

Section 4.11 ON-ROAD MOTORCYCLE ACTIVITY, TECHNOLOGY GROUPS, AND EMISSION RATES

4.11.1 Introduction

The on-road motorcycle (MC) activity and emission data have not been significantly revised since early 1980s. However, over the past two decades MC emission characteristics have changed considerably. ARB staff believe that several factors have had impact on the emission inventory of MCs. First, technologies for controlling motorcycle emissions have been continuously evolving, undoubtedly leading to changes in motorcycle emissions. Second, the compositions of motor vehicle fuels have been modified considerably over time, directly affecting the emissions from all motor vehicles. Third, although the in-use fleet includes a sizable fraction of older MCs, EMFAC7G still assumes no motorcycles older than 7 years. Finally, driving behaviors, which have been found to affect the exhaust emissions of motor vehicles, are significantly different today than many years ago.

To adequately address the changes in MC emissions in EMFAC2000, ARB staff reviewed MC activity and emission data gathered from a number of sources, including emission test results from a recent ARB motorcycle surveillance program. This section describes the analysis of the available MC activity and emission data. The first part of the section discusses MC activity data; the second part examines MC emission data and addresses MC technology groups and basic emission rates.

4.11.2 On-Road Motorcycle Activity Data

The following MC activity data were updated or re-calculated using data from several sources:

- accrual rate and cumulative mileage;
- population (POP) and age distribution;
- vehicle mile traveled (VMT).

The accrual rate for MCs was estimated using mileage accrual data from the Motorcycle Industry Council's (MIC) survey¹. The survey contains mileage accrual rates for MCs ages 1 through 15. The 15 data points were found to be best fit by the following model:

$$\text{Accrual Rate} = 4,104 * \exp(-0.0654 * \text{Age}), \quad R^2 = 0.99 \quad (4.11-1)$$

Equation 4.11-1 was used to calculate the accrual rates for MCs with ages 1 through 45. The cumulative mileage for MCs with age i is the sum of accrual rates for MCs with ages 1 through i .

The MC population was obtained from the Department of Motor Vehicle (DMV) annual vehicle registration reports, which provide the number of motor vehicles registered in each county of California. The MC age distribution was determined from the DMV's 1998 registration data.

¹ Survey of Motorcycle Ownership and Usage, MIC, 1990.

The MC daily VMT for a given year was estimated from the MC POP and accrual rate using the following equation:

$$\text{VMT} = \sum (\text{POP}_i * \text{Accrual Rate}_i), \quad i = 1 \text{ to } 45 \quad (4.11-2)$$

Calculated results for MC accrual rate, cumulative mileage, and age distribution are given in Appendix 4.11-A.

4.11.3 On-Road Motorcycle Technology Groups

Emissions Data from On-Road Motorcycle Surveillance Programs

In 1978 and 1980, the ARB conducted MC Surveillance Testing Programs I and II (MCSTP I and II) to gather emissions data on in-use MCs². Twenty-one uncontrolled MCs were tested in MCSTP I and 40 uncontrolled and controlled MCs in MCSTP II. In 1998, ARB initiated another testing program, Surveillance Testing of Motorcycles for Emissions (MCSTP98), to update the MC emissions inventory.

Note that while all MCs in MCSTP I and II were tested over the Federal Test Procedure (FTP) for HC, CO, and NOx emission levels, all tests in MCSTP98 for the three pollutants were performed over the Unified Cycle (UC). In addition, CO₂ emissions were also measured in MCSTP98.

Since the emission data used in EMFAC2000 are based on the UC, the FTP composite results from MCSTP I and II must be converted to UC bag-specific emission rates. As a result, 26 of the MCs from MCSTP98 were also tested over both the UC and FTP cycle. From this data, a correlation between the FTP and UC emission rates were established (Table 4.11-1). Note that CO₂ emissions were not measured in MCSTP I and II and therefore no FTP-UC correlation calculation was performed for CO₂.

Table 4.11-1. Correlation between FTP and UC Composite Emissions for On-Road Motorcycles.

Pollutant	Correlation	R²
HC	$\text{HC}_{\text{UC}} = 0.8648 \text{ HC}_{\text{FTP}} + 0.2732$	0.97
CO	$\text{CO}_{\text{UC}} = 0.9860 \text{ CO}_{\text{FTP}} + 2.0344$	0.92
NOx	$\text{NOx}_{\text{UC}} = 1.4978 \text{ NOx}_{\text{FTP}} + 0.0648$	0.82

² Final Report of the Motorcycle Surveillance Test Program, First Series, ARB, 1980; Test Report of the Motorcycle Surveillance Test Program, Series 2, ARB, 1981.

With the FTP-UC correlation, the FTP composite results from MCSTP I and II were first converted to UC composite rates and then partitioned into Bags 1, 2, and 3 using the following equations:

$$ER_{com} = 0.109ER_{B1} + 0.782ER_{B2} + 0.109ER_{B3} \quad (4.11-3)$$

$$ER_{B1} / ER_{B2} = A \quad (4.11-4)$$

$$ER_{B1} / ER_{B3} = B \quad (4.11-5)$$

where ER_{com} is the UC composite emission rate, and ER_{B1} , ER_{B2} , and ER_{B3} are the emission rates of UC Bag 1, 2, and 3, respectively. The UC Bag 1 to UC Bag 2 ratio and UC Bag 1 to UC Bag 3 ratio were estimated from the UC bag results obtained in MCSTP98. The values of A and B for HC, CO, and NOx are given in Table 4.11-2.

Table 4.11-2. UC Bag 1/UC Bag 2 and UC Bag 1/UC Bag 3 Ratios.

	Bag 1/Bag 2 (A)	Bag 1/Bag 3 (B)
HC	0.438	0.624
CO	0.778	0.849
NOx	1.374	0.902

On-Road Motorcycle Technology Group

Technology Group Identification

The identification of MC technology groups (tech groups) was based on the emissions data from ARB's surveillance testing programs and a consideration of the past, current, and future MC exhaust and evaporative emission standards. The MC exhaust emission standards are summarized in Table 4.11-3.

Evaporative emissions of Class I and II MCs (50-279 cc) were first controlled in 1983 under a 6.0 g/test standard, which was subsequently revised to 2.0 g/test in 1985. The same evaporative standards were also applicable to Class III (280 cc and over) MCs but with a one-year delay (i.e., 6.0 g/test for 1984-85 and 2.0 for 1986 and later). In order to incorporate the evaporative emission standards into the MC tech groups, it was assumed that MCs built before 1985 had to meet the 6.0 g/test standard and those built in 1985 and later, the 2.0 g/test standard.

A statistical analysis of testing data pooled from the three ARB surveillance programs suggested that four MC tech groups could be distinguished on the basis of technology: 1) those with a two-stroke engine; 2) those built before 1978; 3) those built since 1978 equipped with a carburetor; and 4) those with the same technology as (3) but with their emission control systems tampered.

Lack of test data precluded any analysis of motorcycles with fuel injection and catalyst technologies. It was, however, recognized that these technologies had been in use since mid-1990s and the impending implementation of new emission standards in 2004 and 2008 (Table

4.11-3) called for a high percentage of such technologies. As a result, additional tech groups were identified for MCs equipped with fuel injection, catalyst, or both.

