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Assessment and Modeling Division
Office of Mobile Sources
U.S. Environmental Protection Agency

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- Draft -

Evaluating Multiple Day Diurnal Evaporative Emissions Using RTD Tests

Report Number M6.EVP.003

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U.S. EPA Assessment and Modeling Division

1.0 INTRODUCTION and BACKGROUND

This report documents an analysis of diurnal evaporative emissions from light-duty vehicles (LDVs) and light-duty trucks (LDTs) occurring over periods of more than one day. Results of this study will be used in MOBILE6 in conjunction with estimates of vehicle and truck activity and estimates of evaporative emissions for shorter periods to obtain total diurnal emission values.

The underlying causes of diurnal evaporative emissions are discussed at length in several reports[1,2,3]. By definition, diurnals are those emissions associated with daily temperature change and its effect on vaporization of a vehicle's fuel and the expansion of fuel vapor. The evolution of technology and regulations is assumed to influence diurnal emission rates. These trends also are discussed in the references cited above. In the modeling of multiple day diurnals presented here, several categories of vehicles are considered, based on model year, fuel metering and purge/pressure test[1]. These are chosen to achieve consistency with groupings employed in the MOBILE emissions inventory model.

2.0 DATA SOURCES

In this analysis, EPA considered real-time diurnal (RTD) test data from testing programs (i.e., work assignments) performed under contract for EPA. The data consist of hourly values of HC emissions (in grams) measured under varying conditions of fuel Reid vapor pressure (RVP) and ambient temperature. Daily totals are obtained directly from these hourly values.

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[1]Landman, L. "Evaluating Resting Loss and Diurnal Evaporative Emissions Using RTD Tests," Report No. M6.RTD.001.

[2]Heirigs, P.L. and R.G. Dulla, "Analysis of Real-Time Evaporative Emissions Data," Sierra Research, Report No. SR97-12-01, December, 1997.

[3]Haskew, H.H. and T.F. Liberty, "Diurnal Emissions from In-Use Vehicles," Coordinating Research Council, CRC E-9, January, 1998.

The RTD testing performed for EPA was done by its testing contractor (Automotive Testing Laboratories) over the course of five (5) work assignments from 1994 through 1996 (performed under three different EPA contracts). A total of 119 light-duty vehicles (LDVs) and light-duty trucks (LDTs) were tested in these programs. Table 1 displays the distribution of vehicles and individual tests by several characteristics. Of special interest is the length of the tests, ranging from 33 to 72 hours. More complete descriptions of these data are found in the reports cited earlier.

Other reports on diurnal emissions utilize data from a testing program performed for the Coordinating Research Council (CRC). However, because all these tests were run for 24 hours only, and yield no information on multiple day emissions, they are not employed in the current study.

In addition, the two EPA vehicles identified as "gross liquid leakers" are omitted from these analyses. The emissions of these vehicles are large, tending to skew estimates for non-leakers, while the mechanisms by which emissions are produced are quite different from the two groups. EPA proposes to treat multiple day emissions from gross liquid leakers as constant.

3.0 METHODOLOGY

This work involves estimating the change in diurnal evaporative emissions from the first day to later days. In the MOBILE model these estimates can be used to determine emissions for full Days 2 and 3 given total emissions for Day 1. These in turn can be subdivided into hourly values as needed.

When modeling RTD emissions, potential explanatory factors include fuel metering technology, model year, and outcome of purge and pressure tests performed on the vehicle. Ambient temperature and fuel volatility also are known to play a central role.

3.1 Model Form

The percent change in emissions from one day to the next can be modeled by expressing the natural logarithm of emissions as a linear function of potential explanatory factors:

$$\ln(\text{Emissions}) = b_0 + b_1X_1 + b_2X_2 + ... + b_kX_k$$

where the b_j coefficients are constants and the X_j's are factors related to emissions. In this model, the coefficient b_j is interpreted as an approximate measure of the percentage change in emissions per unit change in X_j when the other factors are unchanged (see Appendix).

