Final Report for:

**Measurement of Primary Particulate Matter Emissions
from Light-Duty Motor Vehicles**

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by Principal Investigator:

Joseph M. Norbeck

Thomas D. Durbin

Timothy J. Truex

Center for Environmental Research and Technology

College of Engineering

University of California

Riverside, CA 92521

(909) 781-5791

(909) 781-5790 fax

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Executive Summary

This report describes the results of a particulate emissions study conducted at the University of California, Riverside, College of Engineering-Center for Environmental Research and Technology (CE-CERT) from September of 1996 to August of 1997. The goal of this program was to expand the database of particulate emissions measurements from motor vehicles to include larger numbers of representative in-use vehicles. This work was co-sponsored by the Coordinating Research Council (CRC), the South Coast Air Quality Management District (SCAQMD), and the National Renewable Energy Laboratory (NREL) and was part of a larger study of particulate emissions being conducted in several states under sponsorship by CRC. The other coordinated CRC studies were performed in Colorado as part of the Northern Front Range Air Quality Study (NFRAQS) (Cadde et al., 1998) and at the Southwest Research Institute (SwRI) (Whitney 1998). The present work was also carried out in conjunction with a larger testing program sponsored by the National Cooperative Highway Research Program (NCHRP) (Barth et al., 1995) to develop a modal emissions model.

For this work, FTP particulate mass emission rates were determined for gasoline and diesel vehicles, along with the fractions of particulates below 2.5 and 10 microns aerodynamic diameter. Chemical characterization of exhaust particulate was performed for a subset of gasoline and diesel vehicles including the determination of the organic and elemental carbon fractions, analysis for trace elements and ions, and speciation of polynuclear aromatic hydrocarbons (PAHs), hopanes, and steranes. Particulate counts and complete size distributions were also obtained for a subset of gasoline and diesel vehicles in the fleet. Finally, the particulate emission results were used to develop emissions inventory and emission factor estimates using the U.S. Environmental Protection Agency's (EPA's) PART5 and the California Air Resources Board's (CARB's) EMFAC7G models which were compared with current estimates.

A total of 129 gasoline-fueled vehicles and 19 diesel-fueled vehicles were tested as part of the program. A 100 vehicle subset of the NCHRP fleet was designated in this project using a simplified target matrix of vehicles based on model year categories. The targeted number of gasoline vehicles in each model year category, together with the actual numbers tested were: pre-1981 targeted-15, actual-14; 1981-1985 targeted-20, actual-21; 1986-1990 targeted-30, actual-33; 1991-1997 targeted-35, actual-61. As the project progressed, additional vehicles above the original target of 100 were added resulting in the total of 129 gasoline vehicles. The gasoline vehicles were all recruited as part of the NCHRP project and included both normal and high gaseous emitter vehicles. The diesel vehicles were identified using the California Department of Motor Vehicles (DMV) database and were recruited randomly by mail solicitation.

A summary of the FTP weighted particulate emissions results for the gasoline and diesel vehicles is presented in Table ES-1. Average, median, maximum, and minimum FTP weighted particulate emission rates are presented by model year categories for the light-duty gasoline fueled vehicles. Since all but one of the diesel-fueled vehicles are pre-1986, the diesel results are presented as one total. The results presented in Table ES-1 show that the average particulate emission rates for newer gasoline vehicles (1991-1997) are low with a fairly steady trend of increased emissions with increasing vehicle age. This is not unexpected given the improvements in technology over time and vehicle deterioration as a function of age. The average emission rates for the diesel-fueled vehicles are approximately one to two orders of magnitude higher than the gasoline

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vehicles. It should be noted, however, that there is some indication that newer diesel vehicles have considerably lower particulate emission rates than those indicated by the average. In particular, two 1985 diesel vehicles had emission rates of 70.1 and 15.5 mg/mi and a 1993 diesel vehicle had an emission rate of 86.6 mg/mi. The diesel vehicle with an emission rate of 15.5 mg/mi was equipped with a particulate trap.

Table ES-1. FTP Weighted Particulate Emission Rates

Category	# of Veh.	Particulate Emission Rates			
		Ave. PM	Median	Max. PM	Min. PM
		mg/mi	mg/mi	mg/mi	mg/mi
Gasoline					
Pre-1981	14	33.8	34.3	72.5	6.4
1981-1985	21	49.0	14.7	388	0.4
1986-1990	33	14.4	3.4	200	0.3
1991-1997	61	2.5	1.2	27.7	0.01
Diesel	19	561	485	1608	15.5

The average THC and CO emissions for the gasoline fueled vehicles increased significantly for the older model years and technologies. Average NO_x emissions for the gasoline vehicles also increase for older vehicles, but not as significantly as for THC and CO emissions. As expected, the average THC and CO emission rates for the diesel-fueled vehicles are considerably lower than those of the gasoline fueled vehicles. The correlation between gaseous and particulate emission rates was poor, with $R^2 = 0.17$ for THC and $R^2 = 0.11$ for CO. An improvement in the correlations is also obtained when the group averages by model year category are used rather than the individual vehicle data, with $R^2 = 0.35$ for THC and $R^2 = 0.43$ for CO. These data imply that there is not a direct relationship between the mechanisms that cause high HC and CO emissions and those that cause high particulate emissions.

The majority (73.6-95.1%) of the total mass particulate emissions from light-duty vehicles was found to be less than 2.5 μm in aerodynamic diameter. For diesel vehicles, the maximum in the size distribution was observed at 0.18-0.10 μm , while for many gasoline vehicles the largest fraction of the particulate mass was found on the after-filter (<0.056 μm). Particulate counts were also obtained for a subset of vehicles. Particle count measurements showed good correlation with the driving cycle, with higher counts observed when the engine was under load or accelerating. Higher particulate counts were measured for diesel than gasoline test vehicles.

Elemental and organic carbon were the primary constituents for the gasoline and diesel particulates. On average, organic carbon composed a larger fraction of the total carbon for the gasoline vehicles, while elemental carbon represented the larger fraction of the total carbon for the diesel vehicles. The average percentage carbon breakdown was 65.7% organic carbon and

34.3% elemental carbon for the gasoline vehicles and 31.4% organic carbon and 68.6% elemental carbon for the diesel vehicles. There was considerable variability from vehicle to vehicle, however, with some gasoline vehicles having higher percentages of elemental carbon than organic carbon and some diesel vehicles having higher percentages of organic carbon than elemental carbon. For the gasoline vehicles, in particular, the newest vehicles (1991-1997) had the highest percentages of elemental carbon with an average of 37.1% organic carbon and 62.9% elemental carbon.

Inorganic species, including ions and trace elements, composed an average of 6.9% and 1.4% of the total particulate composition for gasoline and diesel vehicles, respectively. The most prominent inorganic species included Fe, Si, SO_4^{2-} , NH_4^+ , S, Cl, Ca, and Zn for gasoline vehicles, and SO_4^{2-} , Si, S, Ca, Fe, and Zn for diesel vehicles.

Total PAH emission rates for gasoline and diesel vehicles were comparable with an average emission rate of 16.5 mg/mi for the gasoline vehicles and an average emission rate of 8.5 mg/mi for the diesel vehicles. The distribution of PAHs for the diesel vehicles differs from that of the gasoline vehicle primarily in that it includes lower relative concentrations of naphthalene and methyl-naphthalenes. It should be noted that these gasoline vehicles had relatively high particulate emission rates and the diesel vehicles were primarily pre-1986 technology. As such, these data probably are more useful in developing PAH source profiles than providing an absolute comparison between PAH mass emission rates for gasoline and diesel vehicles in the modern fleet. The fleet average total hopane and sterane emission rate was 23.6 $\mu\text{g}/\text{mi}$ for the gasoline vehicles and 314.1 $\mu\text{g}/\text{mi}$ for the diesel vehicles. The species distributions of hopanes and steranes were not significantly different for the gasoline and diesel vehicles.

The results of this study were compared with results from the EMFAC7G and PART5. This comparison showed that the number of emission categories in EMFAC7G and PART5 should be expanded and that separate categories should be used for normal and high emitters. PM emission inventory estimates in the South Coast Air Basin based on the test fleet emission rates and a weighting of high and low emitters were higher (3.42 tons/day for light-duty passenger cars) than those obtained using the default values in EMFAC7G (1.96 tons/day). A better comparison was obtained, however, when only the results from the normal emitting vehicles in the test fleet were considered, resulting in a PM inventory estimate of 1.64 tons/day for light-duty passenger cars. The PM emission factors from PART5 provided a relatively good comparison with the overall fleet averages. The contribution of sulfate to the exhaust particulate emission factor was significantly greater than that obtained in this work, however. It is suggested that the contribution of sulfate particulate in the PART5 model be reevaluated.

GLOSSARY AND ABBREVIATIONS

CARB.....	California Air Resources Board
CE-CERT.....	College of Engineering-Center for Environmental Research and Technology (University of California, Riverside)
CFR	Code of Federal Regulations
CO.....	carbon monoxide
CRC	Coordinating Research Council
DMV	Department of Motor Vehicles
DRI	Desert Research Institute
EMFAC7G.....	CARB's motor vehicle emissions inventory model
EPA	Environmental Protection Agency
FTP	Federal Test Procedure
LDGV	light-duty gasoline vehicle
LDGT1.....	light-duty gasoline truck GVW < 6,000 lbs.
LDGT2.....	light-duty gasoline truck GVW 6,001-8,500
lpm.....	liters per minute
MPFI	multi-point fuel injection
NREL.....	National Renewable Energy Laboratory
NCHRP.....	National Cooperative Highway Research Program
NFRAQS.....	Northern Front Range Air Quality Study
NO _x	nitrogen oxides
OC.....	oxidation catalyst
PAH	polynuclear aromatic hydrocarbons
PART5	EPA's particulate emission factor model
PM	particulate matter
PUF	polyurethane foam used for measuring semi- volatile organic compounds
RFG	California Phase II reformulated gasoline
SCAQMD.....	South Coast Air Quality Management District
SwRI.....	Southwest Research Institute
TBI.....	Throttle Body Injection
THC	total hydrocarbons
TOR	Thermal/Optical Reflectance analysis
TWC.....	three-way catalyst
VERL.....	Vehicle Emissions Research Laboratory
XAD	polymer resin used for measuring semi-volatile organic compounds

1.0 INTRODUCTION

In recent years, there has been renewed interest in particulate emissions due, in part, to health studies that have indicated that increases in human mortality and morbidity are associated with particulate pollution levels significantly lower than those previously believed to affect human health (Dockery and Pope, 1994; Health Effects Institute, 1995). On a national basis, the United States Environmental Protection Agency (EPA) estimates that fugitive dust makes the largest contribution to PM₁₀ (particulate matter with aerodynamic diameter of 10 microns or less). All highway vehicles, on the other hand, are estimated to contribute approximately 3% of that total. Estimates of the contribution of motor vehicles to PM₁₀ vary widely, however, and studies of the mobile source contribution to PM₁₀ calculated using the Chemical Mass Balance receptor model have been reported to be as high as 50% in Phoenix (Chow et al., 1991) and 59% in downtown Manhattan (Wittorff et al., 1994). This raises concerns as to whether the existing mobile-source inventory for particulate matter is acceptably accurate. In particular, the available data are too limited to provide an accurate assessment of the contribution of in-use light-duty vehicles to the primary PM inventory.

Several studies have shown that particulate emission rates from properly functioning/modern gasoline-fueled vehicles are small— i.e., on the order of 2-10 mg/mi (Hammerle et al., 1991; Siegl et al., 1994; Zinbo et al., 1995). Studies of in-use vehicles indicate somewhat higher particulate emission rates. Hildemann et al. (1991) tested seven 1977-83 catalyst-equipped in-use vehicles and obtained an average PM_{2.0} of 17.6 mg/mi. Gertler et al. (1995) measured the average PM₁₀ emission rate of heavy- and light-duty vehicles passing through the Fort McHenry Tunnel during July, 1993, and obtained a fleet average emission rate for light-duty vehicles of 15 ± 60 mg/mi. Several recent studies have concentrated on determination of the particulate mass emission rates of high emitter vehicles (Dickson et al., 1991; Sagebiel et al., 1997; Cadle et al., 1998; Norbeck et al., 1996). These studies have shown that high CO and HC emitters and smoking vehicles can have particulate emission rates several orders of magnitude higher than properly functioning/modern gasoline fueled vehicles. In other recent work, the species profiles and semi-volatile and particle-phase organic compounds were measured for a fleet of gasoline vehicles and medium-duty diesel trucks (Schauer, 1998; Schauer et al., 1998). Even though recent studies have added considerably to emission inventory estimates from light-duty vehicles, there is still a need to characterize particulate emission rates and chemical composition from larger and more representative fleets of in-use vehicles.

