Draft
Link-Specific CO Analysis Using AKMOBILE6

Introduction

Vehicle emissions are required to be computed using emission factors (in grams per mile traveled) generated by EPA's latest vehicle factor model, MOBILE6. However, this model does not adequately address two very common wintertime practices in Alaska that significantly affect CO emissions:

1. extended initial idling of vehicles to warm them up prior to travel; and

2. the use of "plug-in" heaters to keep the engine warm while parked for long periods to aid in starting the vehicle during the cold winters.

To address these limitations of MOBILE6, EPA has approved a methodology that combined estimates of warm-up idling and plug-in benefits with the "traveling" emission factors in MOBILE6 for use in Alaska. The warm-up idling portion of the vehicle emissions are estimated using a "shell" program, which works in conjunction with MOBILE6, called AKMOBILE6.

This paper describes how AKMOBILE6 can be used to create runs for link-specific analysis, and provides examples of using the model. The discussion assumes that the reader is familiar with EPA's MOBILE6 model and input structure. Readers are encouraged to obtain the model user guides for both MOBILE6[*] *[hyperlink to document]* and AKMOBILE6[†] *[hyperlink to document]* to aid in following this discussion.

Link-Specific Analysis

Link-specific analysis typically involves analysis of a specific location: an intersection or "hot spot", a corridor, or an affected area for a given project. This is in contrast with regional analyses that look at travel patterns over a much larger area. "Hot spots" are fixed locations along a corridor in which emissions are notably higher than in surrounding areas, warranting a closer look. A corridor can be one or a combination of several "facility" or road types. Within EPA's MOBILE model, there are four roadway or facility types simulated:

- Freeways – high volume, main thoroughfares such as interstate freeways, highways and expressways;

[*] Find MOBILE6 User's Guide at http://www.epa.gov/otaq/models/mobile6/420r03010.pdf
[†] "User's Guide to AKMOBILE6 - Alaska Winter Vehicle CO Emission Factor Model," prepared by Sierra Research for the Alaska Department of Environmental Conservation, SR2004-01-01, January 2004.

- Arterials/Collectors – accommodates through traffic and connect to freeways, to other arterials/collectors, and to local streets;
- Local Streets – are typically not through streets and provide access to properties or homes adjacent to arterials/collectors; and
- Freeway Ramps – includes on- and off- ramps for freeways.

When considering a project level link analysis, the area of study can encompass more than just one corridor or intersection. For example, the addition of a roadway can affect traffic patterns at a number of adjacent roadways and intersections, and an analysis will include all of the areas affected by the project.

Depending on the application, a link specific analysis may require emission estimates for a limited number of hours (e.g., during peak or rush-hours for an analysis of a high occupancy vehicle or HOV lane) or for an entire day. In addition, a variety of parameters in MOBILE6 can be used to characterize the local climate, traffic patterns and vehicle fleet operating in the study area. All of these parameters are important for developing a link-specific analysis that accurately simulates the local practice. Since AKMOBILE6 works with existing MOBILE commands, all of the commands used for customizing runs for the local area can also be used with the AKMOBILE6.

Using AKMOBILE6

There are command restrictions when designing an input file for AKMOBILE6 inherent in the design of the model. These command restrictions are shown in Table 1.

Unlike the other commands in Table 1 that are standard commands in MOBILE6, the INITIAL IDLE command is unique to AKMOBILE6. The command allows for tracking the thermal state of vehicles (i.e., how warmed-up the vehicles are). Vehicles are considered fully warmed-up if they have been operating for a long period of time, enough for the engine to heat up. For instance, vehicle operation on freeways is always nearly fully warmed-up, irrespective of time of day. On the other hand, vehicles that have been parked for a while, overnight in a garage for example, would have cold engines when started.

In order to specify a vehicle's thermal state, input files must include the following parameters after the INITIAL IDLE command:

- Soak input option ("S" for soak time, "F" for cold/hot start fractions);
- Soak time (in hours), or alternatively, cold start and hot start fractions[‡];
- Initial idle time (in minutes); and
- Plug-in heater use fraction (a value between 0 and 1 representing a range from no plug-in use to 100% plug-in use prior to the trip, respectively).

[‡]Cold and hot-start fractions refer to the split of all vehicle trips that are either treated as fully cold (12-hour or overnight soak) or fully warmed-up (10-minute soak), respectively. These fractions must sum to 1.0 and can be used as an alternative to input of a single soak time.

