United States Environmental Protection Agency
Air and Radiation
EPA420-P-99-001
January 1999

Exhause Emission Temperature Correction Factors for MOBILE6:

Engine Start and Running LA4 Emissions for Gasoline Vehicles

Draft

Printed on Recycled Paper

Exhaust Emission Temperature Correction Factors for MOBILE6:

Engine Start and Runniing LA4 Emissions for Gasoline Vehicles
Draft

Edward L. Glover
David J. Brzezinski
Assessment and Modeling Division
Office of Mobile Sources
U.S. Environmental Protection Agency

NOTICE

This technical report does not necessarily represent final EPA decisions or positions.
It is intended to present technical analysis of issues using data which are currently available.
The purpose in the release of such reports is to facilitate the exchange of
technical information and to inform the public of technical developments which
may form the basis for a final EPA decision, position, or regulatory action.

EPA420-P-99-001

- Draft -

Exhaust Emission Temperature Correction Factors for MOBILE6: Engine Start and Running LA4 Emissions for Gasoline Vehicles

Report Number M6.STE.004

February 9, 1999

Edward L. Glover
David J. Brzezinski

U.S. EPA Assessment and Modeling Division

1.0 OVERVIEW

In the MOBILE model series vehicle exhaust emissions have always been adjusted for the effects of ambient temperature. In previous versions of MOBILE these correction factors were determined separately for each segment (bag) of the Federal Test Procedure (FTP), and were applied in the model using the user supplied operating mode temperature correction factor inputs. The new MOBILE6 model will estimate exhaust emissions separately for engine running emissions and the effects of engine start. The operating mode temperature correction factor inputs will be removed, and replaced by a count of engine starts per day.

For MOBILE6, the existing MOBILE5 temperature correction factors (one for each FTP bag) will still be used. However, they will be applied separately to cold start, hot start, and running LA4 emissions rather than weighted together into an overall FTP correction using the operating mode temperature correction factor inputs like in MOBILE5. For MOBILE6, the Bag1 temperature correction factor (Equation 1) will be applied to the cold start emissions (a 12 hour soak prior the start). The Bag3 temperature correction factor (Equation 2) will be applied to the hot start emissions (a 10 minute soak prior to the start). A VMT weighted combination of Bag2 and Bag3 temperature correction factor (Equation 3) will be applied to the running LA4 emissions. Linear interpolation between the hot start (10 minute soak) and the cold start (12 hour soak) will be done to obtain temperature correction factors (TCF(x)) for starts with soaks in between these two values (Soak value of ‘x’ in Equation 4). The one exception to this general methodology are the CO start temperature corrections below 75 F. They use an additive correction factor rather than a multiplicative correction factor.

$$TCF_{MOBILE6}(\text{COLD engine start}) = TCF_{MOBILE5}(\text{Bag 1}) \quad \text{Eqn 1}$$

$$TCF_{MOBILE6}(\text{HOT engine start}) = TCF_{MOBILE5}(\text{Bag 3}) \quad \text{Eqn 2}$$

$$TCF_{MOBILE6}(\text{running}) = TCF_{MOBILE5}(\text{Bag 2}) * 0.521 + TCF_{MOBILE5}(\text{Bag 3}) * 0.479 \quad \text{Eqn 3}$$

$$TCF(x) = TCF(h) + [(TCF(c)-TCF(h)) / (Soak(c)-Soak(h))] * (Soak(x)-Soak(h)) \quad \text{Eqn 4}$$

where:

subscript ‘h’ means hot engine start and ‘c’ means cold engine start, and ‘x’ is the soak length of interest.

TCF is the temperature correction factor;

Soak is the soak length in minutes. Soak(c) is defined to be 720 minutes (the FTP cold start soak duration), and Soak(h) is defined to be 10 minutes (the FTP hot start soak duration).

The values of 0.521 and 0.479 are the VMT (vehicle miles traveled) weighting factors for the running LA4. The two FTP bags (bags 2 and 3) are weighted together by these factors to produce the running LA4.