The goal of the present program is to expand the database of particulate emissions measurements from motor vehicles to include larger numbers of representative in-use vehicles. This work was co-sponsored by the Coordinating Research Council (CRC), the South Coast Air Quality Management District (SCAQMD), and the National Renewable Energy Laboratory (NREL) and is part of a larger study of particulate emissions being conducted in several states under sponsorship by CRC. The other coordinated CRC studies are being performed in Colorado as part of the Northern Front Range Air Quality Study (NFRAQS) (Cadle et al., 1998) and at the Southwest Research Institute (SwRI) (Whitney, 1998). The present work was also carried out in conjunction with a larger testing program sponsored by the National Cooperative Highway Research Program (NCHRP) (Barth et al., 1995) to develop a modal emissions model. For this work, FTP particulate mass emission rates were determined for 129 gasoline and 19 diesel vehicles, along with the fractions of particulates below 2.5 and 10 microns. Chemical characterization of exhaust particulate was performed for a subset of gasoline and diesel vehicles including the determination of the organic and elemental carbon fractions, analysis for trace elements and ions, and speciation of polynuclear aromatic hydrocarbons (PAHs), hopanes, and

steranes. Particulate counts and complete size distributions were also obtained for a subset of gasoline and diesel vehicles in the fleet. Finally, the particulate emission results were used to develop emissions inventory and emission factor estimates using Environmental Protection Agency's (EPA's) PART5 and the California Air Resources Board's (CARB's) EMFAC7G models which were compared with current estimates.

2.0 EXPERIMENTAL PROCEDURES

2.1 Vehicle Fleet Description and Recruitment

Light-duty gasoline-fueled vehicles tested in this program were recruited as part of NCHRP to develop a modal gaseous emission model. The NCHRP project recruited over 300 vehicles grouped according to a vehicle/technology matrix based on their estimated relative gaseous emission contribution to the mobile source inventory. A 100 vehicle subset of the NCHRP fleet was designated in this project using a simplified target matrix of vehicles based on model year categories. The targeted number of vehicles in each model year category, together with the actual numbers tested were: pre-1981 targeted-15, actual-14; 1981-1985 targeted-20, actual-21; 1986-1990 targeted-30, actual-33; 1991-1997 targeted-35, actual-61. As the project progressed, additional vehicles above the original target of 100 were added resulting in a total of 129 light-duty gasoline-fueled vehicles being tested. In addition to the gasoline vehicles recruited in conjunction with NCHRP, a fleet of 19 light-duty diesel fueled vehicles was recruited for testing.

Since the NCHRP project required the testing of both normal and high gaseous emitter vehicles, several sources were used to identify and recruit vehicles. Vehicles were randomly recruited by telephone/mail solicitation based on the categorization of vehicles in the vehicle/technology matrix. The California Department of Motor Vehicles (DMV) provided a database of vehicle registration in the SCAQMD which was used in part for recruitment. This database was current up to 1996 and provided license plate numbers, vehicle identification numbers (VINs), and driver information (e.g., address). For high gaseous emitter vehicles, several recruitment techniques were used. These included identification of high gaseous emitters with CE-CERT's remote sensing van, contacts with local car dealers and rental car agencies to identify vehicles brought in by customers for emissions related repair and high mileage vehicles suspected to be high emitters, and use of a high emitter profile developed from inspection and maintenance data. Light-duty diesel vehicles were recruited separately from the NCHRP program. The diesel vehicles were identified using the DMV database and were recruited randomly by mail solicitation.

2.2 Vehicle Testing

All vehicles were tested over the Federal Test Procedure (FTP) to obtain mass emission rates for total particulates, total hydrocarbons (THC), non-methane hydrocarbons (NMHC), carbon monoxide (CO), and nitrogen oxides (NO_x). THC and NMHC measurements for diesel vehicles were collected using a heated sample line as specified in the Code of Federal Regulations (CFR). Additional particulate sampling for the collection of samples for size-segregation and chemical analysis was added to the FTP test procedures to meet the program objectives, as outlined in Section 2.3. Each vehicle was tested over a single FTP after an overnight soak at a temperature of 72±2°F. To provide a more accurate portrayal of in-use emissions, vehicles were not preconditioned over the UDDS prior to testing. All vehicles were tested with the fuel in the tank at the time the vehicle was received. The fuels were California Phase 2 reformulated gasoline (RFG), with the exception of two out of state vehicles, and reformulated diesel. Gasoline fuel samples were not analyzed, but average gasoline characteristics in the SCAQMD during the vehicle testing period were 0.62 vol. % benzene, 18.2 vol. % aromatics, 4.8 vol. % olefins, 1.99 wt. % oxygen, and 20.4 ppm sulfur, consistent with California Phase 2 RFG. For the diesel fuel,

a composite sample consisting of equal portions of fuel from each of the diesel test vehicles was submitted for analysis. The resulting analysis for the composite diesel fuel sample showed it to contain 22.9 wt. % aromatics, 4.15 wt. % PNA, and 0.0149 wt. % sulfur with a cetane number of 51.6.

All tests were conducted in CE-CERT's Vehicle Emission Research Laboratory (VERL) equipped with a Burke E. Porter 48" single-roll electric dynamometer and Pierburg CVS/dilution tunnel system. Particulate sampling was conducted with VERL's 10 inch diameter dilution tunnel for gasoline vehicles and with the 12 inch diameter tunnel for diesel vehicles. A CVS flow rate of 350 SCFM was used for the gasoline vehicles and 856 SCFM for the diesel vehicles.

2.3 Particulate Sample Collection

The particulate sampling protocol for this project was designed to provide mass emissions rates, size distributions, and samples for analysis for organic and elemental carbon fractions, trace elements and ions, and speciation for PAHs, hopanes, and steranes. The gasoline and diesel tunnels were each fitted with three sampling probes located approximately 10 tunnels diameters downstream of the exhaust mixing flange. The sampling configuration, filter media, and analyses are summarized below:

- Probe 1 was fitted with 47 mm, 2.0 μm Gelman Teflon membrane filters using a Pierburg particle sampling system to obtain total mass particulate emission rates for each phase of the FTP. This probe holds three filter assemblies with automatic sampling for each phase of the UDDS. Each filter assembly was fitted with a primary and a backup Teflon membrane filter.
- Probe 2 was fitted with a three-way flow splitter. One filter holder was fitted with 47 mm Gelman Teflon membrane filters for analysis of trace elements and ions. A second filter holder was fitted with prefired Pallflex 2500 QAT-UP quartz fiber filters for organic and elemental carbon analyses, and detailed speciation of the particulate PAHs, hopanes and steranes. Thin stainless steel rings were placed in front of the quartz fiber filters to provide a more uniform and well defined deposit for carbon analysis. The quartz filters were backed up using a vapor-phase trap for collection of PAHs consisting of XAD-4 resin (polystyrene, divinylbenzene polymer) sandwiched between two polyurethane foam plugs (PUF). Backup Teflon membrane and quartz-fiber filters were not collected for the chemical analyses.

For a subset of gasoline and diesel vehicles, a third leg of the flow splitter was connected to a TSI Model 3022A Condensation Particle Counter to obtain particle counts. This particle counter can be used to count particulates ranging in size from 7 nm to $>3\mu\text{m}$.

- Probe 3 was fitted with a MOUDI cascade impactor for collection of size segregated samples. Uncoated aluminum foils were used for impactation substrates together with 47 mm, 2.0 μm pore size Gelman Teflon membrane after-filters. For sixteen of the gasoline fueled vehicles and all nineteen of the diesel fueled vehicles, full MOUDI characterization was obtained with cut-points of >18 , 10, 5.6, 3.2, 1.8, 1.0, 0.56, 0.32, 0.18, 0.10, 0.056, and <0.056 μm aerodynamic diameter. For the remainder of the gasoline fueled vehicles, only the first five stages of the MOUDI were utilized together with the after-filter to obtain results on the percentage of total mass emissions below 10 and 2.5 μm aerodynamic diameter. Although there is no specific impactation substrate for the collection of 2.5 μm particulates, the mass of

particulates below 2.5 μm can be obtained by assuming that half of the mass collected on the 1.8 μm impaction substrate is from sub-2.5 μm particles. Particulate counts, as discussed above, were collected in conjunction with the full MOUDI samples.

For each test, mass emission rates were determined for each phase of the FTP. Samples for chemical analysis on quartz-fiber filters and the PUF/XAD substrate, and Teflon membrane filters were collected cumulatively over the entire FTP, although for some high emitting vehicles samples were collected over only a portion of the FTP. MOUDI samples were collected cumulatively over the entire FTP for the gasoline vehicles. For the diesel vehicles, MOUDI samples were collected for periods ranging from the entire FTP to over only bag 2 of the FTP. The spectra collected over only Phase 2 had generally better overall mass recoveries than those collected over the entire FTP since the MOUDI has a tendency to get overloaded with particulates for high emitting vehicles.

The sampling rates for gasoline vehicles for total particulate mass by phase of the UDDS (probe 1) were collected at 47 lpm. This corresponds to a minimum detection limit of approximately 0.3 mg/mi. For these measurements, the uncertainties are close to the detection limits. PTFE and quartz fiber filters for chemical analyses were sampled at 30 and 60 lpm, respectively, while MOUDI samples were collected at 30 lpm. For diesel vehicles, all samples were collected at 20 lpm with the exception of the MOUDI which was operated at 30 lpm. All flows were measured and controlled using mass flow controllers, and all sampling was performed under isokinetic conditions.

2.4 Particulate Sample Analysis

Teflon membrane and aluminum MOUDI substrates were weighed before and after sampling to determine the collected mass using an ATI Orion ultra-microbalance. The microbalance is located in an environmental weighing chamber maintained at a temperature of 25°C and a relative humidity of 40%. Prior to and at the completion of sample collection, substrates were preconditioned for at least 24 hours in the environmental chamber before weighing. Tunnel blanks for mass emission measurements were collected daily for the gasoline tunnel and weekly for the diesel tunnel throughout testing. Tunnel blanks were converted to mass emission rates based on sample flows and the length of the testing period. Particulate mass emission rates were corrected based on the average equivalent mass emission rates which were 0.19 ± 0.19 mg/mi for the gasoline tunnel and 0.37 ± 0.47 mg/mi for the diesel tunnel.

The Teflon membrane filters collected from probe 2 were utilized for chemical analysis of metals and other trace elements, and sulfate, nitrate, chloride and ammonium ions. All analyses were conducted by the Desert Research Institute (DRI). Samples were stored in petri dishes in a refrigerator prior to shipment to DRI. Shipment to DRI was in a cooler with blue ice packs. Metals and other trace elements were analyzed using x-ray fluorescence (XRF). Filters were extracted in a 60:40 mixture of isopropyl alcohol and distilled, deionized water for nitrate and sulfate analyses using ion chromatography. A separate extraction with distilled, deionized water was used for analysis of chloride and ammonium ions, since the isopropyl alcohol causes interference in the measurements of these two ions. Chloride ions were measured using ion chromatography, while ammonium ions were measured using automated colorimetry.

The quartz fiber filters collected at probe 2 were used for elemental and organic carbon analyses. Quartz fiber filters were obtained from DRI after pre-firing at 900°C for three hours to reduce background carbon levels. The filters were shipped in blue ice to CE-CERT and stored in a

refrigerator until used. Following sample collection, filters were stored in a refrigerator in petri dishes lined with aluminum foil prior to return shipment to DRI in a cooler with blue ice packs. Elemental and organic carbon analyses were performed by DRI using the Thermal Optical Reflectance (TOR) method (Chow et al., 1993). Analyses were performed on a 0.512 cm² punch from the filter.

PAH, hopane and sterane analyses were performed on the PUF/XAD vapor-phase trap and quartz fiber filters. PUF/XAD backup cartridges were utilized to collect semi-volatile PAHs. XAD resin and PUF cartridges were obtained pre-cleaned from DRI. The XAD resin was cleaned by washing with distilled water and methanol, followed by Soxhlet extraction for 48 hours with methanol. The XAD was then drained and Soxhlet extracted for an additional 48 hours with dichloromethane (CH₂Cl₂). The resin was dried in a vacuum oven at 50°C. A second Soxhlet extraction was then performed with dichloromethane for 48 hours. PUF cartridges were cleaned by first washing with distilled water, followed by Soxhlet extraction in acetone for 48 hours, followed by Soxhlet extraction for 48 hours in 10% diethyl ether in hexane. The extracted PUFs were then dried in a vacuum oven and dried at 50°C for approximately 3 days. XAD resin and PUF cartridges were stored in a freezer before and after sampling prior to return to DRI. XAD and PUF filters were shipped to CE-CERT from DRI, and from CE-CERT back to DRI in a cooler with blue ice.

