

Day 5 Agenda (Advanced Course - Day 3)

- Review of Commands
- Regional Modeling
- Site Specific Modeling
- Discussion Topics
- Transportation Control Measures

REVIEW OF COMMANDS LIKELY TO BE USED TO CONFIGURE MOBILE6 TO LOCAL CONDITIONS

Review of Commands

External Condition

Calendar Year of Evaluation

- Identifies the calendar year for which emission factors are to be calculated
- There is no MOBILE6 default
- Users must supply this information
- MOBILE6 can model emission factors for any year between 1952 and 2051
- Requires entry of command name and four-digit (e.g., 2025) in the data portion of the record

Review of Commands

External Condition

Month of Evaluation

- Provides the option of calculating emission factors for either January 1 or July 1 of selected calendar year
- The default is January
- Has two effects on emission factors:
 - changing the composition of the fleet
 - selection of winter or summer RFG rules
- Requires entry of command name and a single digit to select a month
 - 7 selects July
 - 1 selects January
 - omitting this command also selects January

Review of Commands

External Condition

Daily Temperature Range

- Sets the minimum and maximum daily temperature to be evaluated
- Required unless the Hourly Temperature command is selected
- MOBILE6 uses the min/max values to perform:
 - temperature corrections to exhaust HC, CO & NO_x
 - diurnal, hot soak, running loss and resting loss portions of evaporative HC
 - temperature of dispensed fuel to calculate refueling emissions
- MOBILE6 will not correct for effects of RVP at temperatures below 45°F
- Requires entry of command name, followed by min and max values in degrees Fahrenheit

Review of Commands External Condition

Ambient Temperatures for Each Hour of the Day

- Directs MOBILE6 to use the 24 values entered by the user to calculate minimum and maximum daily temperatures
- Also directs MOBILE6 to perform hour-specific emission factor calculations with input values instead of values derived from a default temperature pattern
- Requires entry of command name followed by 24 hourly temperatures, starting with the 6 AM value

Review of Commands

External Condition

Altitude

- Determines whether emissions are calculated for a low or high altitude region
- The default is low altitude
- Low altitude emission factors are based on conditions at roughly 500 feet above sea level
- High altitude emission factors are based on conditions at roughly 5,500 feet above sea level
- Requires entry of command name and a single digit to select altitude
 - 2 selects High
 - 1 selects Low
 - omitting this command also selects Low
- Same definition employed in MOBILE5
- List of high altitude counties in CFR

Review of Commands

External Condition

Absolute Humidity

- Average daily humidity affects NOx emissions
- It is also used to calculate a heat index, which in turn affects HC, CO and NOx emissions for vehicles equipped with air conditioning
- The default value is 75 grains per pound absolute or specific humidity
- Requires entry of the command and a value that represents absolute humidity in grains of water per pound of dry air
- The value must be between 20.0 and 528.0
- MOBILE6 does not check the combination of absolute humidity and temperature range to ensure that calculated relative humidity $\leq 100\%$
- Much more important than in MOBILE5
- Local data can be obtained from NCDC
(<http://www.ncdc.noaa.gov>)

Review of Commands

Environmental Effects on Air Conditioning

Cloud Cover

- Specifies the average percent cloud cover for the day of interest
- Cloud Cover is only used to compute an air conditioning correction factor
- The default value is zero percent
- Requires entry of the command and a value that represents average fraction of cloud coverage
- The value must be between 0.0 and 1.0

Review of Commands

Environmental Effects on Air Conditioning

Peak Sun

- Specifies the midday hours when the sun is at peak intensity
- The default value is 10 AM for the start of peak sun and 4 PM for the end of peak sun
- The default time span is based conditions that occur during early summer
- Peak Sun is only used to compute an air conditioning correction factor
- Requires entry of the command and two integers representing beginning and end hours
- In considering changes to the default values, users should check direct solar radiation data posted at NOAA's Surface Radiation (SURFRAD) monitoring system
(<http://www.srrb.noaa.gov/surfrad/surfpge.htm>)

Review of Commands

Environmental Effects on Air Conditioning

Sunrise/Sunset

- Specifies the time of sunrise and sunset
- The default value is 6 AM for sunrise and 9 PM for sunset
- Sunrise/Sunset is only used to compute an air conditioning correction factor
- Requires entry of the command and two integers representing beginning and end hours
 - the first value must be between 5 and 9 AM
 - the second value must be between 5 and 9 PM

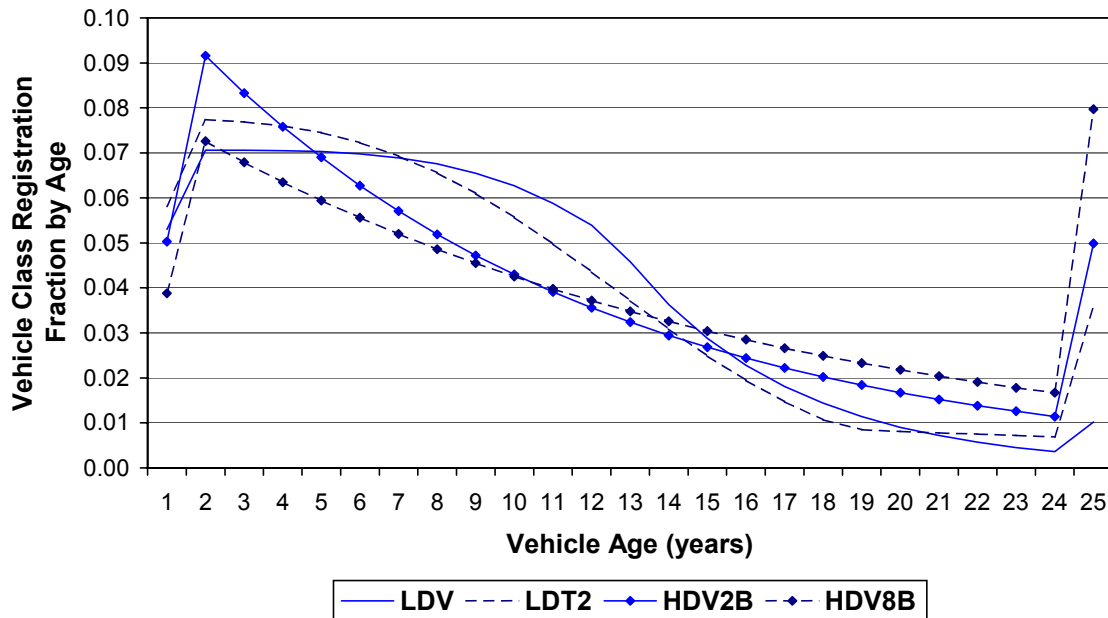
Review of Commands

Vehicle Fleet Characteristics

Distribution of Vehicle Registrations

- Specifies the registration distribution for each of the 16 composite (combined gas and Diesel) types
- Requires fraction of each vehicle type (i.e., they must sum to 1.0) for 25 vehicle ages
- The default values are based on the U.S. vehicle fleet as of July 1, 1996

Default Vehicle Registration Distributions for Selected Vehicle Classes



Review of Commands Vehicle Fleet Characteristics

Distribution of Vehicle Registrations (cont.)

- This command requires an external data file
- See Day 2 for details on conversion from MOBILE5 to MOBILE6
- VIN decoders can help with light-duty truck identification
- New heavy-duty vehicle classes are more difficult

Review of Commands

Vehicle Fleet Characteristics

Diesel Fractions

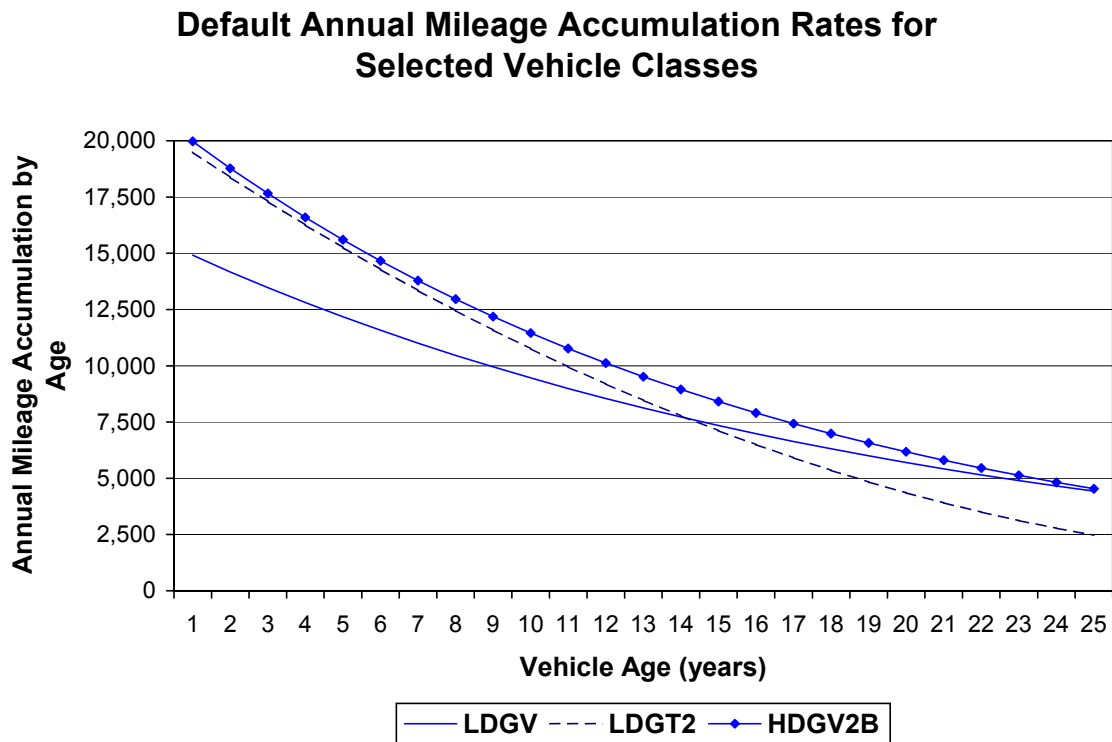
- Specifies Diesel fractions for 14 of the 16 composite (combined gas and Diesel) vehicle categories by vehicle age
- Requires fraction of each vehicle category (i.e., they must sum to 1.0) for 25 vehicle ages
- The default values are based on the U.S. vehicle fleet as of July 1, 1996
- Requires entry of the command followed by 350 decimal values representing the 25 Diesel fractions for each of the 14 vehicle categories
- These values need to be input as part of the command input file **not** as an external data file

Review of Commands

Vehicle Fleet Characteristics

Annual Mileage Accumulation Rates

- Specifies the annual mileage accumulated by vehicles of a given age and vehicle category
- The default values are based on an analysis of 1995 NPTS data



Review of Commands Vehicle Fleet Characteristics

Annual Mileage Accumulation Rates (cont.)