The temperature correction factors in Equations 1 through 4 are not perfectly associated with the basic emission rates to which they will be applied. This is because the individual Bag1 and Bag3 correction factors used in MOBILE5 contain both running emissions and start emissions, and these components <u>cannot</u> be separated. The inconsistency arises because in MOBILE6, both the cold and hot start emissions have been separated from the running emissions, and the start estimates contain only the effect of engine starts on exhaust emissions (See EPA document M6.STE.002 - "The Determination of Hot Running Emissions from FTP Bag Emissions"). Similarly, the running LA4 estimates in MOBILE6 contain only running emissions and do not contain start emissions. Thus, utilizing the MOBILE5 temperature correction factors directly in MOBILE6 will add a small component of running emissions to the start estimates and a small component of start emission to the running LA4 estimate.

Because of a lack of data, we cannot develop new correction factors based directly on start and running LA4 emissions, nor estimate the magnitude of the error introduced by using the individual bag correction factors from MOBILE5. However, the error in applying the MOBILE5 Bag 1 temperature correction factors to engine start emissions in MOBILE6 should be small. This is because the temperature corrections for starts are based on bags. These include some stabilized running emissions, but these stabilized running emissions are less sensitive to ambient temperature, and should not strongly bias the results.

Similarly, VMT weighting the Bag 3 with Bag 2 temperature correction factors from MOBILE5 to determine the hot running emission temperature correction factors for MOBILE6 assumes that the affect on the temperature correction factor from emissions from the engine start following a 10-minute soak are negligible. The reason for combining Bag 3 and Bag 2 is to make the underlying driving cycle identical to the cycle used for the basic hot running emission estimates in MOBILE6 (the running LA4). Both Bag 1 and Bag 3 use the same driving cycle and contain engine starts, so the difference in their temperature correction factors should be only a function of their soak time.

Another possible source of error in applying the MOBILE5 temperature correction factors to MOBILE6 start and running emissions is a possible dependence of vehicle model year on the correction factors. The MOBILE5 correction factors are based mostly on testing from 1980's model year vehicles ,whereas the model now predicts emission effects of 1990's and later model year vehicles. Some error could occur in modeling 1990's vehicles in MOBILE5 if the temperature dependence on emissions has changed with newer model year vehicles and technology. For example, the emission control system on newer model year vehicles may now reach full operating temperature sooner than vehicles of the past. Unfortunately, due to a lack of data, the correction factors cannot be updated to fully reflect 1990's technology, nor any subsequent changes due to advancing technology.

Since the existing MOBILE5 temperature correction estimates are being used in MOBILE6, they will not be reproduced in their entirety in this document. The interested reader is referred to Pages H-23 and H-24 in Appendix H of "Compilation of Air Pollution Emission Factors, Volume II: Mobile Sources" (AP-42, June 1995) for a complete listing of the correction factor coefficients.

2.0 TEMPERATURE AND RVP RANGE

In MOBILE5, exhaust emissions for vehicles of model year later than 1979 are adjusted for the combined effects of fuel volatility (as measured by the Reid Vapor Pressure (RVP)), and temperature for temperatures between 45° and 95°F. Within this temperature range, there are two regions of interest-- above and below the reference temperature of 75° F. All Temperatures using the symbol "T" are in degrees Fahrenheit.