Table 4.11-3. On-Road Motorcycle Exhaust Emission Standards.

Year	Displacement (cc)	HC (g/km)	CO (g/km)
1978-79	50-169	5.0	17
	170-749	X*	17
	750 and over	14.0	17
1980-81	50 and over	5.0	12
1982-84	50-279	1.0	12
	280 and over	2.5	12
1985-87	50-279	1.0	12
	280 and over	1.4	12
1988-03	50-279	1.0	12
	280-699	1.0	12
	700 and over	1.4	12
2004-07	50-279	1.0	12
	280-699	1.0	12
	700 and over	1.4**	12
2008 and later	50-279	1.0	12
	280-699	1.0	12
	700 and over	0.8**	12
* X = 5.0 + 0.0155 (D – 170), where D = engine displacement.			
** Standards applicable to HC+NOx emissions.			

A total of 18 MC tech groups were established:

1. All Two-Stroke Carbureted (All-CARB2S);
2. Pre-78 Four-Stroke Carbureted (Pre-78CARB4S);
3. 78-79 Four-Stroke Carbureted (78-79CARB4S);
4. 80-81 Four-Stroke Carbureted (80-81CARB4S);
5. 82-84 Four-Stroke Carbureted (82-84CARB4S);
6. 85-87 Four-Stroke Carbureted (85-87CARB4S);
7. 88-03 Four-Stroke Carbureted (88-03CARB4S);
8. 88-03 Four-Stroke Fuel Injected (88-03FI4S);
9. 88-03 Four-Stroke Carbureted/Catalyst (88-03CARB/CAT4S);
10. 88-03 Four-Stroke Fuel Injected-Catalyst (04-07FI/CAT4S);

11. 04-07 Four-Stroke Carbureted (04-07CARB4S);
12. 04-07 Four-Stroke Fuel Injected (04-07FI4S);
13. 04-07 Four-Stroke Carbureted/Catalyst (04-07CARB/CAT4S);
14. 03-07 Four-Stroke Fuel Injected/Catalyst (04-07FI/CAT4S);
15. 08+ Four-Stroke Carbureted (08+CARB4S);
16. 08+ Four-Stroke Fuel Injected (08+FI4S);
17. 08+ Four-Stroke Carbureted/Catalyst (08+CARB/CAT4S);
18. 08+ Four-Stroke Fuel Injected/Catalyst (08+FI/CAT4S).

The following provides a brief description of the 18 tech groups. The emission rates for these groups will be discussed in the section that follows.

All-CARB2S Group

Emission testing data show that two-stroke MCs have distinctively higher emission rates than uncontrolled four-stroke MCs. Thus, two-stroke MCs of all model years are collected in this technology group.

Pre-78CARB4S Group

All MCs were uncontrolled prior to 1978. Therefore, all four-stroke MCs built before 1978 are placed in one technology group.

78+CARB4S Group

Motorcycles were first controlled for their emissions in 1978 and over the next two decades there have been amendments to the original standards. Thus, controlled MCs equipped with carburetors are divided into 7 technology groups corresponding to the different emission standards (see Table 4.11-3): 1978-79, 1980-81, 1982-84, 1985-87, 1988-2003, 2004-07, and 2008 and later.

88+FI4S Group

Although fuel injection was used occasionally on MCs prior to 1994, it was not until that year that a consistent application of this technology in MCs occurred. According to ARB MC certification reports, over the last few years fuel-injected units have been steadily rising from 2% to around 10% of the annual production. It is projected that the application of this technology will remain at its current level for the next few years and then increase significantly with the implementation of Tier 1 standards in 2004 and Tier 2 in 2008. Accordingly, fuel-injected MCs are divided into three groups: *88-03FI4S*, *04-07FI4S*, and *08+FI4S*.

88+CARB/CAT4S Group

Motorcycles with catalysts began to appear on the market during the 1994 model year. Although both oxidation and three-way catalysts are being offered on selected models, MCs equipped with oxidation catalysts dominate the sales (>90% oxidation vs. <10% three-way). The total sales of catalyst-equipped MCs have been fairly constant at about 20% and it is projected that the

percentage of Carbureted catalyst-equipped MCs is likely to remain at current levels. Similar to the fuel-injection groups, MCs with a carburetor-catalyst control system are divided into three groups: *88-03CARB/CAT4S*, *04-07CARB/CAT4S*, and *08+CARB/CAT4S*.

88+FI/CAT4S Group

Motorcycles equipped with both fuel injectors and catalysts first entered the market in 1994. Over the last 5 years, the percentage of fuel-injected and catalyst-equipped MCs has remained small at 4-5% of the total sales. However, such a control system is generally considered to be crucial in achieving California's two-tier MC emission standards, in particular for the 2008 Tier 2 standards (see Table 4.11-3). All MCs with a fuel injection-catalyst control system are further divided into three groups: *88-03FI/CAT4S*, *04-07FI/CAT4S*, and *08+FI/CAT4S*.

Fractions of Technology Groups for Years 1960 to 2020

The fractions of MCs of different tech groups (technology fractions) for model years from 1960 to 2020 were estimated using data from ARB certification reports, manufacturers' production reports, and ARB staff's future year projections. The results are given in Appendix 4.11-B.

4.11.4 On-Road Motorcycle Emission Rates

UC-Based Exhaust Emission Rate for On-Road Motorcycles

The UC-based basic emission rates (BER, which includes a zero-mile, ZM, emission rate and a deterioration rate, DR) for the 18 tech groups, are listed in Appendix 4.11-C. In Appendix 4.11-D the FTP-based basic emission rates for the 18 tech groups are also provided.

For each of the 18 groups, two sets of BERs are given: one for non-tampered MCs and one for tampered. The overall BER for a given tech group is calculated as follows:

$$BER_X = (1-f) BER_{X/NT} + f BER_{X/T} \quad (4.11-6)$$

where BER_X is the overall emission rate for tech group x ; $BER_{X/NT}$ and $BER_{X/T}$ are, respectively, the rates for the non-tampered and tampered MCs in tech group x ; and f is the tampering rate for tech group x . The tampering rate is specific to both model year and tech group. A tampering rate of 0.34, which is the rate found by MIC in its 1990 and 1998 motorcycle owner surveys³, is assumed for all 18 tech groups and all model years.

Only one set of BERs for CO₂ is given for each tech group. An examination of test data showed that tampered and non-tampered MCs in each tech group were statistically indistinguishable in terms of their CO₂ emission levels. Thus, for each tech group the CO₂ BER was calculated using the CO₂ results from both tampered and non-tampered MCs.

For each tech group, HC, CO, NO_x, and CO₂ emission data from the three ARB surveillance programs (MCSTP I&II and MCSTP98) were pooled and then plotted as a function of odometer

³ Letter from Pamela Amette, MIC Vice President, to James Ryden, ARB Office of Legal Affairs, August 14, 1998.

readings. For each plot, attempt was made to see if a statistically significant line exist. A regression line would provide a ZM emission rate and a DR. In the cases where no meaningful regression line could be found, the average of all data points were used as the ZM emission rate and a zero DR was assumed.