- MOBILE6 will apply default values for any vehicle type that the user does not specify
- This command requires an external data file
- Requires entry of mileage accumulations for each of 25 ages, starting with the youngest
- Values are input as miles divided by 100,000 (e.g., 12,000 miles is input as 0.12000)

Review of Commands

Vehicle Fleet Characteristics

Natural Gas Vehicles (NGVs) Fraction

- Specifies the percent of vehicles in the fleet certified to operate on, **not retrofitted for**, either compressed or liquified natural gas
- Identifies the percent of NGVs in each of the 28 individual vehicle classes beginning with the 1994 model year
- Use of NGV Fraction affects both exhaust and evaporative emission rates
- The default value is zero
- This command requires an external data file
- NGV Fraction requires data for each vehicle type and model year from 1994 through 2050
 - 57 years of data are required for each of the 28 vehicle categories
- Values can range between 0.0000 to 100.0000

Review of Commands Vehicle Fleet Characteristics

Alternate Emission Factors for Natural Gas Vehicles (NGVs)

- Specifies alternate NGV emission factors for each of the 28 vehicle types, for HC, CO and NO_x for running and start emissions
- Default NGV's have
 - zero evaporative emissions
 - higher emission factors for 2004+ MYs
- This command can only be entered if the NGV Fraction command has been used
- User is **not** required to enter a value for all 28 vehicle types
- User is **not** allowed to specify emission factors for separate model years (i.e., each class has the same EF for 94+ MYs)

Review of Commands Activity

VMT Fractions

- VMT fractions (or mix) refers to the distribution of travel by vehicle class input to the model
- In MOBILE6, the VMT fractions are specified for 16 “composite” vehicle classes:

LDV	LDT1	LDT2	LDT3	LDT4	HDV2b	HDV3	HDV4
HDV5	HDV6	HDV7	HDV8a	HDV8b	HDBS	HDBC	MC

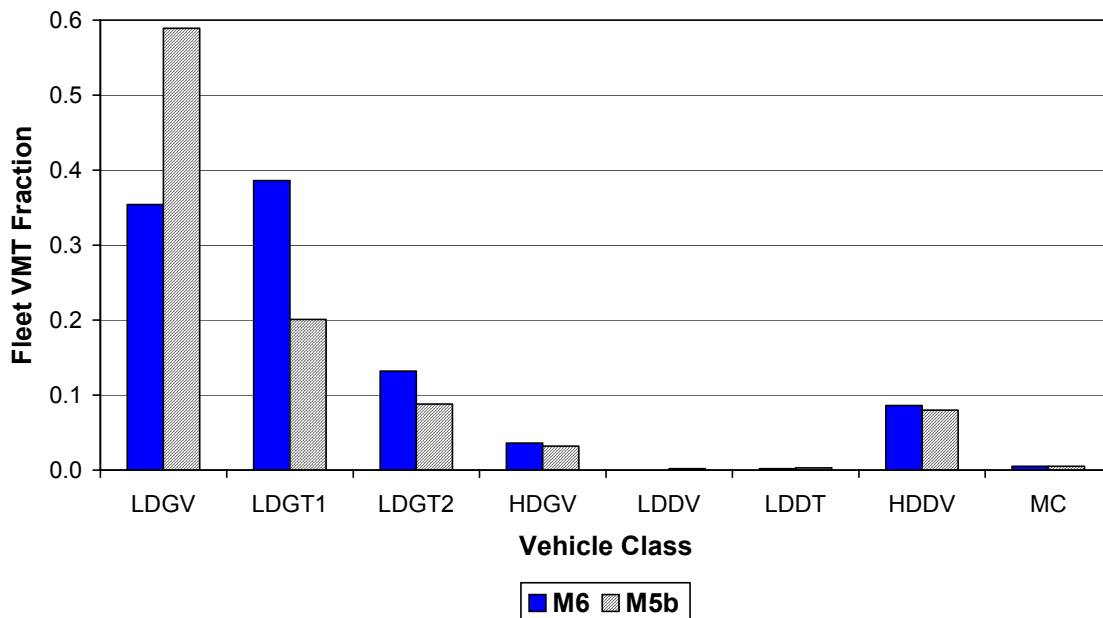
- By default, MOBILE6 dynamically computes the fleet VMT mix from:
 - calendar year being evaluated
 - default population data by vehicle class
 - default or user-input registration by age data
 - default or user-input Diesel fractions
 - default or user-input mileage accumulate data
- The optional VMT FRACTIONS input can be used to override the VMT mix computed internally by the model

Review of Commands Activity

VMT Fractions (cont.)

- As discussed during Day 2, MOBILE6 VMT mix defaults exhibit lower passenger car and higher light-truck fractions than MOBILE5
- This shift is due to recent sales growth of SUVs and minivans that was not seen in 1990-based MOBILE5 registration distribution defaults

**Comparison of Default VMT Mixes
MOBILE6 vs. MOBILE5b, Calendar Year 2010**



Review of Commands Activity

VMT Fractions (cont.)

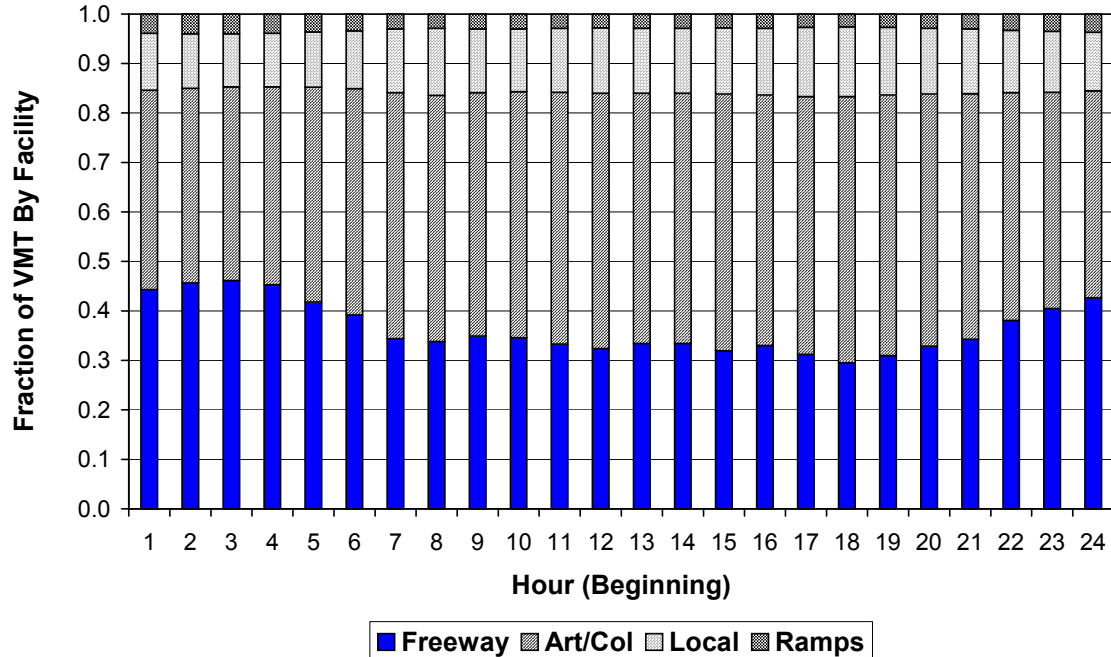
- When converting MOBILE5 inputs based on local data, the user can **not** apply MOBILE5 VMT mix weights directly in MOBILE6
- Instead use one of the following:
 - MOBILE6 defaults
 - convert your MOBILE5 fractions using the M6_Utility.xls spreadsheet
 - re-process local DMV data, making sure SUVs and minivans are properly classified as light-trucks

Review of Commands Activity

VMT By Facility

- Allows users to allocate VMT to various roadway or facility types by vehicle class and hour of the day
- VMT fractions must sum to one across the facility types: freeway, arterial/collector, local, ramps

Default VMT By Facility Type Distribution



Review of Commands Activity

VMT By Facility (cont.)