Table 1 Required Commands and Command Restrictions in AKMOBILE6		
Command	Location Within Input	Utility
INITIAL IDLE	Scenario	Command must be preceded by a ">" symbol. The command tracks the thermal state of the vehicles within the scenario.
NO SFTP SPEED	Scenario	Disables the Supplemental FTP (SFTP) benefits in MOBILE6. Winter driving in Alaska does not involve the aggressive driving usually found in the SFTP.
POLLUTANTS	Header	The AKMOBILE6 model is designed to provide only CO emissions factors. This command must specify CO only.
SPREADSHEET	Header	This output layout must be specified to run AKMOBILE6. The model does not support other output layouts.
VMT FRACTIONS	Run	Must be used to apply a locality-specific fleet mix and must appear in the Run section of the input.
EVALUATION MONTH	Scenario	This command must specify a January run (i.e., a value of "1") in order to ensure that the model executes under the seasonal conditions for which it is valid.

Examples for the INITIAL IDLE command lines are shown below.

Example A `> INITIAL IDLE : S, 12, 0.5, 0.8`
Example B `> INITIAL IDLE : F, 0.9, 0.1, 5, 0.8`

In Example A, the line specifies a soak input option ("S") with a single soak time of 12 hours (cold start), an initial idle time of 0.5 minutes, and an 80% plug-in use fraction ("0.8"). Example B shows the start fraction option ("F") with 90% cold-start ("0.9"), 10% hot-start ("0.1"), a 5-minute initial idle time, and 80% plug-in use ("0.8").

The other commands in Table 1 are those that are required to customize the input file to Alaska conditions and those that are restricted by the design of AKMOBILE6. The VMT FRACTIONS command is restricted by the design of the model to appear in the Run section of the input file. Moreover, it must be included in the input file in order to change the national default VMT fractions by vehicle class assignments to reflect those in Alaska. In addition to this command, others should be used to create a more locality-specific run, which will overwrite national default parameters included in the model code.

Additional commands that are useful in customizing an AKMOBILE6 run are shown in Table 2. Also included in Table 2 are the possible sources of data useful for creating a locality-specific input file.

Alaska Data Sources

As noted in Table 2, a number of different data sources can be used to customize an AKMOBILE6 run. One approach is to use MOBILE6 default values from EPA, another is to use regional profiles developed for Anchorage and Fairbanks and still another is to collect data to represent vehicles operating at the location of the project. In most cases, use of the regional profiles may be sufficient. Some projects, however, may target a unique category of vehicles and require on-site surveys to collect the information needed to correctly represent the mix of vehicles operating at the project. When in doubt about which approach to use, contacts should be established with local air pollution control agencies. They can provide guidance not only on which approach is appropriate but provide aid on the specific data that may need to be collected.

Both Anchorage and Fairbanks recently prepared State Implementation Plan (SIP) revisions that demonstrate how they will maintain compliance with the ambient carbon monoxide (CO) standard. The on-road mobile source emission estimates developed for those plans are based on MOBILE6 (the most recent version of EPA's emission factor model). The input files used to characterize local vehicle fleets, related emission control programs and ambient conditions provide an excellent starting point for developing emission estimates for projects located within the two communities. They can easily be modified for use in AKMOBILE6 by adding in the commands specified in Table 1. Considerable effort may be required to represent projects located in other communities since the age distribution of vehicles operating in them and the local control programs will not be the same. In these cases, contacts should be established with either the local air pollution agencies or DEC. *[need to specify a contact]*

Listed below are links to examples of the most recent input files used for on-road mobile emissions modeling for Anchorage and Fairbanks:

- Anchorage On-Road Modeling Input File *[hyperlink]*
- Fairbanks On-Road Modeling Input File *[hyperlink]*

Table 2 Other AKMOBILE6 Commands Relevant for Site-Specific Modeling		
Command	Location Within Input	Utility and Data Sources
REG DIST	Run	Allows for overwriting the vehicle registration distribution (by vehicle age and type) national defaults in the model. Data can be obtained from the Alaska Division of Motor Vehicles (DMV), which keeps records or vehicle registration by area. For Anchorage and Fairbanks, the most recent SIP or Maintenance Plan should also include this data.
MILE ACCUM RATE	Run	Allows users to supply the annual mileage accumulation rates by vehicle age for any or all of the vehicle types. Vehicle mileage accumulation data can be culled from Inspection and Maintenance (I/M) records as odometer readings are taken during vehicle inspection.
I/M PROGRAM	Run	Users should specify the I/M program in place in the area during the study timeframe. I/M programs are currently in place in Anchorage and Fairbanks, and details of the current programs are included in the following examples.
FUEL PROGRAM	Run	Allows users to set the sulfur levels in the model to reflect local gasoline levels. The command can specify one of two Tier 2 sulfur phase-in schedules or specify sulfur content for gasoline after 1999.
VMT BY FACILITY	Run or Scenario	This command allows for allocation of VMT to various roadway or facility types by vehicle class. All VMT can be assigned to only one facility type, if needed. On-site count data can be used instead of the national defaults in the model.
VMT BY HOUR	Run or Scenario	This command allows users to allocate the fraction of VMT that occurs at each hour of the day. On-site count data can be used instead of the national defaults.
AVERAGE SPEED	Scenario	Allows users to designate an average speed to use for all facility or roadway types or for a specific type. For a link-specific analysis, distinct values must be set for each roadway link and run separately through AKMOBILE6. A traffic survey of the area of interest should provide an estimate for the average speed occurring at the site.

