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# Day 4 Agenda
# (Advanced Course – Day 2)

- Detailed discussion of database output
  - Commands
  - Aggregating results
- Working with model year output – vehicle lifetime emissions estimates
- Control measure analysis
  - Measures analyzed directly with MOBILE6
  - “Off-Model” emissions estimates

# VIII. DETAILED DISCUSSION OF DATABASE OUTPUT

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# Database Output Options in MOBILE6

- Database output format allows the user to specify very detailed output (most similar output in MOBILE5 was the by-model-year output)
- However, unless variables in the output file are limited, each run will comprise approximately 40 megabytes per scenario
- Details of specific database output formats are summarized on the following pages

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# Database Output

- Requested with the DATABASE OUTPUT command
- All DATABASE commands are placed in the Header section of the input file
- Default file name extension is *.TB1
- The output file is a single table stored in tab-separated ASCII format
- Column headers are added with the WITH FIELDNAMES command

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## Three Formats of Database Output

- Hourly output
  - Default format
  - Most detailed output
  - Maximum number of lines in this file is 295,800
- Daily output
  - Specified with the DAILY OUTPUT command
  - Maximum number of lines in this file is 12,325
- Aggregated output
  - Specified with the AGGREGATED OUTPUT command
  - The maximum number of lines in this file is 84 (28 vehicle classes × 3 pollutants)

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# Sample MOBILE6 Database Output File (DAILY OUTPUT Specified)

| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | FILE | RUN | SCEN | POL | VTYPE | ETYPE | FTYPE | AGE | GM_MILE | GM_DAY | STARTS | ENDS | MILES | MPG | FACVMT | REGDIST | VCOUNT | MYR |
| 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 7 | 0.234 | 6.783 | 7.28 | 5.38 | 29.04 | 22.64 | 0.3421 | 0.0831 | 110.8046 | 1995 |
| 3 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 7 | 0.208 | 6.043 | 7.28 | 5.38 | 29.04 | 22.64 | 0.4978 | 0.0831 | 110.8046 | 1995 |
| 4 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 7 | 0.289 | 8.378 | 7.28 | 5.38 | 29.04 | 22.64 | 0.1305 | 0.0831 | 110.8046 | 1995 |
| 5 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 7 | 0.335 | 9.719 | 7.28 | 5.38 | 29.04 | 22.64 | 0.0297 | 0.0831 | 110.8046 | 1995 |
| 6 | 1 | 1 | 1 | 1 | 1 | 2 | 5 | 7 | 0.179 | 5.195 | 7.28 | 5.38 | 29.04 | 22.64 | 1 | 0.0831 | 110.8046 | 1995 |
| 7 | 1 | 1 | 1 | 1 | 1 | 5 | 5 | 7 | 0.092 | 2.664 | 7.28 | 5.38 | 29.04 | 22.64 | 1 | 0.0831 | 110.8046 | 1995 |
| 8 | 1 | 1 | 1 | 1 | 1 | 8 | 5 | 7 | 0.035 | 1.028 | 7.28 | 5.38 | 29.04 | 22.64 | 1 | 0.0831 | 110.8046 | 1995 |
| 9 | 1 | 1 | 1 | 1 | 1 | 3 | 5 | 7 | 0.090 | 2.622 | 7.28 | 5.38 | 29.04 | 22.64 | 1 | 0.0831 | 110.8046 | 1995 |
| 10 | 1 | 1 | 1 | 1 | 1 | 4 | 5 | 7 | 0.020 | 0.583 | 7.28 | 5.38 | 29.04 | 22.64 | 1 | 0.0831 | 110.8046 | 1995 |
| 11 | 1 | 1 | 1 | 1 | 1 | 7 | 5 | 7 | 0.010 | 0.299 | 7.28 | 5.38 | 29.04 | 22.64 | 1 | 0.0831 | 110.8046 | 1995 |
| 12 | 1 | 1 | 1 | 1 | 1 | 6 | 1 | 7 | 0.225 | 6.523 | 7.28 | 5.38 | 29.04 | 22.64 | 0.3421 | 0.0831 | 110.8046 | 1995 |
| 13 | 1 | 1 | 1 | 1 | 1 | 6 | 2 | 7 | 0.266 | 7.713 | 7.28 | 5.38 | 29.04 | 22.64 | 0.4978 | 0.0831 | 110.8046 | 1995 |
| 14 | 1 | 1 | 1 | 1 | 1 | 6 | 3 | 7 | 0.643 | 18.67 | 7.28 | 5.38 | 29.04 | 22.64 | 0.1305 | 0.0831 | 110.8046 | 1995 |
| 15 | 1 | 1 | 1 | 1 | 1 | 6 | 4 | 7 | 0.234 | 6.802 | 7.28 | 5.38 | 29.04 | 22.64 | 0.0297 | 0.0831 | 110.8046 | 1995 |
| 16 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 7 | 0.235 | 8.158 | 8.06 | 5.75 | 34.73 | 16.87 | 0.3421 | 0.0731 | 14.4963 | 1995 |
| 17 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 7 | 0.214 | 7.426 | 8.06 | 5.75 | 34.73 | 16.87 | 0.4978 | 0.0731 | 14.4963 | 1995 |
| 18 | 1 | 1 | 1 | 1 | 2 | 1 | 3 | 7 | 0.300 | 10.419 | 8.06 | 5.75 | 34.73 | 16.87 | 0.1305 | 0.0731 | 14.4963 | 1995 |
| 19 | 1 | 1 | 1 | 1 | 2 | 1 | 4 | 7 | 0.343 | 11.908 | 8.06 | 5.75 | 34.73 | 16.87 | 0.0297 | 0.0731 | 14.4963 | 1995 |
| 20 | 1 | 1 | 1 | 1 | 2 | 2 | 5 | 7 | 0.183 | 6.346 | 8.06 | 5.75 | 34.73 | 16.87 | 1 | 0.0731 | 14.4963 | 1995 |
| 21 | 1 | 1 | 1 | 1 | 2 | 5 | 5 | 7 | 0.077 | 2.664 | 8.06 | 5.75 | 34.73 | 16.87 | 1 | 0.0731 | 14.4963 | 1995 |
| 22 | 1 | 1 | 1 | 1 | 2 | 8 | 5 | 7 | 0.048 | 1.65 | 8.06 | 5.75 | 34.73 | 16.87 | 1 | 0.0731 | 14.4963 | 1995 |
| 23 | 1 | 1 | 1 | 1 | 2 | 3 | 5 | 7 | 0.071 | 2.463 | 8.06 | 5.75 | 34.73 | 16.87 | 1 | 0.0731 | 14.4963 | 1995 |
| 24 | 1 | 1 | 1 | 1 | 2 | 4 | 5 | 7 | 0.017 | 0.583 | 8.06 | 5.75 | 34.73 | 16.87 | 1 | 0.0731 | 14.4963 | 1995 |
| 25 | 1 | 1 | 1 | 1 | 2 | 7 | 5 | 7 | 0.014 | 0.499 | 8.06 | 5.75 | 34.73 | 16.87 | 1 | 0.0731 | 14.4963 | 1995 |
| 26 | 1 | 1 | 1 | 1 | 2 | 6 | 1 | 7 | 0.225 | 7.82 | 8.06 | 5.75 | 34.73 | 16.87 | 0.3421 | 0.0731 | 14.4963 | 1995 |
| 27 | 1 | 1 | 1 | 1 | 2 | 6 | 2 | 7 | 0.251 | 8.723 | 8.06 | 5.75 | 34.73 | 16.87 | 0.4978 | 0.0731 | 14.4963 | 1995 |
| 28 | 1 | 1 | 1 | 1 | 2 | 6 | 3 | 7 | 0.646 | 22.445 | 8.06 | 5.75 | 34.73 | 16.87 | 0.1305 | 0.0731 | 14.4963 | 1995 |
| 29 | 1 | 1 | 1 | 1 | 2 | 6 | 4 | 7 | 0.216 | 7.515 | 8.06 | 5.75 | 34.73 | 16.87 | 0.0297 | 0.0731 | 14.4963 | 1995 |

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# Three Types of Database Fields

- Key Fields – Used to identify records
- Echoed Fields – Provided to facilitate conversion of emisson factor results into alternate units (e.g., grams per gallon, etc.)
- Calculated Fields – Results that have been calculated by the model

# Key Fields

- FILE, RUN, SCEN – identify the file number, run number, and scenario number

- VTYPE – identifies the vehicle type (ranges from 1 to 28)

- POL – identifies pollutant:

  1 = HC
  2 = CO
  3 = NOx

- AGE – identifies vehicle age (ranges from 0 to 24)

- ETYPE – identifies emission type:

  1 = Exhaust running emissions (+ start emissions from HDVs)
  2 = Exhaust start emissions from LDVs
  3 = Evaporative hot soak emissions
  4 = Evaporative diurnal emissions
  5 = Evaporative resting loss emissions
  6 = Evaporative running loss emissions
  7 = Crankcase emissions
  8 = Evaporative refueling emissions

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# Key Fields (Continued)

- FTYPE – identifies facility type:

  1 = Freeway
  2 = Arterial
  3 = Local
  4 = Freeway Ramp
  5 = None (e.g., for starts or diurnals)

- HOUR – identifies the hour of the day (ranges from 1 to 24; recall that 1 = 6:00 a.m. to 6:59 a.m.)