Consider the following representation of multiple day diurnal evaporative emissions:

$$\ln(HC) = b_0 + b_1D + b_2P_1{*}D + b_3P_2{*}D + b_4Y_1{*}D + b_5Y_2{*}D + b_6F{*}D + b_7R + b_8T$$

where dummy variables are used to switch on or off the categorical factors of day, purge/pressure test status, model year, and fuel metering:

D = 0 if day i, 1 if day i+1;
P_1 = 1 if vehicle fails the purge test and passes the pressure test (F/P), 0 otherwise;
P_2 = 1 if vehicle fails the pressure test (P/F or F/F: these outcomes are combined due to lack of data), 0 otherwise;
Y_1 = 1 for pre-1980 model years; 0 otherwise;
Y_2 = 1 for 1980-85 model years; 0 otherwise;
F = 1 for carbureted vehicles; 0 for fuel injected;

and

R = Reid vapor pressure (pounds per square inch);
T = temperature (degrees Fahrenheit).

The nominal factors are chosen because they represent the categories to be used in MOBILE6. As shown in the Appendix, for a given combination of purge/pressure status, model year range, and fuel metering, the percent change in HC from Day i to Day i+1 is given by:

$$b_1 + b_2P_1 + b_3P_2 + b_4Y_1 + b_5Y_2 + b_6F \qquad (1)$$

For example, with 1986-96 fuel injected vehicles that fail the pressure test, the percent change over a one day period is

$$b_1 + b_3P_2 \qquad (2)$$

For the continuous variables of Reid vapor pressure and temperature, the coefficients (b_7 and b_8) represent the percent change in emissions per unit change in the given variable.

3.2 Model Estimation

The above model can be fitted using ordinary least squares regression. In order to account for additional variation, a vehicle factor was included. This effectively fits a different intercept term to each vehicle and helps produce sharper estimates of the coefficients shown above. The goal of the analysis is to obtain point estimates of the linear combinations of the type shown in equation (2). Given the categories of fuel metering, model year and purge/pressure test status, a total of 18 different values can be estimated for each day (and vapor pressure/temperature combination). This number can be reduced if there is insufficient evidence to justify separating categories. That approach is adopted in the analysis reported below.

Because the available data include tests of varying length, it is difficult to compare emission values from all tests for the purpose of estimating full day changes. In particular, complete 72-hour tests are available in only six of the technology, model year and pressure purge test status categories. However, as seen in Table 1, there are a large number of EPA 33-hour and 38-hour tests, and these provide more complete coverage of the categories. These tests give some indication of change in evaporative emissions from the first day to the second. One way to use these data is to consider only the first nine hours of each day, since the 33-hour tests give only that number of hours in Day 2. If it is assumed that the total emissions in the first nine hours are comparable across days then the effective data set numbers 564 tests.

4.0 Initial Results

Two models were fitted to the 9-hour data described above, one for Days 1 and 2, and the other for Days 2 and 3. Regression coefficient estimates, computed using the SAS GLM procedure, are found in Tables 2(a) and 2(b), respectively.

4.1 Effect of Fuel Metering, Pressure/Purge Test Status, and Model Year

In both models, neither of the model year terms is statistically significant. Therefore, as a first step toward simplification, the model year factor was removed from the analysis. Refitting the models gives estimates shown in Tables 3(a) and 3(b). In the Day 1-to-Day 2 equation, all terms are significant. For Day 2-to-Day 3, the purge/pressure test terms are not significant, possibly because 23 of the 26 vehicles tested for three days were from the single pass/pass purge/pressure group.

Actual percentage effects from the various combinations of fuel metering and purge/pressure test status can be estimated using the ESTIMATE feature of the SAS GLM procedure. This is applied to the linear functions illustrated by equation (2). Tables 3(a) and 3(b) display the results. Across the two models, the only percent change that is clearly different than zero is for the class of fuel injected vehicles that pass both purge and pressure tests. For the Day 1-to-Day 2 model, two other categories are significant at the five percent level: fuel injected vehicles that fail the purge test and carbureted pass/fail vehicles. However, when the three categories of pressure/purge test result are compared on a pairwise basis, it is seen that the F/P and (F/F or P/F) groups do not differ significantly ($p=0.5423$). Therefore, a further simplification is proposed in which a vehicle is classed as “PASS” (pass both tests) or “FAIL” (fail one or both tests). Table 4 gives results for the model using this classification.