Link-Specific Analysis Examples

Example 1 – Fairbanks Daily Freeway Emissions

CO emission estimates are needed for vehicle emissions occurring at a freeway during a 20 ºF winter day in Fairbanks. An on-site survey shows there is an average of 1,500 vehicles going through the two-mile stretch of road each day and that the average speed of the vehicles is 45 miles/hour.

Local Data - The vehicle age registration distribution, the VMT fractions by vehicle class, the mileage accumulation rates and the I/M program characteristics were obtained from AKMOBILE6 input files used in the 2003 Fairbanks CO Maintenance Plan update. The characteristics of the I/M program in Fairbanks are shown in Table 3 below.

Table 3
Fairbanks North Star Borough (FNSB) I/M Program Parameters
(as of June, 2004)

Program Element	FNSB Program
Network type	Decentralized
Start date	July 1, 1985
Inspection frequency	Biennial
Model year coverage	MY1975 and newer except newest two
Vehicle type coverage	LDGV, LDGT1-4, HDGV2B, HDGV3, GAS BUS
OBDII checks	1996 and newer LDGVs and LDGTs
Tailpipe test type	Two-speed idle for pre-1996 vehicles
Underhood inspection	Comprehensive visual/functional checks
Pre-1981 stringency	23%
Waiver rate	0%
Compliance rate	96% (projected from 2002 survey results)
I/M Effectiveness	100% for all pollutants

AKMOBILE6 Input – The resulting AKMOBILE6 input file is shown in Figure 1 and can be accessed here *[link to file]*. Default assumptions were used for parameters where no local data were available. As shown in Figure 1, model inputs for AKMOBILE6 are identical to MOBILE6 input files, with the exception of the INITIAL IDLE command. Consequently, old input files used with MOBILE6 can be easily converted to work with AKMOBILE6.

Figure 1
AKMOBILE6 Input File for Example 1

```
******************  Header Section  ************************
MOBILE6 INPUT FILE :
POLLUTANTS         : CO
SPREADSHEET        :
RUN DATA           :
******************  Run Section  ***************************
* I/M Program -- Idle/2500 Testing for MY75-MY95
I/M PROGRAM        : 1 1985 2020 2 TRC 2500/IDLE
I/M MODEL YEARS    : 1 1975 1995
I/M VEHICLES       : 1 22222 11111111 1
I/M STRINGENCY     : 1 23.0
I/M COMPLIANCE     : 1 96.0
I/M GRACE PERIOD   : 1 2
I/M WAIVER RATES   : 1 0.0 0.0
I/M EFFECTIVENESS  : 1.00 1.00 1.00

I/M PROGRAM        : 2 1985 2020 2 TRC 2500/IDLE
I/M MODEL YEARS    : 2 1975 2020
I/M VEHICLES       : 2 11111 22111111 2
I/M STRINGENCY     : 2 23.0
I/M COMPLIANCE     : 2 96.0
I/M GRACE PERIOD   : 2 2
I/M WAIVER RATES   : 2 0.0 0.0
I/M EFFECTIVENESS  : 1.00 1.00 1.00

* I/M Program -- OBD Testing for MY96+ in 2001+
I/M PROGRAM        : 3 1985 2020  2 TRC OBD I/M
I/M MODEL YEARS    : 3 1996 2020
I/M VEHICLES       : 3 22222 11111111 1
I/M STRINGENCY     : 3 23.0
I/M COMPLIANCE     : 3 96.0
I/M GRACE PERIOD   : 3 2
I/M WAIVER RATES   : 3 0.0 0.0

* Anti-Tampering Program for MY1975+
ANTI-TAMP PROG     :
85 75 20 22222 22111111 2 12 096. 22112221

* Fuel Program set to Western Conventional Gasoline
FUEL PROGRAM       : 3
FUEL RVP           : 14.7

VMT FRACTIONS      :
0.3817  0.1417  0.1454  0.1940  0.0001  0.1131  0.0127  0.0065
0.0022  0.0024  0.0001  0.0001  0.0000  0.0000  0.0000  0.0000

MILE ACCUM RATE    : fai_mar.prn
REG DIST           : fai_reg.prn

******************  Scenario Section  **********************
* A separate scenario must be written for each calendar
* year to be analyzed.

SCENARIO RECORD    : Winter2004 - Freeway Scenario

* Winter 2004 includes January 2005
EVALUATION MONTH   : 1
CALENDAR YEAR      : 2005

MIN/MAX TEMP       : 20.0 20.0

* Command sets speed and all VMT to occur on freeways
AVERAGE SPEED      : 45.0 Freeway

* Vehicles are fully warmed-up, the hot start fraction
* is set to 1 and initial idle to 5 minutes.  Plug-in
* rates are assumed to be 80%.
> INITIAL IDLE     : F, 0, 1.0, 5, 0.8

NO SFTP SPEED      :

******************  End of Run  ****************************
END OF RUN
```