Table 4.11-4 summarizes the emission data used for estimating HC, CO, NO_x, or CO₂ BERs for each of the tech groups.

Table 4.11-4. Emission Data Base Used for Estimating Basic Emission Rates of On-Road Motorcycle Technology Groups.

Technology Group	No. of Data Points Used in BER Calculation		
	HC/CO/NO _x		CO ₂
	MCSTP I & II	MCSTP98	MCSTP98
All-CARB2S	4	1	1
Pre-78CARB4S	25	10	10
78-79CARB4S (Non-Tampered)	21	3	4
80-81CARB4S (Non-Tampered)	1	6	10
82-84CARB4S (Non-Tampered)		9	11
85-87CARB4S (Non-Tampered)		8	12
88-03CARB4S (Non-Tampered)		28	
04-07CARB4S, 08+CARB4S (Non-Tampered)		See text	33
78-79CARB4S, 80-81CARB4S, 82-84CARB4S, 85-87CARB4S, 88-03CARB4S, 04-07CARB4S, 08+CARB4S	6	9	See text
88-03FI4S, 04-07FI4S, 08+FI4S (Non-Tampered)		See text	1
88-03FI4S, 04-07FI4S, 08+FI4S (Tampered)		1	
88-03CARB/CAT4S, 04-07CARB/CAT4S, 08+CARB/CAT4S (Non-Tampered)		2	4
88-03CARB/CAT4S, 04-07CARB/CAT4S, 08+CARB/CAT4S (Tampered)		2	
88-03FI/CAT4S (Non-Tampered)		2	2
88-03FI/CAT4S (Tampered)		See text	

04-07FI/CAT4S, 08+FI/CAT4S (Non-Tampered and Tampered)		See text	See text
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Emissions data were not available for several tech groups (noted in Table 4.11-4 under “See text”). The BERs for these groups, which were obtained differently from the procedures outlined above, are discussed below.

04-07CARB4S and 08+CARB4S Groups (Non-Tampered)

Since the 1998 MC emission regulation recognizes the likely continuing marketing of carburetor-equipped MCs after the implementation of Tier 1 (2004) and Tier 2 (2008) standards, the BERs for *88-03CARB4S* group were assumed to be applicable to non-tampered MCs in *04-07CARB4S* and *08+CARB4S* groups.

78+CARB4S Groups (Tampered)

Among the 91 1978+ carburetor-equipped MCs in the pooled data set used for estimating emission rates, six were identified during vehicle inspection as being tampered. In addition, nine of the test vehicles have Bag 2 HC emissions over 6 g/mile and are clearly outside the cluster formed by the majority of the data points. These 15 MCs were collectively treated as “tampered” and their average emissions were assumed to be applicable to all 78+ carburetor groups.

The BER of CO₂ for each of the groups was assumed to be the same as that of its corresponding non-tampered group (non-tampered *78-79CARB4S* group and tampered *78-79CARB4S* group).

88-03FI4S, 04-07FI4S, and 08+FI4S Groups (Non-Tampered and Tampered)

No emission test data was available for fuel-injected non-catalyst MCs. As a result, for non-tampered MCs in these three groups the BERs for HC, CO, and NO_x were assumed to be the same as those for non-tampered *88-03CARB4S* groups. The BERs of HC, CO, and NO_x for the tampered MCs in these three groups were based on the test result of a fuel-injected 1985 Honda test in MCSTP98. Although no tampering was reported during its inspection, this Honda exhibited high HC and CO emissions during the test. The BER of CO₂ for both non-tampered and tampered MCs in these groups were also based on the test result of this 1985 Honda.

88-03FI/CAT4S Group (Tampered)

For MCs in this group, the BERs of HC, CO, and NO_x estimated for tampered MCs in *88-03CARB/CAT4S* group were used and the BER of CO₂ was assumed to be the same as that for the non-tampered MCs in this group.

04-07FI/CAT4S and 08+FI/CAT4S Groups (Non-Tampered and Tampered)

The BERs of HC, CO, and NO_x for non-tampered MCs in these two groups were assumed to be the same as the BERs used in the emission inventory evaluations for 1998 California MC emission control regulation (the scenario used for estimating emissions benefit for the regulation

calls for 60% of the 2008 and later MCs to be equipped with fuel-injection and catalyst system to attain 0.4 g/km HC+NOx emissions in order for the entire fleet to meet the Tier 2 standard, 0.8 g/km HC+NOx). Calculation of the 1998 regulation BERs assumed that fuel-injection/catalyst system of a non-tampered 2008 and later MCs would deteriorate 30% in HC and 10% in NOx controls over 30,000 km (its useful life span) and would emit 0.4 g/km HC+NOx at 30,000 km. These assumptions are based on emission data for on-road passenger cars.

The BERs of HC, CO, and NOx for tampered MCs in these two groups were assumed to be the same as the BER for tampered MCs in 88-03FI4S group.

The BERs of CO₂ for both non-tampered and tampered MCs in the group were assumed to be the same as that estimated for 88-03FI/CAT4S group.

Evaporative Emissions: Diurnal and Hot-Soak Emission Rates

Ten MCs from MCSTP98 were tested for diurnal and hot-soak evaporative emissions using the Sealed Housing Evaporative Determination (SHED) method. The ten MCs are divided into two model-year groups: Pre-1985 and 1985 and later. The Pre-1985 group consists of two 1981 MCs and the other group has eight MCs ranging from 1985 to 1999 model years. For each of the two groups, the SHED results were averaged and used as the diurnal and hot-soak emission rates for Pre-1985 and 1985 and later model year MCs (Table 4.11-5).

Table 4.11-5. On-Road Motorcycle Evaporative Emission Rates.

	Diurnal (g/event)	Hot Soak (g/35min)
Pre-1985	6.515	1.397
1985 and Later	2.392	0.806

4.11.5 On-Road Motorcycle Emission Correction Factors

Temperature, Speed, and Fuel Correction Factors

The temperature, speed, and fuel correction factors (TCF, SCF, and FCF) are used in inventory models to correct for the effects of non-standard speeds, temperatures, and fuels on the UC-based emission rates. In EMFAC2000, the TCF, SCF, and FCF for MCs are the same as those used for light-duty vehicles (LDV) with similar emission control technologies. A complete discussion of these correction factors is given in Section 6.1-6.3 of this document. Table 4.11-6 provides the equivalent LDV tech groups for the 18 MC tech groups for the purpose of applying LDV correction factors to MCs.

Start Correction Factor

Start Correction Factors (StCF) are used in the emissions inventory model to adjust the basic UC based Bag1 emission rates to model start emissions for real-world driving conditions. Following the definition for passenger cars (Section Z), the StCF for MCs is defined as:

$$\text{StCF} = (\text{CE}_{100/\text{UCBag1}}) / (\text{ER}_{\text{UCBag1}}) \quad (4.11-7)$$

where $\text{CE}_{100/\text{UCBag1}}$ is the cumulative emissions within the first 100 seconds of Bag 1 of the UC (grams); $\text{ER}_{\text{UCBag1}}$ is the emission rate of the UC (g/mi).

