 1993-and-older diesel vehicles and Equation #3 for 1994-and-newer diesel vehicles from "Humidity and Temperature Correction Factors For NOx Emissions From Diesel Engines" and Equation #13 for 2003-and-older heavy-duty gasoline vehicles and Equation #11 for 2004-and-newer heavy-duty gasoline vehicles from "Humidity and Temperature Correction Factors For NOx Emissions From Spark Ignited Engines" (Southwest Research Institute, June 2003 and October 2003, included as Appendices F.4 and F.5 to the Houston-Galveston-Brazoria Area Attainment  Demonstration SIP, respectively). For the gasoline vehicle type, a temperature adjustment is also applied. This adjustment is calculated using the temperature correction data. Using the hourly temperature, the temperature adjustment factor for the bounding temperatures (i.e., the temperature greater than and the temperature less than the hourly temperature), is calculated by dividing the emission factor for each bounding temperature by the emission factor for 85° F. Using interpolation, the temperature adjustment is then calculated using the hourly temperature, the bounding temperatures, and the adjustment factors for the bounding temperatures. This calculated adjustment is then applied to the gasoline vehicle type adjustment factors for each vehicle age group.
The vehicle type specific adjustment factors are then calculated using the NOx contribution percentages for each age group and vehicle type and the four adjustment

factors described above. For each of the heavy-duty gasoline vehicle types, the NOx contribution percentage for vehicle age group 1 (2003-and-older) is multiplied by the gasoline adjustment factor for vehicle age group 1 and the NOx contribution percentage for vehicle age group 2 (2004-and-newer) is multiplied by the gasoline adjustment factor for vehicle age group 2. These two adjustment factors by vehicle age group are then summed to attain the composite adjustment factor for the vehicle type. For each of the light-duty diesel and heavy-duty diesel vehicle types, the NOx contribution percentage for vehicle age group 1 (1993-and-older) is multiplied by the diesel adjustment factor for vehicle age group 1 and the NOx contribution percentage for vehicle age group 2 (1994-and-newer) is multiplied by the diesel adjustment factor for vehicle age group 2. These two adjustment factors by vehicle age group are then summed to attain the composite adjustment factor for the vehicle type. This process is repeated for each hour of the day.

The output for this program is a dBASE file (*.dbf) that is used directly in the EMSADJTAB program. This file consists of an adjustment factor for each of the 28 MOBILE6 vehicle types. However, only the light-duty diesel, heavy-duty diesel, and heavy-duty gasoline vehicle types (22 MOBILE6 vehicle types) have calculated factors. For the remaining six vehicle types, an adjustment factor of 1.0 is output.

**EMSIDLEADJTAB**
The EMSIDLEADJTAB program adjusts the HDDV8a and HDDV8b emissions in the tab-delimited output from IMPSUM62 and SUMALL62. The six primary inputs to EMSIDLEADJTAB are:

- The tab-delimited emissions output from IMPSUM62 and SUMALL62;

- An hour index file relating the hour description in the tab-delimited emissions input file to an hour number (i.e., 0:00 AM TO 0:59 AM in the tab-delimited file as hour 1);

- The file associating the MOBILE6 drive cycle (Freeway, Arterial, Local, Ramp) emissions factors (or percentages thereof) to specific travel model functional classifications used in IMPSUM62;

- The desired idling adjustment factor;

- Hourly factors to distribute the extended idling emissions to each hour of the day;

- County fractions to distribute the extended idling emissions for the area to each individual county.

The program reads the regional 24-hour emission totals (VOC, CO, and NOx) for the HDDV8a and HDDV8b. The idling adjustment factor is applied to the 24-hour emission totals to obtain the 24-hour regional extended idling emissions. The program then reads the tab-delimited emissions input file to determine the data set it is reading. If the data set

is not VOC, CO, or NOx emissions, the data set is written directly to the new tab-delimited output file. If the data set is VOC, CO, or NOx, the emissions for each roadtype for the HDDV8a and HDDV8b vehicle classes is multiplied by the idling adjustment factor to obtain the amount of extended idling emissions to be removed. This amount is then removed from the roadtype totals for these vehicle classes. The appropriate hourly factor and county fraction is then applied to the regional total for either the VOC, CO, or NOx (depending upon which pollutant is currently being adjusted) to obtain the extended idling emissions for that county. This process is repeated for each pollutant and county within a given hour. The regional hourly totals are then calculated from these newly adjust county totals. Once all 24-hours have been adjusted, the new 24-hour totals are calculated.

The output from this program is a tab-delimited emissions summary very similar to that of the IMPSUM62 and SUMALL62 programs except that the vehicle type headings of "HDDV8a" and "HDDV8b" are re-named "HDDV8a_R" and "HDDV8b_R". Two new columns are also added for the new extended idling emissions ("HDDV8a_I and "HDDV8b_R").