2.1 Corrections Above 75°F

The form of the temperature correction factor for temperatures above 75°F is shown in Equation 5a for pre-1980 model years and in Equation 5b for 1980 and later model years. It is used in MOBILE6 as a multiplicative factor. An example of the coefficients used in Equation 5a and Equation 5b for light-duty gasoline vehicles are shown in Appendix A-2. The coefficients labeled Test Segment 1 are used for the cold start, the coefficients labeled Test Segment 3 are used for the hot start, and a weighted percentage of Test Segment 2 and Test Segment 3 coefficients are used for the hot running LA4 corrections. The weighting for Test Segment 2 and Test Segment 3 is shown in Equation 3.

$$TCF(b) = EXP[\ TC(b)*(T-75)] \qquad \text{Eqn 5a}$$

$$TRCF(b) = EXP[\ RC(b)*(RVP-9.0) + TC(b)*(T-75) + TRC(b)*(RVP-9.0)*(T-75)] \qquad \text{Eqn 5b}$$

Where b = 1: Cold Start (Bag1)
= 2: Hot Stabilized (Bag2)
= 3: Hot Start (Bag3)

2.1.1 Adjustment Between 75°F and 95°F

At temperatures above 75°F, the temperature correction factor is a combined temperature and fuel volatility factor. This factor is a function of both temperature in degrees Fahrenheit and fuel RVP in units of psi. Graphically, it can be thought of as a family of curves, each curve representing the impact of emissions versus temperature for a given fuel volatility. The emission rate corresponding to 9.0 psi fuel RVP and 75°F temperature is the base rate. It is the lowest emission rate allowed for temperatures above 75°F regardless of RVP. This means that the combined affect of temperature and RVP for fuels which have RVP values less than 9.0 are the same as the affect for a 9.0 psi RVP fuel at 75°F. The effect only increases when the combined affect of temperature and RVP for that fuel exceed the effect at 9.0 psi RVP and 75°F. In other words, the correction factor has a minimum value equal to the 9.0 psi and 75°F case. This is the same methodology as used in MOBILE5.

2.1.2 Adjustments Above 95°F

Emissions at temperatures between 95°F and 110°F are adjusted only as a function of temperature. The terms in the equation related to fuel volatility (RVP) are set to their value at 95°F and only the temperature effects are allowed to increase beyond 95°F. In some model years the correction factors are further differentiated by fuel delivery system (carbureted versus fuel injection). Equation 5b is used, and the RVP terms are removed.

2.2 Corrections Below 75°F

2.2.1 HC and NOx Correction Factors

Below 75°F there is only a temperature correction factor. There is no RVP component to the overall temperature/fuel volatility correction factor. The form of the temperature correction factor below 75°F is shown in Equation 6. This equation applies to HC and NOx for cold start, hot start and running LA4 emissions. It also applies for running LA4 CO emissions (the coefficients for Equation 6 are shown in Appendix A-2), and for CO start emissions of pre-1980 model year vintage. The analogous weighting between cold and hot start like in Equation 4 is also applied to these correction factors to make them a function of soak time.

$$TCF(b) = EXP[\ TC(b) * (T-75)\ ] \qquad \text{Eqn 6}$$

Where b = 1: Cold Start (Bag1)
= 2: Hot Stabilized (Bag2)
= 3: Hot Start (Bag3)

2.2.2 CO Start Correction Factors

The methodology for Start CO on 1980 and later model year vehicles is slightly different than for the other pollutants. For Start CO the correction factor is additive, and there is a temperature correction factor coefficient only for cold start CO (soak time = 720 minutes). The correction factor will increase the CO emissions as temperature (T in Equation 7) is lowered. It has the mathematical form shown in Equation 7.

$$TCF(1) = Coeff * (T - 75.0) \qquad \text{Eqn 7}$$

The values of the coefficients (Coeff) are shown in Table 1 below by model year for the 1980 - 1982 model years, and by technology type for the 1983 and later model years. They are the values of the Start CO temperature correction factor coefficients at a soak length of 720 minutes in units of g/mi-°F. MOBILE will also correct Start CO emission for soak times other than 720 minutes. The methodology for this is discussed in Section 3.4 because of the relationship between the additive Start CO temperature correction factor and additive Cold CO emission standard effects.