AKMOBILE6 Output – The output file produced by AKMOBILE6, available here *[link to file]*, is a tab-delimited ASCII file that can be easily read and manipulated using spreadsheet software like MS Excel. For each run, the output will include (1) a VMT mix record that shows the VMT fractions by vehicle class, (2) the idle emission factor record with initial idle CO emissions in grams/trip for the composite vehicle fleet and for each vehicle class, and (3) the traveling CO emission factors in grams/mile for the composite vehicle fleet and for each vehicle class. A portion of the model output produced from the input file shown in Figure 1 is shown in Figure 2.

Figure 2
Portion of AKMOBILE6 Output for Example 1

Run	Scenario	Description	CY	Parameter	Units	AmbTemp	SoakTemp	I/M?	Avg Spd	ALL VEH
1	1	Winter2004 - Freeway Scenario	2005	VMT	fraction	20	20	Yes	45	1
1	1	Winter2004 - Freeway Scenario	2005	CO-Idle	(g/trip)	20	20	Yes	45	6.546
1	1	Winter2004 - Freeway Scenario	2005	CO-Trav	(g/mile)	20	20	Yes	45	25.354

Example 1 Calculations – Because Example 1 describes a freeway (i.e., no vehicle starts), only the composite fleet traveling emission factor is used in the link-specific analysis. Again, the problem calls for the CO emissions during a 20°F winter day in Fairbanks at a 2-mile stretch of freeway with 1,500 veh/day traveling at 45 mph. The total daily CO emissions for the two-mile stretch of freeway can then be calculated as follows:

(25.354 g/mi) * (2 mi) * (1,500 veh/day) * (0.0022 lb/g) * (5E-4 ton/lb) = **0.084 ton/day**

Using the conversion factors:
1 gram = 0.0022 lb (mass)
1 lb = $5x10^{-4}$ ton

As a variation of the problem, the following Example 2 considers a similar freeway scenario as in Example 1, however a specific hour of the day is of interest for the analysis.

Example 2 – Fairbanks Hourly Freeway Emissions

Hourly CO emission estimates are needed for vehicle emissions occurring during an 8-hour period (12:00 noon to 7:59 pm) at a freeway during a typical winter day in Fairbanks. An on-site survey shows the following trends for temperature, vehicles traveling and average speed seen on the 2-mile stretch of road during the 8-hour timeframe:

Hour	Avg. Temp. (ºF)	Total Vehicles	Avg. Speed (mph)
12:00-12:59 pm	20.0	300	35
1:00-1:59 pm	21.0	220	40
2:00-2:59 pm	22.5	200	45
3:00-3:59 pm	23.5	195	45
4:00-4:59 pm	25.0	210	42
5:00-5:59 pm	24.0	280	38
6:00-6:59 pm	23.0	320	33
7:00-7:59 pm	22.0	250	39

Local Data – As with Example 1, the vehicle age registration distribution, the VMT fractions by vehicle class, the mileage accumulation rates and the I/M program characteristics were obtained from AKMOBILE6 input files used in the 2003 Fairbanks CO Maintenance Plan update.