Table 4.11-6. Equivalent Light-Duty Vehicle Technology Groups.

MC Technology Groups		LDV Technology Groups	
Tech Group	Description	Tech Group	Description
1	All CARB 2S	3	75+ LDV NCAT
2	Pre-78 CARB 4S	3	75+ LDV NCAT
3	78-79 CARB 4S	3	75+ LDV NCAT
4	80-81 CARB 4S	3	75+ LDV NCAT
5	82-84 CARB 4S	3	75+ LDV NCAT
6	85-87 CARB 4S	3	75+ LDV NCAT
7	88-03 CARB 4S	3	75+ LDV NCAT
8	88-03 FI 4S	3	75+ LDV NCAT
9	88-03 CARB/CAT 4S	6	80+ OxCAT No AIR
10	88-03 FI/CAT 4S	11	77-80 TWC MPFI
11	04-07 CARB 4S	3	75+ LDV NCAT
12	04-07 FI 4S	3	75+ LDV NCAT
13	04-07 CARB/CAT 4S	6	80+ OxCAT No AIR
14	04-07 FI/CAT 4S	11	77-80 TWC MPFI
15	08+ CARB 4S	3	75+ LDV NCAT
16	08+ FI 4S	3	75+ LDV NCAT
17	08+ CARB/CAT 4S	6	80+ OxCAT No AIR
18	08+ FI/CAT 4S	11	77-80 TWC MPFI

The UC modal (second-by-second) emission data from 11 MCs tested in MCSTP98 were used to calculate the StCFs for non-catalyst MCs according to Equation 4.11-7. No UC modal data was available for catalyst-equipped MCs. However, FTP modal data were collected for a 1997 Harley-Davidson both with and without its catalyst. From this FTP-based modal data two StCFs (representing cases with and without catalyst) were calculated and their ratio was then used to

estimate the UC-based StCFs for catalyst-equipped MCs from the UC-based non-catalyst StCFs. Table 4.11-7 shows the calculated StCFs for MCs with and without catalyst control system.

Table 4.11-7. Start Correction Factor for On-Road Motorcycles (mile).

Pollutant	Non-Catalyst	Catalyst*
HC	0.387	0.653
CO	0.420	0.618
NOx	0.087	0.195
* Calculated from the values for Non-Catalyst MCs.		

4.11.6 Recommendations

In the future, staff should consider emissions testing of fuel-injected MCs equipped with and without a catalyst. Staff has assumed that MCs are driven in a manner similar to passenger cars and hence characterized by UC-based emission rates. Staff would like to collect real-world activity data to evaluate the driving behavior of MCs. Staff would also like to derive MC-specific TCF, SCF, and FCF.

Appendix 4.11-A. Annual Mileage Accrual Rate, Cumulative Mileage, and Population Distribution for On-Road Motorcycles

Age	Accrual Rate (mi/year)	Cumulative Mileage	Population
45	216	57,331	1,417
44	231	57,102	251
43	247	56,857	325
42	263	56,596	296
41	281	56,317	364
40	300	56,019	366
39	320	55,701	323
38	342	55,362	395
37	365	55,000	395
36	390	54,613	584
35	416	54,200	794
34	444	53,759	919
33	474	53,288	1,820
32	506	52,786	2,903
31	540	52,249	4,521
30	577	51,677	7,214
29	616	51,065	7,200
28	658	50,413	7,788
27	702	49,716	8,741
26	749	48,972	9,097
25	800	48,178	11,089
24	854	47,330	7,954
23	912	46,425	6,766
22	974	45,458	10,138
21	1,039	44,427	11,670
20	1,110	43,325	14,339
19	1,185	42,150	19,310
18	1,265	40,894	31,259
17	1,350	39,554	29,508
16	1,441	38,124	21,563
15	1,539	36,596	41,797
14	1,643	34,966	45,910
13	1,754	33,225	34,183
12	1,872	31,366	20,088
11	1,999	29,382	22,362
10	2,134	27,264	18,846
9	2,278	25,003	17,177
8	2,432	22,588	15,016
7	2,596	20,011	16,029
6	2,772	17,260	16,932
5	2,959	14,322	16,294
4	3,159	11,186	22,082
3	3,373	7,838	17,391
2	3,601	4,264	1,407
1	3,844	961	37

Appendix 4.11-B (continued)

Model Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
	Two-Stroke	Pre-78	78-79 Carb	80-81 Carb	82-84 Carb	85-87 Carb	88-03 Carb	88-03 FI	88-03 Carb+Cat	88-03 FI+Cat	03-08 Carb	03-08 FI	03-08 Carb+Cat	03-08 FI+Cat	08+ Carb	08+ FI	08+ Carb+Cat	08+ FI+Cat	
1992							1.000												1.000
1993							1.000												1.000
1994							0.980	0.005		0.015									1.000
1995							0.740	0.010	0.220	0.030									1.000
1996							0.735	0.045	0.180	0.040									1.000
1997							0.720	0.060	0.180	0.040									1.000
1998							0.720	0.060	0.180	0.040									1.000
1999							0.720	0.060	0.180	0.040									1.000
2000							0.720	0.060	0.180	0.040									1.000
2001							0.720	0.060	0.180	0.040									1.000
2002							0.720	0.060	0.180	0.040									1.000
2003							0.720	0.060	0.180	0.040									1.000
2004											0.560	0.260	0.140	0.040					1.000
2005											0.560	0.260	0.140	0.040					1.000
2006											0.560	0.260	0.140	0.040					1.000
2007											0.560	0.260	0.140	0.040					1.000
2008															0.224	0.104	0.056	0.616	1.000
2009															0.224	0.104	0.056	0.616	1.000
2010															0.224	0.104	0.056	0.616	1.000
2011															0.224	0.104	0.056	0.616	1.000
2012															0.224	0.104	0.056	0.616	1.000
2013															0.224	0.104	0.056	0.616	1.000
2014															0.224	0.104	0.056	0.616	1.000
2015															0.224	0.104	0.056	0.616	1.000
2016															0.224	0.104	0.056	0.616	1.000
2017															0.224	0.104	0.056	0.616	1.000
2018															0.224	0.104	0.056	0.616	1.000
2019															0.224	0.104	0.056	0.616	1.000
2020															0.224	0.104	0.056	0.616	1.000