The PUF/XAD vapor trap was combined with the quartz fiber filter from the corresponding test for extraction. This provided a combined sample of gaseous and particulate phase PAHs, hopanes, and steranes. The gasoline vehicle samples selected for PAH analysis were generally those from vehicles with relatively high particulate emissions, to obtain sample loadings on the order of 2 mg or more. In some cases, filter samples from more than one test vehicle were combined to provide an adequate sample for analyses. The combined samples were all vehicles with similar technologies and classes. The combined test vehicle samples were all collected individually, and then combined during extraction to provide a single sample for analysis. The PUF plugs were Soxhlet extracted with 10% diethyl ether in hexane, while the filters and XAD resin were microwave extracted with dichloromethane. The extracts were combined and reduced to a volume of ~1 ml by rotary evaporation and analyzed by GC/MS in selected ion monitoring mode.

3.0 EMISSIONS TEST RESULTS AND DISCUSSION

3.1 Particulate Sampling Correlation with Southwest Research Institute

Prior to initiating particulate sampling on the main fleet, a correlation exercise was conducted with Southwest Research Institute (SwRI). For this correlation, total particulate mass emission rates were collected for each phase of the Federal Test Procedure (FTP) on three (3) vehicles: a 1988 Ford Festiva and a 1986 Ford Tempo procured by CE-CERT and a 1996 Buick LeSabre procured by SwRI. Each vehicle was tested at least three times at each laboratory.

Table 1 presents a summary of the average and standard deviation of the emission results obtained by SwRI and CE-CERT. The results for the Ford Festiva are separated into initial and retest results since there was a dramatic change in the emission characteristics after it was shipped to SwRI and then returned. Results for the Buick LeSabre are also separated into initial and retest results since lower particulate emissions were measured by SwRI after the vehicle was shipped to CE-CERT and then returned. Overall, particulate emission rates for SwRI are slightly higher than those reported for CE-CERT. These differences are relatively small, however, in comparison with the test-to-test variability, as well as the differences observed for Ford Festiva and Buick LeSabre when these vehicles were retested at their original laboratories. The results of this correlation exercise are discussed in greater detail in Appendix A.

Table 1. Averages and Standard Deviations of CE-CERT and SwRI Results

	1988 Ford Festiva				1996 Ford Tempo			1996 Buick LeSabre		
	CE-CERT Initial n=3	CE-CERT Retest n=3	SwRI n=4		CE-CERT n=3	SwRI n=3		CE-CERT n=3	SwRI Initial n=4	SwRI Retest n=2
	ave. (s.d.)	ave. (s.d.)	ave. (s.d.)		ave. (s.d.)	ave. (s.d.)		ave. (s.d.)	ave. (s.d.)	ave. (s.d.)
Particles (mg/mi)	21.6 (3.4)	101.2 (20.9)	113.4 (12.1)		10.1 (0.7)	14.2 (3.9)		1.5 (0.1)	7.5 (1.5)	3.5 (0.1)
THC (g/mi)	0.268 (0.013)	0.568 (0.097)	0.493 (0.035)		0.377 (0.006)	0.332 (0.008)		0.115 (0.017)	0.092 (0.003)	0.104 (0.001)
NMHC (g/mi)	0.206 (0.011)	0.455 (0.080)	N.A.		0.291 (0.006)	N.A.		0.103 (0.018)	N.A.	N.A.
NOx (g/mi)	0.887 (0.033)	0.632 (0.018)	0.759 (0.006)		0.758 (0.026)	0.637 (0.015)		0.118 (0.011)	0.198 (0.010)	0.161 (0.021)
CO (g/mi)	3.064 (0.251)	5.411 (0.877)	6.693 (0.710)		3.515 (0.205)	3.469 (0.012)		1.074 (0.135)	0.849 (0.053)	0.902 (0.112)
CO2 (g/mi)	234.6 (5.5)	236.0 (3.9)	266.4 (6.7)		358.5 (2.7)	338.0 (1.6)		398.7 (1.7)	424.2 (2.2)	417.3 (0.5)

3.2 Description of Vehicle Test Fleet

Table 2 presents a summary by model year, fuel type and vehicle category of vehicles tested in this program. A total of 129 gasoline and 19 diesel vehicles were tested. The gasoline fleet is approximately equally split between passenger cars and trucks. The light-duty diesel fleet is almost exclusively passenger cars. Due to the vehicle population characteristics in California, the light-duty diesel fueled fleet is dominated by older pre-1986 vehicles. It should be noted that particulate emission results for newer light heavy-duty diesel pick-up trucks were, however, obtained as part of another CE-CERT project (Norbeck et al., 1998). Gasoline vehicles were also classified as normal and high emitters, as listed in Table 2 and discussed further in Section 3.3.1. A full listing and description of all 129 gasoline vehicles and 19 vehicles is presented in Appendices B and C, respectively.

Table 2. Vehicle Fleet according to Model Year, Vehicle Type, and Fuel Type

	Number of Vehicles Tested
Light-Duty Gasoline	129
Pre-1981 Cars	8
Trucks	6
Normal emitters	4
High emitters	10
1981-1985 Cars	10
Trucks	11
Normal emitters	8
High emitters	13
1986-1990 Cars	15
Trucks	18
Normal emitters	22
High emitters	11
1991-1997 Cars	34
Trucks	27
Normal emitters	56
High emitters	5
Light-Duty Diesel	19
Pre-1981	6
1981-1985	12
1986-1990	0
1991-1997	1

3.3 Particulate and Gas Phase Mass Emission Results

The test results for particulate and gas phase emissions are summarized in sections 3.3.1. and 3.3.2, respectively. The complete particulate and gas phase results for all gasoline and diesel vehicles are included in Appendices D and E, respectively. These appendices include particulate, THC, CO, and NO_x emissions results for each bag of the FTP.

3.3.1 Particulate Emission Results

A summary of the FTP weighted particulate emissions results for the gasoline and diesel vehicles is presented in Table 3. Average, median, maximum, and minimum FTP weighted particulate emission rates are presented by model year categories for the light-duty gasoline-fueled vehicles. Since all but one of the diesel-fueled vehicles are pre-1986, the diesel results are presented as one total. The results presented in Table 3 show that the average particulate emission rates for newer vehicles (1991-1997) are low with a fairly steady trend of increased emissions with increasing vehicle age. This is not unexpected given the improvements in technology over time and vehicle deterioration as a function of age. As indicated by comparison of the average and median emission rates for the 1981-1985 and 1986-1990 model year categories, the average emission rate for these categories is strongly influenced by high emitter vehicles. Removal of these two highest emitting vehicles reduces the fleet average for the 1981-1985 model year category to 16.6 mg/mi, while removal of the highest emitting vehicle reduces the fleet average for the 1986-1990 model year category to 8.6 mg/mi. The average emission rates for the diesel-fueled vehicles are approximately one to two orders of magnitude higher than the gasoline vehicles. It should be noted, however, that there is some indication that newer diesel vehicles have considerably lower particulate emission rates than those indicated by the average. In particular, two 1985 diesel vehicles had emission rates of 70.1 and 15.5 mg/mi and a 1993 diesel vehicle had an emission rate of 86.6 mg/mi. The diesel vehicle with an emission rate of 15.5 mg/mi was equipped with a particulate trap.

Table 3. FTP Weighted Particulate Emission Rates

Category	# of Veh.	Particulate Emission Rates			
		Ave. PM	Median	Max. PM	Min. PM
		mg/mi	mg/mi	mg/mi	mg/mi
Gasoline					
Pre-1981	14	33.8	34.3	72.5	6.4
1981-1985	21	49.0	14.7	388	0.4
1986-1990	33	14.4	3.4	200	0.3
1991-1997	61	2.5	1.2	27.7	0.01
Diesel	19	561	485	1608	15.5

Figure 1 compares the FTP weighted particulate emission rates for the gasoline-fueled vehicles characterized as normal and high gaseous emitters. These vehicles were classified based on categories used in the larger NCHRP study, with high gaseous emitters defined as those having 2 times the HC or

Figure 1. Comparison of FTP Weighted Particulate Emission Rates for Normal and High Emitter Light-duty Gasoline Vehicles

CO, or 4 times the certified NO_x emission level for Tier 0 vehicles. For Tier 1 vehicles, high gaseous emitters were defined as those having 1.5 times the certified HC, CO, or NO_x emission level. These definitions were developed based on the categorizations used in emissions inventory models. Results are presented as average, median, and range of particulate emission rates. Normal emitter vehicles newer than the 1981 model year have low emission levels, with all of the average emission rates less than 6.3 mg/mi. For 1981 model year and newer vehicles, the high gaseous emitters in the same categories have particulate emission rates approximately 5-10 times those of the normal emitters. For vehicles older than the 1981 model year, there is a much smaller difference between the normal and high emitter category.

Table 4 compares the FTP weighted particulate emission rates for gasoline-fueled passenger cars and trucks. Interestingly, very little difference is seen in the average particulate emission rates for passenger cars and trucks in the same model year categories, although in many cases there are significant differences in emission control technologies and certification level.

Table 4. Comparison of FTP Weighted Particulate Emission Rates for Light-Duty Gasoline Cars and Trucks

Model Year	Vehicle	Particulate Emission Rates			
		Ave. mg/mi	Median mg/mi	Max. mg/mi	Min. mg/mi
Pre-1981	Cars(8)	31.5	26.9	67.5	6.4
	Trucks(6)	36.8	36.7	72.5	13.5
1981-1985	Cars(10)	48.6	13.2	325	0.4
	Trucks(11)	49.3	15.1	388	1.3
1989-1990	Cars(15)	17.2	1.9	200	0.3
	Trucks(18)	12.2	4.9	54.5	0.4
1991-1997	Cars(34)	1.8	0.8	27.7	0.01
	Trucks(27)	3.5	1.9	13.3	0.5

3.3.2 Gaseous Emission Results

Average, median, maximum, and minimum FTP weighted THC, CO, and NO_x emission rates by vehicle category are presented in Tables 5, 6, and 7, respectively. The average THC and CO emissions for the gasoline fueled vehicles increase significantly for the older model years and technologies. Average NO_x emissions for the gasoline vehicles also increase for older vehicles, but not as significantly as for THC and CO emissions. As expected, the average THC and CO emission rates for the diesel-fueled vehicles are lower than those of gasoline-fueled vehicles.

Table 5. FTP Weighted THC Emission Rates

THC Emission Rates					
Category	# of Veh.	Ave. g/mi	Median g/mi	Max. g/mi	Min. g/mi
Gasoline					
Pre-1981	14	5.06	2.92	24.58	0.44
1981-1985	21	2.07	1.65	8.71	0.30
1986-1990	33	0.96	0.54	6.06	0.20
1991-1997	61	0.34	0.20	3.50	0.06
Diesel	19	0.54	0.38	1.43	0.11

Table 6. FTP Weighted CO Emission Rates

CO Emission Rates					
Category	# of Veh.	Ave. g/mi	Median g/mi	Max g/mi	Min. g/mi
Gasoline					
Pre-1981	14	63.9	25.2	332	6.17
1981-1985	21	29.6	18.8	118	2.39
1986-1990	33	9.48	7.08	31.4	0.54
1991-1997	61	2.77	1.90	13.1	0.65
Diesel	19	1.90	1.47	7.81	0.86

Table 7. FTP Weighted NO_x Emission Rates

NO _x Emission Rates					
Category	# of Veh.	Ave. g/mi	Median g/mi	Max. g/mi	Min. g/mi
Gasoline					
Pre-1981	14	2.14	1.64	6.16	0.43
1981-1985	21	1.46	1.03	5.11	0.11
1986-1990	33	1.08	0.73	7.15	0.22
1991-1997	61	0.48	0.32	4.85	0.08
Diesel	19	1.53	1.58	2.83	0.69

Further investigations were conducted to determine whether there was any correlation between particulate and THC and CO emissions. Figures 2 and 3, respectively, present results from a linear regression analysis of the FTP weighted THC and CO emission rates for all of the gasoline-fueled vehicles versus the total particulate emission rates. In each case, the correlation was poor between gaseous and particulate emissions, with $R^2 = 0.17$ for THC and $R^2 = 0.11$ for CO. Since these regressions appear to be significantly influenced by the higher particulate emission vehicles, the analysis was repeated after removal of these vehicle categories. Removal of the high emitters resulted in only a slight improvement in the correlations, with $R^2 = 0.21$ for THC and $R^2 = 0.20$ for CO. These results imply that factors that lead to high particulate emission rates are not directly related to the THC and CO emission rates. An improvement in the correlations is also obtained when the group averages by model year category are used rather than the individual vehicle data, with $R^2 = 0.35$ for THC and $R^2 = 0.43$ for CO. These data imply that there is not a direct relationship between the mechanisms that cause high HC and CO emissions and those that cause high particulate emissions.

