

# **Assessing the Effect of Five Gasoline Properties on Exhaust Emissions from Light-Duty Vehicles certified to Tier-2 Standards**

## **Analysis of Data from EPA Phase 3**

**(EPAct/V2/E-89)**

### **Appendix L.3**

#### **Model Fitting Information for**

#### **Formaldehyde (Bag 1)**

This appendix summarizes model fitting for Formaldehyde (Bag 1). Model-fitting techniques and approaches are described in Section 8.7. Features of the data and modeling for this compound are listed below.

Fuel-parameter matrix: FULL

No. measurements: 956

No. vehicles: 15

No. censored values: 0

Modeling approach: MIXED MODEL

### Models fit for Formaldehyde (Bag 1).

Model Term	Notation	Model					
		Full Model	FM4	FM5	FM6	FM7	Linear Effects
etOH	$Z_e$	•	•	•	•	•	•
Arom	$Z_a$	•	•	•	•	•	•
RVP	$Z_r$	•	•	•	•	•	•
T50	$Z_5$	•	•	•	•	•	•
T90	$Z_9$	•	•	•	•	•	•
etOH $\times$ etOH	$ZZ_{ee}$	•	•	•	$\times$		
T50 $\times$ T50	$ZZ_{55}$	•	•	•	•	•	$\times$
etOH $\times$ Arom	$ZZ_{ea}$	•	•	•	•	•	$\times$
etOH $\times$ RVP	$ZZ_{er}$	•	$\times$				
etOH $\times$ T50	$ZZ_{e5}$	•	•	•	•	•	$\times$
etOH $\times$ T90	$ZZ_{e9}$	•	•	•	•	•	$\times$
Arom $\times$ RVP	$ZZ_{ar}$	•	$\times$				
Arom $\times$ T50	$ZZ_{a5}$	•	$\times$				
Arom $\times$ T90	$ZZ_{a9}$	•	•	$\times$			
T90 $\times$ T90	$ZZ_{99}$	•	•	•	•	$\times$	
T50 $\times$ T90	$ZZ_{59}$	•	•	•	•	•	$\times$
RVP $\times$ T90	$ZZ_{r9}$	•	$\times$				

### Fitting history for Bag-1 Formaldehyde – with “FM7” selected as the reduced model.

Fit Parameters				Test with respect to Full			Test with respect to Previous Model		
Model	$p$	$-2\ln L$	BIC <sup>1</sup>	Dev. <sup>1</sup>	$d$	$\text{Pr}>\chi^2$	Dev.	$d$	$\text{Pr}>\chi^2$
Full	17	-102.866	-48.705						
FM4	13	-101.651	-58.322	1.215	4	0.876			
FM5	12	-100.336	-59.715	2.530	5	0.772	1.315	1	0.252
FM6	11	-99.040	-61.127	3.826	6	0.700	1.296	1	0.255
FM7 <sup>2</sup>	10	-95.848	-60.643	7.018	7	0.427	3.192	1	0.074
Linear Effects	5	-13.166	8.498	89.700	12	0.000000	82.682	5	0.000000
<sup>1</sup> A lower value indicates a better fit. <sup>2</sup> Selected as “best fit” with respect to the 17-term full model. Note that based on the history, FM6 is actually the “best fit,” however, we have retained FM7 due to the decision to exclude the T90 $\times$ T90 term from final model fitting. See Section 7.2.1.				<sup>1</sup> The deviation is the difference in the -2loglik statistics for the nested and reference models, respectively, per Equation 14.					

### Coefficients and Type-III Tests of Effect for the Full and Best-Fit Models – Formaldehyde (Bag 1).

Effect	<i>Full Model</i>					<i>Best-Fit Model (FM7)</i>				
	Estimate	Std.Err.	d.f.	t-value	Pr>t	Estimate	Std.Err.	d.f.	t-value	Pr>t
Intercept	-5.9771	0.1498	15	-39.9	0.000000	-5.9771	0.1498	15	-39.9	0.000000
Z <sub>e</sub>	0.2279	0.01234	898	18.5	0.000000	0.2299	0.009640	898	23.8	0.000000
Z <sub>a</sub>	0.03528	0.008841	898	3.99	0.000071	0.02822	0.007979	898	3.54	0.00043
Z <sub>r</sub>	-0.05202	0.01234	898	-4.21	0.000028	-0.04718	0.008457	898	-5.58	0.000000
Z <sub>5</sub>	0.1577	0.01738	898	9.07	0.000000	0.1672	0.01001	898	16.7	0.000000
Z <sub>9</sub>	0.1357	0.01064	898	12.7	0.000000	0.1302	0.007360	898	17.7	0.000000
ZZ <sub>ee</sub>	-0.01498	0.01475	898	-1.02	0.31					
ZZ <sub>55</sub>	0.05026	0.01251	898	4.02	0.000064	0.05262	0.008341	898	6.31	0.000000
ZZ <sub>ea</sub>	0.02017	0.01241	898	1.63	0.10	0.01651	0.007340	898	2.25	0.025
ZZ <sub>er</sub>	0.004100	0.008366	898	0.490	0.62					
ZZ <sub>e5</sub>	-0.03686	0.01594	898	-2.31	0.021	-0.01627	0.008177	898	-1.99	0.047
ZZ <sub>e9</sub>	0.02181	0.01023	898	2.13	0.033	0.02004	0.008838	898	2.27	0.024
ZZ <sub>ar</sub>	0.007384	0.01535	898	0.481	0.63					
ZZ <sub>a5</sub>	-0.006739	0.01645	898	-0.41	0.68					
ZZ <sub>a9</sub>	-0.01036	0.008437	898	-1.23	0.22					
ZZ <sub>99</sub>	0.02104	0.01435	898	1.47	0.14					
ZZ <sub>59</sub>	0.03974	0.01080	898	3.68	0.00025	0.03489	0.009322	898	3.74	0.00019
ZZ <sub>r9</sub>	-0.003140	0.009498	898	-0.331	0.74					
$\sigma_{veh}^2$	0.3360					0.3358				
$\sigma_{\varepsilon}^2$	0.1395					0.1406				