**EMSADJTAB**
The EMSADJTAB program allows the user to adjust VOC, CO or NOx emissions by hour and vehicle type in the emissions tab-delimited file from the EMSIDLEADJTAB program. The six primary inputs to EMSADJTAB are:

- The tab-delimited emissions file that is to be adjusted;

- The adjustment factors for VOC (only if the VOC emissions are to be adjusted);

- The adjustment factors for CO (only if the CO emissions are to be adjusted);

- The adjustment factors for NOx (only if the NOx emissions are to be adjusted);

- An hour index file relating the hour description in the tab-delimited emissions input file to an hour number (i.e., 0:00 AM TO 0:59 AM in the tab-delimited file as hour 1);

- The file associating the MOBILE6 drive cycle (Freeway, Arterial, Local, Ramp) emissions factors (or percentages thereof) to specific travel model functional classifications used in IMPSUM62;

The program reads the tab-delimited emissions input file to determine the data set it is reading. If the data set is not VOC, CO, or NOx emissions, the data set is written directly to the new tab-delimited output file. If the data set is VOC, CO, or NOx, the emissions for each roadtype are multiplied by the corresponding emission adjustment factors for

that data set, hour, and vehicle type. The vehicle type and roadtype totals are calculated. Once all of the counties in the area have been adjusted, the regional totals are then calculated. After all 24 hours have been adjusted, the 24-hour totals are calculated.

The output from this program is a tab-delimited file in the same format as the EMSIDLEADJTAB program.

The final post-processing step utilizes EMSADJTAB to correct for the effects of Texas Low Emission Diesel (TxLED) and the implementation of new EPA regulations limiting NOx and VOC emissions from highway motorcycles. The LED and motorcycle post-processing adjustments are more specifically calculated in the following way:

- NOx emission rate output from a regional MOBILE6.2 run which incorporates VMT by hour, VMT by facility, and Speed VMT is fed into an adjustment spreadsheet that calculates the TxLED NOx adjustment factors for each of the diesel vehicle categories. The factors used in the adjustment correspond to the LED NOx benefit range of 4.8 to 6.2 percent (where 4.8% applies to 2002 and later, and 6.2% applies to 2001 and earlier model years) as estimated by the EPA and documented in "Texas Low Emission Diesel Fuel Benefits" (EPA Memorandum, September 27, 2001). The adjustment NOx emission rates are then pasted into a NOx database input file that will be used in a subsequent step.
- Emission rate information from Harris County for the freeway facility is pasted into a spreadsheet that calculates the VOC and NOx adjustments due to the recent federal motorcycle rule. The adjustment factors are copied into NOx and VOC database input files that will be used in a subsequent step.
- The final post-processing JCF is run. Important input files are:
  - Emission rate output from the previous post-processing step.
  - A database input file describing the hourly index.
  - An input file describing emission rate percentages by roadway facility.
  - The NOx database input file with the adjustment factors for diesel and motorcycle vehicles
  - The VOC database input file with the adjustment factors for motorcycle vehicles.

The adjustment factors are summarized for each year in Tables 1 & 2 below:

**Table 1**
**TxLED Adjustment Factors**

| Diesel Vehicle Type | 2009 | | 2019 | | 2025 | | 2035 | |
|---|---|---|---|---|---|---|---|---|
| | NOx Reduction | Adjustment Factor | NOx Reduction | Adjustment Factor | NOx Reduction | Adjustment Factor | NOx Reduction | Adjustment Factor |
| LDDV | 6.00% | 0.9400 | 5.35% | 0.9465 | 4.89% | 0.9511 | 4.80% | 0.9520 |
| LDDT12 | 6.20% | 0.9380 | 0.00% | 0.0000 | 0.00% | 0.0000 | 0.00% | 0.0000 |
| HDDV2b | 4.96% | 0.9504 | 4.87% | 0.9513 | 4.84% | 0.9516 | 4.80% | 0.9520 |
| HDDV3 | 5.12% | 0.9488 | 4.87% | 0.9513 | 4.83% | 0.9517 | 4.80% | 0.9520 |
| HDDV4 | 5.22% | 0.9478 | 4.91% | 0.9509 | 4.87% | 0.9513 | 4.80% | 0.9520 |
| HDDV5 | 5.11% | 0.9489 | 5.08% | 0.9492 | 4.96% | 0.9504 | 4.80% | 0.9520 |
| HDDV6 | 5.35% | 0.9465 | 5.02% | 0.9498 | 4.89% | 0.9511 | 4.80% | 0.9520 |
| HDDV7 | 5.43% | 0.9457 | 4.99% | 0.9501 | 4.89% | 0.9511 | 4.80% | 0.9520 |
| HDDV8a | 5.78% | 0.9422 | 5.20% | 0.9480 | 4.99% | 0.9501 | 4.80% | 0.9520 |
| HDDV8b | 5.39% | 0.9461 | 4.94% | 0.9506 | 4.84% | 0.9516 | 4.80% | 0.9520 |
| HDDBT | 5.70% | 0.9430 | 5.03% | 0.9497 | 4.93% | 0.9507 | 4.80% | 0.9520 |
| HDDBS | 5.77% | 0.9423 | 5.61% | 0.9439 | 5.34% | 0.9466 | 4.80% | 0.9520 |
| LDDT34 | 5.32% | 0.9468 | 4.90% | 0.9510 | 4.83% | 0.9517 | 4.80% | 0.9520 |

**Table 2**
**Motorcycle Adjustment Factors for NOx and VOC**

| Year | NOx Reduction | Adjustment Factor | Exhaust VOC | Adjustment Factor |
|------|---------------|-------------------|-------------|-------------------|
| **2009** | 8.91% | 0.91086 | 7.16% | 0.954334 |
| **2019** | 48.43% | 0.515672 | 47.89% | 0.699026 |
| **2025** | 55.44% | 0.445644 | 57.51% | 0.599948 |
| **2035** | 56.99% | 0.430098 | 59.71% | 0.584637 |

*Reductions are only calculated through model year 2030; therefore, the reductions used in 2035 are those calculated for model year 2030.