Figure. 2 THC vs. PM FTP Weighted Emissions

Figure 3. CO vs. PM FTP Weighted Emissions

3.4 Particle Size Distributions and Particle Counts

Percentages of total particulate mass emissions below 10 and 2.5 μm aerodynamic diameter are summarized in Table 8 and presented for all vehicles in Appendix F. The majority of the particulate is below 2.5 μm aerodynamic diameter for all vehicle categories. Interestingly, there appears to be a modest trend toward a larger fraction of the particulate below 10 and 2.5 μm aerodynamic diameter with increased particulate emission rate. Thus, the diesel and older gasoline-fueled vehicle categories have the largest mass fraction of particulate below 2.5 μm .

Figures 4 and 5 present average composite MOUDI size distributions for 12 gasoline-fueled vehicles and 19 diesel-fueled vehicles, respectively. These composite averages were obtained by determining the percentage of mass on each stage for each vehicle and then averaging these percentages. Note that the four gasoline vehicles with mass emissions rates below 1.0 mg/mi were excluded from the composite spectra since it is difficult to obtain accurate size distributions with such low mass levels. MOUDI results for individual gasoline and diesel vehicles are presented in Appendices G and H. The results for diesel vehicles are generally more consistent from vehicle to vehicle than those for the gasoline vehicles. This could be due in part to the relatively low emission rates for some of the gasoline vehicles tested, and hence the low loadings on individual impaction substrates. Tables 9 and 10 present the full MOUDI results for individual gasoline and diesel vehicles.

Table 8. Percent of Particulate Mass Less than 10 and 2.5 μm Aerodynamic Diameter

		Percent Less Than	
Category		10 μm	2.5 μm
Gasoline			
	1991-97	83.2	73.6
	1986-90	90.2	84.1
	1981-85	94.9	89.0
	Pre-1981	96.1	91.7
Diesel		99.4	95.1

The gasoline-fueled MOUDI results presented in Figure 4 show the largest single mass fraction to be on the after-filter (aerodynamic diameter $<0.056 \mu\text{m}$). The diesel vehicle results, on the other hand, show a maximum at approximately 0.10-0.18 μm , as shown in Figure 5. Since the loss of particulates in the cascade impactor can affect the MOUDI results, the impact of such losses needs to be evaluated. As shown in Tables 9 and 10, MOUDI mass recoveries were often less than 100%, with some spectra substantially below 100%. For diesel vehicles, a comparison was made between spectra with collection efficiencies greater than 70% and those less than 70%, as shown in Figures 6 and 7. Overall, the spectra are very similar and indicate that losses had little impact on the percentage of mass below 10 and 2.5 μm . The slightly greater mass in the 1.0-1.8 μm size range for the spectra with efficiencies greater than 70% is probably more attributable to the high percentage of mass on stage 6 for the 1984 Toyota Corolla and the 1984

Volkswagen Rabbit than the impact of losses in the MOUDI. For the gasoline MOUDI data, the

Figure 4. Composite Gasoline MOUDI Impactor Results.

Figure 5. Composite Diesel MOUDI Impactor Results.

Table 9. Full MOUDI Size Distributions for Gasoline Vehicles

Model Year	Make	Model	Particulate Emission Rate mg/mi	Mass Recovery %	Particulate Counts Counts/mi	Percentage of Mass for each Cut Point, μm												
						>18	10	5.6	3.2	1.8	1.0	0.56	0.32	0.18	0.10	0.056	<0.056	
1990	Pontiac	Le Mans	0.5	408%	4.2 x 10 ¹¹	1.5%	0.0%	6.1%	0.0%	12.1%	3.0%	1.5%	13.6%	1.5%	50.0%	0.0%	10.6%	
1990	Geo	Storm	1.9	106%	2.1 x 10 ¹²	1.1%	0.0%	1.1%	8.9%	1.1%	3.3%	16.7%	7.8%	26.7%	21.1%	8.9%	3.3%	
1988	Buick	Park Avenue	0.5	173%	4.7 x 10 ¹¹	0.0%	0.0%	0.0%	0.0%	0.0%	6.5%	0.0%	22.6%	6.5%	0.0%	29.0%	35.5%	
1986	Mazda	B2000	4.4	60%	N.A.	0.0%	0.0%	0.0%	3.1%	6.3%	2.1%	5.2%	10.4%	18.8%	26.0%	21.9%	6.3%	
1986	Nissan	Sentra	0.3	419%	N.A.	2.6%	10.3%	10.3%	2.6%	5.1%	0.0%	12.8%	2.6%	5.1%	10.3%	15.4%	23.1%	
1985	Mitsubishi	Mighty Max	3.2	63%	1.0 x 10 ¹³	0.0%	0.0%	0.0%	0.0%	3.0%	3.0%	6.0%	20.9%	9.0%	4.5%	3.0%	50.7%	
1985	Toyota	Celica	2.3		1.4 x 10 ¹²	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	
1984	Dodge	Ram	44.0	77%	7.1 x 10 ¹³	5.3%	1.3%	0.6%	0.8%	0.4%	1.6%	1.3%	1.8%	16.4%	23.2%	23.0%	24.4%	
1984	Nissan	Sentra	40.9	69%	1.7 x 10 ¹³	0.0%	0.0%	0.0%	0.1%	8.1%	14.2%	10.1%	9.9%	22.8%	19.4%	12.5%	2.8%	
1984	Honda	Accord	0.4	104%	1.6 x 10 ¹²	14.3%	0.0%	0.0%	0.0%	0.0%	14.3%	21.4%	21.4%	7.1%	0.0%	7.1%	14.3%	
1983	Ford	Econoline	8.1	95%	4.9 x 10 ¹³	2.0%	4.1%	5.7%	12.7%	10.6%	4.9%	16.3%	3.7%	1.6%	4.9%	9.4%	24.1%	
1983	Mazda	626	11.6	98%	4.1 x 10 ¹³	1.0%	0.0%	0.8%	5.7%	2.8%	8.2%	11.9%	10.6%	13.4%	12.9%	15.2%	17.5%	
1981	Chevy	Monte Carlo	14.7	94%	N.A.	1.6%	0.5%	1.3%	0.5%	1.0%	1.3%	9.7%	1.5%	16.7%	26.5%	21.2%	18.3%	
1978	Chevy	El Camino	14.4	78%	9.6 x 10 ¹³	2.4%	1.5%	2.2%	2.4%	3.7%	0.5%	1.0%	2.0%	3.4%	3.2%	15.9%	61.9%	
1978	Toyota	Corolla	6.4	61%	1.7 x 10 ¹³	2.8%	1.9%	0.0%	0.0%	5.6%	7.5%	9.3%	7.5%	16.8%	11.2%	0.0%	37.4%	
1978	Pontiac	Le Mans	11.1	62%	N.A.	2.0%	0.0%	0.0%	0.7%	0.3%	3.0%	2.0%	4.6%	4.0%	7.9%	32.3%	43.2%	
1972	Ford	F250 PU	13.5	70%	N.A.	0.3%	3.0%	0.5%	1.9%	3.3%	6.6%	3.3%	0.0%	5.8%	11.5%	17.3%	46.6%	
				127%	Average	2.3%	1.4%	1.8%	2.5%	4.0%	5.0%	8.0%	8.8%	11.0%	14.5%	14.5%	26.2%	
				78%	Ave. *	1.6%	1.0%	1.0%	3.1%	3.8%	4.7%	7.7%	6.7%	12.9%	14.4%	15.0%	28.0%	

Ave* =Average excluding vehicles with mass emission rates < 1 mg/mi

Table 10. Full MOUDI Size Distributions for Diesel Vehicles

Model Year	Make	Model	Particulate Emission Rate mg/mi	Mass Recovery %	Particulate Counts Counts/mi	Percentage of Mass for each Cut Point, μm												
						>18	10	5.6	3.2	1.8	1.0	0.56	0.32	0.18	0.10	0.056	<0.056	
1993	Mercedes	300 D	86.6	137%	1.7 x 10 ¹⁴	2.8%	0.4%	2.1%	2.8%	5.3%	5.7%	6.8%	7.0%	17.0%	24.6%	21.9%	3.6%	
1985	Mercedes	300D Turbo	70.1	105%	1.3 x 10 ¹⁴	2.0%	0.2%	0.2%	1.8%	4.2%	10.1%	4.7%	12.7%	20.6%	18.8%	24.7%	0.0%	
1985	Mercedes	300	15.5	114%	N.A.	0.0%	0.0%	2.6%	3.8%	0.0%	2.6%	12.8%	11.5%	15.4%	14.1%	5.1%	32.1%	
1984	Volkswagen	Rabbit	636.6	80%	N.A.	1.4%	0.0%	0.0%	3.5%	10.5%	17.1%	7.1%	6.1%	13.0%	21.1%	16.8%	3.4%	
1984	Toyota	Corolla	572.4	76%	3.9 x 10 ¹⁴	0.3%	0.0%	0.7%	1.6%	6.8%	19.7%	7.2%	8.3%	12.2%	20.1%	15.7%	7.5%	
1984	Mercedes	300 D	748.7	59%	1.9 x 10 ¹⁴	0.0%	0.0%	0.1%	1.4%	5.1%	6.9%	6.6%	7.8%	15.3%	27.9%	20.0%	8.9%	
1982	Isuzu	I-Mark	267.7	38%	2.3 x 10 ¹⁴	0.0%	0.0%	0.3%	0.4%	6.5%	9.4%	5.0%	9.5%	16.1%	26.6%	22.4%	3.9%	
1982	Volkswagen	Vanagon	475.6	62%	N.A.	0.2%	0.2%	0.0%	1.1%	1.4%	2.1%	5.8%	14.4%	26.6%	25.3%	15.7%	7.3%	
1982	Mercedes	300 TD	654.0	67%	N.A.	0.0%	0.1%	0.2%	3.1%	6.2%	4.6%	15.1%	22.0%	23.6%	15.9%	7.6%	1.7%	
1982	Volkswagen	Rabbit	485.1	84%	3.1 x 10 ¹⁴	0.1%	0.0%	0.3%	2.2%	6.9%	8.8%	6.7%	14.0%	24.8%	17.2%	9.6%	9.7%	
1982	Mercedes	300 TD	464.4	75%	2.0 x 10 ¹⁴	0.0%	0.1%	0.0%	0.4%	1.9%	3.4%	5.1%	6.8%	14.9%	27.7%	25.9%	13.8%	
1981	Peugeot	505 TD	677.4	64%	N.A.	0.2%	0.3%	0.3%	1.3%	2.4%	2.7%	3.9%	13.4%	17.1%	23.4%	15.2%	19.9%	
1981	Mercedes	300 SD	247.3	77%	2.8 x 10 ¹⁴	0.0%	0.0%	0.0%	0.0%	0.5%	2.2%	6.8%	5.5%	15.9%	31.1%	25.3%	12.8%	
1980	Mercedes	300 TD	1608.3	71%	4.0 x 10 ¹⁴	0.4%	0.3%	0.4%	1.1%	2.0%	2.9%	11.4%	13.4%	27.9%	20.5%	13.5%	6.2%	
1980	Volkswagen	Rabbit	338.2	57%	2.7 x 10 ¹⁴	0.4%	0.5%	0.5%	0.9%	4.2%	5.1%	10.8%	12.2%	18.7%	23.5%	16.4%	6.7%	
1980	Mercedes	240 D	289.0	82%	2.6 x 10 ¹⁴	0.0%	0.2%	0.0%	0.4%	0.7%	3.6%	1.8%	5.6%	13.5%	28.2%	31.9%	14.0%	
1979	Volkswagen	Rabbit	991.2	47%	3.3 x 10 ¹⁴	0.2%	0.3%	0.4%	1.0%	3.6%	7.7%	6.7%	16.1%	25.6%	16.4%	14.2%	7.7%	
1979	Cadillac	Seville	1402.4	128%	4.2 x 10 ¹⁴	0.5%	0.8%	3.5%	5.2%	4.4%	7.2%	11.0%	21.6%	30.1%	12.1%	3.3%	0.3%	
1977	Mercedes	300D	633.8	50%	3.9 x 10 ¹⁴	0.1%	0.1%	0.0%	0.3%	3.1%	5.4%	7.1%	18.0%	25.6%	23.8%	13.4%	3.0%	
Average				78%		0.5%	0.2%	0.6%	1.7%	4.0%	6.7%	7.5%	11.9%	19.7%	22.0%	16.8%	8.5%	

Figure 6. Composite Diesel MOUDI Impactor Results (Recoveries >70%)

Figure 7. Composite Diesel MOUDI Impactor Results (Recoveries <70%)

large variability from vehicle to vehicle makes it difficult to assess the impact of particle losses, although they are not expected to be significant. It should be noted that significant losses were not observed with partial-stage MOUDI spectra, as the mass emission rates for these spectra were typically within $\pm 10\text{-}15\%$ of those found for the PTFE filters.