AKMOBILE6 Input – The AKMOBILE6 input file for Example 2 is shown here *[link to file]* and in Figure 3A and 3B. Default assumptions were used for parameters where no local data were known. Note that the input file is similar to the input file in Example 1 except for the addition of the VMT BY HOUR command and the additional scenarios. Each scenario represents one hour during the 8-hour period. An example of the external file referred to by the command, *hvmt5.fai*, is shown in Figure 4, and all of the VMT BY HOUR reference files can be accessed here *[link to file]*. The file *hvmt5.fai* was designed to assign all of the VMT to the 5:00 pm hour (5:00-5:59 pm). Note that the entries to the file are arranged such that the first fraction represents the VMT during the 6:00-6:59 am hour, the second fraction represents the 7:00-7:59 am hour, and so on. The other files referred to in the other scenarios differ only in the location of the fraction "1.0000" to indicate the hour of interest.

Figure 3A
AKMOBILE6 Input File for Example 2

```
*******************  Header Section  ************************
MOBILE6 INPUT FILE  :
POLLUTANTS          : CO
SPREADSHEET         :
RUN DATA            :
*******************  Run Section  ***************************
* I/M Program -- Idle/2500 Testing for MY75-MY95
I/M PROGRAM         : 1 1985 2020 2 TRC 2500/IDLE
I/M MODEL YEARS     : 1 1975 1995
I/M VEHICLES        : 1 22222 11111111 1
I/M STRINGENCY      : 1 23.0
I/M COMPLIANCE      : 1 96.0
I/M GRACE PERIOD    : 1 2
I/M WAIVER RATES    : 1 0.0 0.0
I/M EFFECTIVENESS   : 1.00 1.00 1.00

I/M PROGRAM         : 2 1985 2020 2 TRC 2500/IDLE
I/M MODEL YEARS     : 2 1975 2020
I/M VEHICLES        : 2 11111 22211111 2
I/M STRINGENCY      : 2 23.0
I/M COMPLIANCE      : 2 96.0
I/M GRACE PERIOD    : 2 2
I/M WAIVER RATES    : 2 0.0 0.0
I/M EFFECTIVENESS   : 1.00 1.00 1.00

* I/M Program -- OBD Testing for MY96+ in 2001+
I/M PROGRAM         : 3 1985 2020  2 TRC OBD I/M
I/M MODEL YEARS     : 3 1996 2020
I/M VEHICLES        : 3 22222 11111111 1
I/M STRINGENCY      : 3 23.0
I/M COMPLIANCE      : 3 96.0
I/M GRACE PERIOD    : 3 2
I/M WAIVER RATES    : 3 0.0 0.0

* Anti-Tampering Program for MY1975+
ANTI-TAMP PROG      :
85 75 20 22222 22211111 2 12 096, 22112221

* Fuel Program Set to Western Conventional Gasoline
FUEL PROGRAM        : 3
FUEL RVP            : 14.7

VMT FRACTIONS       :
0.3817  0.1417  0.1454  0.1940  0.0001  0.1131  0.0127  0.0065
0.0022  0.0024  0.0001  0.0001  0.0000  0.0000  0.0000  0.0000
MILE ACCUM RATE     : fai_mar.prn
REG DIST            : fai_reg.prn

*******************  Scenario Section  **********************
* A separate scenario must be written for each calendar
* year to be analyzed.

* ALL COMMENTS:
* Winter 2004 includes January 2005.
* AVERAGE SPEED sets speed and all VMT to occur in freeways.
* All VMT in hvmt#.fai are set to occur at hour designated
* to isolate the emissions for the hour.
* For INITIAL IDLE command, vehicles are fully warmed-up,
* the hot start fraction is set to 1 and initial idle to 5
* minutes. Plug-in rates are assumed to be 80%.

SCENARIO RECORD     : Winter2004 - 12PM Freeway Scenario
EVALUATION MONTH    : 1
CALENDAR YEAR       : 2005
MIN/MAX TEMP        : 20.0 20.0
AVERAGE SPEED       : 35.0 Freeway
VMT BY HOUR         : hvmt12.fai
> INITIAL IDLE      : F, 0, 1.0, 5, 0.8
NO SFTP SPEED       :

SCENARIO RECORD     : Winter2004 - 1PM Freeway Scenario
EVALUATION MONTH    : 1
CALENDAR YEAR       : 2005
MIN/MAX TEMP        : 21.0 21.0
AVERAGE SPEED       : 40.0 Freeway
VMT BY HOUR         : hvmt1.fai
> INITIAL IDLE      : F, 0, 1.0, 5, 0.8
NO SFTP SPEED       :

SCENARIO RECORD     : Winter2004 - 2PM Freeway Scenario
EVALUATION MONTH    : 1
CALENDAR YEAR       : 2005
MIN/MAX TEMP        : 22.5 22.5
AVERAGE SPEED       : 45.0 Freeway
VMT BY HOUR         : hvmt2.fai
> INITIAL IDLE      : F, 0, 1.0, 5, 0.8
NO SFTP SPEED       :
```