Table 1
Temperature Correction Factor Equation Coefficients for Start CO

Model Year Group	ALL or CARB (g/mi -°F)	TBI** (g/mi -°F)	PFI** (g/mi -°F)
1980	-1.24480		
1981	-1.30945		
1982	-1.28402		
1983 +	-1.22620*	-1.22620	-0.65727

* For Carbureted Vehicles Only
** TBI is throttle body fuel injection type
** PFI is ported fuel injection type

3.0 Effects of the Cold Temperature CO Certification Standard(s)

As part of the Clean Air Act requirements, EPA developed a new cold temperature CO certification standard and a 20°F test. The new requirements have two phases. Under the first phase, passenger cars were built to pass a 10 g/mi cold CO standard, and light-duty trucks were built to pass a 12 g/mi cold temperature CO standard as well as the traditional FTP CO standard at 75°F. The requirements for Phase 1 of the cold temperature CO standard were phased into the fleet starting in 1994 and ending in 1996. For passenger cars and light trucks the phase-in requirement was 40 percent of the fleet, 80 percent of the fleet and 100 percent of the fleet were required to pass the cold temperature standard in 1994, 1995 and 1996 respectively.

Because of the unknown nature of the Phase 2 standard, the parameters will not be 'hard-coded' into MOBILE6. Instead, the default case will be no implementation. Optional user inputs will be coded in case a new cold temperature CO standard is implemented. These inputs will include the implementation year, the phase-in schedule (three percentages), and the car and truck standards in grams per mile.

3.1 Data

An additive temperature correction factor for cold start CO will be used in MOBILE6 to model the effects of the cold CO certification standard. This assumes that only engine start emissions will be affected by the cold temperature CO standards. Table 1 shows a summary of the 1997 cold temperature CO certification data used to develop cold CO offsets for vehicles certified for Phase 1 cold CO standards (10 g/mi certification standard at 20°F). The summarized certification data were provided by the American Automobile Manufacturers Association (AAMA).

Table 1: 1997 Certification Data Summary

		FTP CO @ 75°F (g/mi)		FTP CO @ 20°F (g/mi)	
Manufacturer	Vehicle Type	4K Miles	50K Miles	4K Miles	50K Miles
All	Car	0.95	1.15	4.68	5.51
	LDT	1.32	1.54	4.81	5.76
Big Six[1]	Car	**0.98**	1.23	**4.80**	5.86
	LDT	**1.36**	1.55	**4.60**	5.48

[1] Sales-weighted average of GM, Ford, Chrysler, Honda, Nissan and Toyota.

<u>CO Offsets</u>

CO Offsets for cars @ 4K	= 4.8 - 0.98	=	3.82 g/mi
CO Offsets for trucks @ 4K	= 4.6 - 1.36	=	3.24 g/mi

The results from the Big Six Dataset were used. The 4.8 g/mi number for cars is the 20°F FTP emission result and the 0.98 g/mi number is the 75°F FTP emission result.

3.2 Use in MOBILE6

The Phase 1 CO offset (P1 CO Offset) value in MOBILE6 is the CO offset for Bag1 or cold start emissions. It is used for all temperatures below 75°F, and is in units of g/mi-°F. It is a negative number because it reflects the lower CO emissions due to the new CO Cold Start certification standards. It is used in MOBILE6 to reduce the cold start CO emissions calculated in Equation 7. Equation 8 shows how the P1 CO Offset is calculated from the FTP difference determined in the previous section. The value of 0.206 is the standard Bag 1 cold start FTP vehicle miles traveled (VMT) weighting. The value of -3.82 g/mi is based on the entire FTP. The Bag1 VMT weighting of 0.206 is used to transform the full FTP emissions into equivalent Bag1 emissions. The temperature Delta is 55°F. This is the difference between the standard FTP temperature condition of 75°F and the cold CO certification temperature of 20°F.