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# Echoed Fields

- STARTS – reports the number of starts per day (daily output) or starts per hour (hourly output)
- ENDS – reports the number of trip ends per day (daily output) or trip ends per hour (hourly output) that result in a hot soak
- MILES – reports the number of miles per day (daily output) or miles per hour (hourly output)
- MPG – reports the fuel economy (miles per gallon)
- HRVMT – reports the fraction of VMT occurring during each hour
- FACVMT – reports the fraction of VMT occurring on each facility
- REGDIST – reports the registration distribution (function of vehicle type and vehicle age)

## Echoed Fields (Continued)

- VCOUNT – reports the **national** vehicle count for each vehicle type (in millions)
- AMBTEMP – reports the ambient temperature by hour (°F)
- DIURTEMP – reports the temperature by hour used in the diurnal calculations (°F)
- MYR – reports the vehicle model year
- VMT – reports the VMT fraction (or VMT mix) for each vehicle type (Aggregated output)
- CAL_YEAR – reports the calendar year

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## Calculated Fields

- GM_DAY – grams per day (daily output)
- GM_HR – grams per hour (hourly output)
- GM_MI – grams per mile
- Note:

  GM_MI = GM_DAY ÷ MILES

  GM_MI = GM_HR ÷ MILES

- Other Units:

  Grams/Start = GM_DAY ÷ STARTS

  Grams/Gallon = GM_DAY * MPG ÷ MILES

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# Summary of DATABASE Output Fields

| Field Type | Output Field | Output Format | | |
|---|---|---|---|---|
| | | Hourly | Daily | Aggregate |
| Key | FILE/RUN/SCEN | X | X | X |
| | POL | X | X | X |
| | VTYPE | X | X | X |
| | ETYPE | X | X | -- |
| | FTYPE | X | X | -- |
| | AGE | X | X | -- |
| | HOUR | X | -- | -- |
| Echoed | STARTS | X | X | X |
| | ENDS | X | X | X |
| | MILES | X | X | X |
| | MPG | X | X | X |
| | HRVMT | X | -- | -- |
| | FACVMT | X | X | -- |
| | REGDIST | X | X | -- |
| | VCOUNT | X | X | -- |
| | AMBTEMP | X | -- | -- |
| | DIURTEMP | X | -- | -- |
| | MYR | X | X | -- |
| | VMT | -- | -- | X |
| | CAL_YEAR | -- | -- | X |
| Calc'd | GM_HR | X | -- | -- |
| | GM_DAY | -- | X | X |
| | GM_MI | X | X | X |



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# Aggregating DATABASE Output (AGGREGATED OUTPUT)

- The most aggregated form of DATABASE output is when the command "AGGREGATED OUTPUT" is specified

- This is very similar to descriptive output, except that all 28 vehicle classes are included in the output file (unless specified otherwise)

- In addition, <u>an overall fleet-average emission rate is not included in this (or any) DATABASE output format</u>

- However, the fleet-average emission rate can be calculated by applying the appropriate weighting factors (i.e., the "VMT" field)

- BE CAREFUL...

  - Specifying roadway type <u>will not</u> impact results from AGGREGATED OUTPUT (all are included in the reported emission values)

  - Specifying emission type (DATABASE EMISSIONS) <u>will</u> impact emission values



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# Sample DATABASE Output Using the AGGREGATED OUTPUT Command

| | A | B | C | D | E | F | G | H | I | J | K | L | M | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | FILE | RUN | SCEN | CAL_YEAR | POL | VTYPE | GM_MILE | GM_DAY | STARTS | ENDS | MILES | MPG | VMT | |
| 2 | 1 | 1 | 1 | 2000 | 1 | 1 | 2.2904 | 67.511 | 0.0769 | 0.0569 | 29.4755 | 22.61 | 0.494114 | |
| 3 | 1 | 1 | 1 | 2000 | 1 | 2 | 2.4082 | 84.989 | 0.2971 | 0.2122 | 35.2916 | 16.91 | 0.065396 | |
| 4 | 1 | 1 | 1 | 2000 | 1 | 3 | 2.4533 | 86.582 | 0.2971 | 0.2122 | 35.2916 | 16.91 | 0.217702 | |
| 5 | 1 | 1 | 1 | 2000 | 1 | 4 | 3.6829 | 125.502 | 0.6209 | 0.4433 | 34.0771 | 16.5 | 0.066258 | |
| 6 | 1 | 1 | 1 | 2000 | 1 | 5 | 3.7108 | 126.452 | 0.6209 | 0.4433 | 34.0771 | 16.5 | 0.03047 | |
| 7 | 1 | 1 | 1 | 2000 | 1 | 6 | 2.8643 | 102.046 | 0.4563 | 0.3258 | 35.6267 | 10.34 | 0.028452 | |
| 8 | 1 | 1 | 1 | 2000 | 1 | 7 | 5.086 | 157.205 | 0.9809 | 0.7004 | 30.9094 | 10.17 | 0.001015 | |
| 9 | 1 | 1 | 1 | 2000 | 1 | 8 | 7.9752 | 159.605 | 1.2412 | 0.8862 | 20.0126 | 10.02 | 0.000592 | |
| 10 | 1 | 1 | 1 | 2000 | 1 | 9 | 4.6834 | 126.779 | 0.7628 | 0.5446 | 27.0698 | 10.26 | 0.001186 | |
| 11 | 1 | 1 | 1 | 2000 | 1 | 10 | 5.0613 | 133.602 | 1.0336 | 0.738 | 26.3966 | 10.23 | 0.00255 | |
| 12 | 1 | 1 | 1 | 2000 | 1 | 11 | 7.4078 | 166.318 | 1.7181 | 1.2267 | 22.4517 | 10.06 | 0.001229 | |
| 13 | 1 | 1 | 1 | 2000 | 1 | 12 | 8.158 | 171.733 | 2.0367 | 1.4542 | 21.0507 | 10.01 | 0.000005 | |
| 14 | 1 | 1 | 1 | 2000 | 1 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 15 | 1 | 1 | 1 | 2000 | 1 | 14 | 0.7935 | 15.44 | 0.2988 | 0.2134 | 19.4586 | 0 | 0.001166 | |
| 16 | 1 | 1 | 1 | 2000 | 1 | 15 | 2.6205 | 28.181 | 1.7458 | 1.2465 | 10.7539 | 0 | 0.00028 | |
| 17 | 1 | 1 | 1 | 2000 | 1 | 16 | 0.2974 | 13.506 | 0 | 0 | 45.4056 | 0 | 0.009513 | |
| 18 | 1 | 1 | 1 | 2000 | 1 | 17 | 0.3406 | 16.851 | 0.0006 | 0.0004 | 49.4674 | 0 | 0.002789 | |
| 19 | 1 | 1 | 1 | 2000 | 1 | 18 | 0.3851 | 23.951 | 0.0259 | 0.0185 | 62.2014 | 0 | 0.00227 | |
| 20 | 1 | 1 | 1 | 2000 | 1 | 19 | 0.3826 | 24.941 | 0.008 | 0.0057 | 65.185 | 0 | 0.000977 | |
| 21 | 1 | 1 | 1 | 2000 | 1 | 20 | 0.5826 | 37.895 | 0.0553 | 0.0395 | 65.0443 | 0 | 0.005671 | |
| 22 | 1 | 1 | 1 | 2000 | 1 | 21 | 0.7385 | 45.541 | 0.1144 | 0.0817 | 61.6706 | 0 | 0.008572 | |
| 23 | 1 | 1 | 1 | 2000 | 1 | 22 | 0.8257 | 89.992 | 0.5482 | 0.3914 | 108.9881 | 0 | 0.010823 | |
| 24 | 1 | 1 | 1 | 2000 | 1 | 23 | 1.0467 | 175.949 | 0.5514 | 0.3937 | 168.0957 | 0 | 0.038601 | |
| 25 | 1 | 1 | 1 | 2000 | 1 | 24 | 2.5372 | 25.424 | 0 | 0 | 10.0204 | 0 | 0.006229 | |
| 26 | 1 | 1 | 1 | 2000 | 1 | 25 | 10.9871 | 299.18 | 1.7675 | 1.262 | 27.2301 | 9.42 | 0.000597 | |
| 27 | 1 | 1 | 1 | 2000 | 1 | 26 | 1.1166 | 109.058 | 0.0789 | 0.0563 | 97.6678 | 0 | 0.000921 | |
| 28 | 1 | 1 | 1 | 2000 | 1 | 27 | 0.8317 | 22.647 | 0.0068 | 0.0048 | 27.2301 | 0 | 0.001305 | |
| 29 | 1 | 1 | 1 | 2000 | 1 | 28 | 0.653 | 28.644 | 0 | 0 | 43.8645 | 0 | 0.001315 | |
| 30 | 1 | 1 | 1 | 2000 | 2 | 1 | 18.3333 | 540.382 | 0.0769 | 0.0569 | 29.4755 | 22.61 | 0.494114 | |