Appendix 4.11-C. UC-Based Basic Emission Rate for On-Road Motorcycles

TECH GROUP	UC BAG 1 HC				UC BAG 2 HC			
	NON TAMPERED		TAMPERED		NON TAMPERED		TAMPERED	
	ZME	DR	ZME	DR	ZME	DR	ZME	DR
	g/mi	g/mi/10kmi	g/mi	g/mi/10kmi	g/mi	g/mi/10kmi	g/mi	g/mi/10kmi
(1) Two-Stroke	56.9910	0.0000	--	--	14.6780	0.0000	--	--
(2) Pre-78	9.9657	0.0000	--	--	4.3501	0.0000	--	--
(3) 78-79Carb	8.8903	0.0000	20.6765	0.0000	3.0120	0.0000	7.8651	0.0000
(4) 80-81Carb	7.1570	0.0000	20.6765	0.0000	2.4847	0.0000	7.8651	0.0000
(5) 82-84Carb	9.4022	0.0000	20.6765	0.0000	2.2781	0.0000	7.8651	0.0000
(6) 85-87Carb	6.5444	0.0000	20.6765	0.0000	2.4214	0.0000	7.8651	0.0000
(7) 88-03Carb	3.7937	0.0000	20.6765	0.0000	1.8884	0.0000	7.8651	0.0000
(8) 88-03FI	3.7937	0.0000	12.2860	0.0000	1.8884	0.0000	7.0080	0.0000
(9) 88-03Carb+Cat	5.2960	0.0000	11.3790	0.0000	0.8380	0.0000	5.2940	0.0000
(10) 88-03FI+Cat	5.2960	0.0000	12.2860	0.0000	0.8380	0.0000	7.0080	0.0000
(11) 03-08Carb	3.7937	0.0000	20.6765	0.0000	1.8884	0.0000	7.8651	0.0000
(12) 03-08FI	3.7937	0.0000	12.2860	0.0000	1.8884	0.0000	7.0080	0.0000
(13) 03-08Carb+Cat	5.2960	0.0000	11.3790	0.0000	0.8380	0.0000	5.2940	0.0000
(14) 03-08FI+Cat	1.4000	0.0932	12.2860	0.0000	0.6132	0.0408	7.0080	0.0000
(15) 08+Carb	3.7937	0.0000	20.6765	0.0000	1.8884	0.0000	7.8651	0.0000
(16) 08+FI	3.7937	0.0000	12.2860	0.0000	1.8884	0.0000	7.0080	0.0000
(17) 08+Carb+Cat	5.2960	0.0000	11.3790	0.0000	0.8380	0.0000	5.2940	0.0000
(18) 08+FI+Cat	1.4000	0.0932	12.2860	0.0000	0.6132	0.0408	7.0080	0.0000

Appendix 4.11-C (continued)

TECH GROUP	UC BAG 1 CO			UC BAG 2 CO			TAMPERED	DR	g/mi/10kmi	ZME	g/mi	g/mi/10kmi	TAMPERED	DR	ZME	g/mi	g/mi/10kmi
	NON TAMPERED		TAMPERED	NON TAMPERED		TAMPERED											
	ZME	DR	ZME	ZME	DR	ZME											
(1) Two-Stroke	68.8010	0.0000	--	53.5270	--	0.0000	--	--	--	--	--	0.0000	--	--	--	--	--
(2) Pre-78	63.2569	0.0000	--	49.1300	--	0.0000	--	--	--	--	--	0.0000	--	--	--	--	--
(3) 78-79Carb	42.1417	0.0000	70.9200	29.6058	0.0000	0.0000	0.0000	0.0000	49.6093	0.0000	0.0000	0.0000	49.6093	0.0000	0.0000	0.0000	0.0000
(4) 80-81Carb	34.7414	0.0000	70.9200	26.9886	0.0000	0.0000	0.0000	0.0000	49.6093	0.0000	0.0000	0.0000	49.6093	0.0000	0.0000	0.0000	0.0000
(5) 82-84Carb	32.9578	0.0000	70.9200	19.7378	0.0000	0.0000	0.0000	0.0000	49.6093	0.0000	0.0000	0.0000	49.6093	0.0000	0.0000	0.0000	0.0000
(6) 85-87Carb	35.0413	0.0000	70.9200	21.5838	0.0000	0.0000	0.0000	0.0000	49.6093	0.0000	0.0000	0.0000	49.6093	0.0000	0.0000	0.0000	0.0000
(7) 88-03Carb	30.5482	0.0000	70.9200	21.6196	0.0000	0.0000	0.0000	0.0000	49.6093	0.0000	0.0000	0.0000	49.6093	0.0000	0.0000	0.0000	0.0000
(8) 88-03FI	30.5482	0.0000	48.8450	21.6196	0.0000	0.0000	0.0000	0.0000	21.2050	0.0000	0.0000	0.0000	21.2050	0.0000	0.0000	0.0000	0.0000
(9) 88-03Carb+Cat	36.5000	0.0000	66.6627	9.4520	0.0000	0.0000	0.0000	0.0000	47.2247	0.0000	0.0000	0.0000	47.2247	0.0000	0.0000	0.0000	0.0000
(10) 88-03FI+Cat	36.5000	0.0000	48.8450	9.4520	0.0000	0.0000	0.0000	0.0000	21.2050	0.0000	0.0000	0.0000	21.2050	0.0000	0.0000	0.0000	0.0000
(11) 03-08Carb	30.5482	0.0000	70.9200	21.6196	0.0000	0.0000	0.0000	0.0000	49.6093	0.0000	0.0000	0.0000	49.6093	0.0000	0.0000	0.0000	0.0000
(12) 03-08FI	30.5482	0.0000	48.8450	21.6196	0.0000	0.0000	0.0000	0.0000	21.2050	0.0000	0.0000	0.0000	21.2050	0.0000	0.0000	0.0000	0.0000
(13) 03-08Carb+Cat	36.5000	0.0000	66.6627	9.4520	0.0000	0.0000	0.0000	0.0000	47.2247	0.0000	0.0000	0.0000	47.2247	0.0000	0.0000	0.0000	0.0000
(14) 03-08FI+Cat	11.7309	0.7821	48.8450	6.1654	0.0000	0.0000	0.0000	0.4110	21.2050	0.0000	0.0000	0.0000	21.2050	0.0000	0.0000	0.0000	0.0000
(15) 08+Carb	30.5482	0.0000	70.9200	21.6196	0.0000	0.0000	0.0000	0.0000	49.6093	0.0000	0.0000	0.0000	49.6093	0.0000	0.0000	0.0000	0.0000
(16) 08+FI	30.5482	0.0000	48.8450	21.6196	0.0000	0.0000	0.0000	0.0000	21.2050	0.0000	0.0000	0.0000	21.2050	0.0000	0.0000	0.0000	0.0000
(17) 08+Carb+Cat	36.5000	0.0000	66.6627	9.4520	0.0000	0.0000	0.0000	0.0000	47.2247	0.0000	0.0000	0.0000	47.2247	0.0000	0.0000	0.0000	0.0000
(18) 08+FI+Cat	11.7309	0.7821	48.8450	6.1654	0.0000	0.0000	0.0000	0.4110	21.2050	0.0000	0.0000	0.0000	21.2050	0.0000	0.0000	0.0000	0.0000

Appendix 4.11-C (continued)