Table 5 shows estimates for the Day 1-to-Day 2 changes when the sample includes only the vehicles for which 72-hour data was collected. This is the same subsample that applies to the Day 2-to-Day 3 estimates. Therefore, the values are more directly comparable for the two sets of estimates. For this reduced set, only the percentage effect for the fuel injected P/P group is significant, and its value is substantially larger than for the full sample (49.6% vs. 36.5%).

Using the values from Tables 3 to 5, the following recommendations are made for multiple day percent changes to be used in MOBILE6:

1. Fuel-injected vehicles passing both purge and pressure tests. Point estimate percentage increases are **36.5%** for Day 1-to-Day 2; and 43.8% for Day 2-to-Day 3. However, when only the 72-hour data are considered (Table 5), the Day 1-to-Day 2 value is 51.2%. We can argue that the first figure is more precise (because it is based on the larger sample) and should be used, but the

<u>ratio</u> of the two daily changes ought to reflect estimation which is based on the same data, i.e., the 72-hour data. That ratio, 43.8/51.2 or 0.856, applied to the first day percentage gives an estimate for Day 2-to-Day 3 of **31.2%** for the larger sample. This suggests that while the daily emissions are continuing to increase into the third day, they appear to be leveling off. EPA proposes to use the 36.5% value as the percent increase in diurnal emissions from the first to the second day, and 31.2% for the second to third day increase.

2. Fuel-injected vehicles failing one or both of the purge and pressure tests. When the P/F and F/P-F/F groups are estimated separately, the significance tests give mixed results: for Day 1-to-Day 2, the P/F group percent increase is not significant, while the F/P-F/F group is significant (p=0.010). These two groups show similar percentages. After combining these groups, the estimated percentage for Day 1-to-Day 2 is **13.3%**, and is statistically significant (Table 5a). The Day 2-to-Day 3 value is not significant and EPA proposes to set it to **zero**.

3. For the carbureted vehicles, the Day 1-to-Day 2 P/F class has a marginally significant value. Because it is negative, and the other classes are not significant, EPA proposes setting all carbureted vehicle percent changes to **zero**.

These results are summarized in the following table.

Pressure/ Purge	Fuel Metering	Day 1 to Day 2	Day 2 to Day 3
Fail One or Both	Carbureted	0.0%	0.0%
Fail One or Both	Fuel Injected	13.3%	0.0%
Pass Both	Carbureted	0.0%	0.0%
Pass Both	Fuel Injected	36.5%	31.2%

It is further proposed that all changes be assumed to stabilize at zero following Day 3. This appears reasonable for the first three cases in the table, where none of the Day 2-to-Day 3 percent changes is statistically significant. For the most common situation, fuel injected vehicles that pass both pressure and purge tests, an argument could be made for modeling continued positive but decreasing changes in diurnal evaporative emissions for succeeding days. That is not proposed here since we lack data with which to form estimates.

Otherwise, the numbers in the above table do not seem unreasonable. In passing fuel-injected vehicles, the evaporative emission control system is assumed to be functioning properly. For these vehicles, the Day 1 base level of evaporative emissions is comparatively small. Over time, the canister fills and excess evaporative emissions escape from the vehicle. The daily <u>increase</u> in these emissions is estimated to be greatest on the second day, somewhat smaller the third day, and constant thereafter. Thus, absolute emissions are larger on the second day than on the first, still larger on the third day, and unchanged beyond that time.

In the other categories, base emissions are higher so that canister overloading is a smaller component of overall emissions. This along with smaller sample sizes would account for estimates of zero multiple day change for all but the failing fuel-injected Day 1-to-day 2 class.