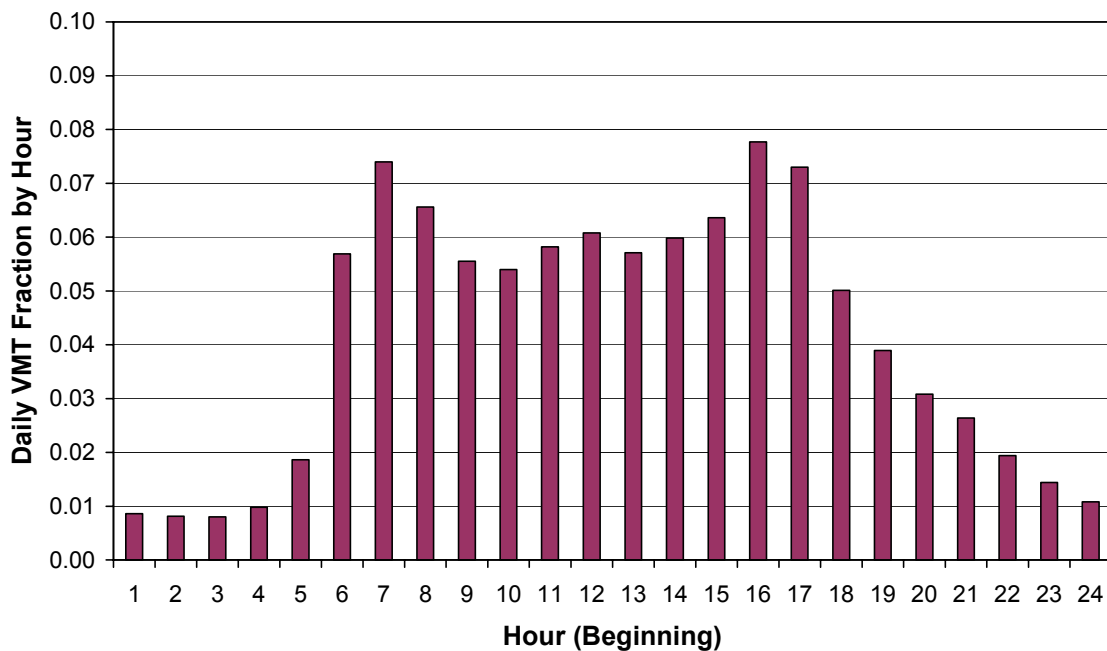
- Distributions must be entered for each combination of 28 “complete” vehicle classes and 24 hours
- The inputs are indexed first by hour (starting at 6 AM) and then by vehicle class
- Current MOBILE6 defaults use the same distributions for each vehicle class
- States and MPOs should seriously consider overriding these defaults with local data

Review of Commands Activity

VMT By Hour

- Can be used to optionally allocate VMT fractions by hour of day
- Enables the user to allocate total VMT among the 24 hours of the day
- The values in this command are independent of facility type, i.e., they apply to **all** facility types

Default VMT By Hour Distribution



Review of Commands Activity

VMT By Hour (cont.)

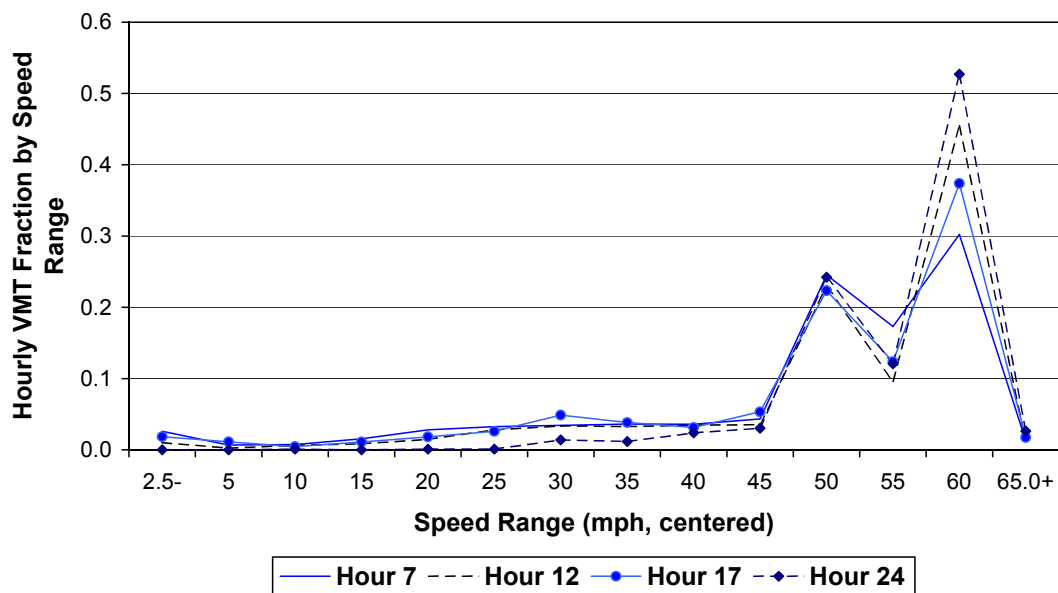
- The 24 hourly values must sum to one
- The data in this command are independent of VMT BY FACILITY command data
- The default distribution exhibits the typical weekday bi-modal AM and PM peaks that reflect commute travel activity
- Inputs are indexed so that entry # 1= 6 AM

Review of Commands Activity

Speed VMT

- Enables users to allocate VMT by speed range
- These allocations can be defined separately for both freeways and arterial/collector roads, by hour
- Default distributions were based on 1995 HPMS data from Chicago, Houston, Charlotte and New York (see Technical Report M6.SPD.003)

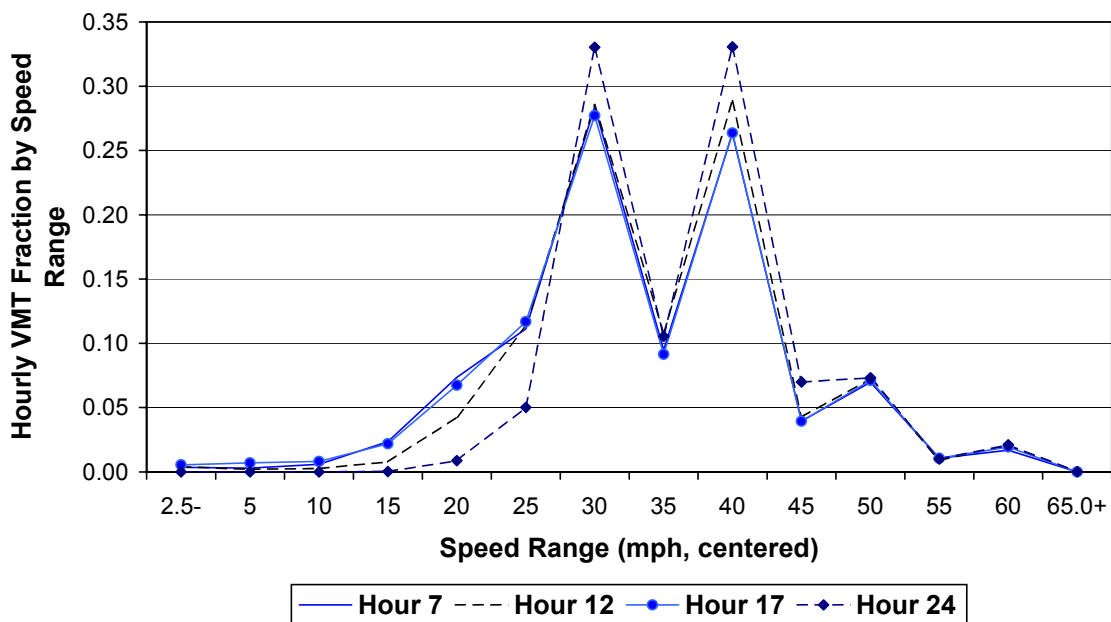
**Default VMT by Speed Range (Speed VMT) Distributions
Freeways**



Review of Commands Activity

Speed VMT (cont.)

Default VMT by Speed Range (Speed VMT) Distributions
Arterials/Collectors



- SPEED VMT distributions must sum to one across 14 pre-defined speed ranges (from 0 to 65+ mph in 5 mph increments)
- The data inputs are indexed first by hour (starting at 6 AM) and then by facility type

Review of Commands Activity

Average Speed

- Directs the model to use a single average speed for a specified facility type or group for the entire day
- Inputs can be specified for four different “roadway scenarios”:
 - Non-Ramp (freeways, excluding ramps)
 - Freeway (freeways, including ramps)
 - Arterial (arterials and collectors)
 - Areawide (all facility types combined)
- If the Areawide scenario is used, the VMT is weighted across facility types using either:
 - model defaults (34.2% freeway, 49.8% arterial/collector, 13.0% local, 3.0% ramp)
 - VMT BY FACILITY command inputs, or
 - weights specified with the AVERAGE SPEED command

Review of Commands Activity

Average Speed (cont.)

- If the Freeway scenario is used, the model assumes a default freeway/ramp VMT split of 92%/8% that can be similarly overridden using weights specified in the AVERAGE SPEED command
- Input in this command supercedes data specified in either the SPEED VMT or VMT BY FACILITY commands

Review of Commands Activity

Starts Per Day

- This command allows users to override default values of the number of engine starts (trips) per day
- STARTS PER DAY inputs can be specified by vehicle age (0-24), vehicle class (using the 28 “complete” classes) and separately for weekdays and weekends
- Model assumes that starts and running emissions are combined for heavy-duty Diesel vehicles and Diesel buses, STARTS PER DAY inputs are not required for these vehicle classes (16-23, 26-27)
- Default values are based on instrumented vehicle studies in Baltimore and Spokane
- The model defaults assume the same number of starts per day across all ages within a vehicle class
- For light-duty vehicle classes, default starts per day vary from weekdays to weekends

Review of Commands Activity

Starts Per Day (cont.)