TECH GROUP	UC BAG 1 NOx			TAMPERED			UC BAG 2 NOx			TAMPERED		
	NON TAMPERED		DR	ZME		g/mi/10kmi	NON TAMPERED		DR	ZME		g/mi/10kmi
	ZME	g/mi	g/mi/10kmi	ZME	g/mi	g/mi/10kmi	ZME	g/mi	g/mi/10kmi	ZME	g/mi	g/mi/10kmi
(1) Two-Stroke	0.0900	0.0900	0.0000	--	--	--	0.1240	0.1240	0.0000	--	--	--
(2) Pre-78	0.5759	0.5759	0.0000	--	--	--	0.7655	0.7655	0.0000	--	--	--
(3) 78-79Carb	0.8499	0.8499	0.0000	0.8863	0.8863	0.0000	1.1382	1.1382	0.0000	0.9789	0.9789	0.0000
(4) 80-81Carb	1.1706	1.1706	0.0000	0.8863	0.8863	0.0000	1.3957	1.3957	0.0000	0.9789	0.9789	0.0000
(5) 82-84Carb	0.9741	0.9741	0.0000	0.8863	0.8863	0.0000	1.3086	1.3086	0.0000	0.9789	0.9789	0.0000
(6) 85-87Carb	1.0979	1.0979	0.0000	0.8863	0.8863	0.0000	1.2134	1.2134	0.0000	0.9789	0.9789	0.0000
(7) 88-03Carb	0.8465	0.8465	0.0000	0.8863	0.8863	0.0000	1.0118	1.0118	0.0000	0.9789	0.9789	0.0000
(8) 88-03FI	0.8465	0.8465	0.0000	1.6023	1.6023	0.0000	1.0118	1.0118	0.0000	1.8790	1.8790	0.0000
(9) 88-03Carb+Cat	0.7760	0.7760	0.0000	1.1410	1.1410	0.0000	0.9520	0.9520	0.0000	1.4210	1.4210	0.0000
(10) 88-03FI+Cat	0.7760	0.7760	0.0000	1.6023	1.6023	0.0000	0.9520	0.9520	0.0000	1.8790	1.8790	0.0000
(11) 03-08Carb	0.8465	0.8465	0.0000	0.8863	0.8863	0.0000	1.0118	1.0118	0.0000	0.9789	0.9789	0.0000
(12) 03-08FI	0.8465	0.8465	0.0000	1.6023	1.6023	0.0000	1.0118	1.0118	0.0000	1.8790	1.8790	0.0000
(13) 03-08Carb+Cat	0.7760	0.7760	0.0000	1.1410	1.1410	0.0000	0.9520	0.9520	0.0000	1.4210	1.4210	0.0000
(14) 03-08FI+Cat	0.3833	0.3833	0.0255	1.6023	1.6023	0.0000	0.5266	0.5266	0.0351	1.8790	1.8790	0.0000
(15) 08+Carb	0.8465	0.8465	0.0000	0.8863	0.8863	0.0000	1.0118	1.0118	0.0000	0.9789	0.9789	0.0000
(16) 08+FI	0.8465	0.8465	0.0000	1.6023	1.6023	0.0000	1.0118	1.0118	0.0000	1.8790	1.8790	0.0000
(17) 08+Carb+Cat	0.7760	0.7760	0.0000	1.1410	1.1410	0.0000	0.9520	0.9520	0.0000	1.4210	1.4210	0.0000
(18) 08+FI+Cat	0.3833	0.3833	0.0255	1.6023	1.6023	0.0000	0.5266	0.5266	0.0351	1.8790	1.8790	0.0000

Appendix 4.11-C (continued)

TECH GROUP	UC BAG 1 CO ₂				UC BAG 1 CO ₂			
	NON TAMPERED		TAMPERED		NON TAMPERED		TAMPERED	
	ZME	DR	ZME	DR	ZME	DR	ZME	DR
	g/mi	g/mi/10kmi	g/mi	g/mi/10kmi	g/mi	g/mi/10kmi	g/mi	g/mi/10kmi
(1) Two-Stroke	109	0.0	--	--	53.8	0.0	--	--
(2) Pre-78	138	0.0	--	--	103	0.0	--	--
(3) 78-79Carb	218	0.0	218	0.0	156	0.0	156	0.0
(4) 80-81Carb	216	0.0	216	0.0	147	0.0	147	0.0
(5) 82-84Carb	237	0.0	237	0.0	161	0.0	161	0.0
(6) 85-87Carb	246	0.0	246	0.0	163	0.0	163	0.0
(7) 88-03Carb	227	0.0	227	0.0	152	0.0	152	0.0
(8) 88-03FI	297	0.0	297	0.0	204	0.0	204	0.0
(9) 88-03Carb+Cat	239	0.0	239	0.0	162	0.0	162	0.0
(10) 88-03FI+Cat	242	0.0	242	0.0	197	0.0	197	0.0
(11) 03-08Carb	227	0.0	227	0.0	152	0.0	152	0.0
(12) 03-08FI	297	0.0	297	0.0	204	0.0	204	0.0
(13) 03-08Carb+Cat	239	0.0	239	0.0	162	0.0	162	0.0
(14) 03-08FI+Cat	242	0.1	242	0.0	197	0.0	197	0.0
(15) 08+Carb	227	0.0	227	0.0	152	0.0	152	0.0
(16) 08+FI	297	0.0	297	0.0	204	0.0	204	0.0
(17) 08+Carb+Cat	239	0.0	239	0.0	162	0.0	162	0.0
(18) 08+FI+Cat	242	0.1	242	0.0	197	0.0	197	0.0

Appendix 4.11-C (continued)