The large percentage changes estimated for fuel-injected vehicles that pass both pressure and purge tests are derived from base Day 1 emissions that are considerably smaller than those of the failing fuel-injected vehicles. However, in practice a straightforward application of these numbers can lead to projected multiple day evaporative emissions for passing vehicles which *exceed* those of vehicles that fail at least one test. For example, suppose Day 1 emissions for a model year class of fuel injected vehicles passing both tests is modeled as 4 grams. For vehicles failing at least one test let this value be 6 grams. Applying the growth factors gives the following estimates for:

Pass Both Tests:

Day 1-to-Day 2: 4 grams * (1+.365) = 5.46 grams

Day 2-to-Day 3: 5.46 grams * (1+.312) = 7.16 grams

Fail One or Both Tests:

Day 1-to-Day 2: 6 grams * (1+.133) = 6.80 grams

Day 2-to-Day 3: 6.80 grams * (1+0) = 6.80 grams

Thus, by Day 3, the passing vehicle class is projected to have higher emissions than the failing group.

To avoid this anomaly, it is proposed that within a given model year range, the pass/pass fuel-injected vehicle projections be capped by the projection for failing fuel-injected vehicles in that group. The cap proposal would set the passing vehicle estimate equal to that of the vehicles that fail at least one test. Thus, in the illustration above, both passing and failing fuel-injected vehicle emissions in the third day would be assigned the value 6.80 grams.

For the data employed in this analysis, the problem does not exist if judged using sample means. The following table shows mean daily HC emissions for the (nine-hour) data in the categories proposed.

	Fail			Pass		
	Day 1	Day 2	Day 3	Day 1	Day 2	Day 3
Carbureted	22.12	19.09	19.44	11.80	12.69	10.71
Fuel-Injected	10.41	10.00[4]	5.94	3.93	4.78	5.52

[4]The apparent decrease in the failing fuel-injected mean from Day 1 to Day 2 appears inconsistent with the finding of a 13.3% rate of increase. This is explained by the fact that the percent change is derived from the logarithms of individual emission levels, which has a disproportionate effect larger emission values. For these two subsamples, the means of the logarithms increase (from 1.59 to 1.76) as expected.

The mean values do not refute the hypothesis that passing vehicles perform better than failing vehicles, and that fuel-injected vehicles outperform carbureted. While these data suggest that the differences between categories are more extreme than in the example, they are subject to sampling variation.

4.2 Temperature and RVP

The models considered above include the covariates Reid vapor pressure and temperature. The RVP variable was controlled at nominal values of 6.3, 6.8, and 9.0 psi. Temperature varied over a 24-hour period according to three cycles: 60 to 84 degrees F; 72 to 96; and 82 to 106. For this analysis, the midpoint values, 72, 84 and 94 degrees, were used. As seen in Tables 3 to 5, RVP and temperature have high statistical significance. This implies that emissions are sensitive to the values of these variables. Thus, it is appropriate to include them in models of real-time diurnal emissions.

For the purpose of MOBILE6 modeling, the somewhat different question has been raised of whether the adjustments for fuel metering and pressure/purge status are related to RVP and temperature. To answer this, terms were added to the linear models to account for possible interactions between the categorical variables and the continuous. A significant interaction between, say fuel metering and temperature, would suggest that the factor used to adjust for fuel metering should vary with temperature. In those models, which are not reported here, none of these interaction terms was found to be statistically significant. Therefore, EPA recommends that the adjustment scheme described in Section 4.1 be applied without regard for temperature and RVP.

5.0 CONCLUSION

Day-to-day diurnal evaporative emissions are found to change over the first three days for several combinations of a vehicle's fuel metering and pressure/purge test status. Temperature and fuel vapor pressure effects also are evident. Estimates of these changes are proposed for application in MOBILE6

The MOBILE model distinguishes between resting loss and diurnal evaporative emissions. The analysis presented here takes a simplified approach, treating resting losses as constant so that any change from one day to the next is entirely due to the diurnal. The estimated multiple day diurnal effect is greatest when applied only to 1986-95 fuel injection vehicles that pass both purge and pressure tests.

Appendix

The results presented in this report hinge on the interpretation of regression coefficients as measures of percent change in emissions. The mathematics supporting this assumption follows.