# Example 15

Using the DATABASE OUTPUT and AGGREGATED OUTPUT commands, generate fleet-average VOC, CO, and NOx emission rates for calendar year 2005.

Compare those results to the results reported in the descriptive output file for this run.

Temperature: 72°F to 92°F
RVP: 8.7 psi
Evaluation month: July

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# Aggregating DATABASE Output (DAILY OUTPUT)

- Daily output results in emissions being reported for each vehicle type, model year, facility type, etc.
- To generate an average g/mi emission rate by vehicle type, model-year specific g/mi emission rates need to be properly weighted (a simple average across all MY **is not** correct)
- Recall (from Day 1) that this weighting factor is the travel fraction
- Although travel fraction is not reported, it can be calculated from the MILES and REGDIST fields:

$$TF_{MY} = (MILES_{MY} * REGDIST_{MY}) \, / \, \Sigma \, (MILES_{MY} * REGDIST_{MY})$$

- Alternatively, the average g/day estimates can be divided by the average mi/day to arrive at g/mi:

$$G\_MI_{Ave} = \Sigma \, (GM\_DAY_{MY} * REGDIST_{MY}) \, / \, \Sigma \, (MILES_{MY} * REGDIST_{MY})$$

- These calcs are performed for each facility type

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# Sample DATABASE Output Using the DAILY OUTPUT Command

| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | FILE | RUN | SCEN | POL | VTYPE | ETYPE | FTYPE | AGE | GM_MILE | GM_DAY | STARTS | ENDS | MILES | MPG | FACVMT | REGDIST | VCOUNT | MYR | |
| 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 4.1236 | 51.959 | 7.28 | 5.3783 | 12.6006 | 14.58 | 0.3421 | 0.0106 | 113.772 | 1976 | |
| 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 23 | 5.3307 | 70.657 | 7.28 | 5.3783 | 13.2548 | 15.32 | 0.3421 | 0.0037 | 113.772 | 1977 | |
| 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 22 | 5.2978 | 73.864 | 7.28 | 5.3783 | 13.9425 | 16.55 | 0.3421 | 0.0046 | 113.772 | 1978 | |
| 5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 21 | 5.2162 | 76.507 | 7.28 | 5.3783 | 14.6672 | 16.83 | 0.3421 | 0.0058 | 113.772 | 1979 | |
| 6 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 20 | 2.855 | 44.048 | 7.28 | 5.3783 | 15.4283 | 19.42 | 0.3421 | 0.0072 | 113.772 | 1980 | |
| 7 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 19 | 1.7922 | 29.085 | 7.28 | 5.3783 | 16.229 | 20.74 | 0.3421 | 0.0087 | 113.772 | 1981 | |
| 8 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 18 | 1.7966 | 30.669 | 7.28 | 5.3783 | 17.0709 | 21.55 | 0.3421 | 0.0113 | 113.772 | 1982 | |
| 9 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 17 | 1.3002 | 23.348 | 7.28 | 5.3783 | 17.958 | 21.52 | 0.3421 | 0.0146 | 113.772 | 1983 | |
| 10 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 16 | 1.219 | 23.026 | 7.28 | 5.3783 | 18.8896 | 21.85 | 0.3421 | 0.0185 | 113.772 | 1984 | |
| 11 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 15 | 1.1414 | 22.679 | 7.28 | 5.3783 | 19.8691 | 22.47 | 0.3421 | 0.0235 | 113.772 | 1985 | |
| 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 14 | 0.8853 | 18.502 | 7.28 | 5.3783 | 20.9 | 23.21 | 0.3421 | 0.0299 | 113.772 | 1986 | |
| 13 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 13 | 0.85 | 18.688 | 7.28 | 5.3783 | 21.9851 | 23.42 | 0.3421 | 0.0377 | 113.772 | 1987 | |
| 14 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 0.4943 | 11.433 | 7.28 | 5.3783 | 23.127 | 23.74 | 0.3421 | 0.0476 | 113.772 | 1988 | |
| 15 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 11 | 0.4813 | 11.708 | 7.28 | 5.3783 | 24.3264 | 23.31 | 0.3421 | 0.056 | 113.772 | 1989 | |
| 16 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 | 0.4524 | 11.576 | 7.28 | 5.3783 | 25.5895 | 23.03 | 0.3421 | 0.0611 | 113.772 | 1990 | |
| 17 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 | 0.4319 | 11.626 | 7.28 | 5.3783 | 26.9184 | 22.73 | 0.3421 | 0.0651 | 113.772 | 1991 | |
| 18 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 | 0.414 | 11.722 | 7.28 | 5.3783 | 28.3152 | 22.71 | 0.3421 | 0.0681 | 113.772 | 1992 | |
| 19 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 7 | 0.3895 | 11.602 | 7.28 | 5.3783 | 29.7845 | 22.68 | 0.3421 | 0.0703 | 113.772 | 1993 | |
| 20 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 6 | 0.3946 | 12.361 | 7.28 | 5.3783 | 31.3298 | 22.66 | 0.3421 | 0.0717 | 113.772 | 1994 | |
| 21 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 5 | 0.3924 | 12.932 | 7.28 | 5.3783 | 32.956 | 22.64 | 0.3421 | 0.0726 | 113.772 | 1995 | |
| 22 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 0.368 | 12.756 | 7.28 | 5.3783 | 34.6665 | 22.64 | 0.3421 | 0.0731 | 113.772 | 1996 | |
| 23 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 0.3199 | 11.667 | 7.28 | 5.3783 | 36.466 | 22.64 | 0.3421 | 0.0733 | 113.772 | 1997 | |
| 24 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 0.2665 | 10.224 | 7.28 | 5.3783 | 38.3579 | 22.64 | 0.3421 | 0.0734 | 113.772 | 1998 | |
| 25 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.2124 | 8.569 | 7.28 | 5.3783 | 40.3492 | 22.64 | 0.3421 | 0.0734 | 113.772 | 1999 | |
| 26 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0.1771 | 7.237 | 7.28 | 5.3783 | 40.8534 | 22.64 | 0.3421 | 0.0184 | 113.772 | 2000 | |
| 27 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 24 | 5.5168 | 40.817 | 8.06 | 5.7531 | 7.3987 | 12.05 | 0.3421 | 0.0369 | 12.5762 | 1976 | |
| 28 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 23 | 7.1961 | 59.827 | 8.06 | 5.7531 | 8.3138 | 13.09 | 0.3421 | 0.0072 | 12.5762 | 1977 | |
| 29 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 22 | 7.1377 | 66.549 | 8.06 | 5.7531 | 9.3235 | 12.78 | 0.3421 | 0.0073 | 12.5762 | 1978 | |
| 30 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 21 | 6.7968 | 70.88 | 8.06 | 5.7531 | 10.4284 | 12.31 | 0.3421 | 0.0076 | 12.5762 | 1979 | |
| 31 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 20 | 6.5437 | 76.111 | 8.06 | 5.7531 | 11.6313 | 15.3 | 0.3421 | 0.0078 | 12.5762 | 1980 | |
| 32 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 19 | 2.7321 | 35.323 | 8.06 | 5.7531 | 12.9287 | 16.43 | 0.3421 | 0.0079 | 12.5762 | 1981 | |
| 33 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 18 | 2.7091 | 38.798 | 8.06 | 5.7531 | 14.3213 | 16.77 | 0.3421 | 0.0083 | 12.5762 | 1982 | |
| 34 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 17 | 2.6241 | 41.493 | 8.06 | 5.7531 | 15.8119 | 17.31 | 0.3421 | 0.0109 | 12.5762 | 1983 | |
| 35 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 16 | 1.4268 | 24.823 | 8.06 | 5.7531 | 17.3969 | 17.02 | 0.3421 | 0.0152 | 12.5762 | 1984 | |
| 36 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 15 | 1.4096 | 26.89 | 8.06 | 5.7531 | 19.0773 | 17.16 | 0.3421 | 0.0203 | 12.5762 | 1985 | |