TECH GROUP	UC BAG 1 PM			UC BAG 2 PM			TAMPERED	ZME	g/mi	g/mi/10kmi	DR	g/mi	g/mi/10kmi	DR	ZME	g/mi	g/mi/10kmi
	NON TAMPERED		TAMPERED	NON TAMPERED		TAMPERED											
	ZME	DR	ZME	ZME	DR	ZME											
(1) Two-Stroke	0.3300	0.0000	--	0.3300	0.0000	--	0.0460	0.3300	0.0000	--	0.0460	0.0000	--	0.0460	0.0000	--	0.0000
(2) Pre-78	0.0460	0.0000	--	0.0460	0.0000	--	0.0460	0.0460	0.0000	--	0.0460	0.0000	--	0.0460	0.0000	--	0.0000
(3) 78-79Carb	0.0460	0.0000	0.0460	0.0460	0.0000	0.0000	0.0460	0.0460	0.0000	0.0000	0.0000	0.0460	0.0000	0.0460	0.0000	0.0460	0.0000
(4) 80-81Carb	0.0460	0.0000	0.0460	0.0460	0.0000	0.0000	0.0460	0.0460	0.0000	0.0000	0.0000	0.0460	0.0000	0.0460	0.0000	0.0460	0.0000
(5) 82-84Carb	0.0460	0.0000	0.0460	0.0460	0.0000	0.0000	0.0460	0.0460	0.0000	0.0000	0.0000	0.0460	0.0000	0.0460	0.0000	0.0460	0.0000
(6) 85-87Carb	0.0460	0.0000	0.0460	0.0460	0.0000	0.0000	0.0460	0.0460	0.0000	0.0000	0.0000	0.0460	0.0000	0.0460	0.0000	0.0460	0.0000
(7) 88-03Carb	0.0460	0.0000	0.0460	0.0460	0.0000	0.0000	0.0460	0.0460	0.0000	0.0000	0.0000	0.0460	0.0000	0.0460	0.0000	0.0460	0.0000
(8) 88-03FI	0.0460	0.0000	0.0460	0.0460	0.0000	0.0000	0.0460	0.0460	0.0000	0.0000	0.0000	0.0460	0.0000	0.0460	0.0000	0.0460	0.0000
(9) 88-03Carb+Cat	0.0460	0.0000	0.0460	0.0460	0.0000	0.0000	0.0460	0.0460	0.0000	0.0000	0.0000	0.0460	0.0000	0.0460	0.0000	0.0460	0.0000
(10) 88-03FI+Cat	0.0460	0.0000	0.0460	0.0460	0.0000	0.0000	0.0460	0.0460	0.0000	0.0000	0.0000	0.0460	0.0000	0.0460	0.0000	0.0460	0.0000
(11) 03-08Carb	0.0460	0.0000	0.0460	0.0460	0.0000	0.0000	0.0460	0.0460	0.0000	0.0000	0.0000	0.0460	0.0000	0.0460	0.0000	0.0460	0.0000
(12) 03-08FI	0.0460	0.0000	0.0460	0.0460	0.0000	0.0000	0.0460	0.0460	0.0000	0.0000	0.0000	0.0460	0.0000	0.0460	0.0000	0.0460	0.0000
(13) 03-08Carb+Cat	0.0460	0.0000	0.0460	0.0460	0.0000	0.0000	0.0460	0.0460	0.0000	0.0000	0.0000	0.0460	0.0000	0.0460	0.0000	0.0460	0.0000
(14) 03-08FI+Cat	0.0460	0.0000	0.0460	0.0460	0.0000	0.0000	0.0460	0.0460	0.0000	0.0000	0.0000	0.0460	0.0000	0.0460	0.0000	0.0460	0.0000
(15) 08+Carb	0.0460	0.0000	0.0460	0.0460	0.0000	0.0000	0.0460	0.0460	0.0000	0.0000	0.0000	0.0460	0.0000	0.0460	0.0000	0.0460	0.0000
(16) 08+FI	0.0460	0.0000	0.0460	0.0460	0.0000	0.0000	0.0460	0.0460	0.0000	0.0000	0.0000	0.0460	0.0000	0.0460	0.0000	0.0460	0.0000
(17) 08+Carb+Cat	0.0460	0.0000	0.0460	0.0460	0.0000	0.0000	0.0460	0.0460	0.0000	0.0000	0.0000	0.0460	0.0000	0.0460	0.0000	0.0460	0.0000
(18) 08+FI+Cat	0.0460	0.0000	0.0460	0.0460	0.0000	0.0000	0.0460	0.0460	0.0000	0.0000	0.0000	0.0460	0.0000	0.0460	0.0000	0.0460	0.0000

Appendix 4.11-D. FTP-Based Basic Emission Rate for On-Road Motorcycles

TECH GROUP	FTP BAG 1 HC				FTP BAG 2 HC			
	NON TAMPERED		TAMPERED		NON TAMPERED		TAMPERED	
	ZME	DR	ZME	DR	ZME	DR	ZME	DR
	g/mi	g/mi/10kmi	g/mi	g/mi/10kmi	g/mi	g/mi/10kmi	g/mi	g/mi/10kmi
(1) Two-Stroke	28.040	0.0000	--	--	17.687	0.0000	--	--
(2) Pre-78	4.9031	0.0000	--	--	5.2419	0.0000	--	--
(3) 78-79Carb	4.3740	0.0000	10.1728	0.0000	3.6295	0.0000	9.4774	0.0000
(4) 80-81Carb	3.5212	0.0000	10.1728	0.0000	2.9941	0.0000	9.4774	0.0000
(5) 82-84Carb	4.6259	0.0000	10.1728	0.0000	2.7451	0.0000	9.4774	0.0000
(6) 85-87Carb	3.2198	0.0000	10.1728	0.0000	2.9178	0.0000	9.4774	0.0000
(7) 88-03Carb	1.8665	0.0000	10.1728	0.0000	2.2755	0.0000	9.4774	0.0000
(8) 88-03FI	1.8665	0.0000	6.0447	0.0000	2.2755	0.0000	8.4446	0.0000
(9) 88-03Carb+Cat	2.6056	0.0000	5.5985	0.0000	1.0098	0.0000	6.3793	0.0000
(10) 88-03FI+Cat	2.6056	0.0000	6.0447	0.0000	1.0098	0.0000	8.4446	0.0000
(11) 03-08Carb	1.8665	0.0000	10.1728	0.0000	2.2755	0.0000	9.4774	0.0000
(12) 03-08FI	1.8665	0.0000	6.0447	0.0000	2.2755	0.0000	8.4446	0.0000
(13) 03-08Carb+Cat	2.6056	0.0000	5.5985	0.0000	1.0098	0.0000	6.3793	0.0000
(14) 03-08FI+Cat	0.6000	0.0932	6.0447	0.0000	0.7546	0.0408	8.4446	0.0000
(15) 08+Carb	1.8665	0.0000	10.1728	0.0000	2.2755	0.0000	9.4774	0.0000
(16) 08+FI	1.8665	0.0000	6.0447	0.0000	2.2755	0.0000	8.4446	0.0000
(17) 08+Carb+Cat	2.6056	0.0000	5.5985	0.0000	1.0098	0.0000	6.3793	0.0000
(18) 08+FI+Cat	0.6000	0.0932	6.0447	0.0000	0.7546	0.0408	8.4446	0.0000

Appendix 4.11-D (continued)

TECH GROUP	FTP BAG 1 CO			FTP BAG 2 CO			DR	g/mi/10kmi	ZME	g/mi	g/mi/10kmi	ZME	g/mi	g/mi/10kmi			
	NON TAMPERED		TAMPERED	NON TAMPERED		TAMPERED									NON TAMPERED		TAMPERED
	ZME	DR	ZME	ZME	DR	ZME									DR	ZME	DR
(1) Two-Stroke	45.340	0.000	--	52.831	0.000	--	52.831	0.000	--	--	--	--	--	--			
(2) Pre-78	41.686	0.000	--	48.491	0.000	--	48.491	0.000	--	--	--	--	--	--			
(3) 78-79Carb	27.771	0.000	46.736	29.221	0.000	0.000	29.221	0.000	48.964	48.964	0.000	48.964	48.964	0.000			
(4) 80-81Carb	22.895	0.000	46.736	26.638	0.000	0.000	26.638	0.000	48.964	48.964	0.000	48.964	48.964	0.000			
(5) 82-84Carb	21.719	0.000	46.736	19.481	0.000	0.000	19.481	0.000	48.964	48.964	0.000	48.964	48.964	0.000			
(6) 85-87Carb	23.092	0.000	46.736	21.303	0.000	0.000	21.303	0.000	48.964	48.964	0.000	48.964	48.964	0.000			
(7) 88-03Carb	20.131	0.000	46.736	21.339	0.000	0.000	21.339	0.000	48.964	48.964	0.000	48.964	48.964	0.000			
(8) 88-03FI	20.131	0.000	32.189	21.339	0.000	0.000	21.339	0.000	20.929	20.929	0.000	20.929	20.929	0.000			
(9) 88-03Carb+Cat	24.054	0.000	43.931	9.329	0.000	0.000	9.329	0.000	46.611	46.611	0.000	46.611	46.611	0.000			
(10) 88-03FI+Cat	24.054	0.000	32.189	9.329	0.000	0.000	9.329	0.000	20.929	20.929	0.000	20.929	20.929	0.000			
(11) 03-08Carb	20.131	0.000	46.736	21.339	0.000	0.000	21.339	0.000	48.964	48.964	0.000	48.964	48.964	0.000			
(12) 03-08FI	20.131	0.000	32.189	21.339	0.000	0.000	21.339	0.000	20.929	20.929	0.000	20.929	20.929	0.000			
(13) 03-08Carb+Cat	24.054	0.000	43.931	9.329	0.000	0.000	9.329	0.000	46.611	46.611	0.000	46.611	46.611	0.000			
(14) 03-08FI+Cat	7.2306	0.7821	32.189	6.075	0.000	0.000	6.075	0.411	20.929	20.929	0.000	20.929	20.929	0.000			
(15) 08+Carb	20.131	0.000	46.736	21.339	0.000	0.000	21.339	0.000	48.964	48.964	0.000	48.964	48.964	0.000			
(16) 08+FI	20.131	0.000	32.189	21.339	0.000	0.000	21.339	0.000	20.929	20.929	0.000	20.929	20.929	0.000			
(17) 08+Carb+Cat	24.054	0.000	43.931	9.3291	0.000	0.000	9.3291	0.0000	46.611	46.611	0.0000	46.611	46.611	0.0000			
(18) 08+FI+Cat	7.2306	0.7821	32.189	6.0753	0.000	0.000	6.0753	0.4110	20.929	20.929	0.0000	20.929	20.929	0.0000			