Figure 3B
AKMOBILE6 Input File for Example 2 (cont.)

```
SCENARIO RECORD     : Winter2004 - 3PM Freeway Scenario
EVALUATION MONTH    : 1
CALENDAR YEAR       : 2005
MIN/MAX TEMP        : 23.5 23.5
AVERAGE SPEED       : 45.0 Freeway
VMT BY HOUR         : hvmt3.fai
> INITIAL IDLE      : F, 0, 1.0, 5, 0.8
NO SFTP SPEED       :

SCENARIO RECORD     : Winter2004 - 4PM Freeway Scenario
EVALUATION MONTH    : 1
CALENDAR YEAR       : 2005
MIN/MAX TEMP        : 25.0 25.0
AVERAGE SPEED       : 42.0 Freeway
VMT BY HOUR         : hvmt4.fai
> INITIAL IDLE      : F, 0, 1.0, 5, 0.8
NO SFTP SPEED       :

SCENARIO RECORD     : Winter2004 - 5PM Freeway Scenario
EVALUATION MONTH    : 1
CALENDAR YEAR       : 2005
MIN/MAX TEMP        : 24.0 24.0
AVERAGE SPEED       : 38.0 Freeway
VMT BY HOUR         : hvmt5.fai
> INITIAL IDLE      : F, 0, 1.0, 5, 0.8
NO SFTP SPEED       :

SCENARIO RECORD     : Winter2004 - 6PM Freeway Scenario
EVALUATION MONTH    : 1
CALENDAR YEAR       : 2005
MIN/MAX TEMP        : 23.0 23.0
AVERAGE SPEED       : 33.0 Freeway
VMT BY HOUR         : hvmt6.fai
> INITIAL IDLE      : F, 0, 1.0, 5, 0.8
NO SFTP SPEED       :

SCENARIO RECORD     : Winter2004 - 7PM Freeway Scenario
EVALUATION MONTH    : 1
CALENDAR YEAR       : 2005
MIN/MAX TEMP        : 22.0 22.0
AVERAGE SPEED       : 39.0 Freeway
VMT BY HOUR         : hvmt7.fai
> INITIAL IDLE      : F, 0, 1.0, 5, 0.8
NO SFTP SPEED       :

********************  End of Run  ****************************
END OF RUN
```

Figure 4
VMT BY HOUR Command External File *hvmt5.fai*

```
VMT BY HOUR
*
*  Fraction of all vehicle miles traveled by hour of the day.
*  First hour is 6:00-6:59 a.m.
*
      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
      0.0000  0.0000  0.0000  0.0000  0.0000  1.0000
      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
```

AKMOBILE6 Output – The output file produced by AKMOBILE6 for all of the hours in Example 2 can be viewed here *[link to file]*. A portion of the output file showing the relevant fleet average CO emissions is shown in Figure 5. As shown in the figure, each

scenario represents one hour in the 8-hour period starting with the 12:00-12:59 hour. For each scenario, results for the VMT fraction, idle CO emissions and traveling CO emissions are given.