DB_DAY

# Aggregating DATABASE Output

- As noted on Day 2 of training, there are a number of DATABASE commands that will limit the output records produced:

| Command | Comment | Add'l Data? |
|---|---|---|
| POLLUTANTS | Specifies pollutants | Yes |
| DATABASE EMISSIONS | Specifies emission types | Yes |
| DATABASE FACILITIES | Specifies roadway types | Yes |
| DATABASE VEHICLES | Specifies vehicle classes | Yes |
| DATABASE YEARS | Specifies model years | Yes |
| DATABASE AGES | Specifies vehicle ages | Yes |
| DATABASE HOURS | Specifies hours of the day | Yes |
| DAILY OUTPUT | Average daily emissions | No |
| AGGREGATED OUTPUT | Aggregates ages, MY, etc. | No |

- The format of the above commands are reprinted on the following pages...

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# DATABASE Commands Limiting Output

1 2 3 4 5 6 7 8 ..... 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 ....

**POLLUTANTS :** `HC CO NOX`

<u>Options:</u>
HC
CO
NOX

First Pollutant / Second Pollutant / Third Pollutant

1 2 3 4 5 6 7 8 ..... 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 ....

**DATABASE EMISSIONS :** `2222 1111`

(2=ON; 1=OFF)

Exh Running / Exh Starting / Hot Soak / Diurnal / Evp Resting / Evp Running Loss / Crankcase / Refueling

1 2 3 4 5 6 7 8 ..... 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 ....

**DATABASE FACILITIES:** `LOCAL RAMP ETC...`

<u>Options:</u>
ARTERIAL
FREEWAY
LOCAL
RAMP
NONE (i.e., for exh start and evap processes)

First Facility Type / Second Facility Type, etc.

1 2 3 4 5 6 7 8 ..... 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 ....

**DATABASE YEARS :** `1990,2000`

(Valid Entries = 1928 to 2050)

First MY / Last MY

1 2 3 4 5 6 7 8 ..... 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 ....

**DATABASE AGES :** `09,20`

(Valid Entries = 0 to 24)

First Age / Last Age

1 2 3 4 5 6 7 8 ..... 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 ....

**DATABASE HOURS :** `09,20`

(Valid Entries = 0 to 24)

First Hour / Last Hour

1 2 3 4 5 6 7 8 ..... 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 ....

**DAILY OUTPUT :**
**AGGREGATED OUTPUT :**
No data entry required

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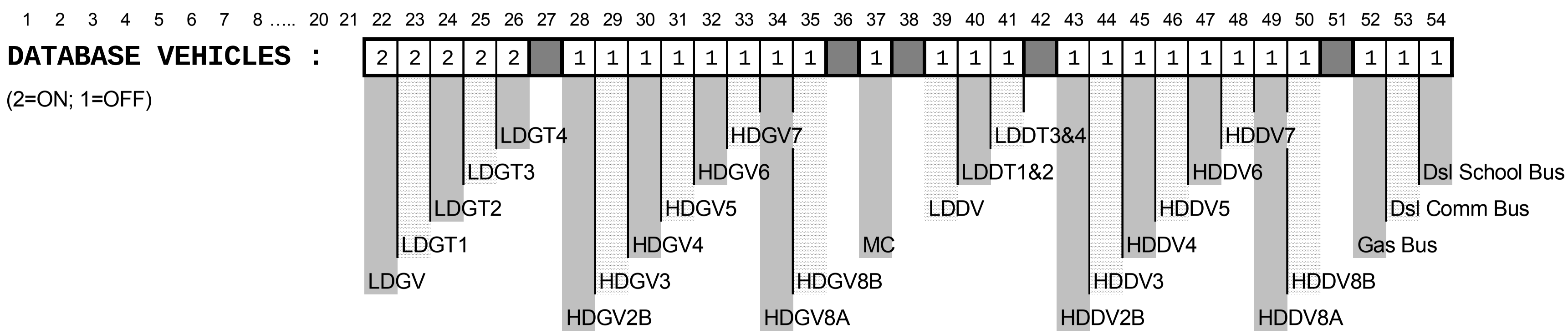
# Database Output – Specifying Vehicle Types

**Commands Limiting Output (Continued)**



# Example 16

Using DATABASE OUTPUT and related DATABASE commands, generate LDGT2 fleet-average running and starting NOx emission rates for calendar year 2005.

Compare those results to the results reported in the descriptive output file for this run.

Temperature: 72°F to 92°F
RVP: 8.7 psi
Evaluation month: July

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# Aggregating DATABASE Output
# (HOURLY OUTPUT)

- Hourly output is the most disaggregated form of DATABASE output
- The methods used to aggregate hourly output are similar to those required for daily output
- Only difference is that hourly results must first be aggregated into daily results with the HRVMT field

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# Sample DATABASE Output Showing Hourly Output

| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | FILE | RUN | SCEN | POL | VTYP | ETYP | FTYP | AGE | HOUR | GM_MILI | GM_HOU | STARTS | ENDS | MILES | MPG | HRVMT | FACVMT | REGDIST | VCOUNT | AMBT | DIURTI | MYR |
| 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 1 | 3.6064 | 2.5854 | 0.1486 | 0.1254 | 0.7169 | 14.58 | 0.0569 | 0.392 | 0.0106 | 113.772 | 72 | 72 | 1976 |
| 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 2 | 3.6226 | 3.3775 | 0.4034 | 0.3255 | 0.9323 | 14.58 | 0.074 | 0.344 | 0.0106 | 113.772 | 72.4 | 72.4 | 1976 |
| 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 3 | 3.4273 | 2.8327 | 0.4389 | 0.3389 | 0.8265 | 14.58 | 0.0656 | 0.338 | 0.0106 | 113.772 | 74.9 | 74.9 | 1976 |
| 5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 4 | 3.497 | 2.4453 | 0.344 | 0.2486 | 0.6993 | 14.58 | 0.0555 | 0.349 | 0.0106 | 113.772 | 78.9 | 78.9 | 1976 |
| 6 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 5 | 3.7156 | 2.528 | 0.376 | 0.2733 | 0.6804 | 14.58 | 0.054 | 0.346 | 0.0106 | 113.772 | 83 | 83 | 1976 |
| 7 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 6 | 4.0101 | 2.9405 | 0.4891 | 0.34 | 0.7333 | 14.58 | 0.0582 | 0.333 | 0.0106 | 113.772 | 86.5 | 86.5 | 1976 |
| 8 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 7 | 4.4482 | 3.4075 | 0.5874 | 0.4196 | 0.766 | 14.58 | 0.0608 | 0.324 | 0.0106 | 113.772 | 89.6 | 89.6 | 1976 |
| 9 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 8 | 4.5765 | 3.2924 | 0.5314 | 0.3938 | 0.7194 | 14.58 | 0.0571 | 0.334 | 0.0106 | 113.772 | 91.3 | 91.3 | 1976 |
| 10 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 9 | 4.7254 | 3.5603 | 0.5851 | 0.4234 | 0.7534 | 14.58 | 0.0598 | 0.334 | 0.0106 | 113.772 | 91.8 | 91.8 | 1976 |
| 11 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 10 | 4.9169 | 3.94 | 0.6537 | 0.4643 | 0.8013 | 14.58 | 0.0636 | 0.32 | 0.0106 | 113.772 | 92 | 92 | 1976 |
| 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 11 | 5.9086 | 5.7844 | 0.6126 | 0.4686 | 0.979 | 14.58 | 0.0777 | 0.33 | 0.0106 | 113.772 | 91.6 | 91.6 | 1976 |
| 13 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 12 | 5.0356 | 4.6315 | 0.5623 | 0.4299 | 0.9198 | 14.58 | 0.073 | 0.312 | 0.0106 | 113.772 | 90.4 | 90.4 | 1976 |
| 14 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 13 | 4.4488 | 2.8082 | 0.4377 | 0.3163 | 0.6312 | 14.58 | 0.0501 | 0.295 | 0.0106 | 113.772 | 88.4 | 88.4 | 1976 |
| 15 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 14 | 3.9879 | 1.9545 | 0.1009 | 0.0737 | 0.4901 | 14.58 | 0.0389 | 0.31 | 0.0106 | 113.772 | 85.8 | 85.8 | 1976 |
| 16 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 15 | 3.5851 | 1.3912 | 0.1009 | 0.0737 | 0.3881 | 14.58 | 0.0308 | 0.329 | 0.0106 | 113.772 | 83.3 | 83.3 | 1976 |
| 17 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 16 | 3.2361 | 1.0764 | 0.1009 | 0.0737 | 0.3326 | 14.58 | 0.0264 | 0.343 | 0.0106 | 113.772 | 81 | 81 | 1976 |
| 18 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 17 | 3.0173 | 0.7375 | 0.1009 | 0.0737 | 0.2444 | 14.58 | 0.0194 | 0.381 | 0.0106 | 113.772 | 79.4 | 79.4 | 1976 |
| 19 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 18 | 2.8538 | 0.5178 | 0.1009 | 0.0737 | 0.1814 | 14.58 | 0.0144 | 0.405 | 0.0106 | 113.772 | 77.8 | 77.8 | 1976 |
| 20 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 19 | 2.704 | 0.3679 | 0.1009 | 0.0737 | 0.1361 | 14.58 | 0.0108 | 0.426 | 0.0106 | 113.772 | 76.3 | 76.3 | 1976 |
| 21 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 20 | 2.6209 | 0.284 | 0.1009 | 0.0737 | 0.1084 | 14.58 | 0.0086 | 0.443 | 0.0106 | 113.772 | 75.2 | 75.2 | 1976 |
| 22 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 21 | 2.606 | 0.266 | 0.1009 | 0.0737 | 0.1021 | 14.58 | 0.0081 | 0.457 | 0.0106 | 113.772 | 74.3 | 74.3 | 1976 |
| 23 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 22 | 2.6209 | 0.2642 | 0.1009 | 0.0737 | 0.1008 | 14.58 | 0.008 | 0.461 | 0.0106 | 113.772 | 73.6 | 73.6 | 1976 |
| 24 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 23 | 2.6741 | 0.3302 | 0.1009 | 0.0737 | 0.1235 | 14.58 | 0.0098 | 0.453 | 0.0106 | 113.772 | 73.1 | 73.1 | 1976 |
| 25 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 24 | 2.713 | 0.6358 | 0.1009 | 0.0737 | 0.2343 | 14.58 | 0.0186 | 0.418 | 0.0106 | 113.772 | 72.5 | 72.5 | 1976 |
| 26 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 24 | 1 | 3.6048 | 2.5843 | 0.1486 | 0.1254 | 0.7169 | 14.58 | 0.0569 | 0.457 | 0.0106 | 113.772 | 72 | 72 | 1976 |
| 27 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 24 | 2 | 3.7812 | 3.5254 | 0.4034 | 0.3255 | 0.9323 | 14.58 | 0.074 | 0.497 | 0.0106 | 113.772 | 72.4 | 72.4 | 1976 |
| 28 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 24 | 3 | 3.6183 | 2.9906 | 0.4389 | 0.3389 | 0.8265 | 14.58 | 0.0656 | 0.497 | 0.0106 | 113.772 | 74.9 | 74.9 | 1976 |
| 29 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 24 | 4 | 3.8862 | 2.7175 | 0.344 | 0.2486 | 0.6993 | 14.58 | 0.0555 | 0.492 | 0.0106 | 113.772 | 78.9 | 78.9 | 1976 |
| 30 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 24 | 5 | 4.3066 | 2.93 | 0.376 | 0.2733 | 0.6804 | 14.58 | 0.054 | 0.497 | 0.0106 | 113.772 | 83 | 83 | 1976 |
| 31 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 24 | 6 | 4.7919 | 3.5138 | 0.4891 | 0.34 | 0.7333 | 14.58 | 0.0582 | 0.509 | 0.0106 | 113.772 | 86.5 | 86.5 | 1976 |
| 32 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 24 | 7 | 5.246 | 4.0186 | 0.5874 | 0.4196 | 0.766 | 14.58 | 0.0608 | 0.516 | 0.0106 | 113.772 | 89.6 | 89.6 | 1976 |
| 33 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 24 | 8 | 5.3738 | 3.8661 | 0.5314 | 0.3938 | 0.7194 | 14.58 | 0.0571 | 0.506 | 0.0106 | 113.772 | 91.3 | 91.3 | 1976 |
| 34 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 24 | 9 | 5.4782 | 4.1275 | 0.5851 | 0.4234 | 0.7534 | 14.58 | 0.0598 | 0.506 | 0.0106 | 113.772 | 91.8 | 91.8 | 1976 |
| 35 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 24 | 10 | 5.6331 | 4.5139 | 0.6537 | 0.4643 | 0.8013 | 14.58 | 0.0636 | 0.519 | 0.0106 | 113.772 | 92 | 92 | 1976 |
| 36 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 24 | 11 | 5.9795 | 5.8537 | 0.6126 | 0.4686 | 0.979 | 14.58 | 0.0777 | 0.506 | 0.0106 | 113.772 | 91.6 | 91.6 | 1976 |
| 37 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 24 | 12 | 5.6417 | 5.1889 | 0.5623 | 0.4299 | 0.9198 | 14.58 | 0.073 | 0.521 | 0.0106 | 113.772 | 90.4 | 90.4 | 1976 |

DB_HOUR

# Example 17

Using DATABASE OUTPUT and related DATABASE commands, generate hourly diurnal and resting loss emission rates for 1999 and 1994 model year LDGVs in calendar year 2005.

Plot the hourly combined diurnal + resting loss VOC emission rates for the two model years along with the diurnal temperature profile.