Appendix 4.11-D (continued)

TECH GROUP	FTP BAG 1 NOx		TAMPERED		FTP BAG 2 NOx		TAMPERED	
	ZME	DR	ZME	DR	ZME	DR	ZME	DR
	g/mi	g/mi/10kmi	g/mi	g/mi/10kmi	g/mi	g/mi/10kmi	g/mi	g/mi/10kmi
(1) Two-Stroke	0.0938	0.0000	--	--	0.0408	0.0000	--	--
(2) Pre-78	0.6001	0.0000	--	--	0.2518	0.0000	--	--
(3) 78-79Carb	0.8856	0.0000	0.9235	0.0000	0.3745	0.0000	0.3221	0.0000
(4) 80-81Carb	1.2198	0.0000	0.9235	0.0000	0.4592	0.0000	0.3221	0.0000
(5) 82-84Carb	1.0150	0.0000	0.9235	0.0000	0.4305	0.0000	0.3221	0.0000
(6) 85-87Carb	1.1440	0.0000	0.9235	0.0000	0.3992	0.0000	0.3221	0.0000
(7) 88-03Carb	0.8821	0.0000	0.9235	0.0000	0.3329	0.0000	0.3221	0.0000
(8) 88-03FI	0.8821	0.0000	1.6696	0.0000	0.3329	0.0000	0.6182	0.0000
(9) 88-03Carb+Cat	0.8086	0.0000	1.1889	0.0000	0.3132	0.0000	0.4675	0.0000
(10) 88-03FI+Cat	0.8086	0.0000	1.6696	0.0000	0.3132	0.0000	0.6182	0.0000
(11) 03-08Carb	0.8821	0.0000	0.9235	0.0000	0.3329	0.0000	0.3221	0.0000
(12) 03-08FI	0.8821	0.0000	1.6696	0.0000	0.3329	0.0000	0.6182	0.0000
(13) 03-08Carb+Cat	0.8086	0.0000	1.1889	0.0000	0.3132	0.0000	0.4675	0.0000
(14) 03-08FI+Cat	0.4182	0.0255	1.6696	0.0000	0.1471	0.0351	0.6182	0.0000
(15) 08+Carb	0.8821	0.0000	0.9235	0.0000	0.3329	0.0000	0.3221	0.0000
(16) 08+FI	0.8821	0.0000	1.6696	0.0000	0.3329	0.0000	0.6182	0.0000
(17) 08+Carb+Cat	0.8086	0.0000	1.1889	0.0000	0.3132	0.0000	0.4675	0.0000
(18) 08+FI+Cat	0.4182	0.0255	1.6696	0.0000	0.1471	0.0351	0.6182	0.0000

Appendix 4.11-D (continued)

TECH GROUP	FTP BAG 1 CO ₂		TAMPERED		DR g/mi/10kmi	NON TAMPERED		FTP BAG 1 CO ₂		TAMPERED
	NON TAMPERED		ZME			NON TAMPERED		TAMPERED		
	ZME g/mi	DR g/mi/10kmi	ZME g/mi	DR g/mi/10kmi		ZME g/mi	DR g/mi/10kmi	ZME g/mi	DR g/mi/10kmi	
(1) Two-Stroke	80.4	0.0	--	--	--	57.1	0.0	--	--	--
(2) Pre-78	101.8	0.0	--	--	--	109.4	0.0	--	--	--
(3) 78-79Carb	160.9	0.0	160.9	0.0	0.0	165.7	0.0	165.7	0.0	0.0
(4) 80-81Carb	159.4	0.0	159.4	0.0	0.0	156.1	0.0	156.1	0.0	0.0
(5) 82-84Carb	174.9	0.0	174.9	0.0	0.0	171.0	0.0	171.0	0.0	0.0
(6) 85-87Carb	181.5	0.0	181.5	0.0	0.0	173.1	0.0	173.1	0.0	0.0
(7) 88-03Carb	167.5	0.0	167.5	0.0	0.0	161.4	0.0	161.4	0.0	0.0
(8) 88-03FI	219.2	0.0	219.2	0.0	0.0	216.6	0.0	216.6	0.0	0.0
(9) 88-03Carb+Cat	176.4	0.0	176.4	0.0	0.0	172.0	0.0	172.0	0.0	0.0
(10) 88-03FI+Cat	178.6	0.0	178.6	0.0	0.0	209.2	0.0	209.2	0.0	0.0
(11) 03-08Carb	167.5	0.0	167.5	0.0	0.0	161.4	0.0	161.4	0.0	0.0
(12) 03-08FI	219.2	0.0	219.2	0.0	0.0	216.6	0.0	216.6	0.0	0.0
(13) 03-08Carb+Cat	176.4	0.0	176.4	0.0	0.0	172.0	0.0	172.0	0.0	0.0
(14) 03-08FI+Cat	178.6	0.0	178.6	0.0	0.0	209.2	0.0	209.2	0.0	0.0
(15) 08+Carb	167.5	0.0	167.5	0.0	0.0	161.4	0.0	161.4	0.0	0.0
(16) 08+FI	219.2	0.0	219.2	0.0	0.0	216.6	0.0	216.6	0.0	0.0
(17) 08+Carb+Cat	176.4	0.0	176.4	0.0	0.0	172.0	0.0	172.0	0.0	0.0
(18) 08+FI+Cat	178.6	0.0	178.6	0.0	0.0	209.2	0.0	209.2	0.0	0.0