MOBILE6 Default Starts Per Day		
Vehicle Class	Weekdays	Weekends
LDGV, LDDV	7.28	5.41
LDGT1-4, LDDT12, LDDT34	8.06	5.68
HDGV2B-8B, HDGB	6.88	6.88
MC	1.35	1.35

- STARTS PER DAY input must be carefully identified and ordered:
 - 1st item = vehicle class number (1-28)
 - 2nd item = day type (1-weekday, 2-weekend)
 - 3rd item = 25 starts/day values by vehicle age

STARTS PER DAY

```

1  1  10.3  9.8  9.3  8.9  8.4  8.0  7.6  7.2  6.9  6.5
      6.2  5.9  5.6  5.3  5.1  4.8  4.6  4.4  4.2  3.9
      3.8  3.6  3.4  3.2  3.1
1  2  10.3  9.8  9.3  8.9  8.4  8.0  7.6  7.2  6.9  6.5
      6.2  5.9  5.6  5.3  5.1  4.8  4.6  4.4  4.2  3.9
      3.8  3.6  3.4  3.2  3.1
  
```

Review of Commands Activity

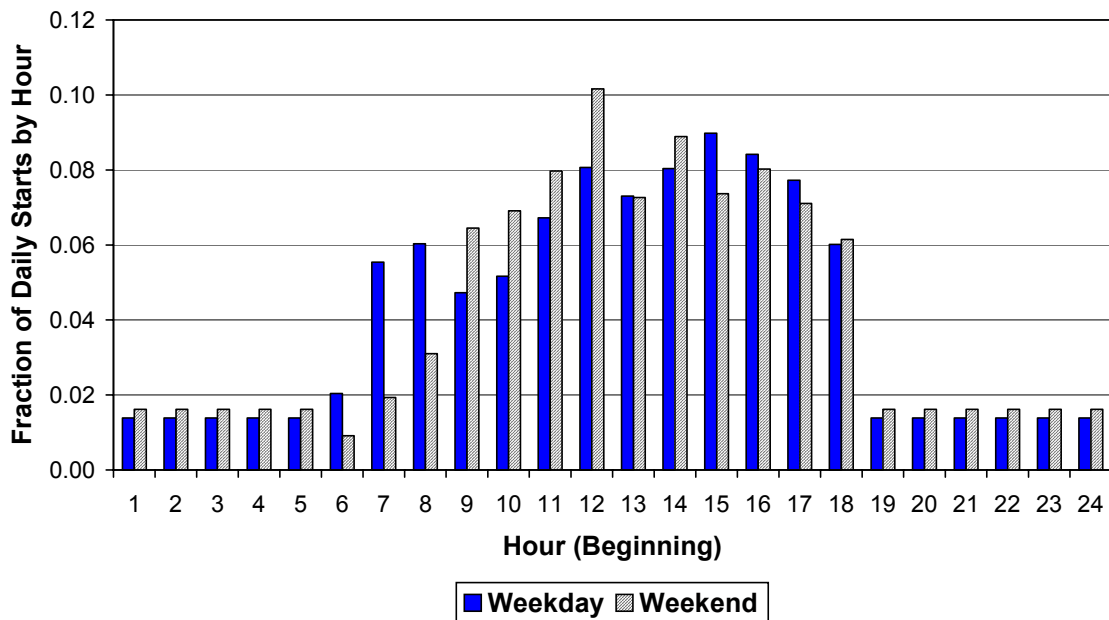
Start Distribution

- Allows users to allocate starts by hour of the day
- Separate hourly distributions can be entered for both weekdays and weekends
- Input hourly start fractions are entered eight per line starting at 6 AM, first for weekdays then weekends
- Default values in MOBILE6 were based on Baltimore/Spokane instrumented vehicle studies

Review of Commands Activity

Start Distribution (cont.)

Default Distributions of Vehicle Starts During the Day
Weekday vs. Weekend



Review of Commands Activity

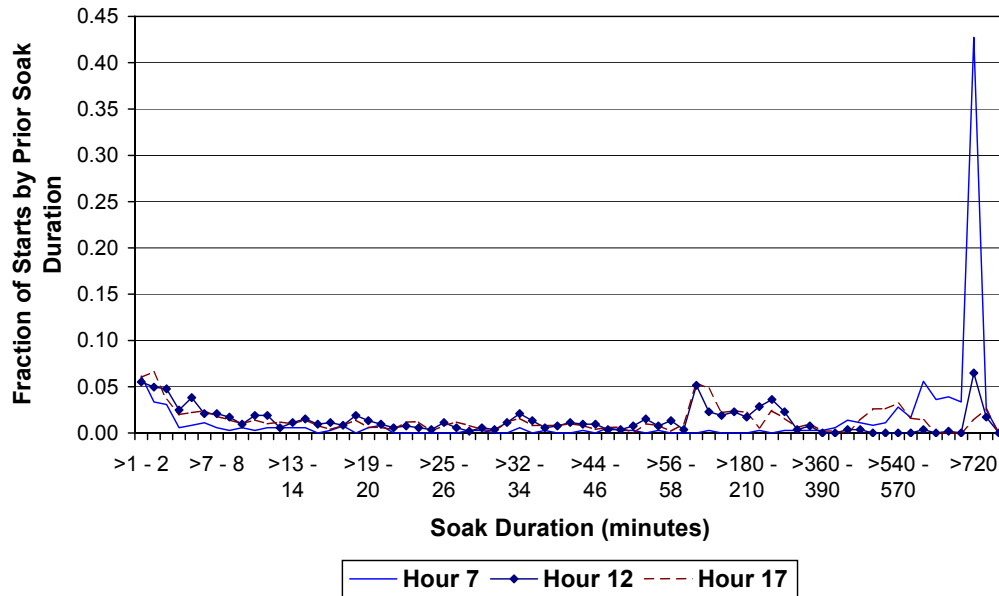
Soak Distribution

- Enables users override default soak duration distributions
- Soak duration is the time between when a vehicle's engine is turned off and the next time it is started
- Distributions are specified separately by hour of day and type of day (weekday/weekend)
- A total of 70 time intervals are used to define the soak distributions, ranging from less than 1 minute to over 720 minutes
- MOBILE6 soak distribution defaults were based on the Baltimore/Spokane instrumented vehicle studies (see Technical Report M6.FLT.003)
- These defaults **do not** reflect FTP conditions
- Soak duration distributions reflect the thermal or “warmed-up” state of the vehicle fleet and affect running and starting exhaust emissions

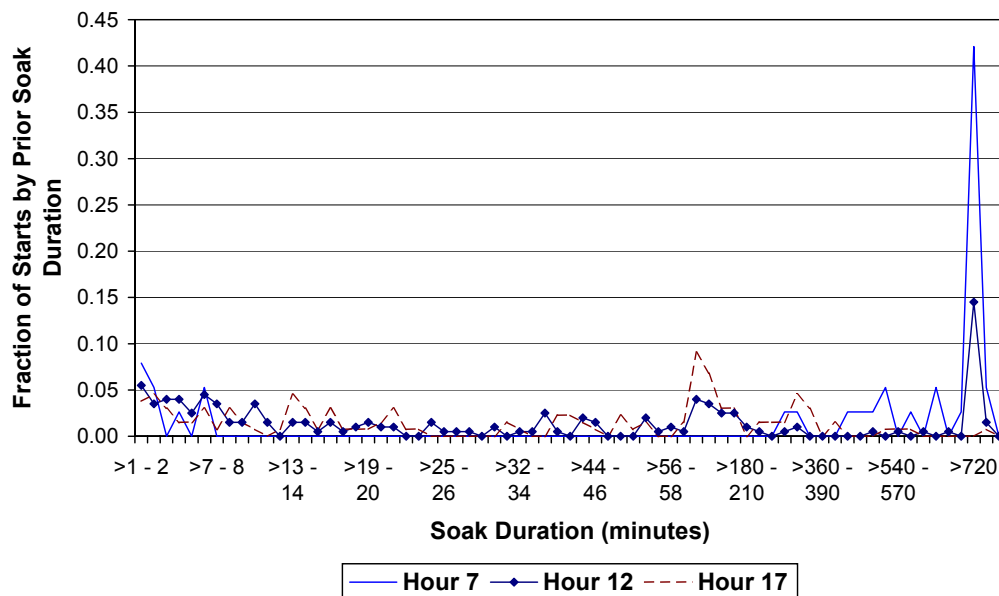
Review of Commands Activity

Soak Distribution (cont.)

Default Weekday Soak Distributions



Default Weekend Soak Distributions



Review of Commands Activity

Soak Distribution (cont.)