Although the gasoline MOUDI data are somewhat variable, there seems to be a trend of more particulates in the smallest size range for gasoline than diesel vehicles. One possible explanation for this trend is that greater numbers of particulates are formed during the combustion process in a diesel engine and hence can more rapidly and readily coagulate into the accumulation mode. Differences in the combustion processes could also contribute to this effect. It should be cautioned, however, in comparing the gasoline and diesel size distributions that there are also significant differences in the mass emission rates of vehicles tested which could contribute to some of the observed differences. In this regard, it is worth noting that a relatively high percentage of mass (32.1%) was also observed on the after-filter for the lowest emitting diesel vehicle (15.5 mg/mi).

Particle count measurements were collected in conjunction with the full MOUDI samples for gasoline and diesel vehicles. FTP weighted particulate count data for gasoline and diesel vehicles are presented in Tables 9 and 10 along with the MOUDI size distributions. Figures 8 and 9 present spectra of particle count measurements for a gasoline and diesel vehicle, respectively, as a function of time throughout the driving cycle. In general, the particle count measurements show good correlation with the driving cycle, with higher counts observed when the engine is under load or during accelerations. Overall, higher counts were observed for diesel vehicles than the gasoline vehicles. It should be noted that the particulate counts for diesel vehicles were typically off-scale during the periods of highest emissions, hence the counts reported for diesel vehicles represent lower limits. The diesel particulate counts are similar to those reported by other researchers, however (Cadle et al., 1998). Similar problems were not observed for the gasoline vehicles. The correlation between particulate counts and mass emission rates was examined for both gasoline and diesel vehicles. The correlation between particulate counts and mass emission rates was $R^2 = 0.52$ for the diesel vehicles and $R^2 = 0.27$ for the gasoline vehicles. Excluding the two highest emitting vehicles improved the correlation for gasoline vehicles to $R^2 = 0.87$.

Figure 8A. Particle Counts for 1984 Nissan Sentra for FIP Bag 1

Figure 8B. Particle Counts for 1984 Nissan Sentra for FTP Bag 2

Figure 8C: Particle Counts for 1984 Nissan Sentra for FIP Bag 3

Figure 9A Particle Counts for 1982 Izumi I-Mark Diesel for FTP Reg 1

Figure 9B. Particle Counts for 1982 Isuzu I-Mark Diesel for FTP Reg 2

Figure 9C. Particle Counts for 1982 Isuzu L-Mark Diesel for FIP Bag 3

4.0 CHEMICAL ANALYSIS RESULTS AND DISCUSSION

4.1 Chemical Species

Chemical analyses were performed on a subset of 40 gasoline vehicles and all 19 diesel vehicles to determine emissions for elemental and organic carbon, ions, and trace elements. The gasoline vehicles used for analysis are presented in Table 11, along with their FTP weighted mass emission rate and relevant technology. A summary of the mass emissions results is presented in Tables 12 and 13, respectively for the gasoline and diesel vehicles including the average mass emission rates, standard deviations of the rates, maximum and minimum values, and average uncertainties. The mass emission rates for individual chemical species are corrected for the contribution of trace components found in tunnel blanks and, as a result, include some negative values. The error for each measurement is calculated by propagating the uncertainty for the chemical analysis and sampling volumes. Chemical components whose concentrations are at least twice the analytical uncertainty are shown in bold. Full chemical analysis results for the individual gasoline and diesel vehicles are presented in Appendices I and J, respectively.

The results presented in Tables 12 and 13 show that elemental and organic carbon are the primary constituents for gasoline and diesel particulates, consistent with the observations of other researchers (Hildemann et al., 1991, Watson et al., 1994, Sagebiel et al., 1997, Cadle et al., 1997). The percentage of total carbon as percent of total mass and the organic and elemental carbon fractions are presented in Tables 14 and 15, respectively, for gasoline and diesel vehicles. Total carbon accounted for an average of 71% and 73% of the total mass for gasoline and diesel vehicles, respectively, with considerable variability from vehicle-to-vehicle. Note these numbers may underestimate the true contribution of carbon to the particulate composition since the total mass identified through chemical analysis was typically less than that determined by gravimetric measurements. Total mass recoveries for the chemical analyses averaged 79.4% and 74.5%, respectively, for gasoline and diesel vehicles, and again varied from vehicle to vehicle, as shown in Tables 15 and 16. This result has been observed by other researchers (Hildemann et al., 1991, Watson et al., 1994, and Sagebiel et al., 1997 on more heavily loaded samples), and could be attributed, in part, to the fact that not all of the species that contribute to the particle composition are measured or to the possible impact of filter inhomogeneities on carbon analysis which uses only a small section of the filter. If organic carbon fraction of the particulate is multiplied by a fraction of 1.2 to account for hydrogen, oxygen, and other trace elements, then the average contribution for carbonaceous material increases to 80% and 79%, respectively, for gasoline and diesel vehicles.

The percentage of total carbon identified as organic carbon and elemental carbon is presented in Figures 10 and 11. Overall, organic carbon composed the larger fraction of carbon for the gasoline vehicles while elemental carbon represented the larger fraction of the total carbon for the diesel vehicles. The average percentage carbon breakdown was 65.7% organic carbon and 34.3% elemental carbon for the gasoline vehicles and 31.4% organic carbon and 68.6% elemental carbon for the diesel vehicles. There was considerable variability from vehicle-to-vehicle, however, with some gasoline vehicles having higher percentages of elemental carbon than organic carbon and some diesel vehicles having higher percentages of organic carbon than elemental carbon. For the gasoline vehicles, in particular, the newest vehicles (1991-1997) had

Table 11. Gasoline Vehicles for Chemical Analysis

	Model Year	Make	Model	FTP Weighted Particulates mg/mi	Odometer	Catalyst	Fuel Delivery	A.I.R.	PAH
1991-1997									
1	1997	Ford	Windstar	13.3	19743	TWC	MPFI	No	*
2	1994	Chevrolet	C1500 Suburban	9.1	36449	TWC	TBI	No	*
3	1994	Dodge	Spirit	1.7	57407	TWC	MPFI	No	
4	1994	Dodge	Caravan	6.2	77603	TWC	MPFI	No	
5	1992	Dodge	Dakota LE	7.4	76384	TWC	TBI	No	
6	1992	Toyota	PU	5.0	58773	TWC	MPFI	Yes	
7	1991	Toyota	Tercel	3.4	104710	TWC	MPFI	No	
8	1991	Toyota	Pick-up	5.3	30440	TWC	MPFI	Yes	
9	1991	Pontiac	Transport	12.3	123618	TWC	TBI	No	
1986-1990									
10	1990	Dodge	Ram 250	24.3	60753	TWC	TBI	Yes	*
11	1990	Nissan	Sentra	5.1	141134	TWC	TBI	Yes	
12	1990	Honda	Accord EX	3.4	109713	TWC	MPFI	No	
13	1989	Hyundai	EXCEL GL	200	61058	TWC	Carb	Yes	*
14	1989	GMC	Sierra 1500	4.3	100863	TWC	TBI	No	*
15	1989	Dodge	Caravan	47.9	83057	TWC	MPFI	No	*
16	1988	Dodge	Ram Royal	5.5	139526	TWC	MPFI	No	
17	1988	Mazda	MX-6	10.7	151512	TWC	MPFI	No	*
18	1988	Dodge	Caravan	54.5	101045	TWC	MPFI	No	*
19	1986	Alfa Romeo	Spider	19.4	46495	TWC	MPFI	No	*
20	1986	Chrysler	5 th Ave.	7.2	87798	TWC	Carb/TBI	Yes	
1981-1985									
21	1985	Toyota	Pick-up	5.5	162398	TWC	Carb	No	
22	1985	Chevrolet	Sprint	325	55719	TWC	Carb	Yes	*
23	1985	Dodge	Caravan	388	55665	TWC	TBI	Yes	*
24	1985	Chevrolet	Caprice Classic	8.1	93486	TWC	Carb	Yes	
25	1984	Buick	Regal LTD	48.3	46057	TWC	Carb	Yes	*
26	1984	Dodge	Ram	44.0	14672	OC	Carb	Yes	*
27	1984	Nissan	Sentra	40.9	163270	TWC+OC	Carb	Yes	*
28	1981	Chevrolet	C-10	21.5	41322	OC	Carb	Yes	*
29	1981	Chevrolet	G-10	22.0	206341	OC	Carb	Yes	*
Pre-1981									
30	1980	Ford	E350 Van	45.1	75463	OC	Carb	Yes	*
31	1979	Honda	Civic	13.4	48372	No Catalyst	Carb	No	
32	1979	Ford	Mustang	41.0	18631	TWC+OC	Carb	Yes	*
33	1979	Nissan	280ZX	9.3	35355	OC	MPFI	No	
34	1978	Chevrolet	C-20 PU	72.5	974	OC	Carb	Yes	*
35	1978	Toyota	Corolla	6.4	14836	OC	Carb	Yes	
36	1978	Pontiac	LeMans	11.1	50041	OC	Carb	Yes	*
37	1977	Datsun	200 SX	40.3	30224	OC	Carb	Yes	*
38	1973	Ford	Ranger	46.8	18037	No Catalyst	Carb	No	*
39	1972	Chevrolet	Custom 20	28.3	51170	No Catalyst	Carb	No	*
40	1965	Ford	Mustang	63.2	25426	No Catalyst	Carb	No	*

Table 12. Statistics for Gasoline Vehicle PM Emission Rates of Chemical Species (mg/mi)

Species	Average	St. Dev.	Ave. Uncert.	Max.	Min.
Organic Carbon	26.63	50.70	3.49	225.5	0.64
Elemental Carbon	5.60	7.79	0.78	41.61	0.32
Total Carbon	32.24	56.29	4.24	267.1	1.87
NO ₃ ⁻	0.01	0.04	0.02	0.17	-0.02
SO ₄ ²⁻	0.15	0.31	0.03	1.87	-0.02
Cl ⁻	0.08	0.41	0.03	2.60	0.00
NH ₄ ⁺	0.11	0.24	0.02	1.37	0.01
Na	0.00	0.04	0.06	0.24	-0.01
Mg	0.04	0.05	0.01	0.22	-0.01
Al	0.03	0.06	0.01	0.27	0.00
Si	0.51	1.13	0.05	6.44	0.01
P	0.09	0.12	0.01	0.50	0.00
S	0.14	0.23	0.01	1.26	0.01
Cl	0.12	0.50	0.01	3.20	0.00
K	0.00	0.01	0.01	0.03	0.00
Ca	0.13	0.19	0.01	0.87	0.00
Ti	0.00	0.00	0.02	0.01	0.00
V	0.00	0.00	0.01	0.01	0.00
Cr	0.00	0.01	0.00	0.05	0.00
Mn	0.00	0.01	0.00	0.04	0.00
Fe	0.45	1.10	0.04	5.93	0.01
Co	0.00	0.00	0.01	0.00	0.00
Ni	0.01	0.02	0.00	0.14	0.00
Cu	0.01	0.01	0.00	0.03	0.00
Zn	0.18	0.28	0.02	1.16	0.00
Ga	0.00	0.00	0.00	0.00	0.00
As	0.00	0.00	0.01	0.00	0.00
Se	0.00	0.00	0.00	0.00	0.00
Br	0.00	0.00	0.00	0.02	0.00
Rb	0.00	0.00	0.00	0.00	0.00
Sr	0.00	0.00	0.00	0.00	0.00
Y	0.00	0.00	0.00	0.00	0.00
Zr	0.00	0.00	0.00	0.00	0.00
Mo	0.00	0.00	0.00	0.00	0.00
Pd	0.00	0.00	0.01	0.00	0.00
Ag	0.00	0.00	0.01	0.00	0.00
Cd	0.00	0.00	0.01	0.00	0.00
In	0.00	0.00	0.01	0.01	0.00
Sn	0.00	0.00	0.02	0.02	0.00
Sb	0.00	0.01	0.03	0.03	0.00
Ba	0.00	0.01	0.04	0.03	-0.01
La	0.00	0.01	0.05	0.03	-0.01
Au	0.00	0.00	0.01	0.00	0.00
Hg	0.00	0.00	0.00	0.00	0.00
Tl	0.00	0.00	0.00	0.00	0.00
Pb	0.04	0.15	0.00	0.95	0.00
U	0.00	0.00	0.00	0.00	0.00

Table 13. Statistics for Diesel Vehicle PM Emission Rates of Chemical Species (mg/mi)

