CONCEPT On-Road Motor Vehicle Model

Approach – Version 1.0

The CONCEPT On-Road Motor Vehicle model (MV) will combine vehicle activity data (vehicle miles traveled, or VMT, and vehicle trips) with motor vehicle emission factors derived from the EPA MOBILE6 model to generate hourly model-ready emissions estimates. While the mathematics of combining the MOBILE6 emissions factors with the activity data are relatively straightforward, running the MOBILE6 model is generally very time-consuming. The model is not optimized for generating a large matrix of emission factors for different locations, speeds, and meteorological conditions suitable for interpolating or use as a lookup table. Therefore, great care must be exercised in deriving the minimum number of MOBILE6 runs required to adequately represent the conditions of the CONCEPT model scenario.

Vehicle activity data for CONCEPT will come primarily from the Transportation Demand Model Transformation Tool (T3) which is being developed under a separate contract. Data may also be provided directly to CONCEPT in the formats described in the RPO Data Exchange Protocol (RPODEP) documentation. The data will typically be provided for generalized time periods (average day, annual average, or partial day periods) and will need to be temporally allocated to hourly values for the CONCEPT scenario period. In addition, the activity data will be spatially allocated to the model grid since the MOBILE6 emission factors will be generated by grid cell using the gridded meteorological data.

The speed data provided to CONCEPT may also need to be adjusted according to a volume-delay function. The T3 documentation describes the options for providing speed adjustments instructions to CONCEPT.

Refueling emissions will not be estimated in the CONCEPT MV model. It is assumed that all refueling emissions will be provided to CONCEPT as area or point source data.

Once the activity data have been processed, the output of the MOBILE6 model will be digested to produce the appropriate emission factors and hourly emissions will be determined. These hourly emissions will need to be speciated in a similar fashion to the existing CONCEPT Area and Point Source models.

The following steps describe the proposed approach to implementing the CONCEPT MV model, and will form the basis for coding the model in PostgreSQL:

1. Input QA – examine the VMT, Trips, Volume, Capacity, Speed, network, speed adjustment, and meteorological input and execute appropriate QA checks.

2. Eliminate Overlapping Data – where statewide networks overlap with county-level HPMS data, eliminate the HPMS data for the facility types that are provided in the statewide network. This will be done for whole counties only. Also, the HPMS VMT total will not be compared to the statewide network VMT total and no adjustments will be applied to the network data (unless already done in T3). All VMT scaling to HPMS data must be completed outside CONCEPT. The preferred statewide data will be identified where a single county/facility type has both link-level activity data and county-level activity data. The link-level data will be assumed to be part of the statewide network and the county-level data will be assumed to be part of the HPMS dataset. The latter will be dropped for that combination of county and facility type. The model run output will include the value of the VMT dropped from the HPMS data and the value included from the statewide network by county and facility type.

3. Temporal Allocation – similar in logical design to the area source temporal allocator. Select closest match activity records for each model hour and apply appropriate profile factors to calculate hourly activity. The recently developed total-volume hourly profiles will be used for determining appropriate allocation factors for the hours spanned by each activity record. For partial-hour activity records, apply a time-weighted allocation to an hourly value. For example, assume that the activity data is provided for periods from 12:00 am – 6:30 am and from 6:30 am – 11:00 am. The total-volume hourly profiles will be used to determine hourly allocation factors for the hours from 12 am to 11 am. For the 6 am – 7 am hour, the temporal allocator will apply the appropriate profile allocation factor for that hour to the activity for both periods, then blend the two periods using 50% of the allocated activity from the first period and 50% of the allocated activity from the second period. Temporal allocation will be applied to the VMT, Volume, Capacity, and Trips data.

4. Speed Adjustment – if speed adjustment is indicated in the input, calculate the hourly volume-capacity ratios and apply appropriate adjustments to the free-flow speeds for each link to estimate hourly actual speeds. Some networks may provide this data as output from their TDM or TDM post-processors, in which case they will specify no speed adjustments in the input data.