<u>Estimate of P1 CO Offset values:</u>

P1 CO Offset = -CO Offset FTP / (Bag1 FTP Weighting * Temp Delta) Eqn 8

For example, the offset for cars certified to the Phase 1 Cold CO Standard would be:

P1 CO Offset = -3.82 g/mi / (0.206 * 55°F) = -0.33709 g/mi -°F

and

P1 CO Offset for LDTs certified to Phase 1 cold CO = -0.28600 g/mi -°F

Since cold start emissions in MOBILE6 are in grams per start rather than grams per mile, the value of -0.33709 g/mi -°F can be converted to g/°F by multiplying the value by 3.59 miles. This is the distance of Bag1 (cold start bag) of the FTP. This produces values of P1 CO Offset in grams / start -°F of:

P1 CO Offset for cars certified to Phase 1 cold CO = -1.210 g/start -°F
P1 CO Offset for LDTs certified to Phase 1 cold CO = -1.027 g/start -°F

The cold start CO offsets are shown on a per degree basis with the baseline temperature of 75°F, and soak time length of 720 minutes (full cold start). An evaluation showing an example calculation of the CO cold start correction factor at a soak time of 720 minutes and application of the phase 1 offset at 60°F is as follows:

TCF(T) = Coeff * (T - 75°F) Eqn 9

Then, from Table 1, the TC(1) coefficient for 1992+ model years is -0.7739. Thus:

TCF(60) = -0.65727*(60-75) = 9.859 g/mi CO

Converting to grams per start by multiplying by 3.59 miles produces 35.39 g/start CO.

The CO offset as the result of the cold start CO rulemaking is: -1.210 g/start -°F

Multiplying this by the change in temperature from 75°F to 60°F (delta is 15°F) gives -18.15 g/start.

The final TCF at 60°F for a soak time of 720 minutes (full cold start) is the sum of the cold start temperature correction factor and the CO offset from the rulemaking. It is shown by:

$$\text{Final TCF(T)} = \text{TCF(T)}*3.59 - \text{P1 CO Offset}*(T - 75) \qquad \text{Eqn 10}$$

or

$$\text{Final TCF(Temp=60, soak=720)} = 35.39 - 18.15 = 17.24 \text{ g/start}$$

This value is added to the base CO emission factor at 75°F to correct the CO emissions for the lower temperature of 60°F.

3.3 The Effects of Potential Phase 2 Cold CO Standards

In the current MOBILE5b, Phase 2 cold CO standards are assumed to affect only the CO offset for Bag 1. For vehicles certified to Phase 2 standards, the CO offset for Phase 1 vehicles is reduced by the difference between pre-Phase 1 cold CO emissions at 20° F and an estimated Phase 2 CO level assuming a certification margin of about 20%. The MOBILE5b approach has two problems: (1) the CO offset for a low proposed Phase 2 standard (i.e. 3.4 g/mi) could be less than zero, and (2) the CO offset for vehicles certified to the Phase 1 standard was higher than the certification data now shows.

The cold CO offset for vehicles certified to the Phase 1 cold CO standard was discussed in the previous section. The proposed method for Phase 2 also assumes that only Bag 1 CO is affected by a potential Phase 2 standard. However, in this new method, the Phase 1 CO offset is reduced in proportion to the standard, so that it is equivalent to the Phase 1 CO offset at a Phase 2 standard of 10 g/mi (equal to the Phase 1 standard for cars) and is zero at a Phase 2 standard of 3.4 grams/mi (the standard for cars at 75°F) by using Equation 11.

$$\text{Phase 2 CO Offset} = \text{Phase 1 CO Offset} * [1-((10-x)/(10-3.4))] \qquad \text{Eqn 11}$$

Where :
10 = Phase 1 CO standard (g/mi)
x = User Input Phase 2 CO Standard (g/mi)
3.4 = Minimum Phase 2 CO standard (g/mi)

In MOBILE6 the Phase 2 CO Offset will be applied as a multiplicative factor to the Phase 1 CO Offset.

