Section 6.0 CORRECTION FACTORS

Correction factors are used to correct emissions from non-standard conditions. In a general sense, emissions can be described as:

ER = BER*CF1*CF2*CF3….etc.

For a given technology group. In EMFAC2000, the following correction factors are addressed:

Temperature correction factors (TCF) adjust exhaust emissions for temperatures other than 75F. Section 6.1 largely adjusts the MVEI7G TCFs to be consistent EMFAC2000 technology groups. Speed correction factors (SCF) adjust the UC-based BERs for other trip speeds, and are detailed in section 6.2. Section 6.3 details the methodologies employed to adjust for gasoline fuel characteristics (FCF). Section 6.4 details a newly modeled correction factor, air conditioning correction factors (ACCF). Similarly, section 6.5 describes a new methodology to adjust NOx emissions for humidity. Finally, section 6.6 describes how emissions are adjusted for high altitude areas (namely, Lake Tahoe).

Section 6.1 TECHNOLOGY SPECIFIC TEMPERATURE CORRECTION FACTORS

This section details the temperature correction factors (TCFs) used in EMFAC2000. The TCFs are based on a memorandum entitled "Temp/RVP Exhaust Correction Factors" dated November 22, 1991, which details the exhaust TCF used in EMFAC7F.

6.1.1 Introduction

The basic exhaust emission rates are based on FTP or UC tests that were performed between 68-86^{o}F (nominally 75^{o}F), the standard temperature specifications for the FTP test. Various research projects were conducted, as detailed in the above memorandum, in which the FTP tests were performed at non-standard temperatures. This data was then used to develop TCFs, which adjust the basic emission rates for non-FTP temperature conditions.

6.1.2 Methodology

In EMFAC7F, the technology specific TCFs were weighted with the model year specific technology fractions to calculate a weighted model year specific TCF. The weighted model year TCFs were determined for passenger cars, light-, and medium- duty trucks. Equation 6.1-1 shows the general form of the TCFs, where the regression coefficients A, B and C have been weighted with respect to the technology fractions.

$$TCF_{(9\ RVP)} = A * (T-75) + B*(T-75)^2 + C*(T-75)^3 + 1 \qquad \textbf{(6.1-1)}$$

In EMFAC2000, the TCFs are applied at a technology specific level. Since the TCF memorandum contains technology specific TCF coefficients (A, B and C) that have been weighted with respect to technology fraction to arrive at model year specific weighted TCF coefficients, staff determined the technology specific TCF by applying the inverse of the model year technology fractions. This process was necessary to determine the technology specific TCF coefficients.

Table 6.1-1 shows the model year specific technology fractions applied to passenger cars in EMFAC7F. The technology specific TCF coefficients were determined using linear matrix algebra, where matrix A contains technology fractions for three model years, matrix B represents the unknown technology specific coefficients and matrix C contains the resulting weighted TCF coefficients. Therefore, A*B=C and matrix B=A^{-1} *C, where A^{-1} is an inverse matrix.

Table 6.1-1 Technology Fractions Used In EMFAC7F

M Year	Carb-OL	Carb-CL	FI	CARB	MPFI	TBI
1980	1.000					
1981	0.350	0.436	0.214			
1982	0.318	0.436	0.246			
1983				0.644	0.216	0.140
1984				0.543	0.297	0.160
1985				0.399	0.359	0.242
1986				0.358	0.467	0.175
1987				0.314	0.501	0.185
1988				0.234	0.596	0.170
1989				0.119	0.663	0.218
1990				0.048	0.718	0.234
1991				0.048	0.718	0.234
1992				0.048	0.718	0.234
1993				0.000	0.900	0.100
1994+				0.000	0.900	0.100

Where:
CARB-OL represents carbureted open loop vehicles
CARB-CL represents carbureted closed loop vehicles
FI represents fuel-injected vehicles
MPFI represents multi-point fuel-injected vehicles
TBI represents throttle body injected vehicles

Table 6.1-2 shows the technology specific TCF coefficients used in EMFAC7F. These coefficients were weighted with respect to the technology fractions to determine model year weighted TCF coefficients. These weighted coefficients were then compared with those shown in the EMFAC7F TCF memorandum to ensure that correct technology coefficients were calculated. Table 6.1-2 contains a column labeled "TCF groups" which shows the numbers assigned to technology specific TCFs. This numbering scheme was used to map these TCF coefficients to the EMFAC2000 technology groups. Table 6.1-3 shows the EMFAC2000 technology groups. The column labeled "MAP_GRP" shows, which set of TCF coefficients (from Table 6.1-2) are applied to the EMFAC2000 technology groups. For example, the non-cat TCF are used in adjusting the basic emission rates for technology groups 1, 2, 3 and 40.