- These soak distribution inputs replace the FTP-based operating mode fraction inputs in MOBILE5
- The default soak distributions are well-suited to regional analysis
- For hot-spot or link-specific emission factors, the default soak distributions may not reflect the thermal state on specific facilities
- Example: operation on freeways is always nearly fully warmed-up, irrespective of time of day
- The user must understand vehicle warm-up effects to know how to use this input to model localized emission factors
- Local soak distribution data sources:
 - Region-wide: instrumented vehicle or trip survey data
 - Localized: engineering judgement

Review of Commands Activity

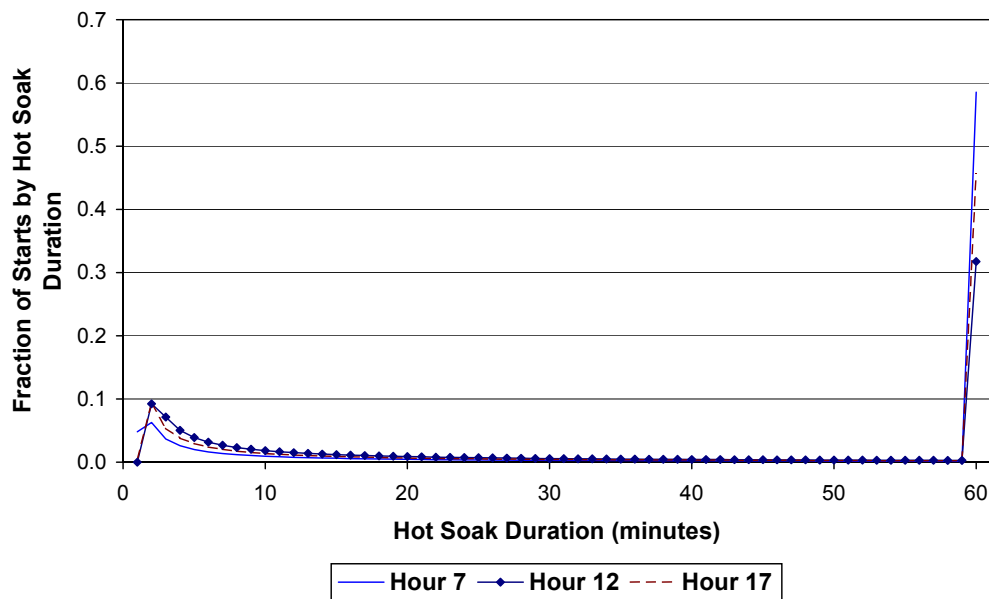
Hot Soak Activity

- Used to specify hot soak duration distributions by hour of the day and day type (weekday or weekend)
- This input is used to model hot soak evaporative emission factors and is independent of the SOAK DISTRIBUTION command input
- Hot soak emissions occur when fuel vapors escape from a hot engine after it has been turned off
- Hot soak emission rates are highest immediately after shut off and decrease to a “baseline” level in roughly one hour
- Input distributions reflect the fraction of vehicles experiencing a hot soak of a given duration between 1 minute and 60 minutes
- Default distributions were based on instrumented vehicle data from Baltimore and Spokane (see Technical Report M6.FLT.004)

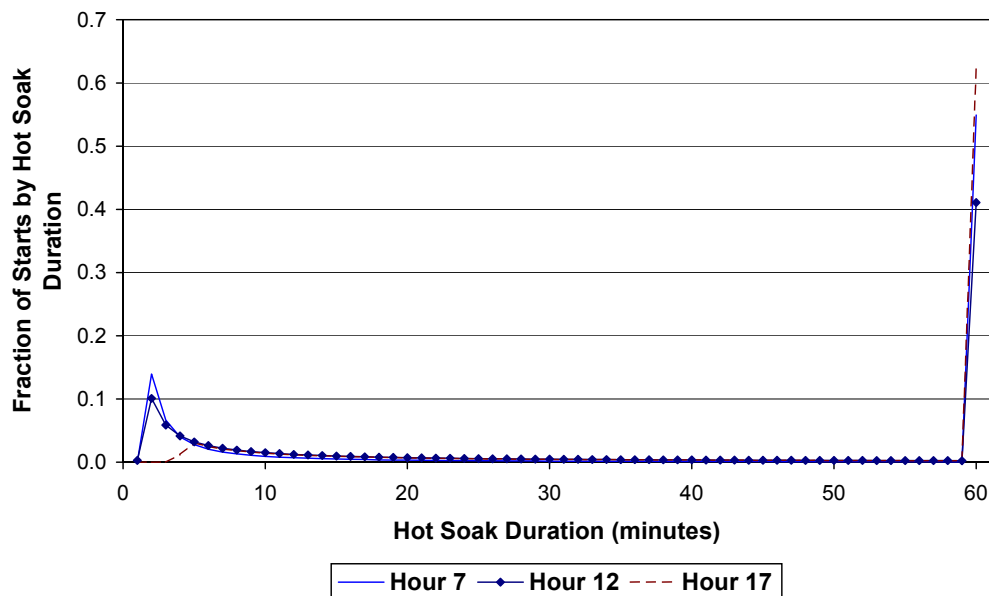
Review of Commands Activity

Hot Soak Activity (cont.)

Default Weekday Hot Soak Activity Distributions



Default Weekend Hot Soak Activity Distributions



Review of Commands Activity

Hot Soak Activity (cont.)

- Distributions must be specified for 14 time periods: one for each hour between 6 AM and 7 PM, plus one for combined hours between 7 PM and 5 AM (the next day)
- There is partial overlap in HOT SOAK ACTIVITY and SOAK DISTRIBUTION inputs - both distributions contain “engine off” durations for intervals up to 60 minutes
- Despite this ambiguity, MOBILE6 uses these input distributions independent of each other
- If the user supplies data for either or both of these optional inputs, the overlapping engine off durations between zero and 60 minutes should be checked to ensure inherent consistency

Review of Commands Activity

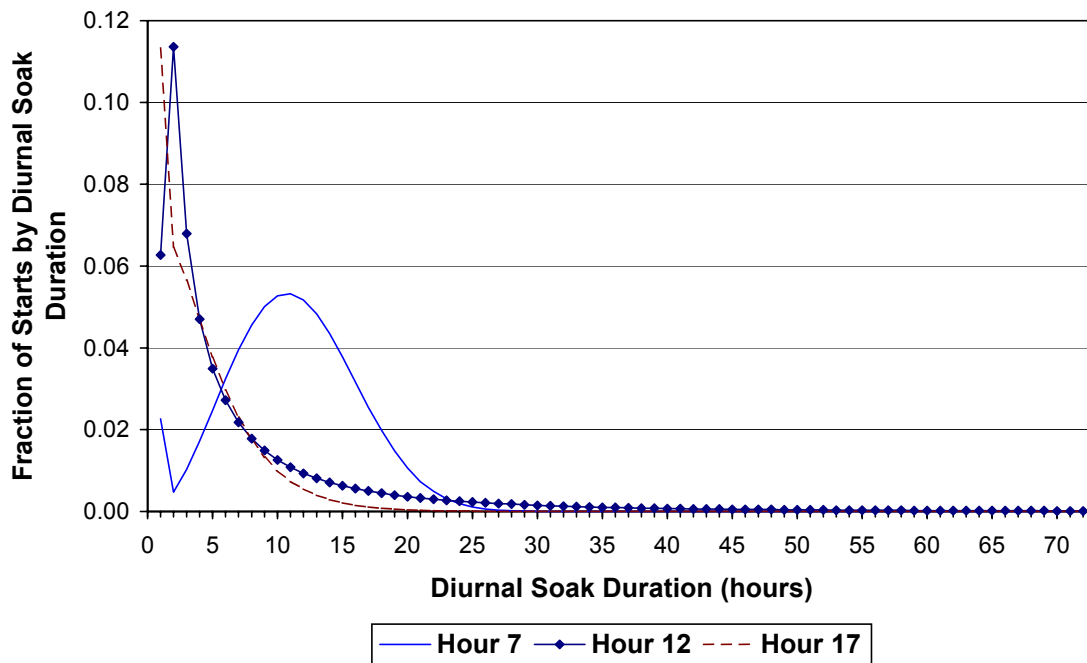
Diurnal Soak Activity

- Allows the user to specify a soak time distribution for diurnal evaporative emissions
- Diurnal emissions are gasoline vapors emitted as a result of fuel volatilization as the gas tank heats up during the course of the day
- Distributions are entered for 18 daily time periods: one for each hour between 6 AM and 12 midnight
- Diurnal breathing emissions are zeroed by MOBILE6 between 12 midnight and 6 AM (coinciding with falling ambient temperatures)
- Diurnal soak distributions are **not** day-specific (i.e., weekday vs. weekend)
- MOBILE6 default diurnal soak distributions are based on Baltimore/Spokane instrumented vehicle data (see Technical Report M6.FLT.006)

Review of Commands Activity

Diurnal Soak Activity (cont.)