For the emissions function

$$\ln(HC) = b_0 + b_1D + b_2P_1*D + b_3P_2*D + b_4Y_1*D + b_5Y_2*D + b_6F*D + b_7R + b_8T ,$$

if we invert the log transformation we get:

$$HC = \exp(b_0 + b_1D + b_2P_1*D + b_3P_2*D + b_4Y_1*D + b_5Y_2*D + b_6F*D + b_7R + b_8T)$$

The change in HC with respect to D is found by differentiating:

$$dHC/dD = (b_1 + b_2P_1 + b_3P_2 + b_4Y_1 + b_5Y_2 + b_6F) *\exp(-)$$

As a percentage of HC, this is simply the ratio of the last two expressions,

$$[dHC/dD]/HC = [(b_1 + b_2P_1 + b_3P_2 + b_4Y_1 + b_5Y_2 + b_6F) *\exp(-)]/\exp(-)$$

$$= b_1 + b_2P_1 + b_3P_2 + b_4Y_1 + b_5Y_2 + B6f$$

Table 1
Distribution of EPA Vehicles and Tests

MODEL YEAR	FUEL METERING	PURGE/ PRESSURE	HOURS 33 VEHS		38 VEHS		72 VEHS		ALL VEHS	
			VEHS	TESTS	VEHS	TESTS	VEHS	TESTS	VEHS	TESTS
Pre-80	CARB	F/P	1	6	.	.	.	.	1	6
		P/F	2	12	1	4	1	4	4	20
		P/P	1	6	.	.	.	.	1	6
80-85	CARB	F/P	5	24	.	.	.	.	5	24
		P/F	5	19	.	.	.	.	5	19
		P/P	.	.	2	8	6	27	8	35
	FI	F/P	4	21	.	.	.	.	4	21
		P/F	2	12	.	.	.	.	2	12
		P/P	3	12	.	.	.	.	3	12
86-95	CARB	F/P	1	4	.	.	.	.	1	4
		P/F	3	12	.	.	.	.	3	12
		P/P	2	6	.	.	1	1	3	7
	FI	F/P	17	96	1	4	1	6	19	106
		P/F	19	96	1	4	1	4	21	104
		P/P	20	88	2	8	16	80	38	176
ALL			85	414	7	28	26	122	267	736

Table 2(a): Day 1 to Day 2 - Full Model

Dependent Variable: LHC

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	123	1869.22443	15.19695	63.07	0.0001
Error	971	233.95714	0.24094		
Corrected Total	1094	2103.18157			

R-Square	C.V.	Root MSE	LHC Mean
0.888760	33.19699	0.49086	1.47863

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
Day	0.37355527	7.77	0.0001	0.04810178
FI-F/P	-0.24896979	-3.35	0.0008	0.07427266
FI-F/F or P/F	-0.21158987	-2.94	0.0033	0.07189721
CARB-P/P	-0.23482963	-2.32	0.0203	0.10100772
Pre-80-P/P	-0.01467024	-0.09	0.9301	0.16723868
80-85-P/P	-0.08646772	-0.92	0.3563	0.09369706
TEMP	0.06577755	36.78	0.0001	0.00178864
RVP	0.31847117	23.07	0.0001	0.01380463

Table 2(b): Day 2 to Day 3 - Full Model

Dependent Variable: LHC

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	120	981.491408	8.179095	43.48	0.0001
Error	535	100.631337	0.188096		
Corrected Total	655	1082.122745			

R-Square	C.V.	Root MSE	LHC Mean
0.907006	28.63212	0.43370	1.51473

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
Day	0.43752226	6.38	0.0001	0.06857404
FI-F/P	-0.44914073	-1.73	0.0842	0.25961712
FI-F/F or P/F	-0.41435187	-1.32	0.1879	0.31424573
CARB-P/P	-0.44407966	-0.72	0.4721	0.61716636
80-85-P/P	0.06286394	0.10	0.9199	0.62459983
TEMP	0.07473522	36.62	0.0001	0.00204069
RVP	0.41597033	26.35	0.0001	0.01578645