Figure 5
Portion of AKMOBILE6 Output for Example 2

Scenario	Description	CY	Parameter	Units	AmbTemp	SoakTemp	I/M?	Avg Spd	ALL VEH
1	Winter2004 - 12PM Freeway Scenario	2005	VMT	fraction	20	20	Yes	35	1
1	Winter2004 - 12PM Freeway Scenario	2005	CO-Idle	(g/trip)	20	20	Yes	35	6.826
1	Winter2004 - 12PM Freeway Scenario	2005	CO-Trav	(g/mile)	20	20	Yes	35	24.169
2	Winter2004 - 1PM Freeway Scenario	2005	VMT	fraction	21	21	Yes	40	1
2	Winter2004 - 1PM Freeway Scenario	2005	CO-Idle	(g/trip)	21	21	Yes	40	6.826
2	Winter2004 - 1PM Freeway Scenario	2005	CO-Trav	(g/mile)	21	21	Yes	40	24.379
3	Winter2004 - 2PM Freeway Scenario	2005	VMT	fraction	22.5	22	Yes	45	1
3	Winter2004 - 2PM Freeway Scenario	2005	CO-Idle	(g/trip)	22.5	22	Yes	45	6.826
3	Winter2004 - 2PM Freeway Scenario	2005	CO-Trav	(g/mile)	22.5	22	Yes	45	24.5
4	Winter2004 - 3PM Freeway Scenario	2005	VMT	fraction	23.5	24	Yes	45	1
4	Winter2004 - 3PM Freeway Scenario	2005	CO-Idle	(g/trip)	23.5	24	Yes	45	6.826
4	Winter2004 - 3PM Freeway Scenario	2005	CO-Trav	(g/mile)	23.5	24	Yes	45	24.164
5	Winter2004 - 4PM Freeway Scenario	2005	VMT	fraction	25	25	Yes	42	1
5	Winter2004 - 4PM Freeway Scenario	2005	CO-Idle	(g/trip)	25	25	Yes	42	6.826
5	Winter2004 - 4PM Freeway Scenario	2005	CO-Trav	(g/mile)	25	25	Yes	42	23.303
6	Winter2004 - 5PM Freeway Scenario	2005	VMT	fraction	24	24	Yes	38	1
6	Winter2004 - 5PM Freeway Scenario	2005	CO-Idle	(g/trip)	24	24	Yes	38	6.826
6	Winter2004 - 5PM Freeway Scenario	2005	CO-Trav	(g/mile)	24	24	Yes	38	23.19
7	Winter2004 - 6PM Freeway Scenario	2005	VMT	fraction	23	23	Yes	33	1
7	Winter2004 - 6PM Freeway Scenario	2005	CO-Idle	(g/trip)	23	23	Yes	33	6.826
7	Winter2004 - 6PM Freeway Scenario	2005	CO-Trav	(g/mile)	23	23	Yes	33	23.223
8	Winter2004 - 7PM Freeway Scenario	2005	VMT	fraction	22	22	Yes	39	1
8	Winter2004 - 7PM Freeway Scenario	2005	CO-Idle	(g/trip)	22	22	Yes	39	6.826
8	Winter2004 - 7PM Freeway Scenario	2005	CO-Trav	(g/mile)	22	22	Yes	39	23.937

Example 2 Calculations – Only the composite fleet traveling CO emission factor is relevant for Example 2. The example called for the hourly winter CO vehicle emission estimates occurring on a freeway during the 8-hour period starting at 12:00 noon. The CO emissions for each hour in tons per day (tpd) can then be calculated using the following formula:

Hourly CO = (Fleet traveling CO g/mi)*(2 miles)*(veh/day)* (0.0022 lb/g)*(5E-4 ton/lb)

Using the conversion factors:
1 gram = 0.0022 lb (mass)
1 lb = $5x10^{-4}$ ton

Results of the calculation for each hour using a spreadsheet (Excel) are summarized in Figure 6.

Figure 6
Calculation Results for Example 2

Scenario	Hour	Amb. Temp (F)	Avg Speed (mph)	Fleet Traveling CO (g/mi)	Veh/Day	**Hourly CO (tpd)**
1	12:00-12:59 pm	20	35	24.169	300	**0.0160**
2	1:00-1:59 pm	21	40	24.379	220	**0.0118**
3	2:00-2:59 pm	22.5	45	24.5	200	**0.0108**
4	3:00-3:59 pm	23.5	45	24.164	195	**0.0104**
5	4:00-4:59 pm	25	42	23.303	210	**0.0108**
6	5:00-5:59 pm	24	38	23.19	280	**0.0143**
7	6:00-6:59 pm	23	33	23.223	320	**0.0163**
8	7:00-7:59 pm	22	39	23.937	250	**0.0132**

Example 3 – Anchorage Arterial Road Emissions

A one-mile stretch of an arterial road in Anchorage sees an average of 350 vehicles per day. The average speed of the vehicles is 25 miles/hour. The total daily CO emissions are needed for an average winter day (20 ºF).

Local Data - The vehicle age registration distribution, the VMT fractions by vehicle class, the mileage accumulation rates and the I/M program characteristics were obtained from MOBILE6 input files used in the 2003 Anchorage SIP Update. The I/M program in Anchorage has the characteristics shown in Table 4 below.

Table 4
Municipality of Anchorage (MOA) I/M Program Parameters
(as of June, 2004)

Program Element	MOA Program
Network type	Decentralized
Start date	July 1, 1985
Inspection frequency	Biennial
Model year coverage	MY1968 and newer except newest two
Vehicle type coverage	LDGV, LDGT1-4, HDGV2B, HDGV3, GAS BUS
OBDII checks	1996 and newer LDGVs and LDGTs
Tailpipe test type	Two-speed idle (TSI) for pre-1996 vehicles
Underhood inspection	Comprehensive visual/functional checks
Pre-1981 stringency	23%
Waiver rate	0%
Compliance rate	90% for TSI testing, 93% for OBD testing
I/M Effectiveness	80% for HC and CO

AKMOBILE6 Input – Figure 6 shows the AKMOBILE6 input file for Example 3. A file copy of this input file can be accessed here *[link to file]*. Default MOBILE6 assumptions were used for parameters where no local data were available.