Temperature: 72°F to 92°F
RVP: 8.7 psi
Evaluation month: July

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# Working with Model Year Output

- Needed for many control measure analyses
- The approach for aggregating model year output into a fleet-average result was described above
  - Generate travel fractions
  - Compile fleet-average emission factors
- Similarly, Database output can be used to generate vehicle lifetime emission rates (often needed for cost-effectiveness calculations)

## Vehicle Lifetime Emissions Estimates

- "Quick and Dirty" Method
  - Assume a 10-year life
  - Generate emission factors for years 1 to 10
  - Apply annual mileage accumulation rates (function of age) to the emission factors
  - Sum over the 10-year life

- More Precise Method
  - Assume a 25-year life
  - Generate emission factors for years 1 to 25
  - Apply annual mileage accumulation rates (function of age) to the emission factors
  - Apply survival curve to each vehicle age
  - Discount HC/NOx for ozone season
  - Discount CO for CO season
  - Discount emissions to present value
  - Sum over the 25-year life

- Depending on the purpose of the analysis, discounting is sometimes ignored

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# Vehicle Survival/Attrition Curves

- Several sources of vehicle survival/attrition curves:
  - ORNL and NHTSA (used in Tier 2 rulemaking)
  - CARB's EMFAC model
  - Possibly through analysis of DMV data
- For this course, we will use the NHTSA curves

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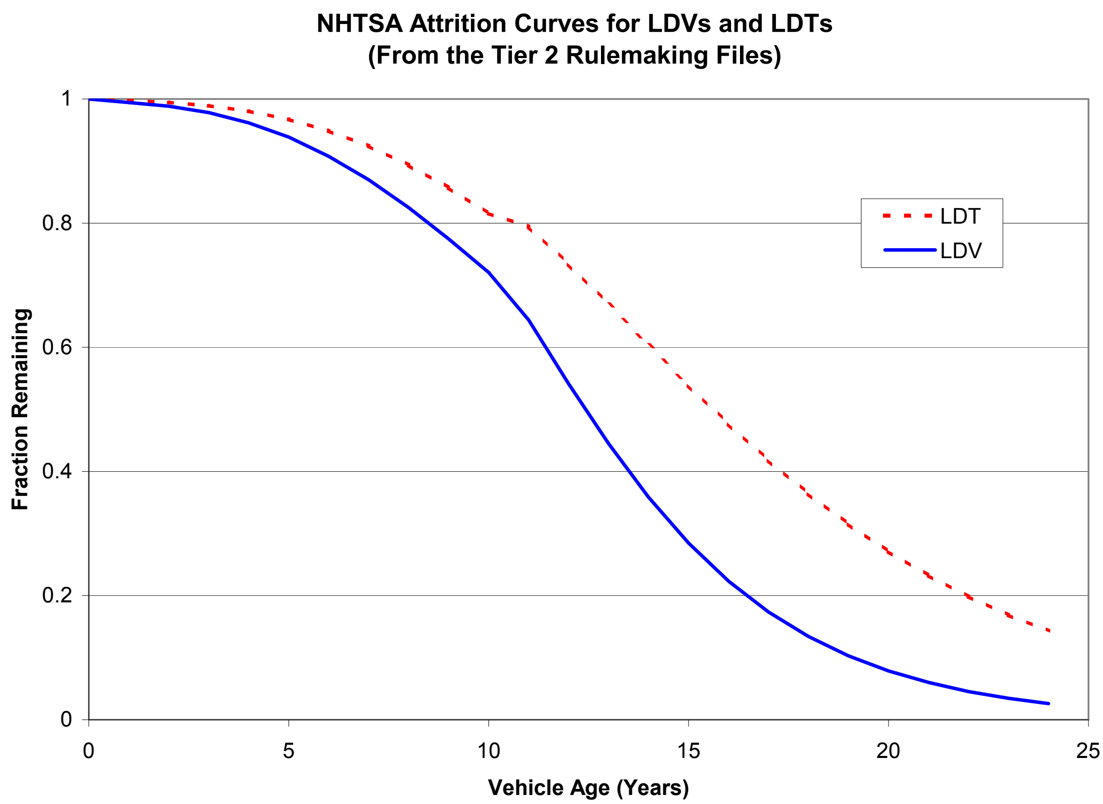


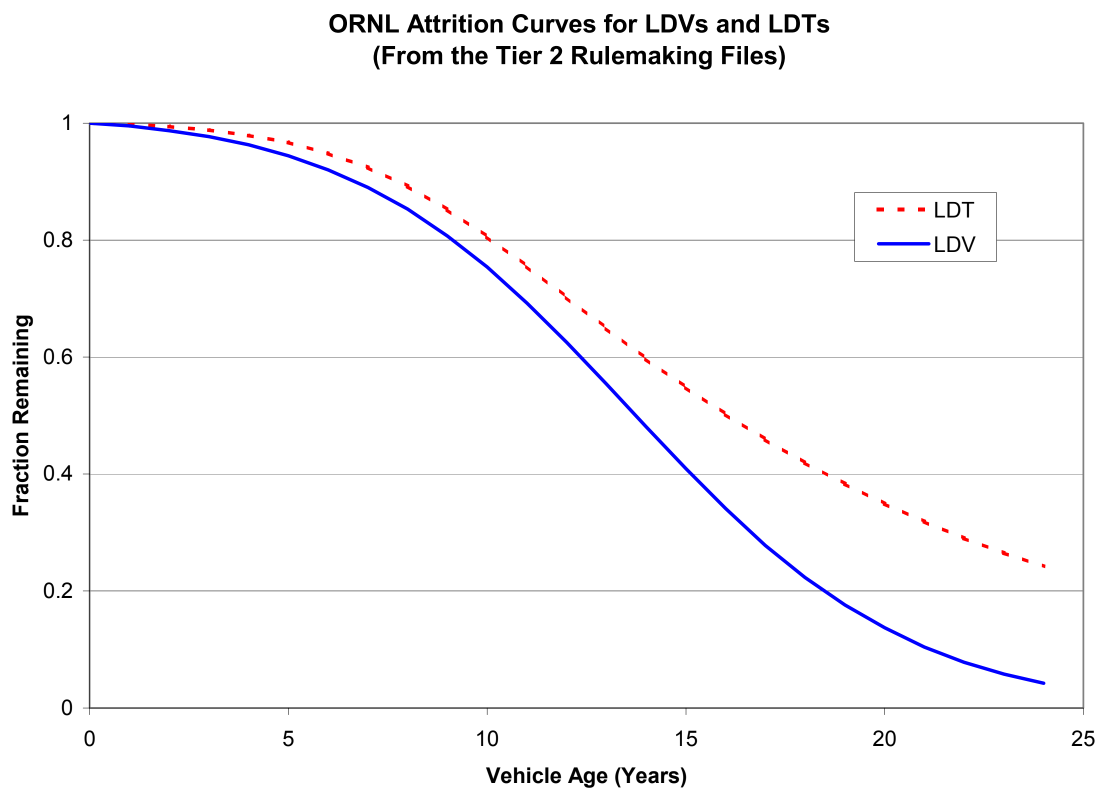




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# Sample Spreadsheet
# Lifetime NOx Emissions from a Tier 2 LDGV

| | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|
| 131 | | **Lifetime NOx Emissions from a Tier 2 LDGV** | | | | | | | |
| 132 | | **(Emission Factors Based on MOBILE6 without I/M)** | | | | | | | |
| 133 | | | | | | | | | |
| 134 | | | NHTSA | | | | Annual NOx (lb/yr) | | |
| 135 | | | Attrition | Annual | NOx | | No | With | |
| 136 | | AGE | Curve | Miles | (g/mi) | | Attrition | Attrition | |
| 137 | | 0 | 1.000 | | 0.025 | | | | |
| 138 | | 1 | 0.995 | 14911 | 0.029 | | 0.894 | 0.891 | |
| 139 | | 2 | 0.988 | 14727 | 0.040 | | 1.132 | 1.122 | |
| 140 | | 3 | 0.978 | 14001 | 0.077 | | 1.810 | 1.780 | |
| 141 | | 4 | 0.962 | 13310 | 0.114 | | 2.798 | 2.714 | |
| 142 | | 5 | 0.938 | 12653 | 0.151 | | 3.699 | 3.514 | |
| 143 | | 6 | 0.908 | 12029 | 0.190 | | 4.522 | 4.174 | |
| 144 | | 7 | 0.870 | 11435 | 0.232 | | 5.311 | 4.721 | |
| 145 | | 8 | 0.825 | 10871 | 0.274 | | 6.062 | 5.138 | |
| 146 | | 9 | 0.775 | 10335 | 0.318 | | 6.748 | 5.398 | |
| 147 | | 10 | 0.721 | 9825 | 0.363 | | 7.376 | 5.515 | |
| 148 | | 11 | 0.644 | 9340 | 0.409 | | 7.947 | 5.422 | |
| 149 | | 12 | 0.541 | 8879 | 0.456 | | 8.465 | 5.017 | |
| 150 | | 13 | 0.445 | 8441 | 0.503 | | 8.926 | 4.400 | |
| 151 | | 14 | 0.358 | 8025 | 0.553 | | 9.343 | 3.751 | |
| 152 | | 15 | 0.285 | 7629 | 0.604 | | 9.727 | 3.127 | |
| 153 | | 16 | 0.223 | 7252 | 0.656 | | 10.072 | 2.557 | |
| 154 | | 17 | 0.174 | 6895 | 0.710 | | 10.382 | 2.060 | |
| 155 | | 18 | 0.134 | 6555 | 0.764 | | 10.651 | 1.638 | |
| 156 | | 19 | 0.103 | 6231 | 0.821 | | 10.889 | 1.290 | |
| 157 | | 20 | 0.079 | 5924 | 0.880 | | 11.106 | 1.008 | |
| 158 | | 21 | 0.060 | 5631 | 0.940 | | 11.298 | 0.783 | |
| 159 | | 22 | 0.046 | 5354 | 1.003 | | 11.465 | 0.605 | |
| 160 | | 23 | 0.035 | 5089 | 1.067 | | 11.609 | 0.465 | |
| 161 | | 24 | 0.026 | 4838 | 1.133 | | 11.733 | 0.357 | |
| 162 | | | | | | | | | |
| 163 | | | **Lifetime NOx Emissions (lbs.):** | | | | **184** | **67** | |