Table 6.1-2 Technology Specific Temperature Correction Factors

TCF Groups		BAG1_HC			BAG2_HC			BAG3_HC		
		A	B	C	A	B	C	A	B	C
1	NON_CAT	-0.029798	0.004427	0	-0.011131	0.0048358	0	-0.0090264	0.0074688	0
2	CARB-OL	-0.0454000000	0.0016360000	0.0000152100	0.0061870000	0.0008449000	0.0000095940	0.0053680000	0.0009159000	0.0000118100
3	CARB-CL	-0.0191200000	0.0008523000	0.0000057879	0.0028450000	0.0000443897	0.0000005637	-0.0026460000	-0.0000427500	-0.0000006094
4	FI	-0.0191200000	0.0008523000	0.0000057881	0.0028450000	0.0000443906	0.0000005627	-0.0026460000	-0.0000427500	-0.0000006056
5	CARB	-0.0454000000	0.0016360000	0.0000152101	0.0061870000	0.0008448999	0.0000095940	0.0053680000	0.0009159007	0.0000118102
6	MPFI	-0.0191200000	0.0008523000	0.0000057866	0.0028450000	0.0000443900	0.0000005632	-0.0026460000	-0.0000427500	-0.0000006079
7	TBI	-0.0191200000	0.0008523000	0.0000057900	0.0028450000	0.0000443902	0.0000005636	-0.0026460000	-0.0000427502	-0.0000006085
8	Diesel	0	0	0	0	0	0	0	0	0
		BAG1_CO			BAG2_CO			BAG3_CO		
		A	B	C	A	B	C	A	B	C
1	NON_CAT	0	0.0062182	0	-0.014584	0.014943	0	-0.011371	0.014923	0
2	CARB-OL	-0.0516300000	0.0012250000	0.0000166800	0.0045770000	0.0004151000	0.0000017830	0.0066080000	0.0010680000	0.0000120200
3	CARB-CL	-0.0328200000	0.0011260000	0.0000160800	0.0027370000	0.0001239000	0.0000007077	-0.0007422000	0.0003014000	0.0000036847
4	FI	-0.0328200000	0.0011260000	0.0000160800	0.0027370000	0.0001239000	0.0000007080	-0.0007422000	0.0003014000	0.0000036825
5	CARB	-0.0516300000	0.0012250000	0.0000166800	0.0045770000	0.0004151000	0.0000017829	0.0066079949	0.0010680000	0.0000120206
6	MPFI	-0.0328200000	0.0011260000	0.0000160800	0.0027370000	0.0001239000	0.0000007076	-0.0007422005	0.0003014000	0.0000036840
7	TBI	-0.0328200000	0.0011260000	0.0000160800	0.0027370000	0.0001239000	0.0000007082	-0.0007421958	0.0003014000	0.0000036836
8	Diesel	0	0	0	0	0	0	0	0	0
		BAG1_NOx			BAG2_NOx			BAG3_NOx		
		A	B	C	A	B	C	A	B	C
1	NON_CAT	-0.007684	0	0	-0.005859	0	0	-0.009088	0	0
2	CARB-OL	-0.0061420000	0.0002478000	0.0000044870	-0.0063320000	0.0003164000	0.0000046260	-0.0070410000	0.0002937000	0.0000045590
3	CARB-CL	-0.0059370000	0.0001700000	0.0000034930	-0.0042800000	0.0002846000	0.0000041804	-0.0066990000	0.0003721000	0.0000063487
4	FI	-0.0059370000	0.0001700000	0.0000034901	-0.0042800000	0.0002846000	0.0000041791	-0.0066990000	0.0003721000	0.0000063496
5	CARB	-0.0061420000	0.0002478000	0.0000044871	-0.0063320000	0.0003164000	0.0000046259	-0.0070410000	0.0002937000	0.0000045589
6	MPFI	-0.0059370000	0.0001700000	0.0000034921	-0.0042800000	0.0002846000	0.0000041805	-0.0066990000	0.0003721000	0.0000063490
7	TBI	-0.0059370000	0.0001700000	0.0000034918	-0.0042800000	0.0002846000	0.0000041797	-0.0066990000	0.0003721000	0.0000063492
8	Diesel	0	0	0	0	0	0	0	0	0