Species	Average	St. Dev.	Ave. Uncert.	Max.	Min.
Organic Carbon	247.7	535.7	28.3	2345	8.2
Elemental Carbon	255.9	164.6	26.0	664.7	16.4
Total Carbon	503.6	596.0	52.6	2773	24.6
NO ₃ ⁻	0.40	0.62	0.16	2.78	-0.06
SO ₄ ²⁻	1.24	1.49	0.22	5.20	-0.08
Cl ⁻	0.12	0.25	0.11	0.72	-0.09
NH ₄ ⁺	0.73	0.85	0.14	2.83	0.03
Na	-0.25	0.07	0.38	0.00	-0.28
Mg	0.16	0.32	0.09	1.44	-0.03
Al	0.05	0.12	0.03	0.45	-0.05
Si	1.33	0.70	0.13	3.18	0.23
P	0.68	1.27	0.07	5.67	0.01
S	1.70	1.69	0.16	7.23	0.07
Cl	0.64	1.28	0.07	5.67	0.00
K	0.08	0.28	0.02	1.21	-0.01
Ca	1.04	1.49	0.10	6.34	0.02
Ti	0.00	0.00	0.12	0.00	0.00
V	0.00	0.00	0.06	0.02	0.00
Cr	0.01	0.02	0.02	0.05	0.00
Mn	0.01	0.01	0.01	0.03	0.00
Fe	1.34	1.65	0.13	5.90	0.10
Co	0.00	0.00	0.02	0.00	0.00
Ni	0.02	0.03	0.01	0.12	0.00
Cu	0.03	0.05	0.01	0.21	0.00
Zn	1.31	2.45	0.12	10.95	0.03
Ga	0.00	0.00	0.01	0.00	0.00
As	0.00	0.00	0.01	0.00	0.00
Se	0.00	0.00	0.01	0.00	0.00
Br	0.00	0.00	0.00	0.01	0.00
Rb	0.00	0.00	0.00	0.00	0.00
Sr	0.00	0.00	0.01	0.01	0.00
Y	0.00	0.00	0.01	0.00	0.00
Zr	0.00	0.00	0.01	0.00	0.00
Mo	0.01	0.02	0.01	0.05	0.00
Pd	0.00	0.01	0.04	0.03	0.00
Ag	0.00	0.01	0.04	0.04	-0.01
Cd	-0.02	0.01	0.04	0.00	-0.02
In	0.00	0.01	0.05	0.05	0.00
Sn	0.00	0.01	0.07	0.02	-0.01
Sb	0.00	0.02	0.08	0.07	-0.01
Ba	0.11	0.12	0.29	0.37	0.00
La	-0.05	0.11	0.40	0.38	-0.11
Au	0.00	0.00	0.05	0.00	0.00
Hg	0.00	0.00	0.01	0.00	0.00
Tl	0.00	0.00	0.01	0.00	0.00
Pb	0.03	0.10	0.02	0.44	0.00
U	0.00	0.00	0.01	0.00	0.00

Table 14. Elemental and Organic Carbon Fractions for Gasoline Vehicles

Year	Make	Model	FTP PM (mg/mi)	Organic % of total carbon	Elemental % of total carbon	Total Carbon % of total mass	Mass Recovery %
1991-1997							
1997	Ford	Windstar	13.3	5.5	94.5	77.7	80.4
1994	Chevrolet	C1500	9.1	32.4	67.6	32.6	54.4
		Suburban					
1994	Dodge	Spirit	1.7	46.7	53.3	73.8	84.3
1994	Dodge	Caravan	6.2	30.4	69.6	53.1	62.6
1992	Dodge	Dakota LE	7.4	26.9	73.1	74.6	87.3
1992	Toyota	PU	5.0	42.8	57.2	89.1	92.7
1991	Toyota	Tercel	3.4	42.3	57.7	85.7	91.5
1991	Toyota	PU	5.3	13.9	86.1	59.8	68.9
1991	Pontiac	Transport	12.3	93.0	7.0	83.0	85.4
1986-1990							
1990	Dodge	Ram 250	24.3	88.5	11.5	45.8	63.0
1990	Nissan	Sentra	5.1	12.1	87.9	70.4	72.1
1990	Honda	Accord EX	3.4	79.6	20.4	78.5	87.5
1989	Hyundai	Excel GL	200	98.1	1.9	53.2	54.1
1989	GMC	Sierra 1500	4.3	93.7	6.3	65.5	67.9
1989	Dodge	Caravan	47.9	97.0	3.0	84.9	86.0
1988	Dodge	Ram Royal	5.5	59.1	40.9	67.2	71.6
1988	Mazda	MX-6	10.7	33.6	66.4	72.2	85.5
1988	Dodge	Caravan	54.5	92.6	7.4	97.7	100.3
1986	Alfa	Spider	19.4	75.3	24.7	76.6	79.2
	Romeo						
1986	Chrysler	5th Ave.	7.2	37.4	62.6	88.1	91.4
1981-1985							
1985	Toyota	Pick-up	5.5	75.7	24.3	68.3	78.8
1985	Chevrolet	Sprint	325	84.4	15.6	69.6	70.8
1985	Dodge	Caravan	388	91.0%	9.0	37.0	38.6
1985	Chevy	Caprice	8.1	87.5	12.5	67.9	72.5
1984	Buick	Regal LTD	48.3	72.4	27.6	43.0	64.5
1984	Dodge	Ram	44.0	85.5%	14.5	74.3	76.1
1984	Nissan	Sentra	40.9	48.3	51.7	66.4	70.3
1981	Chevrolet	C-10	21.5	20.3	79.7	81.3	86.2
1981	Chevrolet	G-10	22.0	88.3	11.7	84.1	90.2
pre-1981							
1980	Ford	E350 Van	45.1	91.7	8.3	65.0	66.0
1979	Honda	Civic	13.4	66.4	33.6	79.8	94.2
1979	Ford	Mustang	41.0	75.3	24.7	76.9	79.7
1979	Nissan	280ZX	9.3	49.8	50.2	76.7	86.2
1978	Chevrolet	C-20 PU	72.5	95.2	4.8	63.0	69.8
1978	Toyota	Corolla	6.4	65.3	34.7	88.4	98.7
1978	Pontiac	LeMans	11.1	92.2%	7.8	88.8	92.4
1977	Datsun	200 SX	40.3	52.3	47.7	56.2	74.0
1973	Ford	Ranger	46.8	96.3	3.7	90.7	94.7

1972 Chevy	C-10 PU	28.3	93.4	6.6	58.3	59.8
1965 Ford	Mustang	63.2	94.6	5.4	65.0	73.2

Table 15. Elemental and Organic Carbon Fractions for Diesel Vehicles

Year	Make	Model	FTP PM (mg/mi)	Organic % of total carbon	Elemental % of total carbon	Total Carbon % of total mass	Mass Recovery %
1993	Mercedes	300D	86.6	15.3	84.7	58.8	60.8
1985	Mercedes	300D	70.1	49.7	50.3	131.9	132.6
1985	Mercedes	300SD	15.5	33.4	66.6	127.4	126.9
1984	Volkswagen	Rabbit	636.6	19.0	81.0	66.6	68.0
1984	Toyota	Corolla	572.4	10.3	89.7	43.5	43.9
1984	Mercedes	300D	748.7	9.0	91.0	79.8	81.9
1982	Isuzu	I-Mark	267.7	22.4	77.6	65.1	65.8
1982	Volkswagen	Vanagon	475.6	27.5	72.5	60.8	61.6
1982	Mercedes	300TD	654.0	42.1	57.9	54.0	54.6
1982	Volkswagen	Rabbit	485.1	46.2	53.8	61.1	62.2
1982	Mercedes	300 TD	464.4	9.7	90.3	118.2	119.9
1981	Peugeot	505 TD	677.4	19.4	80.6	46.2	47.5
1981	Mercedes	300SD	247.3	14.5	85.5	71.7	72.5
1980	Mercedes	300TD	1608.3	71.4	28.6	43.4	45.3
1980	Volkswagen	Rabbit	338.2	27.4	72.6	60.3	61.1
1980	Mercedes	240D	289.0	33.1	66.9	54.7	55.6
1979	Cadillac	Seville	1402.4	84.6	15.4	147.4	148.7
1979	VW	Rabbit	991.2	79.2	20.8	52.8	54.0
1977	Mercedes	300D	633.8	31.2	68.8	52.0	52.7

Figure 10. Carbon Percentage Fractions for Gasoline Vehicles

Figure 11. Carbon Percentage Fractions for Diesel Vehicles

4.2 PAH, Hopane, and Sterane Emission Results

Tables 16 and 17 summarize the PAH emissions for the gasoline and diesel test fleets, respectively, including the fleet average, standard deviation, average uncertainty, maximum and minimum. The emission rates are corrected for the contribution of trace compounds found in tunnel blanks, and as a result, include some negative values. The error for each measurement is calculated by propagating the uncertainty for the chemical analysis and sampling volumes. Chemical components whose concentrations are at least twice the analytical uncertainty are shown in bold. The PAH results for individual gasoline and diesel vehicles are presented in Appendices K and L, respectively.

Total PAH emission rates for gasoline and diesel vehicles are comparable with an average emission rate of 16.5 mg/mi for the gasoline vehicles and an average emission rate of 8.5 mg/mi for the diesel vehicles. These levels are comparable to those reported by Siegl et al. (1994) for high and low emitting gasoline vehicles, but are slightly less than those reported by Sagebiel et al., (1997) for high emitting gasoline vehicles in Nevada. The distribution of PAHs for gasoline vehicles is similar to that reported previously (Siegl et al., 1994; Sagebiel et al., 1997) with naphthalene, 2-methylnaphthalene, 1-methylnaphthalene, and dimethylnaphthalenes being primary constituents. The distribution of PAHs for diesel vehicles differs from that of the gasoline vehicles primarily in that it includes lower relative concentrations of naphthalene and methyl-naphthalenes. It should be noted that these gasoline vehicles had relatively high particulate emission rates and the diesel vehicles were primarily pre-1986 technology. As such, these data are probably more useful in developing PAH source profiles than providing an absolute comparison between PAH mass emission rates for gasoline and diesel vehicles in the modern fleet.

The hopanes and sterane results for the gasoline and diesel fleets are presented in Tables 18 and 19, respectively. The hopane and sterane results for individual vehicles are presented in Appendices M and N, respectively. Unlike the PAH results, hopane and sterane emissions were considerably higher for the diesel vehicles than the gasoline vehicles, with hopane and sterane emissions for some gasoline vehicles at or near background levels. The fleet average total hopane and sterane emission rate was 23.6 $\mu\text{g}/\text{mi}$ for the gasoline vehicles and 314.1 $\mu\text{g}/\text{mi}$ for the diesel vehicles. Overall, the distributions of hopanes and steranes for the gasoline and diesel vehicles were similar.

The mass emission rates for PAHs, hopanes and steranes are compared with the organic carbon mass emission rates in Tables 20 and 21, respectively, for individual gasoline and diesel vehicles. Although the semi-volatile and particulate phase PAHs were combined for extraction, an estimate of the contribution of particulate phase PAHs can be made based on gas chromatograph retention times. For this estimate, PAHs with gas chromatographic retention times equal to or greater than that of phenanthrene were classified as particulate PAHs. Although semi-volatile organic compounds are distributed in both gas and particle phases, and their distribution depends on environmental conditions, using a different phase change point will have relatively small impact on the overall particulate mass distributions since PAHs compose only a small fraction of the total organic carbon. A similar approximation was made for the development of source profiles for NFRAQS (Watson, et al., 1998). On this basis, semi-volatile PAHs make a considerable larger contribution to the PAH total than do particulate PAHs. These estimates

show that particulate PAHs represent a relatively small fraction of the organic carbon portion of the particulate, averaging 4.2% of the organic carbon for gasoline vehicles and 2.8% of the organic carbon for diesel vehicles. Hopanes and steranes represent, on average, only 0.1% of the particulate organic carbon for gasoline vehicles and 0.3% of the particulate organic carbon for diesel vehicles.

Correlations were examined between PAH, hopane and sterane emissions and THC and total particulate emissions. For both gasoline and diesel vehicles, the correlation between PAH and THC emissions was relatively good, with $R^2 = 0.74$ for gasoline vehicles and $R^2 = 0.71$ for the diesel vehicles. The correlation between PAH and particulate emissions was weaker, with $R^2 = 0.22$ for the gasoline vehicles and $R^2 = 0.26$ for the diesel vehicles. This is not surprising since previous studies have shown that the majority of the PAHs are found on the PUF back-up and can primarily be attributed to gas phase or semi-volatile emissions (Sagebiel et al., 1997). Hopane and sterane emissions did not show strong correlation with either THC or particulate emissions. For the gasoline vehicles, the correlation between hopanes and sterane emissions and THC emissions was $R^2 = 0.09$ and the correlation with particulate emissions was $R^2 = 0.17$. For the diesel vehicles, the correlation between hopanes and sterane emissions and THC emissions was $R^2 = 0.23$ and the correlation with particulate emissions was $R^2 = 0.34$.