Figure 6
AKMOBILE6 Input File for Example 3

```
******************  Header Section  ************************
MOBILE6 INPUT FILE :
POLLUTANTS         : CO
SPREADSHEET        :
RUN DATA           :
******************  Run Section  ***************************
REG DIST           : anc_reg.prn
MILE ACCUM RATE    : anc_mar.prn
VMT FRACTIONS      :
0.6890  0.0511  0.1699  0.0349  0.0161  0.0127  0.0013  0.0009
0.0007  0.0027  0.0033  0.0036  0.0129  0.0006  0.0003  0.0000

* Anti-Tampering Program for MY1975+
ANTI-TAMP PROG     :
85 75 20 22222 22111111 2 12 090. 22112221

* Fuel Program set to Western Conventional Gasoline
FUEL PROGRAM       : 3
FUEL RVP           : 14.7

* I/M Program -- Idle/2500 Testing for MY68-MY95
I/M PROGRAM        : 1 1985 2020 2 TRC 2500/IDLE
I/M MODEL YEARS    : 1 1968 1995
I/M VEHICLES       : 1 22222 11111111 1
I/M STRINGENCY     : 1 23.0
I/M COMPLIANCE     : 1 90.0
I/M GRACE PERIOD   : 1 2
I/M WAIVER RATES   : 1 0.0 0.0
I/M EFFECTIVENESS  : 0.85 0.85 0.00

I/M PROGRAM        : 2 1985 2020 2 TRC 2500/IDLE
I/M MODEL YEARS    : 2 1968 2020
I/M VEHICLES       : 2 11111 22111111 2
I/M STRINGENCY     : 2 23.0
I/M COMPLIANCE     : 2 90.0
I/M GRACE PERIOD   : 2 2
I/M WAIVER RATES   : 2 0.0 0.0
I/M EFFECTIVENESS  : 0.85 0.85 0.00

* I/M Program -- OBD Testing for MY96+ in 2001+
I/M PROGRAM        : 3 1985 2020 2 TRC OBD I/M
I/M MODEL YEARS    : 3 1996 2020
I/M VEHICLES       : 3 22222 11111111 1
I/M STRINGENCY     : 3 23.0
I/M COMPLIANCE     : 3 93.0
I/M GRACE PERIOD   : 3 2
I/M WAIVER RATES   : 3 0.0 0.0

******************  Scenario Section  **********************
* A separate scenario must be written for each calendar
* year to be analyzed.

SCENARIO RECORD    : Winter 2004 - Arterial Scenario

* Winter 2004 includes January 2005
CALENDAR YEAR      : 2005
EVALUATION MONTH   : 1
MIN/MAX TEMP       : 20.0 20.0
AVERAGE SPEED      : 25.0 Arterial
> INITIAL IDLE     : F, 0.5, 0.5, 5, 0.8
NO SFTP SPEED      :

* For an arterial road, some cars will be warmed-up and
* some are not.  Assumed 50:50 hot to cold, initial idle
* of 5 minutes and 80% plug-in use.

******************  End of Run  ****************************
END OF RUN         :
```

AKMOBILE6 Output – The output file produced by AKMOBILE6 for Example 3 can be viewed here *[link to file]*. A portion of the output file is shown in Figure 7.

Figure 7
Portion of AKMOBILE6 Output for Example 3

Run	Scenario	Description	CY	Parameter	Units	AmbTemp	SoakTemp	I/M?	Avg Spd	ALL VEH
1	1	Winter 2004 - Arterial Scenario	2005	VMT	fraction	20	20	Yes	25	1
1	1	Winter 2004 - Arterial Scenario	2005	CO-Idle	(g/trip)	20	20	Yes	25	39.484
1	1	Winter 2004 - Arterial Scenario	2005	CO-Trav	(g/mile)	20	20	Yes	25	24.228

Example 3 Calculations – For this example, the composite fleet traveling emission factor is used in the arterial link-specific analysis. To restate the analysis goal, CO emissions need to be estimated for a one-mile stretch of an arterial road in Anchorage that sees an average of 350 veh/day going an average speed of 25 mph. The total daily CO emissions in tons for the one-mile stretch of arterial roadway can then be calculated as follows:

(24.228 g/mi) * (1 mi) * (350 veh/day) * (0.0022 lb/g) * (5E-4 ton/lb) = **0.0093 ton/day**

Using the conversion factors:
1 gram = 0.0022 lb (mass)
1 lb = $5x10^{-4}$ ton