The Bag 1 CO offset is linearly interpolated at all points in between 10 and 3.4 g/mi. In this manner the CO offset cannot be negative, unless the Phase 2 CO standard is less than 3.4 g/mi (an unlikely scenario). Proposed Phase 2 standards of less than 3.4 g/mi will not be allowed in MOBILE6. The temperature sensitivities of Bags 2 and 3 are assumed to be unaffected by the Phase 2 standard (same assumption as for Phase 1).

3.4 Start CO Effects Versus Soak Time Length

The Start CO temperature correction factor is also a function of soak time which can range from 0 minutes (an immediate restart after a fully warmed up engine is shut down) to 720 minutes. The relationship between soak time and the Start CO temperature correction factor was developed from the value at 720 minutes, and the assumption that the start CO temperature correction factor at a soak time of zero minutes is 0.00. This means that there is no temperature correction for warmed up vehicles which were immediately restarted after being shut off. Also, there is no P1 CO Offset or P2 CO Offset at soak times of zero minutes. These are also assumed to be 0.00, since if there is no effect, there could not be an offset to that effect. These are reasonable assumptions also since ambient temperature is not likely to be a major factor on a warmed up vehicle which has not had any time to soak and cool down.

For example for the 1983+ PFI vehicles the Start CO emissions at 500 minutes are:

Final TCF(Temp=60, soak=720) = 35.39 - 18.15 = 17.24 g/start

Final TCF(Temp=60, soak=500) = (17.24 / 720 minutes)*500 = 11.972 g/start

4.0 The Temperature Correction Factor in MOBILE6

The application of the temperature correction factor in MOBILE6 is slightly different depending on whether it is a multiplicative correction factor or an additive correction factor. Also, the running emission temperature correction factors are handled slightly different than the start temperature correction factors.

The multiplicative correction factors are of the form in the MOBILE6 function BEF:

BEF = BEF * TEMPCOR * FUEL_CF Eqn 12

Where BEF is the basic emission factor, TEMPCOR is the multiplicative temperature correction factor and FUEL_CF is the fuel type correction factor.

Subsequent to this subroutine multiplicative correction factors are applied to BEF. For running emissions these correct for speed, A/C, Load, Humidity and RVP. For HC and NOx start emissions, these correct only for humidity and RVP.

The additive correction factors are of the form in the MOBILE6 function BEF:

$$BEF = (BEF + TEMPCOR) * FUEL\_CF \qquad \text{Eqn 13}$$

Where TEMPCOR is the additive temperature correction factor. Since the additive correction factor is only for start CO emission, these are corrected subsequently only for humidity and RVP.

APPENDIX A-1

LOW (< 75F) TEMPERATURE CORRECTION FACTOR COEFFICIENTS FOR
LIGHT DUTY GASOLINE POWERED VEHICLES

* TCF(1) = TC(1)*(T - 75.0), 1980+ CO,
TCF(b) = EXP [TC(b)*(T - 75.0)], all others