Table 16. Statistics on PAH Emissions for Gasoline Vehicles (mg/mi)

	Ave	St Dev	Ave Uncert	Max	Min
Naphthalene	7.074	5.457	0.773	18.638	1.656
2-Methylnaphthalene	3.410	3.442	0.364	11.370	0.411
1-Methylnaphthalene	1.862	1.867	0.194	6.367	0.246
2,6+2,7-Dimethylnaphthalene	0.517	0.517	0.054	1.814	0.080
1,7+1,3+1,6-Dimethylnaphthalene	0.769	0.749	0.079	2.660	0.110
2,3+1,4+1,5-Dimethylnaphthalene	0.269	0.277	0.029	0.965	0.031
1,2-Dimethylnaphthalene	0.104	0.108	0.012	0.418	0.012
1,8-Dimethylnaphthalene	0.003	0.003	0.003	0.011	0.000
Biphenyl	0.136	0.098	0.015	0.340	0.021
2-Methylbiphenyl	0.012	0.021	0.002	0.052	-0.014
3-Methylbiphenyl	0.087	0.072	0.009	0.236	0.006
4-Methylbiphenyl	0.040	0.033	0.004	0.106	0.003
A-Trimethylnaphthalene	0.165	0.184	0.017	0.572	0.017
1-Ethyl-2-methylnaphthalene	0.046	0.047	0.006	0.160	0.004
B-Trimethylnaphthalene	0.168	0.191	0.0191	0.671	0.013
C-Trimethylnaphthalene	0.172	0.194	0.019	0.696	0.013
2-Ethyl-1-methylnaphthalene	0.007	0.007	0.002	0.024	0.000
E-Trimethylnaphthalene	0.112	0.128	0.014	0.448	0.008
F-Trimethylnaphthalene	0.111	0.126	0.012	0.472	0.008
G-Trimethylnaphthalene	0.058	0.064	0.008	0.213	0.004
H-Trimethylnaphthalene	0.026	0.031	0.003	0.102	0.001
1,2,8-Trimethylnaphthalene	0.002	0.003	0.001	0.013	0.000
Acenaphthylene	0.321	0.343	0.038	1.482	0.026
Acenaphthene	0.057	0.047	0.007	0.153	0.004
Phenanthrene	0.198	0.211	0.021	0.907	0.016
Fluorene	0.118	0.111	0.013	0.424	0.008
A-Methylfluorene	0.039	0.035	0.005	0.134	0.002
1-Methylfluorene	0.019	0.023	0.002	0.078	0.001
B-Methylfluorene	0.011	0.013	0.002	0.051	0.000
C-Methylfluorene	0.066	0.060	0.008	0.234	0.007
A-Methylphenanthrene	0.024	0.021	0.004	0.085	0.002
2-Methylphenanthrene	0.028	0.028	0.003	0.104	0.002
B-Methylphenanthrene	0.013	0.013	0.003	0.044	0.000
C-Methylphenanthrene	0.020	0.021	0.004	0.081	0.001
1-Methylphenanthrene	0.019	0.022	0.003	0.082	0.001
3,6-Dimethylphenanthrene	0.005	0.005	0.001	0.022	0.000
A-Dimethylphenanthrene	0.007	0.008	0.001	0.032	0.001
B-Dimethylphenanthrene	0.004	0.004	0.001	0.018	0.000
C-Dimethylphenanthrene	0.014	0.015	0.002	0.053	0.001
1,7-Dimethylphenanthrene	0.008	0.009	0.002	0.029	0.001
D-Dimethylphenanthrene	0.004	0.004	0.001	0.012	0.000
E-Dimethylphenanthrene	0.007	0.007	0.001	0.028	0.000
Anthracene	0.066	0.085	0.015	0.368	0.004
9-Methylanthracene	0.002	0.002	0.001	0.006	0.000
Fluoranthene	0.071	0.090	0.008	0.379	0.004
Pyrene	0.097	0.120	0.010	0.502	0.006
A-Methylpyrene	0.001	0.001	0.000	0.002	0.000
B-Methylpyrene	0.004	0.004	0.001	0.016	0.000
C-Methylpyrene	0.010	0.013	0.001	0.057	0.001
D-Methylpyrene	0.006	0.009	0.001	0.042	0.000
E-Methylpyrene	0.004	0.004	0.001	0.016	0.000
F-Methylpyrene	0.005	0.007	0.001	0.030	0.000
Retene	0.000	0.000	0.001	0.000	0.000
Benzonaphthothiophene	0.001	0.001	0.001	0.005	0.000
Benz(a)anthracene	0.008	0.011	0.003	0.049	0.001
7-Methylbenz(a)anthracene	0.000	0.000	0.001	0.001	0.000
Chrysene	0.008	0.012	0.002	0.053	0.001
Benzo(b+j+k)fluoranthene	0.019	0.030	0.003	0.131	0.001
Benzo(e)pyrene	0.007	0.010	0.001	0.044	0.000
Benzo(a)pyrene	0.008	0.014	0.002	0.066	0.000
7-Methylbenzo(a)pyrene	0.000	0.001	0.001	0.003	0.000
Indeno[1,2,3-cd]pyrene	0.006	0.012	0.002	0.053	0.000
Dibenz(ah+ac)anthracene	0.000	0.001	0.002	0.005	0.000
Benzo(b)chrysene	0.000	0.001	0.001	0.003	0.000
Benzo(ghi)perylene	0.020	0.033	0.003	0.145	0.000
Coronene	0.014	0.024	0.003	0.101	0.000

Table 17. Statistics on PAH Emissions for Diesel Vehicles (mg/mi)

	Ave	St Dev	Ave Uncert	Max	Min
Naphthalene	2.056	1.916	0.227	7.444	0.469
2-Methylnaphthalene	0.431	0.288	0.047	0.986	0.100
1-Methylnaphthalene	0.347	0.237	0.036	0.756	0.079
2,6+2,7-Dimenaphthalene	0.242	0.171	0.027	0.596	0.044
1,7+1,3+1,6-Dimenaphthalene	0.489	0.331	0.052	1.157	0.091
2,3+1,4+1,5-Dimenaphthalene	0.177	0.124	0.025	0.450	0.034
1,2-Dimenaphthalene	0.067	0.046	0.012	0.179	0.014
1,8-Dimenaphthalene	0.003	0.002	0.008	0.009	0.000
Biphenyl	0.280	0.202	0.030	0.735	0.070
2-Methylbiphenyl	0.050	0.035	0.006	0.149	0.008
3-Methylbiphenyl	0.196	0.145	0.021	0.591	0.047
4-Methylbiphenyl	0.070	0.054	0.008	0.221	0.018
A-Trimethylnaphthalene	0.121	0.098	0.013	0.397	0.020
1-Ethyl-2-methylnaphthalene	0.041	0.032	0.006	0.125	0.007
B-Trimethylnaphthalene	0.158	0.129	0.018	0.523	0.026
C-Trimethylnaphthalene	0.208	0.175	0.023	0.716	0.037
2-Ethyl-1-methylnaphthalene	0.011	0.009	0.003	0.034	0.002
E-Trimethylnaphthalene	0.137	0.121	0.017	0.504	0.024
F-Trimethylnaphthalene	0.117	0.103	0.013	0.432	0.022
G-Trimethylnaphthalene	0.067	0.060	0.009	0.251	0.013
H-Trimethylnaphthalene	0.021	0.022	0.003	0.091	0.004
1,2,8-Trimethylnaphthalene	0.009	0.012	0.003	0.051	0.001
Acenaphthylene	0.545	0.646	0.066	2.483	0.070
Acenaphthene	0.048	0.048	0.007	0.179	0.009
Phenanthrene	0.594	0.506	0.063	1.764	0.122
Fluorene	0.214	0.213	0.023	0.745	0.035
A-Methylfluorene	0.046	0.056	0.006	0.241	0.007
1-Methylfluorene	0.043	0.053	0.006	0.233	0.006
B-Methylfluorene	0.011	0.012	0.002	0.051	0.002
C-Methylfluorene	0.155	0.175	0.018	0.774	0.032
A-Methylphenanthrene	0.060	0.088	0.010	0.408	0.010
2-Methylphenanthrene	0.070	0.104	0.008	0.481	0.013
B-Methylphenanthrene	0.003	0.005	0.002	0.020	0.000
C-Methylphenanthrene	0.060	0.087	0.013	0.402	0.009
1-Methylphenanthrene	0.045	0.050	0.006	0.232	0.009
3,6-Dimethylphenanthrene	0.015	0.032	0.004	0.145	0.001
A-Dimethylphenanthrene	0.019	0.038	0.003	0.175	0.002
B-Dimethylphenanthrene	0.011	0.023	0.002	0.106	0.001
C-Dimethylphenanthrene	0.044	0.082	0.006	0.375	0.005
1,7-Dimethylphenanthrene	0.025	0.053	0.006	0.241	0.003
D-Dimethylphenanthrene	0.017	0.031	0.005	0.142	0.002
E-Dimethylphenanthrene	0.016	0.028	0.003	0.128	0.002
Anthracene	0.102	0.083	0.022	0.288	0.019
9-Methylanthracene	0.003	0.003	0.003	0.012	0.001
Fluoranthene	0.301	0.323	0.033	1.133	0.032
Pyrene	0.387	0.433	0.040	1.504	0.028
A-Methylpyrene	0.009	0.005	0.002	0.025	0.005
B-Methylpyrene	0.011	0.016	0.002	0.070	0.001
C-Methylpyrene	0.029	0.037	0.004	0.145	0.002
D-Methylpyrene	0.009	0.014	0.002	0.044	0.000
E-Methylpyrene	0.023	0.029	0.003	0.127	0.001
F-Methylpyrene	0.025	0.032	0.003	0.125	0.001
Retene	0.001	0.002	0.002	0.009	0.000
Benzonaphthothiophene	0.001	0.002	0.003	0.009	0.000
Benz(a)anthracene	0.027	0.032	0.009	0.117	0.001
7-Methylbenz(a)anthracene	0.000	0.000	0.001	0.001	0.000
Chrysene	0.032	0.040	0.007	0.130	0.002
Benzo(b+j+k) fluoranthene	0.088	0.114	0.014	0.395	0.003
Benzo(e)pyrene	0.030	0.034	0.005	0.121	0.001
Benzo(a)pyrene	0.025	0.041	0.005	0.161	0.001
7-Methylbenzo(a)pyrene	0.000	0.001	0.002	0.003	0.000
Indeno[1,2,3-cd]pyrene	0.012	0.023	0.004	0.084	0.000
Dibenz(ah+ac)anthracene	0.001	0.002	0.006	0.006	0.000
Benzo(b)chrysene	0.000	0.000	0.003	0.000	0.000
Benzo(ghi)perylene	0.030	0.052	0.007	0.213	0.000
Coronene	0.013	0.029	0.010	0.122	0.000

**Table 18. Hopane and Sterane Emission Results for Gasoline Vehicles
($\mu\text{g}/\text{mi}$)**

	Ave.	St. Dev	Ave Uncert	Max.	Min.
Ergostane	2.14	4.51	1.53	14.51	-1.29
Sitostane	1.91	4.57	1.47	17.59	-1.25
Diasterane-1	2.27	2.34	0.90	8.67	-0.25
Diasterane-2	1.50	1.61	0.76	6.26	-0.02
Cholestane-1	3.44	4.29	1.46	14.34	-0.15
Cholestane-2	0.48	1.38	0.72	4.10	-0.73
Cholestane-3	3.97	4.02	1.21	12.26	0.38
Trisnorhopane-1	0.85	0.99	0.67	3.91	0.00
Trisnorhopane-2	0.72	0.69	0.60	2.37	0.08
Norhopane-1	2.69	2.96	1.43	10.60	0.00
Norhopane-2	0.17	0.22	0.54	0.72	-0.01
Hopane-1	1.49	1.75	0.96	5.84	-0.25
Hopane-2	0.16	0.29	0.55	1.11	-0.04
Homohopane-1	0.43	0.77	0.82	2.70	-0.34
Homohopane-2	0.52	0.55	0.70	2.19	0.00
Hopane-3	0.03	0.05	0.53	0.16	0.00
Bishomohopane-1	0.38	0.51	0.63	1.77	-0.11
Bishomohopane-2	0.43	0.47	0.62	1.76	-0.03

Table 19. Hopane and Sterane Emission Results for Diesel Vehicles ($\mu\text{g}/\text{mi}$)