DB_TIER2

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# Example 18

Using DATABASE OUTPUT and related DATABASE commands, generate vehicle lifetime VOC (exhaust and evap separate) and NOx emissions estimates for a Tier 2 LDGV. Use the NHTSA attrition curve. Also generate the net present value of emissions reductions using a discount rate of 7%. (Results to be used later.)

Temperature: 72°F to 92°F
RVP: 8.7 psi
Evaluation month: July

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# IX. CONTROL MEASURE ANALYSIS

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# Control Measure Analysis
# Measures Analyzed Directly with MOBILE6

- I/M program changes
- Fuel property changes
- Tier 2 (fuels and vehicles)
- California LEVs and fleet rules
- Natural gas vehicles
- HDDV emission standards

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# Control Measure Analysis
# Measures Requiring "Off-Model" Calculations

- Vehicle scrappage
- Catalyst/oxygen sensor replacement program
- Rebuild/Retrofit programs
- Gas cap replacement program
- Canister replacement program

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## Issues to Consider

- How long will benefit last (e.g., scrappage, catalyst replacement)?
- Does the measure result in a net reduction, or are emissions shifted (e.g., fleet rules)?
- Will the reduction occur anyway (e.g., certain fuels measures are somewhat dubious because of Tier 2 sulfur control)?
- Can the measure be reasonably implemented?
- What are the costs of the measure?
- Where does one get data for off-model analyses?
- Is it important to use local data in the calculations?

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# MEASURES ANALYZED DIRECTLY WITH MOBILE6

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# I/M Program Measures

- Implementation of an I/M program, or I/M program changes, is one of the most common of locally developed measures

- There is a vast array of program features that must be considered, many of which impact the benefits of the program:

  - Test frequency
  - Test type and cutpoint stringency
  - Model year coverage
  - Vehicle type coverage
  - Program type (test-only vs. test-and-repair)
  - Repair cost ceiling/waiver rate
  - Technician training and certification

- The impact of some of these will be investigated in the example that follows

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# Example 19

Determine the impact on CY2005 LDGV fleet-average emissions of changing from an annual idle I/M program to a biennial 2-mode ASM program using phase-in cutpoints.

Assuming that test costs increase from $12 to $20, what is the test cost differential for the LDGV fleet?

How do the emissions results change if OBD testing is applied to 1996 and newer model year vehicles instead of ASM testing?  Assume $14 for an OBD inspection.

How do the emission results and test costs change if the first inspection is performed at age 5?

Temperature:  72˚F to 92˚F
RVP:  8.7 psi
Evaluation month:  July
Program start year:  1983
Model year coverage:  All
Waiver rate:  8%
Compliance rate:  95%
Stringency:  20%
No TTC Credits

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# Fuel Property Changes

- Fuel property changes can also be implemented by state and local agencies
- The most common fuel measures are:
  - Winter oxygenate
  - RFG opt-in
  - RVP control

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# Example 20

Determine the impact on CY2005 fleet-average emissions of reducing maximum RVP from 9.0 to 7.0 psi.

Assuming that this level of control will cost 2.5 cents per gallon, what is the cost-effectiveness of this measure?

Temperature: 72°F to 92°F
Evaluation month: July
RVP: 8.7 psi (9.0 psi limit)
RVP: 6.9 psi (7.0 psi limit)

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## New Light-Duty Vehicle Controls (Tier 2 and LEVs)

- MOBILE6 is configured to allow users the option of entering alternative implementation schedules for Tier 2 and LEV-category vehicles (similar to the PROMPT=5 flag in MOBILE5)

- This allows for relatively easy modeling of the emissions impacts of different new vehicle standards

- However, it is likely that the most common use of these features will be to model the impacts of the California LEV program

- That is because the Clean Air Act prevents states from adopting standards that would result in a "Third Car"

- Recall that MOBILE6 rule implementation commands were briefly covered on Day 2 (see next page for summary of commands)

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## Summary of MOBILE6 Rule Implementation Commands

| MOBILE6 Command | Header/ Run/ Scenario? | Comment |
|---|---|---|
| NGV FRACTION : NGVFR.D[a] | R | Natural Gas Vehicle Fractions |
| NGV EF : NGVEF2.D | R | NGV Emission Factors |
| NO CLEAN AIR ACT : | R | Turn Off Effects of 1990 CAAA |
| 94+ LDG IMP : P94IMP.D | R | Alt Tier 1/LEV Implementation |
| NO TIER 2 : | R | Turn Off Effects of Tier 2 Rule |
| T2 CERT : T2CERT.D | R | Alt Tier 2 Stds (for CA LEV II Rule) |
| T2 EXH PHASE-IN : T2EXH.D | R | Alt Phase-in Fractions for Exhaust |
| T2 EVAP PHASE-IN : T2EVAP.D | R | Alt Phase-in Fractions for Evap |
| NO DEFEAT DEVICE : | R | Turn Off Effects of HDDV Off-Cycle |
| NO NOX PULL AHEAD : | R | Turn Off HDDV NOx Pull Ahead |
| NO REBUILD : | R | Turn Off HDDV Rebuild Program |
| REBUILD EFFECTS : 0.50 | R | Alt Effectiveness of Rebuild |
| NO 2007 HDDV RULE : | R | Turn Off 2007 HDDV Rule |

[a] File names refer to the default, or template, files provided with the model.

# MOBILE6 Commands that Impact Tier 2 and LEV Implementation

- `NO TIER 2 :`

  Turns off the impact of Tier 2, including fuel requirements; continues the NLEV program through 2050 with default CY2000 sulfur levels

- `T2 EXH PHASE-IN : T2EXH.D`

  Replaces the default phase-in fractions for Tier 2 exhaust standards, allowing different phase-in schedules to be modeled

- `T2 EVAP PHASE-IN : T2EVAP.D`

  Replaces the default phase-in fractions for Tier 2 evaporative standards, allowing different phase-in schedules to be modeled

- `T2 CERT : T2CERT.D`

  Allows user to specify alternative Tier 2 50,000-mile emission standards (used to model LEV II)

- `94+ LDG IMP : P94IMP.D`

  Allows optional 1994 and later fleet fractions for Tier 1, NLEV (or CA LEV), and Tier 2 standards