Table 3(a): Day 1 to Day 2 - Reduced Model

Dependent Variable: LHC

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	121	1868.98843	15.44619	64.17	0.0001
Error	973	234.19314	0.24069		
Corrected Total	1094	2103.18157			

R-Square	C.V.	Root MSE	LHC Mean
0.888648	33.17957	0.49060	1.47863

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
Day	0.36562242	7.71	0.0001	0.04740431
FI-F/P	-0.25756963	-3.50	0.0005	0.07356632
FI-F/F or P/F	-0.20883320	-2.93	0.0035	0.07131000
CARB-P/P	-0.28232652	-3.99	0.0001	0.07080813
TEMP	0.06577721	36.79	0.0001	0.00178770
RVP	0.31847302	23.08	0.0001	0.01379739
Selected Linear Combinations				
FI-P/P	0.36562242	7.71	0.0001	0.04740431
FI-F/P	0.10805279	1.79	0.0740	0.06041319
FI-F/F or P/F	0.15678922	2.69	0.0073	0.05831582
CARB-P/P	0.08329590	1.15	0.2493	0.07225962
CARB-F/P	-0.17427373	-2.20	0.0281	0.07924244
CARB-F/F or P/F	-0.12553730	-1.67	0.0951	0.07514976

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
F/P vs F/F or P/F	-0.04873643	-0.61	0.5423	0.07995367
P/P vs F/F or P/F	0.57445562	5.41	0.0001	0.10613121
P/P vs F/P	0.62319205	5.77	0.0001	0.10802126

Table 3(b): Day 2 to Day 3 - Reduced Model

General Linear Models Procedure

Dependent Variable: LHC

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	119	981.489503	8.247811	43.93	0.0001
Error	536	100.633242	0.187749		
Corrected Total	655	1082.122745			

R-Square	C.V.	Root MSE	LHC Mean
0.907004	28.60566	0.43330	1.51473

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
Day	0.43752226	6.39	0.0001	0.06851069
FI-F/P	-0.44914073	-1.73	0.0839	0.25937729
FI-F/F or P/F	-0.41435187	-1.32	0.1875	0.31395542
CARB-P/P	-0.38346086	-2.85	0.0045	0.13455232
TEMP	0.07473522	36.66	0.0001	0.00203881
RVP	0.41597033	26.37	0.0001	0.01577186
Selected Linear Combinations				
FI-P/P	0.43752226	6.39	0.0001	0.06851069
FI-F/P	-0.01161846	-0.05	0.9630	0.25016567
FI-F/F or P/F	0.02317039	0.08	0.9397	0.30638912
CARB-P/P	0.05406140	0.47	0.6408	0.11580420
CARB-F/P	-0.39507932	-1.39	0.1648	0.28405491
CARB-F/F or P/F	-0.36029047	-1.08	0.2821	0.33463207

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
F/P vs F/F or P/F	-0.03478886	-0.09	0.9299	0.39554665
P/P vs F/F or P/F	0.85187413	2.54	0.0114	0.33563247
P/P vs F/P	0.88666299	3.11	0.0020	0.28523275

Table 4(a): Collapsed P/F and F/F - Day 1 to Day 2

Dependent Variable: LHC

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	120	1868.89900	15.57416	64.75	0.0001
Error	974	234.28257	0.24054		
Corrected Total	1094	2103.18157			

R-Square	C.V.	Root MSE	LHC Mean
0.888606	33.16887	0.49045	1.47863

Selected Linear Combinations

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
FI-PASS	0.36532558	7.71	0.0001	0.04738652
FI-FAIL	0.13337025	3.04	0.0024	0.04385692
CARB-PASS	0.08445850	1.17	0.2424	0.07221113
CARB-FAIL	-0.14749683	-2.24	0.0255	0.06593070
TEMP	0.06577568	36.81	0.0001	0.00178712
RVP	0.31848139	23.09	0.0001	0.01379293
PASS vs FAIL	0.59728092	6.02	0.0001	0.09927384

Table 4(b): Collapsed P/F and F/F - Day 2 to Day 3

Dependent Variable: LHC

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	118	981.488051	8.317695	44.38	0.0001
Error	537	100.634694	0.187402		
Corrected Total	655	1082.122745			