Pol	Model Years	Test Segment 1	Test Segment 2	Test Segment 3
HC	Pre-1968	-0.20623E-01	-0.24032E-02	-0.10081E-02
	1968-1969	-0.24462E-01	-0.32017E-02	-0.86884E-03
	1970-1971	-0.21255E-01	-0.52755E-03	0.93659E-03
	1972-1974	-0.21427E-01	-0.39442E-03	0.49731E-02
	1975-1979	-0.23517E-01	-0.88057E-02	-0.16222E-02
	1980	-0.26820E-01	-0.75815E-02	-0.51660E-02
	1981	-0.32775E-01	-0.83176E-02	-0.90264E-02
	1982	-0.32082E-01	-0.85130E-02	-0.90264E-02
	1983	-0.36491E-01	-0.74210E-02	-0.59700E-02
	1984	-0.35513E-01	-0.81506E-02	-0.65977E-02
	1985	-0.32437E-01	-0.78173E-02	-0.63349E-02
	1986	-0.30471E-01	-0.84450E-02	-0.68826E-02
	1987	-0.30325E-01	-0.90327E-02	-0.73839E-02
	1988	-0.27959E-01	-0.94236E-02	-0.77326E-02
	1989	-0.26867E-01	-0.85843E-02	-0.70257E-02
	1990	-0.24273E-01	-0.83468E-02	-0.68413E-02
	1991	-0.23768E-01	-0.82591E-02	-0.67700E-02
	1992+	-0.23768E-01	-0.82591E-02	-0.67700E-02
CO	Pre-1968	-0.13487E-01	0.15784E-02	0.11097E-02
	1968-1969	-0.21126E-01	-0.15289E-02	0.15749E-02
	1970-1971	-0.20843E-01	-0.59951E-02	0.18253E-02
	1972-1974	-0.19091E-01	-0.42373E-03	0.57982E-02
	1975-1979	-0.24835E-01	-0.88336E-02	-0.11553E-02
	1980	-0.12448E+01	-0.12478E-01	-0.74106E-02
	1981	-0.13095E+01	-0.14584E-01	-0.11371E-01
	1982	-0.12840E+01	-0.14584E-01	-0.11371E-01
	1983	-0.11761E+01	-0.13550E-01	-0.90777E-02
	1984	-0.11636E+01	-0.14658E-01	-0.90777E-02
	1985	-0.10515E+01	-0.14282E-01	-0.90777E-02
	1986	-0.10032E+01	-0.15277E-01	-0.90777E-02
	1987	-0.10146E+01	-0.16146E-01	-0.90777E-02
	1988	-0.94629E+00	-0.16807E-01	-0.90777E-02
	1989	-0.88655E+00	-0.15614E-01	-0.90777E-02
	1990	-0.79324E+00	-0.15360E-01	-0.90777E-02
	1991	-0.77390E+00	-0.15250E-01	-0.90777E-02
	1992+	-0.77390E+00	-0.15250E-01	-0.90777E-02
NOx	Pre-1968	-0.16897E-03	-0.89245E-02	-0.72580E-02
	1968-1972	-0.25074E-03	-0.59791E-02	-0.62690E-02
	1973-1974	0.38855E-02	-0.24156E-02	-0.21188E-02
	1975-1976	-0.45504E-04	-0.12575E-02	-0.53153E-03
	1977-1979	-0.76044E-02	-0.68045E-02	-0.54198E-02
	1980	-0.19000E-02	-0.61656E-02	-0.49643E-02
	1981	-0.45479E-02	-0.74823E-02	-0.90882E-02
	1982	-0.47657E-02	-0.69890E-02	-0.90882E-02
	1983	-0.43258E-02	-0.97539E-02	-0.10132E-01
	1984	-0.43258E-02	-0.93986E-02	-0.10036E-01
	1985	-0.43258E-02	-0.85213E-02	-0.91794E-02
	1986	-0.43258E-02	-0.78839E-02	-0.88096E-02
	1987	-0.43258E-02	-0.77871E-02	-0.88966E-02
	1988	-0.43258E-02	-0.70534E-02	-0.83745E-02
	1989	-0.43258E-02	-0.68079E-02	-0.79177E-02
	1990	-0.43258E-02	-0.60641E-02	-0.72042E-02
	1991	-0.43258E-02	-0.59229E-02	-0.70563E-02
	1992+	-0.43258E-02	-0.59229E-02	-0.70563E-02

* WHERE :
TCF(b) = Low temperature correction factor for appropriate pollutant, ambient temperature (< 75F), and model year, for test segment b,
T = Ambient temperature (Fahrenheit),
TC(b) = Low temperature correction factor coefficient for appropriate pollutant, reference temperature, and model year, for test segment b.

NOTE : The low temperature correction factor is used in conjunction with the correction factor given in Table 1.7C.