5. Spatial Allocation – the MOBILE6 model will be executed based on gridded meteorological data, so the activity data must be spatially allocated prior to determining the required MOBILE6 runs. The spatial allocation will be performed using similar logic to the area and point source spatial allocators. The link-based VMT, HPMS county-based VMT, and TAZ/county based trip data will be allocated to the model grid. The speed data will also be allocated to the model grid but will remain broken out by link id. Note that the CONCEPT input identifies a "representative county" for each actual county covered by the network. The representative county is used to define programs and fuel characteristics in MOBILE6. The spatial allocation process will retain the representative county identifier from each link, county, or TAZ so that each model grid cell has an associated representative county.

6. Apply VMT Mix Profiles – the VMT data is split out into vehicle classes as input to CONCEPT. The vehicle classes need to be converted to match the 8 MOBILE5 vehicle classes. This will be done using profiles provided as input to CONCEPT.

7. Define Required MOBILE6 Runs – MOBILE6 will be run for each combination of representative county, min/max temperature combination, calendar year, season (January/July), roadway type, and speed bin. The min/max temperature combinations will use a user-defined tolerance level so that similar temperature ranges will be considered equal. For example, if the user defines 5 ºF as the tolerance level, a 52 ºF – 74 ºF range would be considered equal to a 54 ºF – 71 ºC range. Also, since the MOBILE6 model is not sensitive to specific dates, each model day does not need to be treated differently as long as the temperature range is handled. The calendar year and season will need to be handled in separate runs for CONCEPT model periods that span years or seasons. The temperature bins that will be used to determine the representative day for each temperature range will be specified in the user input by county and by bin – i.e., the user will specify the start and end temperatures for each bin, allowing variable size bins. For each group of grid cells that fall into the same group by representative county, temperature range, year, and season, the actual roadway types present in those grid cells will be examined and only those present will be run in MOBILE6. The speeds for which the model will be run will also be defined as a user-specified tolerance with speed bins in user input (also of variable size). Finally, the MOBILE6 model will be run using a single set of 24 hourly values for temperature and humidity – the values will be taken from one selected grid cell within the group.

8. Generate MOBILE6 Input files – for the required runs as determined in step 7. The external file references and other MOBILE6 setup parameters that depend on the user environment will be part of the user input to CONCEPT. Other user parameters will be written with standard MOBILE6 default values. The user will have the opportunity to adjust these input files prior to executing MOBILE6.

9. Execute MOBILE6 – the AIR version of MOBILE6 will be used, and the revised database output format will be specified. Output files will be parsed in to the CONCEPT database. During parsing, the emission factors (given in gm/mile) will be converted using information in the MOBILE6 output to the appropriate units for the emission type (gm/vmt or gm/start). The database will contain both the raw values and the converted values for QA purposes.

10. Process the MOBILE6 Output – for each representative county, generate a matrix of emission factors by grid cell group (i.e., those with similar min/max temperatures as defined above), hour, pollutant, vehicle class, emission mode, road type, and speed bin.

11. Combine Activity Data and Emission factors – Generally speaking, for each hour of each episode day, for each link, CONCEPT will use the grid cell ID, representative county, temperature increase bin, road type, and speed to determine the correct emission factor for each vehicle class, pollutant and (non-start) emission mode.

Emissions for each vehicle class, emission type, and pollutant will be estimated as the product of the emission factor and the VMT on that link associated with the vehicle class. This applies to running exhaust, running loss, crankcase, resting loss, hotsoak, and diurnal emission types. For start emissions, the number of trips allocated to a grid cell for each hour will be combined with g/start emission factors associated with that grid cell and hour. Start emissions are only calculated for light-duty vehicles.

12. Speciate the emissions – using similar logic to the area source speciation module, apply the appropriate speciation profiles by pollutant and emission type to generate the speciated emissions. The speciated emissions will be summed by pollutant, and the emission type detail will be dropped in the final output table (although they will be available in the intermediate tables for QA purposes).