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# 94+ LDG IMP Command

- This command (and the P94IMP.D file) is very similar to PROMPT=5 and NLEV.D file from MOBILE5:

```
* P94IMP.D File from MOBILE6 distribution disk
* LDGV
* T0    T1     T1     T2    TLEV  TLEV  LEV    LEV    ULEV  ULEV  ZEV
*     (int)               (int)       (int)         (int)
  0.6   0.4   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0  /94
  0.2   0.8   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0  /95
  0.0   0.6   0.4   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0  /96
  0.0   0.2   0.8   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0  /97
  0.0   0.0   1.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0  /98
  0.0   0.0   1.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0  /99
  0.0   0.0   1.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0  /00
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   1.0   0.0   0.0   0.0  /01
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   1.0   0.0   0.0   0.0  /02
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   1.0   0.0   0.0   0.0  /03
  0.0   0.0   0.0   1.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0  /04
  0.0   0.0   0.0   1.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0  /05
  0.0   0.0   0.0   1.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0  /06
   .
   .
  0.0   0.0   0.0   1.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0  /25

* LDGT1
  0.6   0.4   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0  /94
  0.2   0.8   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0  /95
  0.0   0.6   0.4   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0  /96
  0.0   0.2   0.8   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0  /97
  0.0   0.0   1.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0  /98
  0.0   0.0   1.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0  /99
  0.0   0.0   1.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0  /00
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   1.0   0.0   0.0   0.0  /01
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   1.0   0.0   0.0   0.0  /02
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   1.0   0.0   0.0   0.0  /03
  0.0   0.0   0.0   1.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0  /04
  0.0   0.0   0.0   1.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0  /05
  0.0   0.0   0.0   1.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0  /06
   .
   .
   .
```

# Example 21

Modify the P94IMP.D file to reflect the NLEV phase-in percentages for the Northeast and compare VOC and NOx results from a CY2005 run to the default MOBILE6 estimates.

Assume the following Northeast implementation:

1999 MY = 40% Tier 1 / 60% LEV
2000 MY = 10% Tier 1 / 90% LEV
2001 MY = 100% LEV

Temperature: 72°F to 92°F
RVP: 8.7 psi
Evaluation month: July

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## Example 22

Using DATABASE OUTPUT and related DATABASE commands, generate vehicle lifetime VOC (exhaust and evap separate) and NOx emissions estimates for LDGVs certified to NLEV emission standards. Use the NHTSA attrition curve. Calculate the net present value of the emission reductions using a discount rate of 7%. (See Example 18.)

Compare these results to the lifetime emissions from Tier 2 vehicles calculated in Example 18.

If the cost of Tier 2 control relative to NLEV for LDGVs is $100 per vehicle and the fuel cost differential is 2 cents per gallon, what is the incremental cost-effectiveness of Tier 2 control (use the net present value of emissions and costs)?

Temperature: 72°F to 92°F
RVP: 8.7 psi
Evaluation month: July



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# Example 23

If a light-duty natural gas vehicle (NGV) is certified to Tier 2 exhaust emission standards, what are the lifetime evaporative benefits from that vehicle? (See Example 18.) If the cost differential for an NGV is $2,000, what is the cost-effectiveness of implementing NGVs? (Ignore fuel cost differences.)

If a zero-emission vehicle costs $21,000 more than a Tier 2 vehicle, what is the cost-effectiveness of implementing ZEVs? (Ignore power plant emissions, assume a ZEV fully replaces a conventional vehicle, and ignore the impact that higher new vehicle costs will have on the retention of older vehicles.)

Temperature: 72°F to 92°F
RVP: 8.7 psi
Evaluation month: July

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# Modifying Tier 2 Implementation

- The most likely use of this feature is to model the impacts of the California LEV II program (e.g., in New York and Massachusetts)
- EPA has not yet issued guidance on how to properly modify the Tier 2 schedule to reflect the LEV II program
- As a result, we will just introduce the mechanics of making this change
- The following commands are used, and the appropriate revisions to the data files would need to be made:

```
T2 EXH PHASE-IN     : T2EXH.D
T2 EVAP PHASE-IN    : T2EVAP.D
T2 CERT             : T2CERT.D
```

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## Natural Gas Vehicles

- The per-vehicle lifetime emissions and cost-effectiveness of light-duty NGVs was discussed in Example 23 (assuming the only benefit was for evap)

- It is also possible to estimate the impact of NGVs on fleet-average emissions directly with MOBILE6 using the following commands:

```
NGV FRACTION          : NGVFR.D
NGV EF                : NGVEF2.D
```

- NGVFR.D allows the user to specify the percent of NGVs in each of 28 vehicle classes for model years 1994 to 2050

- NGVEF2.D allows the user to enter alternate NGV emission factors for each of 28 vehicle classes, three pollutants, and for running and start emissions (where applicable); it <u>does not</u> allow emission factors by model year

- Beware of MY2004+ default emission factors for NGVs

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# Example 24
# (Time Permitting)

Assume that 10% of the LDGV fleet sold between 1998 and 2003 consisted of NGVs. Modify the NGVFR.D file to reflect this and run MOBILE6. What is the impact on fleet-average VOC, CO, and NOx emissions?

Temperature: 72°F to 92°F
RVP: 8.7 psi
Evaluation month: July

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# MEASURES REQUIRING “OFF-MODEL” CALCULATIONS

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# Control Measure Analysis
# Measures Requiring “Off-Model” Calculations

- Vehicle scrappage
- Rebuild/Retrofit programs
- Catalyst/oxygen sensor replacement program
- Gas cap replacement program
- Canister replacement program
- etc.

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# "Off-Model" Analyses

- Although the measures analyzed directly with MOBILE6 sometimes needed additional spreadsheet work, the estimates were based directly on output from MOBILE6

- In certain cases it becomes necessary to perform analyses outside the model

- These measures are typically analyzed by:

  - Preparing baseline model year output;

  - Modifying the emission factors, registration distribution, and/or travel fraction to account for the impact of the proposed control measure; and

  - Recalculating the fleet-average emission rate.

# Example 25

Using the input file from Example 16, run MOBILE6 to obtain LDGV model-year specific VOC, CO, and NOx emission rates for calendar year 2005. Also obtain model-year specific NOx estimates for Class 8B HDDVs.

Set up a spreadsheet to generate fleet-average VOC, CO, and NOx emission rates for LDGVs, and a spreadsheet to generate fleet-average NOx emission rates for Class 8B HDDVs.

Temperature: 72°F to 92°F<br>RVP: 8.7 psi<br>Evaluation month: July

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## Accelerated Vehicle Retirement (Vehicle Scrappage)

- Because of the high emissions associated with older vehicles, vehicle scrappage is sometimes considered as a potential control strategy
- Under a scrappage program, old vehicles are purchased for a set bounty (e.g., $500 or $1,000) and are removed from the road
- In the simplest case, it is assumed that:
  - Scrapped vehicles have an emission rate equivalent to an average vehicle of the same age
  - Overall fleet VMT is conserved (i.e., the miles lost from the scrapped vehicle are made up by other vehicles)
  - Replacement vehicle VMT is equivalent to the overall fleet-average emission rate
- Under the above case, a scrappage program can be evaluated by simply modifying the registration distribution

# Example 26

Using the spreadsheet generated in Example 25, estimate the LDGV fleet-average VOC, CO, and NOx emission benefits of a scrappage program. Assume that 5% of the 15 year and older vehicle have been removed from the fleet by 2005 and are replaced with fleet average vehicles.

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# Retrofit/Rebuild Programs

- Retrofit or rebuild programs are also sometimes considered viable options for additional control of the in-use fleet

- Most recently, the focus has been on rebuild programs aimed at heavy-duty Diesel vehicles

- The approach for analyzing the emissions impacts of such a measure consists of:

  - Determining how many vehicles have been retrofit;

  - Determining the per-vehicle emissions impact;

  - Modifying the model-year specific emission rate accordingly; and

  - Recalculating the fleet-average emission rate with the same travel fraction.

# Example 27

Using the spreadsheet generated in Example 25, estimate the benefits of a rebuild/retrofit program aimed at 1990 through 1997 model year Class 8B HDDVs. Assume that 20% of the fleet would have been rebuilt by 2005, and that the rebuild would result in a decrease in NOx emissions of 60%.

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## More Detailed "Off-Model" Analyses

- The above two examples were fairly simple in terms of analysis techniques
- Although the same general principals apply to most off-model analyses, there are certain cases in which the model-year specific emission rates need to be carefully evaluated
- This often requires one to break-out normal emitters from high emitters (e.g., for an oxygen sensor replacement program), repair the highs, and recalculate fleet-average emissions
- The most direct way to accomplish this is to review the source code and place WRITE statements at suitable locations
- Unfortunately, that level of detail is beyond the scope of this course

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