DATE : JUNE 30, 1995

APPENDIX A-2

HIGH (> 75F) TEMPERATURE CORRECTION FACTOR COEFFICIENTS
AND FUEL RVP CORRECTION FACTORS FOR
LIGHT DUTY GASOLINE POWERED VEHICLES

* TCF(b) = EXP [TC(b)*(T - 75.0)], Pre-1980
TRCF(b) = EXP [RC(b)*(RVP - 9.0) + TC(b)*(T - 75.0)
+ TRC(b)*(RVP - 9.0)*(T - 75.0)], 1980+

Pol	Model Years	Parameter	Test Segment 1	Test Segment 2	Test Segment 3
HC	Pre-1968	TC	-0.14381E-01	0.13219E-02	0.34799E-02
	1968-1969		-0.12552E-01	0.42667E-02	0.75843E-02
	1970-1971		-0.10888E-01	-0.47925E-03	0.76666E-02
	1972-1974		-0.66107E-02	0.26288E-02	0.12320E-01
	1975-1979		-0.14095E-01	0.26179E-01	0.24297E-01
	1980-1982	RC	0.91402E-01	0.42060E-01	0.93179E-01
		TC	0.44270E-02	0.48358E-02	0.74688E-02
		TRC	0.29466E-02	0.00000E+00	0.47276E-02
	1983+	RC	0.23202E-01	0.15373E+00	0.13263E+00
		TC	0.00000E+00	0.86550E-02	0.83730E-02
		TRC	0.00000E+00	0.00000E+00	0.56009E-02
CO	Pre-1968	TC	-0.14691E-01	0.37462E-02	0.11014E-01
	1968-1969		-0.38767E-01	0.84685E-02	0.25179E-01
	1970-1971		-0.21165E-01	0.23603E-01	0.28483E-01
	1972-1974		-0.13146E-01	0.24717E-01	0.25848E-01
	1975-1979		-0.19612E-01	0.48537E-01	0.31439E-01
	1980-1982	RC	0.91345E-01	0.13968E+00	0.16322E+00
		TC	0.62182E-02	0.14943E-01	0.14923E-01
		TRC	0.00000E+00	0.00000E+00	0.00000E+00
	1983+	RC	0.40748E-01	0.26214E+00	0.23218E+00
		TC	0.35170E-02	0.14966E-01	0.20695E-01
		TRC	0.00000E+00	0.56416E-02	0.82344E-02
NOx	Pre-1968	TC	0.38841E-02	-0.87325E-02	-0.10839E-01
	1968-1972		-0.10389E-02	-0.92466E-02	-0.10108E-01
	1973-1974		-0.18301E-01	-0.10925E-01	-0.18042E-01
	1975-1976		-0.71420E-02	-0.87910E-02	-0.75470E-02
	1977-1979		-0.26153E-01	-0.18603E-01	-0.20878E-01
	1980-1982	RC	0.00000E+00	-0.40024E-01	0.00000E+00
		TC	0.00000E+00	0.00000E+00	0.00000E+00
		TRC	0.00000E+00	0.00000E+00	0.00000E+00
	1983+	RC	0.14219E-01	0.27491E-01	0.00000E+00
		TC	0.00000E+00	0.37789E-02	0.00000E+00
		TRC	0.00000E+00	0.00000E+00	0.00000E+00

* WHERE :
TCF(b) = High temperature correction factor for appropriate pollutant, ambient temperature, and model year, for test segment b,
T = Ambient temperature (Fahrenheit),
TC(b) = High temperature correction factor coefficient for appropriate pollutant, temperature, and model year, for test segment b,
TRCF(b)= High temperature and fuel RVP correction factor for appropriate pollutant, ambient temperature, fuel RVP, and model year, for test segment b,
RC(b) = Fuel RVP correction factor coefficient for appropriate pollutant, fuel RVP, and model year, for test segment b,
RVP = Fuel volatility in psi,
TRC(b) = Combined temperature and fuel RVP correction factor coefficient for appropriate pollutant, fuel RVP, ambient temperature, and model year, for test segment b.

NOTE : The temperature correction factor is used in conjunction with the correction factor given in Table 1.7C in APP42.