Table 6.1-3 EMFAC2000 Technology Groups

Technology Group	Description of Gas Fueled Technology Group		Map_Grp TCF
	Model Years	Emission Control Technology	
1	Pre-75	LDV no AIR	1
2	Pre-76	LDV with AIR	1
3	1975+	LDV noncatalyst	1
4	1975-76	LDV OxCat with AIR	2
5	1975-79	LDV OxCat no AIR	2
6	1980+	LDV OxCat no AIR	2
7	1977+	LDV OxCat with AIR	2
8	1977-79	LDV TWC TBI/CARB	3
9	1981-84	LDV TWC TBI/CARB 0.7 NOx	3
10	1985+	LDV TWC TBI/CARB 0.7 NOx	3
11	1977-80	LDV TWC MPFI	4
12	1981-85	LDV TWC MPFI 0.7 NOx	4
13	1986+	LDV TWC MPFI 0.7 NOx	4
14	1981+	LDV TWC TBI/CARB 0.4 NOx	3
15	1981+	LDV TWC MPFI 0.4 NOx	4
16	1980	LDV TWC TBI/CARB	3
17	1993+	LDV TWC TBI/CARB .25 HC	7
18	1993+	LDV TWC MPFI .25 HC	6
19	1996+	LDV TWC TBI/CRB .25 OBD2	7
20	1996+	LDV TWC MPFI .25HC OBD2	6
21	1994-95	LDV TLEV MPFI .25HC	6
22	1996+	LDV TLEV OBD2 GCL	6
23	1996+	LDV LEV OBD2 GCL CBC AFC	6
24	1996+	LDV ULEV OBD2 GCL CBC AFC	6
25	ALL	ZEV	
26	1996+	LDT TWC MPFI OBD2 .7NOx	6
27	1996+	LDV TWC TBI/CARB OBD2	7
28	2004+	LDV LEV II	6
29	2004+	LDV ULEV II	6
30	2004+	LDV SULEV II	6
40	Mex	LDV NoCat/NoAir	40
41	Mex	LDV OxCat with AIR	2
42	Mex	LDV TWC TBI/CARB 0.7 NOx	3
43	Mex	LDV TWC MPFI 0.7 NOx	4
170	1965-74	LDA dsl	8
171	1975-79	LDA dsl	8
172	1980	LDA dsl	8
173	1981-83	LDA dsl	8
174	1984-85	LDA dsl	8
175	1986	LDA dsl	8
176	1987-95	LDA dsl	8
177	1996+	LDA dsl	8
178	1965-78	LDT dsl	8
179	1979-80	LDT dsl	8
180	1981-83	LDT dsl	8
181	1984-85	LDT dsl	8
182	1986	LDT dsl	8
183	1987-93	LDT dsl	8
184	1994-96	LDT dsl	8
185	1997+	LDT dsl	8
186	1965-78	MDT dsl <8500LBS	8
187	1979-80	MDT dsl <8500LBS	8
188	1981-82	MDT dsl <8500LBS	8
189	1983-84	MDT dsl <8500LBS	8
190	1985-86	MDT dsl <8500LBS	8
191	1987-90	MDT dsl <8500LBS	8
192	1991-93	MDT dsl <8500LBS	8

6.1.3 Application of TCF Coefficients

The application of bag 1, 2 or 3 TCF is dependent on the exhaust emissions process under consideration. For example, running exhaust emissions are temperature corrected using bag 2 TCF coefficients. In both EMFAC7F and MVEI7G, the starting emissions were temperature corrected using bag 1 TCF coefficients. This methodology is valid for vehicle starts, which occur after an overnight (8 hour) soak. However, this is not true for starts following short soak durations. The incremental starting emissions methodology indicates that starting emissions are dependent on the amount of soak time. One of the findings of the incremental starts methodology is that starting emissions produced after soak times greater than 60 minutes are not the same as those produced after an overnight soak. This suggests that the catalyst is not completely cold even after 60 minutes. For vehicles that have been sitting for short time intervals, the starting emissions are temperature corrected using bag 3 TCF coefficients. Table 6.1-4 shows the logic used in EMFAC2000 for temperature correcting starting emissions. For non-catalyst vehicles, with soak times less than 60 minutes, the starting emissions are temperature corrected using bag 3 TCF coefficients. For catalyst equipped vehicles, with a soak of less than 90 minutes, the starting emissions are temperature corrected using bag 3 TCF coefficients. For low emission vehicles, with soak times less than 120 minutes, starting emissions are temperature corrected using bag 3 TCF coefficients. The breakpoints (Time-Off) correspond approximately to the inflexion point in the starts emission rate equations.

Table 6.1-4

Technology	Time-Off	Logic
Non-Catalyst	<60 min.	If time-off is less than 60 minutes then use bag 3 TCF, else use bag 1 TCF coefficients.
Catalyst	<90 min.	If time-off is less than 90 minutes then use bag 3 TCF, else use bag 1 TCF coefficients.
Low Emission Vehicles	<120 min.	If time-off is less than 120 minutes then use bag 3 TCF, else use bag 1 TCF coefficients.

6.1.4 Discussion

The temperature correction factors used in EMFAC2000 are the same as those used in both EMFAC7F and MVEI7G. The only substantive changes involve the development of technology specific TCF coefficients, and how these are applied to vehicles with short soak periods. This methodology will reduce the starting emissions slightly.