Default Diurnal Soak Activity Distributions



- Diurnal soak activity distributions are also treated independently of hot soak activity and soak distribution inputs
- There is overlap between soak and diurnal soak activity distributions
- Users must again be careful to ensure consistency if supplying their own distributions

Review of Commands Activity

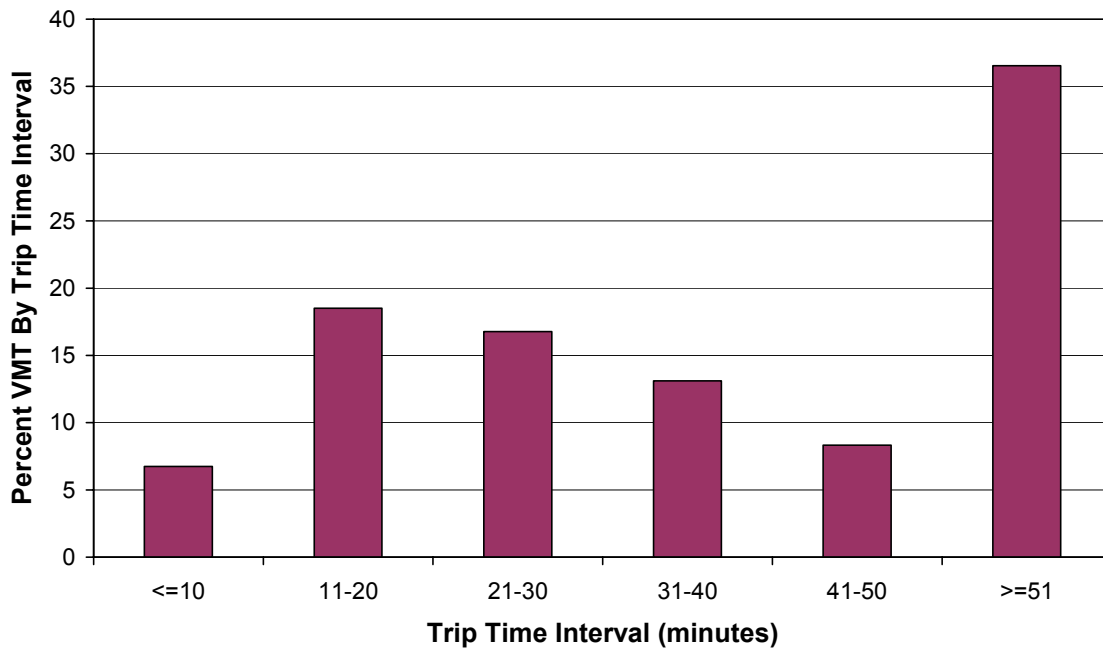
Trip Length

- Can be used to specify VMT fractions by trip time duration intervals
- These distributions are used by MOBILE6 to compute running loss evaporative emissions, which are dependent on trip time
- Distributions are specified over six trip time intervals ranging from less than 10 minutes to over 50 minutes in 10 minute increments
- Separate trip length distributions can be supplied by time of day (14 hourly groups) and day type (weekday/weekend)
- Default values are based on instrumented vehicle data from Baltimore and Spokane (see Technical Report M6.FLT.005)

Review of Commands Activity

Trip Length (cont.)

Default Trip Length Distributions



- MOBILE6 default trip length distributions are identical by time of day and day type

Review of Commands Activity

Use Weekend Vehicle Activity

- Applies weekend activity information to emission calculations that rely on usage rates
- Default applies weekday activity data
- Only requires entry of the command to run
- No data input is required, simply select either default or user supplied weekend distributions for:
 - starts per day
 - hot soak duration
 - trip length

Review of Commands State Programs

Effects of Stage II on Refueling Emissions

- Quantifies the impact of Stage II vapor recovery systems on gasoline refueling emissions
- Reduces HC emissions by reducing the amount of gasoline vapor that escapes to the atmosphere during refueling
- Reductions depend on whether a vehicle is equipped with an onboard vapor recovery system
- The default does **not** calculate the effects of a Stage II program
- Requires entry of the command followed by:
 - last two-digits of the CY that Stage II began
 - a one-digit integer for the # of phase-in years
 - a three-digit integer for the % efficiency on LDGVs and LDGTs (range 0 through 100)
 - three-digit integer for % efficiency on HDGVs
- See Day 2 for details

Review of Commands

State Programs

Anti-Tampering Program

- Quantifies the impact of an anti-tampering program (ATP)
- ATPs reduce the frequency of emission control system tampering (e.g., removal, disablement, etc.)
- Benefits only apply to pre-1996 MY vehicles
- MOBILE6 assumes that any I/M program reduces tampering and adjusts tampering rates even if the ATP command is not specified
- Command format has changed from that used in MOBILE5, see Day 2 for details

Review of Commands State Programs

Inspection/Maintenance (I/M) Programs

- MOBILE6 has the capability of modeling the impact of up to seven different I/M programs
- Default assumes that no I/M program is in place
- A total of 12 separate commands can be used to specify I/M program features
- Command format has changed from that used in MOBILE5, see Days 2 & 4 for details

Review of Commands

Fuels

Fuel Program

- Allows user to specify the gasoline fuel program (conventional vs. reformulated gasoline)
- Entry of the command allows four options:
 - Conventional Gasoline East (“1”)
 - default setting
 - post-1999 sulfur levels for most of the country
 - Conventional Gasoline West (“3”)
 - post-1999 sulfur levels in five western states
 - Reformulated Gasoline (“2N” or “2S”)
 - effects of RFG program (1995+)
 - user must specify north or south region
 - overrides RVP
 - User-supplied gasoline sulfur levels
 - specifies post-1999 average and maximum sulfur levels

Review of Commands

Fuels

Sulfur Content of Gasoline

- Specifies the sulfur content of gasoline for calendar years through 1999 (**not** after 1999)
- To enter values for years after 1999, the Fuel Program command must be used
- Will accept sulfur contents ranging between 30.0 and 600.0 ppm
- Default assumes 300 ppm
- Requires entry of the command followed by a single value for the sulfur content in ppm
- The input value applies to all calendar years through 1999
- The best data sources for developing local inputs are fuel surveys conducted by NIPER and AAM
(<http://www.osti.gov/techtran/niper.html>)
(<http://www.autoalliance.org>)

Review of Commands

Fuels

Oxygenated Fuels Programs

- Evaluates benefits of oxygenated fuels on exhaust emissions for gasoline powered vehicles
- Default assumes no oxygenated fuels benefits only if Oxygenated Fuels and Fuels Program commands are **not** specified
- Requires entry of the command followed by values for:
 - ether blend market share
 - alcohol blend market share
 - average oxygen content of ether blend fuels
 - average oxygen content of alcohol blend fuels
 - whether an RVP waiver has been granted
- See Day 2 for format information
- The oxygenated fuels parameters of RFG take precedence over those in the Oxygenated Fuels command
- Substantial change in CO benefits from MOBILE5

Review of Commands Fuels

Fuel Reid Vapor Pressure (RVP)

- RVP is a measure of gasoline volatility that affects exhaust and more significantly evaporative emissions
- There is no MOBILE6 default
- Users must supply this information
- Requires entry of the command followed by the fuel RVP (in psi)
- MOBILE6 will not correct for effects of RVP at temperatures below 45°F
- The RVP effects are the same for all values greater than 11.7 psi
- Oxygenation Fuels and Fuel Program commands may affect Fuel RVP input values

Review of Commands Fuels

Effective Season for RFG Calculation

- Identifies the effective season (summer or winter) for the RFG calculation regardless of the month being modeled
- Assumes winter when January is selected as evaluation month and summer when July is selected as the evaluation month
- The season command overrides the effect of the Evaluation Month command
- This command only affects RFG related emissions
- Requires entry of the command followed by
 - 1 for summer or
 - 2 for winter
- Interpolation is required for an intermediate month

Review of Commands

Alternative Emission Regulations and Control Measures

Disablement of the 1990 Clean Air Act Requirements

- Allows users to evaluate vehicle emissions as if the 1990 Clean Air Act (CAA) Amendments were **not** implemented
- Default assumes that 1990 CAA Amendments were implemented
- Use of this command disables the following:
 - Federal exhaust standards after Tier 0
 - benefits of Enhanced Evap Test procedure
 - benefits of Supplemental FTP
 - OBD benefits
 - fuel sulfur reductions below 300 ppm
 - detergent gasoline benefits
 - reductions in post 1995 tampering rates
 - cold temperature CO reductions beyond 1993
- Only requires entry of the command to run

Review of Commands

Alternative Emission Regulations and Control Measures

Heavy-Duty Diesel Vehicle NO_x Off-Cycle Emission Effects

- Includes a series of optional commands that **turn off** the benefits of programs designed to eliminate HDDV off-cycle NO_x emissions:
 - No Defeat Device
 - No NO_x Pull Ahead
 - No Rebuild
 - Rebuild Effects (user can change program effectiveness rate)
- Only requires entry of the command to run the first three, Rebuild Effectiveness must be followed by the decimal rate (e.g., 0.50 for 50%)
- These commands are interrelated and should only be used with care
- Default based on national estimates of off-cycle NO_x emissions from HDDVs

Review of Commands

Alternative Emission Regulations and Control Measures

Tier 2 Emission Standards and Fuel Requirements

- Includes a series of optional commands that **turn off** benefits of the Tier 2 standard or modify its implementation:
 - No Tier 2
 - T2 Exh Phase-in
 - T2 Evap Phase-in
 - T2 Cert
- Default assumes Tier 2 implementation
- Allows the user to evaluate alternate phase-in fractions for exhaust and evaporative emission standards
- Can be used to model California's LEV II requirements
- See Users Guide to MOBILE6 for instructions on command structure and Day 4 discussion

Review of Commands Alternative Emission Regulations and Control Measures

Alternative Schedule for 1994 and Later Model Year Light Duty Gasoline Vehicle Standards

- Allows users to input alternate fleet penetration fractions for 1994 and later light-duty gasoline vehicles under Tier 1, NLEV, California LEV, and Tier 2 standards
- Fleet penetration fractions are required for eleven certification standard categories:
 - Tier 0
 - Intermediate Tier 1
 - Tier 1
 - Tier 2
 - Intermediate TLEV
 - TLEV
 - Intermediate LEV I
 - LEV I
 - Intermediate ULEV I
 - ULEV I
 - ZEV
- This command requires an external data file; see Day 4 discussion

Review of Commands Alternative Emission Regulations and Control Measures

2007 Heavy Duty Vehicle Emissions Reductions

- Allows the user to override default settings for 2007 HDDV emission standards
- These standards and associated lower sulfur Diesel fuel will start affecting emissions in 2008
- Default assumes mandated implementation schedule for the 2007 HDDV standards
- Only requires entry of the command to run

REGIONAL AND SITE SPECIFIC MODELING

REGIONAL MODELING

Regional Modeling Background

- Focus is on the development of inventories used in photochemical modeling **not** regional average values
- Link-specific emission estimates are computed for specific time periods and require a large number of calculations
- Results are aggregated into grid cells
- Past efforts typically focused on capturing the effects of speed and temperature variations on emissions
- MOBILE6 includes many defaults derived from national datasets that may or may not well represent activity and operating conditions for a specific community
- Key is developing a framework to prioritize which defaults to replace with local data

Regional Modeling Background (cont.)