R-Square	C.V.	Root MSE	LHC Mean
0.907003	28.57922	0.43290	1.51473

Selected Linear Combinations

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
FI-PASS	0.43752226	6.39	0.0001	0.06844736
FI-FAIL	0.00229708	0.01	0.9905	0.19359838
CARB-PASS	0.05406140	0.47	0.6405	0.11569716
CARB-FAIL	-0.38116378	-1.62	0.1064	0.23569304
TEMP	0.07473522	36.69	0.0001	0.00203692
RVP	0.41597033	26.40	0.0001	0.01575720
PASS vs FAIL	0.87274745	3.68	0.0003	0.23710862

Table 5(a): Day 1 to Day 2 using 72 hour data only

Dependent Variable: LHC

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	29	392.266280	13.526423	50.22	0.0001
Error	206	55.482658	0.269333		
Corrected Total	235	447.748938			

R-Square	C.V.	Root MSE	LHC Mean
0.876085	66.04906	0.51897	0.78574

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
FI-PASS	0.51180929	6.24	0.0001	0.08205688
FI-FAIL	-0.14496360	-0.62	0.5329	0.23209192
CARB-PASS	0.09150151	0.66	0.5102	0.13870145
CARB-FAIL	-0.56527139	-2.00	0.0468	0.28255634
TEMP	0.07496020	18.63	0.0001	0.00402374
RVP	0.36832894	11.70	0.0001	0.03148806

Table 5(b): Day 2 to Day 3 using 72 hour data only

Dependent Variable: LHC

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	29	372.666174	12.850558	79.56	0.0001
Error	206	33.272886	0.161519		
Corrected Total	235	405.939060			

R-Square	C.V.	Root MSE	LHC Mean
0.918035	35.92281	0.40189	1.11877

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
FI-PASS	0.43752226	6.89	0.0001	0.06354504
FI-FAIL	0.00229708	0.01	0.9898	0.17973250
CARB-PASS	0.05406140	0.50	0.6153	0.10741072
CARB-FAIL	-0.38116378	-1.74	0.0830	0.21881226
TEMP	0.08776948	28.17	0.0001	0.00311599
RVP	0.51871100	21.27	0.0001	0.02438442

February ??, 1999

Document Released for Stakeholder Review and Comment

Evaluating Multiple Day Diurnal Evaporative Emissions Using RTD Tests

Report Number EPA420-99-003
The office of Mobile Sources, Assessment and Modeling Division announces the release of "Evaluating Multiple Day Diurnal Evaporative Emissions Using RTD Tests" for stakeholder review and comment. This document EPA420-99-003 also known as document M6.EVP.003.is available at the MOBILE6 section of the OMS Web Site (http://www.epa.gov/oms/m6.htm).

This draft report presents an analysis of diurnal evaporative emissions from light-duty vehicles (LDVs) and light-duty trucks (LDTs) occurring over periods of more than one day, using real-time diurnal (RTD) test data from testing programs performed under contract for EPA.

The data consists of hourly values of HC emissions (in grams)measured under varying conditions of fuel Reid vapor pressure (RVP) and ambient temperature. Daily totals are obtained directly from these hourly values.

Comments on this report and its proposed use in MOBILE6 should be sent to the attention of Phil Enns. Comments may be submitted electronically to mobile@epa.gov, by fax to (734) 214-4821, or by mail to MOBILE6 Review Comments, US EPA Assessment and Modeling Division, 2000 Traverwood Drive, Ann Arbor, MI 48105. Electronic submission of comments is preferred. In your comments please note clearly the document that you are commenting on including the report title and the code number listed. Please be sure to include your name, address, affiliation and any other pertinent information.

This document is being released and posted on February ??, 1999. Comments will be accepted for sixty (60) days ending April ??, 1999. EPA will then review and consider all comments received and will provide a summary of those comments and how we are responding to them in the form of a follow-up document.

Thank you for your continuing interest in the development of MOBILE6.

Sincerely,

Emission Inventory Group, Assessment and Modeling Division, US EPA, Office of Mobile Sources