- No simple answer on how to prioritize which defaults to replace since significance depends on
 - pollutants of interest (ozone precursors or CO)
 - analysis undertaken (SIP inventory, control strategy, conformity, etc.)
 - time of year
 - difference between national defaults and local activity/conditions
 - available data and resources
- Some choices are obvious; others require experimentation

Relevance of External Condition Commands to Regional Modeling		
Command	Required?	Comment
Calendar Year	Yes	critical input
Evaluation Month	Optional	depends on pollutant(s): ozone-summer, CO-winter
Min/Max Temperature	Yes*	critical input
Hourly Temperatures	Yes*	depends on variance between defaults and local values
Altitude	Optional	critical for high altitude areas
Absolute Humidity	Optional	affects NOx and HC and CO from A/C
Environmental Effects on Air Conditioning	Optional	marginal affect on A/C emissions, not a critical input

* One of these commands must be entered

Relevance of Vehicle Fleet Commands to Regional Modeling

Command	Required?	Comment
Registration Distribution	Optional	critical input, unlikely that national defaults well represent local conditions
Diesel Fractions	Optional	given low level of light-duty Diesel sales, not a critical input unless considered as part of a new control strategy
Mileage Accumulation Rate	Optional	unclear how well national defaults from 1995 represent local conditions, may warrant investigation
NGV Fraction	Optional	not critical unless NGVs are being promoted as a control strategy
Alternate EFs for NGVs	Optional	not critical

Relevance of Activity Commands to Regional Modeling

Command	Required?	Comment
VMT Fractions	Optional	critical input, unlikely that national defaults well represent local conditions
VMT by Facility	Optional	critical input for any analysis of link specific emissions
VMT by Hour	Optional	critical input for accurate hourly analysis of emissions as national defaults are not likely to well represent local conditions
Speed VMT	Optional	not a critical input, unless used to estimate emissions for all links within a grid cell
Average Speed	Optional	critical input for all link-specific or gridded analysis
Starts per Day	Optional	uncertain how much variation in daily starts occurs from region to region, household travel surveys tend to underestimate daily starts

Relevance of Activity Commands to Regional Modeling		
Start Distribution	Optional	important input for hourly analysis of emissions since national defaults may not fully represent local conditions (e.g., peak spreading in large urban areas)
Soak Distribution	Optional	critical input for hourly emissions analysis, some variation may occur from region to region, but local data will be difficult to collect
Hot Soak Activity	Optional	not likely to be a critical input, although region to region differences are unknown
Diurnal Soak Activity	Optional	moderately important; more important in very warm climates (e.g., Phoenix, etc.)
Weekday/Weekend Trip Length Distribution	Optional	unclear how well national defaults from 1995 represent local conditions, may warrant investigation, but requires significant effort
Use Weekend Vehicle Activity	Optional	required for weekend analysis

Relevance of State Program Commands to Regional Modeling

Command	Required?	Comment
Stage II Refueling	Optional	critical input for areas with Stage II
Anti-Tampering Program	Optional	critical input for areas with ATP, see Days 2 & 4
I/M Program	Optional	critical input for areas with I/M, see Days 2 & 4

Relevance of Fuel Commands to Regional Modeling

Command	Required?	Comment
Fuel Program	Optional	critical input for ozone modeling if local conditions are not represented by default
Sulfur Content of Gasoline	Optional	critical input if local sulfur values are different from default assumptions
Oxygenated Fuels	Optional	critical input for CO modeling if an oxy fuel program is in place
Fuel RVP	Required	critical input, check NIPER and AAM fuel surveys for local values
Season	Optional	critical input for ozone modeling

**Relevance of Alternate Emission Regulations and Control Measure
Commands to Regional Modeling**

Command	Required?	Comment
No Clean Air Act	Optional	only useful for specialized analysis
HDDV NOx Off-Cycle	Optional	only useful for specialized analysis
Alt. Schedule for 94+ MY LDGV Standards	Optional	only useful for specialized analysis
No 2007 HDDV Rule	Optional	only useful for specialized analysis

Regional Modeling Considerations Speed Tips

Options for developing link-specific speed estimates for a photochemical model

- Use the “AVERAGE SPEED” command to develop a separate emission factor for each link in the network for each hour of the day
 - easy to set up input files
 - separate run for each link can be cumbersome with a large network
 - run time can be an issue
- Use the “AVERAGE SPEED” command to generate EFs for all speed bins (14 values) for all facilities by hour of the day
 - provides basis to interpolate EF’s for all speeds
 - consistent with inventory development software developed to date
 - existing software will need to be modified to handle facility-specific speed values
 - total of 720 runs needed for each calendar year
(24 hours x 2 road types x 14 bins + 24 hours x 2 road types)

Regional Modeling Considerations Speed Tips (cont.)

- Use “SPEED VMT” and “VMT BY FACILITY” to generate grid cell specific EFs by hour of the day
 - eliminates post processing of link-specific EFs
 - overrides default distributions which assume constant vehicle mix across facility types
 - inventory development software not set up to generate VMT weighted speed distributions by facility type (needed for SPEED VMT)
 - computationally intensive if there is a large number of grid cells

Regional Modeling Considerations Fleet Tips

Consider whether different fleets are operating within a region

- Separate EFs may be required for unique vehicle fleets
 - fleets based outside of the region may be subject to different I/M programs, use different fuels and have different trip lengths and vehicle distributions
 - fleets operating within a region may have different start and soak profiles (e.g., commute versus non-commute operation)
- Fleet EFs would then have to be weighted to account for their share of travel on each facility and hour of the day
 - better resolution of vehicle emissions and grid cell variations
 - increased computational effort
 - increased detail makes it more difficult to spot errors in the calculations

Regional Modeling Considerations Fleet Tips (cont.)

Develop mileage accumulation rates from I/M data

- Existing local mileage rates can be directly mapped from MOBILE5 to MOBILE6 (see Day 2)
- Areas with “mature” I/M programs can also use I/M data to update mileage rates for those vehicle classes subject to I/M
- Vehicle odometer data recorded during each I/M inspection can be used to develop annual mileage accumulation rates
- Centralized I/M programs, or those utilizing “electronic transmission” (linking to DMV during the I/M inspection) provide better data quality (minimize license/VIN errors during inspection)
- Annual mileage accumulation rates can be developed from a multi-year I/M test database
- If data span at least 2 or 3 I/M test cycles, most uncertainty from 5-digit odometer rollover or decimal errors can be flagged and corrected

Regional Modeling Considerations Fleet Input Tips (cont.)

Develop mileage accumulation rates from I/M data (cont.)

- The multi-year I/M data must be sorted chronologically by vehicle (using either license or VIN to identify each unique vehicle)
- This sorting will provide a “history” of odometer readings for every vehicle during each I/M test
- Range checks (e.g., $> 50,000$ miles/year or $< 3,000$ miles/year) can be applied to flag and correct rollover or odometer entry errors
- The duration between I/M records for a vehicle can be computed from the recorded test dates
- The vehicle age at each inspection can also be computed from the test date and model year
- Annual mileage accumulation rates can then be calculated for each vehicle, and then binned and averaged by age and vehicle class for use in MOBILE6

SITE SPECIFIC MODELING

Site Specific Modeling Considerations Background

- Multiple types of analysis
 - intersection or “hot spot”
 - corridor
 - project level
- Hot spot modeling is typically focused on CO and requires link-specific estimates for a limited number of hours (typically a single peak hour, sometimes 8, but never 24) at one or more intersections
- For cases in which toxics are considered in a hot-spot analysis, VOC emissions may also be important
- Corridor or project analysis (e.g., new HOV lane, etc.) can be multi-pollutant and examines build/no-build emission changes

Relevance of External Condition Commands to Site-Specific Modeling

Command	Required?	Comment
Calendar Year	Yes	critical input
Evaluation Month	Optional	depends on pollutant(s): ozone-summer, CO-winter
Min/Max Temperature	Yes*	critical input
Hourly Temperatures	Yes*	depends on variance between defaults and local values
Altitude	Optional	critical for high altitude areas
Absolute Humidity	Optional	affects NOx and HC and CO from A/C
Environmental Effects on Air Conditioning	Optional	marginal affect on A/C emissions, not a critical input

* One of these temperature inputs must be entered by the user.

Relevance of Vehicle Fleet Commands to Site-Specific Modeling		
Command	Required?	Comment
Registration Distribution	Optional	critical input, unlikely that national defaults well represent local conditions
Diesel Fractions	Optional	given low level of Diesel sales, not a critical input unless considered as part of a new control strategy
Mileage Accumulation Rate	Optional	unclear how well national defaults from 1995 represent local conditions, may warrant investigation
NGV Fraction	Optional	not critical unless NGVs are being promoted as a control strategy
Alternate EFs for NGVs	Optional	not critical

Relevance of Activity Commands to Site-Specific Modeling

Command	Required?	Comment
VMT Fractions	Optional	critical input for site-specific analysis, will need to be estimated using on-site count data or best judgement
VMT by Facility	Optional	critical input for site-specific analysis, will need to be allocated using on-site count data or best judgement
VMT by Hour	Optional	critical input for accurate hourly analysis of emissions as national defaults are not likely to well represent local conditions
Speed VMT	Optional	not relevant for hot spot or site-specific analysis
Average Speed	Optional	critical input hot spot and site-specific analysis, distinct values must be set for each roadway link and run separately through MOBILE6 model

Relevance of Activity Commands to Site-Specific Modeling	
Starts per Day	Optional uncertain how much variation in daily starts occurs from region to region, household travel surveys tend to underestimate daily starts
Start Distribution	Optional important input for hourly analysis of emissions since national defaults may not fully represent local conditions (e.g., peak spreading in large urban areas)
Soak Distribution	Optional critical input for site-specific analysis, <u>must</u> reflect thermal state of individual links being modeled
Hot Soak Activity	Optional not relevant for hot spot analysis (does not affect “engine on” emissions)
Diurnal Soak Activity	Optional not relevant for hot spot analysis (does not affect “engine on” emissions)

Relevance of Activity Commands to Site-Specific Modeling		
Weekday/Weekend Trip Length Distribution	Optional	not critical for site-specific analysis unless modeling HC emissions
Use Weekend Vehicle Activity	Optional	generally not relevant for site-specific analysis

Relevance of State Program Commands to Site-Specific Modeling

Command	Required?	Comment
Stage II Refueling	Optional	critical input for areas with Stage II
Anti-Tampering Program	Optional	critical input for areas with ATP, see Days 2 & 4
I/M Program	Optional	critical input for areas with I/M, see Days 2 & 4

Relevance of Fuel Commands to Site-Specific Modeling

Command	Required?	Comment
Fuel Program	Optional	critical input for ozone modeling if local conditions are not represented by default
Sulfur Content of Gasoline	Optional	critical input if local sulfur values are different from default assumptions
Oxygenated Fuels	Optional	critical input for CO modeling if an oxy fuel program is in place
Fuel RVP	Required	critical input, check NIPER and AAM fuel surveys for local values
Season	Optional	critical input for ozone modeling

**Relevance of Alternate Emission Regulations and Control Measure
Commands to Site-Specific Modeling**

Command	Required?	Comment
No Clean Air Act	Optional	only useful for specialized analysis
HDDV NOx Off-Cycle	Optional	only useful for specialized analysis
Alt. Schedule for 94+ MY LDGV Standards	Optional	only useful for specialized analysis
No 2007 HDDV Rule	Optional	only useful for specialized analysis

Site Specific Modeling Considerations External Condition and Activity Tips

- Use “HOURLY TEMPERATURE” command to specify temps for hours of interest
- Default “SOAK DISTRIBUTION” may need to be modified
 - default represents **regionwide** time between key off/key on by hour of the day
 - default does not represent thermal state for a specific intersection
 - cold start offset is not likely to apply
 - for example, operation on freeways is always nearly fully warmed-up, irrespective of time of day
 - soak distribution data sources can include instrumented vehicle or trip survey data
- Default “VMT FRACTIONS” and “VMT BY FACILITY” may need to be modified
 - based on national average mix of vehicle types
 - unlikely to represent mix of vehicles operating at a specific intersection and hour of the day

Site Specific Modeling Considerations External Condition and Activity Tips (cont.)

- Estimates of idle emissions may be needed to address intersection queuing
 - idle output flag (IDLFLG) no longer available
 - need to specify Average Speed at 2.5 mph
 - specify either Hourly output or multiply g/mi result by 2.5 mph to get idle in g/hr

Site Specific Modeling Considerations

Speed Tips

- Use “AVERAGE SPEED” command to generate EFs for links of interest
 - easy to use with limited number of links
 - produces EF for speed of interest on facility of interest

- Use “AVERAGE SPEED” command to generate EFs at each of the speed bins needed to interpolate an intermediate value (e.g., 35 and 40 mph would be needed to estimate 37.5 mph)
 - provides flexibility to interpolate EF’s for all speeds between selected bins
 - consistent with inventory development software developed to date
 - requires post processing of EFs to obtain value of interest

DISCUSSION TOPICS

Regional Discussion Topics

- Default parameters for several variables are based on data collected in Baltimore and Spokane (e.g., soak activity, trip length, etc.):
 - how relevant is this data for photochemical modeling for a nonattainment area located in the desert?
 - how much effort is required to collect local data and prepare alternate inputs representative of that community?
- Many nonattainment areas have subfleets operating within their modeling domain:
 - what type of analysis should be performed to determine whether it is appropriate to develop separate emission factors for each subfleet?
- Should the same VMT fraction be employed in base and horizon years in attainment analyses that span 10 years (e.g., 2000 to 2010)?

Regional Discussion Topics (cont.)

- EPA has historically recommended the use of local data for vehicle age distributions:
 - Since DMV registration data does not employ the same classification scheme used in MOBILE6, what approach should be used developing vehicle class specific estimates?
- A variety of analyses rely on comparisons with data collected under FTP operating conditions:
 - how can the default soak distribution contained in MOBILE6 be revised to represent FTP conditions?
- Identify the default parameters that should be changed to represent conditions in a cold temperature community for a CO attainment demonstration.

Site Specific Discussion Topics

- Which MOBILE6 default inputs are valid for hot spot analysis (e.g., addition of left turn lanes at an intersection)?
- Which MOBILE6 inputs used in regional modeling should be modified for
 - hot spot analysis?
 - corridor analysis?
- Should subfleets be considered in site specific modeling?
- Discuss how to use MOBILE6 to develop emission estimates for a new airport parking lot; how should the following parameters be addressed:
 - starts per day
 - start distribution
 - soak distribution
 - hot soak activity
 - diurnal soak activity
 - trip length

TRANSPORTATION CONTROL MEASURES

Transportation Control Measures

Example TCMs

- Freeway incident detection and response
- Telecommuting
- Alternate work schedules
- Transit service increases
- Parking management
- Flexible/staggered work hours
- Off-peak goods movement
- Park and ride lots
- Signalization improvements

Transportation Control Measures

Status of Existing Models

- TCMs produce changes in
 - trips
 - VMT
 - speed
- Variety of methods/models have been developed to estimate changes in travel activity and combine them with related emission factors to quantify impact on regional emission estimates
- Typically referred to as “off modeling” techniques, because travel impacts are not computed by regional transportation planning models
- Existing models provide flexibility to quantify
 - travel effects (elasticities, logit formulation, etc.)
 - emission effects (interpolate among preprocessed bag values at different speeds)
- No models have yet been configured to accept MOBILE6 emission factors

Transportation Control Measures Status of Existing Models (cont.)

- Methods used to quantify impacts generally
 - combine EFs and travel estimates for baseline condition
 - estimate change in trip length, and # of trips for individual TCMs
 - estimate change in network speeds
 - evaluate additivity of individual control measure benefits on travel activity changes
 - quantify change in trip length on operating mode
 - weight bag specific emission factors together with revised operating mode at new speeds
 - combine new EFs with revised VMT
 - contrast baseline and revised values

Transportation Control Measures

MOBILE6 Modeling Issues

- Operating mode has been replaced with soak time distributions
- Will need to quantify the effect of TCMs on default trip length distributions
- Key issue is how to capture effect of TCMs on small portions of a regional fleet
- Options include:
 - ignore the differences
 - create subfleets (i.e., those affected by the TCM and those unaffected by the TCM)
 - devise methods for integrating effects on overall regional distributions
- Key variables to consider revising to capture changes in subfleet EFs include:
 - speed VMT or average speed
 - starts per day
 - start distribution
 - soak distribution
 - hot soak activity
 - diurnal activity

Example 28

Quantify the emissions benefits of adding new a new Park and Ride facility on emissions in 2005.

Assume that 1,500 vehicle trips with a 10-mile commute trip (each way) will now be riding on transit buses and that they will be driving 1 mile each way to and from the Park and Ride lot.

Estimate the overall emission reductions for HC, CO and NOx.

Temperature: 72°F to 92°F

RVP: 8.7 psi

Evaluation month: July

Issues to Related to Park-and-Ride Lot Emissions Estimates

- The solution to Example 28 generally used default assumptions regarding vehicle activity
- A more rigorous analysis would also consider the following issues:
 - impact of park-and-ride on default soak time distribution (i.e., nearly all trips to and from the park-and-ride facility would be cold starts)
 - impact of park-and-ride on default diurnal activity and resulting evaporative emissions
 - the morning drive to the facility should be at lower temperature; the evening trip from the facility at higher temperature (which would also apply to the baseline commute trip emissions estimate)

Impact of Soak Time on Start Emissions

- Using the parameters outlined in Example 28, the following differences exist in LDGV start emissions using the default soak time distribution versus 100% cold starts (i.e., all starts with 12-hour soaks)

	VOC (g/mi)	CO (g/mi)	NO _x (g/mi)
Default Soak Dist.	0.222	2.90	0.150
100% Cold Start	0.477	6.21	0.223

- In terms of grams per start, the above estimates become:

	VOC (g/start)	CO (g/start)	NO _x (g/start)
Default Soak Dist	0.89	11.63	0.60
100% Cold Start	1.91	24.91	0.89

Example 29

Quantify the emissions benefits of shifting all commute trips using SUVs to LDGVs in 2005. Assume the SUVs are LDGT2s and LDGT3s.

Assume that commute trips represent 30 percent of all VMT within the region and for the sake of simplicity that they are distributed in proportion to the default VMT by Hour distribution.

Estimate the overall change in fleet average HC, CO and NOx emissions.

Temperature: 72°F to 92°F

RVP: 8.7 psi

Evaluation month: July