	Ave.	St. Dev	Ave Uncert	Max.	Min.
Ergostane	39.5	80.5	8.6	364.4	2.6
Sitostane	27.6	43.9	6.2	198.0	1.9
Diasterane-1	27.8	76.5	6.5	341.9	1.4
Diasterane-2	20.2	57.3	5.0	255.4	0.6
Cholestane-1	38.1	81.1	9.9	367.4	3.3
Cholestane-2	14.3	36.1	4.3	161.6	-0.4
Cholestane-3	38.5	86.3	7.4	391.1	2.3
Trisnorhopane-1	10.4	16.5	3.3	75.7	1.0
Trisnorhopane-2	5.8	10.7	2.5	48.6	0.6
Norhopane-1	37.5	43.1	11.2	200.0	4.9
Norhopane-2	2.5	2.7	2.0	9.4	0.1
Hopane-1	20.6	23.4	4.1	110.8	3.6
Hopane-2	3.1	5.0	2.1	22.3	0.5
Homohopane-1	10.2	9.0	4.1	42.4	1.5
Homohopane-2	6.8	5.4	3.5	24.3	1.2
Hopane-3	2.3	3.8	2.5	14.7	0.0
Bishomohopane-1	5.7	3.5	1.9	15.6	2.2
Bishomohopane-2	3.4	2.5	1.9	10.2	0.2

Table 20. Organic Carbon, PAH, Hopane and Steranes rates for Individual Gasoline Vehicles

Year	Make	Model	Organic Carbon (mg/mi)	Total PAHs (mg/mi)	Part. PAHs (mg/mi)	Semi-volatile PAHs (mg/mi)	Hopanes and Steranes (mg/mi)
1991-1997							
1997	Ford	Windstar	0.9	3.516	0.151	3.365	0.000
1994	Chevrolet	C1500 Suburban	(ave)				
1986-1990							
1990	Dodge	Ram 250	6.5	3.028	0.079	2.948	-0.001
1989	GMC	Sierra 1500	(ave)				
1989	Hyundai	Excel GL	114.3	6.469	0.360	6.109	0.029
1989	Dodge	Caravan	41.8	8.719	0.317	8.402	0.002
1988	Mazda	MX-6	7.5	9.424	0.492	8.932	0.001
1986	Alfa Romeo	Spider	(ave)				
1988	Dodge	Caravan	48.04	12.076	0.445	11.631	0.011
1981-1985							
1985	Chevrolet	Sprint	225.5	38.182	4.187	33.995	0.018
1985	Dodge	Caravan	220.7	39.971	1.530	38.441	0.086
1984	Buick	Regal LTD	15.1	8.506	0.137	8.369	0.011
1984	Dodge	Ram	30.7	12.113	1.245	10.887	0.016
1984	Nissan	Sentra	13.7	10.473	1.707	8.767	0.099
1981	Chevrolet	C-10	11.1	14.078	0.728	13.35	0.004
1981	Chevrolet	G-10					
pre-1981							
1980	Ford	E350 Van	40.0	25.761	1.318	24.442	0.023
1979	Ford	Mustang	28.4	46.343	2.276	44.067	0.052
1978	Chevrolet	C-20 PU	55.4	3.668	0.329	3.339	0.010
1978	Pontiac	LeMans	10.5	6.350	0.526	5.824	0.003
1977	Datsun	200 SX	14.8	4.178	0.490	3.688	0.053
1973	Ford	Ranger	38.8	12.519	0.230	12.289	0.001
1972	Chevy	C-10 PU	19.6	42.185	1.699	40.486	0.012
1965	Ford	Mustang	46.1	22.169	0.963	21.206	0.041

Table 21. Organic Carbon, PAH, Hopane and Steranes rates for Individual Diesel Vehicles

Year	Make	Model	Organic Carbon (mg/mi)	Total PAHs (mg/mi)	Part. PAHs (mg/mi)	Semi-volatile PAHs (mg/mi)	Hopanes and Steranes (mg/mi)
1993	Mercedes	300D	10.9	2.061	0.462	1.599	0.035
1985	Mercedes	300D	61.6	17.770	3.725	14.045	0.103
1985	Mercedes	300SD	8.2	4.124	0.614	3.510	0.080
1984	Volkswagen	Rabbit	91.1	20.240	6.791	13.448	0.173
1984	Toyota	Corolla	50.0	6.721	1.911	4.810	0.065
1984	Mercedes	300D	65.9	4.952	1.431	3.521	0.115
1982	Isuzu	I-Mark	45.5	2.122	0.720	1.402	0.115
1982	Volkswagen	Vanagon	101.9	4.984	1.782	3.202	0.260
1982	Mercedes	300TD	182.0	6.694	1.565	5.129	0.201
1982	Volkswagen	Rabbit	154.6	2.822	1.191	1.631	0.466
1982	Mercedes	300 TD	50.9	6.354	1.454	4.900	0.175
1981	Peugeot	505 TD	77.7	2.374	0.772	1.601	0.313
1981	Mercedes	300SD	30.2	5.318	1.132	4.185	0.098
1980	Mercedes	300TD	679	13.777	3.368	10.410	0.417
1980	Volkswagen	Rabbit	72.8	9.335	3.042	6.293	0.207
1980	Mercedes	240D	64.1	5.961	1.362	4.600	0.078
1979	Cadillac	Seville	2345	21.661	10.099	11.562	2.641
1979	VW	Rabbit	502	20.770	6.917	13.853	0.160
1977	Mercedes	300D	113.4	3.476	1.250	2.227	0.263

5.0 MODEL COMPARISONS

It is important to compare the particulate emissions measured in this project with EPA's regulatory model PART5 and CARB's EMFAC7G. These models each contain default particulate emissions factors for a number of different vehicle classes according to model or calendar year. A comparison between the average emissions rates for gasoline vehicles obtained in this study with the emission factors currently used in the EMFAC7G and PART5 models is presented in Tables 22 and 23, respectively. In each category, the number of test vehicles is included in parentheses along with the average emission rate. For the PART5, only carbon emission factors are used in the model. Sulfate and lead particulate emissions are added to the carbon emission factor to obtain a total exhaust particulate factor in the model calculations. Carbon emission factors for the test fleet were obtained by multiplying the total emission factors by the average carbon percentages obtained from the chemical analysis for gasoline and diesel vehicles, respectively. A similar comparison for the diesel vehicles is presented in Table 24.

Probably the most important comparison is for the modern gasoline vehicles that represent the largest component of VMT. For this category there is little differentiation between model years in either EMFAC7G or PART5, with all 1981 and newer light-duty passenger cars and 1987 and newer light-duty trucks grouped together. The fleet average emission factors for these newer light-duty passenger cars and trucks from the present study are higher than those presently used in EMFAC7G. For PART5, the fleet average emission factors provide a good comparison for the light-duty passenger cars with no air injection and light-duty trucks with air injection, but are higher than those used in PART5 for the newer light-duty passenger cars with air injection. For both models, the emission factor comparison improves considerably when only the normal emitter test data are included.

In the older model gasoline vehicle categories, the number of vehicles tested is limited and provides only a rough comparison. Where corresponding data were obtained, the results agree reasonably well with the model emission factors, although the values used in PART5 for vehicles equipped with catalyst and air injection are higher than those expected based on the results of this work. The number of diesel-fueled vehicles tested is also probably too limited to provide a meaningful comparison with the model estimates, particularly for newer vehicles. Additional data on diesel vehicles should be collected to provide better model estimates. These emission factors should also be evaluated in the context of data from the other coordinated studies in Colorado and at SwRI.

Emission inventory estimates were developed with EMFAC7G based on the testing results and compared with those obtained using the default emission factors. The resulting emissions inventory estimates are presented in Table 25 for the South Coast Air Basin for light-duty passenger cars and trucks in calendar year 1997. The CE-CERT results were developed by replacing the emission factors in the input files for the EMFAC7G model with values based on the testing results (where available). Emission factors for all model year groupings where the contribution of high emitters was significant were developed by population weighting the emission factors for high emitters and normal emitters. The high emitter population estimates were based on data obtained through the Arizona inspection and maintenance (I/M) program (Wenzel and Ross, 1998). It should be noted that these comparisons include only exhaust particulate and not tire- or brake-wear particulate emissions that were not addressed in this study.

The emission inventory estimates for light-duty passenger cars ranged from 3.42 tons/day using the test fleet average after population weighting the high and normal emitters to 1.64 tons/day using only the normal emitters in the test fleet. This is compared to the EMFAC7G baseline estimate of 1.96 tons/day. For the light-duty trucks, the emission inventory estimates range from 0.89 tons/day using the test fleet average after population weighting to 0.72 tons for the normal emitters compared to the EMFAC7G baseline estimate of 0.67 tons/day. These results reflect the differences in the base emission factors for the newer model year light-duty passenger cars and light-duty trucks, as discussed above. In particular, the emission inventory estimates using the fleet average data are higher than those obtained using EMFAC7G's baseline factors, while a better comparison is obtained using only the normal emitting vehicles.

These results do not include the effects of smoking vehicles. Previous studies have shown that smoking vehicles can also have a significant impact on the particulate emissions inventory, even though they represent only 1-2% of the total population. Previous estimates of the contribution of light-duty smoking vehicles (i.e., smoking vehicles identified with a GVWR <6,000 lbs.) ranged from 0.47 tons/day PM to 0.74 tons/day PM based on high and low population estimates and the median FTP emission rate (Norbeck et al., 1996). Overall, given the significant impact that high emitters can have on the overall fleet average, it is recommended that consideration be given to having either different emission categories for normal and high emitters, or emission factors developed by weighting the distribution of normal and high emitter vehicles.

Comparisons were also made with the PART5 model, which provides a fleet average emission factor for different vehicle classes rather than emission inventory estimates for specific regions. To obtain PART5 estimates for the test fleet, the input fleet distribution was modified to correspond to the model year distribution of the test vehicles. Using the model year distributions for the test fleet, the fleet average output from PART5 was 13 mg/mi for the light-duty gasoline vehicles and 16 mg/mi for light-duty gasoline trucks. These emission factors compare relatively well with the actual fleet average of 15.7 mg/mi for light-duty gasoline passenger cars and 16.6 mg/mi for light-duty gasoline trucks. Although the comparison with PART5 is relatively good, it should be noted that sulfate contributes 8 mg/mi to the total emission for light-duty passenger cars and 10 mg/mi for the light-duty trucks. Although the fuel sulfur levels assumed in PART5 are higher than those found in California Phase 2 gasoline, these sulfate emissions are still considerably higher than those obtained in this study (average sulfate emissions of 0.15 mg/mi), as well as those reported by other researchers (Sagebiel et al., 1997). Based on these data, it is reasonable to suggest that the contribution of sulfate to the exhaust particulate emissions factor be reevaluated, especially as fuel sulfur levels continue to decrease.

Table 22. Comparison of Gasoline Particulate Emission Factors with EMFAC7G

Vehicle Type / Calendar Year		Catalyst-Equipped			Non-Catalyst				
	EMFAC7G (g/mi)		CE-CERT (g/mi)			EMFAC7G (g/mi)		CE-CERT (g/mi)	
Light-Duty Gasoline-Fueled Autos ($<6,000$ Lbs. GVWR)	Non-I/M PMEX EF	All	Normal Emitters	High Emitters		Non-I/M PMEX EF	All	Normal Emitters	High Emitters
Pre-1976	0.022	N.A.	N.A.	N.A.	pre-1970	0.193	0.063 (1)	N.A.	0.063 (1)
1976	0.022	N.A.	N.A.	N.A.	1970-1974	0.068	0.068 (1)	N.A.	0.068 (1)
1977	0.023	0.040 (1)	0.040 (1)	N.A.					
1978	0.022	0.009 (2)	N.A.	0.009 (2)					
1979	0.020	0.025 (2)	0.009 (1)	0.041 (1)					
1980	0.008	N.A.	N.A.	N.A.	1975-1980	0.030	0.013 (1)	N.A.	0.013 (1)
1981-1997	0.004	0.014 (59)	0.002 (48)	0.066 (11)	1981+	0.017	N.A.	N.A.	N.A.
Light-Duty Gasoline-Fueled Trucks ($<6,000$ Lbs. GVWR)									
Pre-1976	0.016	N.A.	N.A.	N.A.	pre-1970	0.193	N.A.	N.A.	N.A.
1976	0.022	N.A.	N.A.	N.A.	1970-1974	0.068	0.047 (1)	0.047 (1)	N.A.
1977	0.022	N.A.	N.A.	N.A.					
1978	0.022	0.014 (1)	N.A.	0.014 (1)					
1979	0.021	N.A.	N.A.	N.A.					
1980	0.021	N.A.	N.A.	N.A.					
1981	0.015	0.022 (1)	N.A.	0.022 (1)					
1982	0.011	N.A.	N.A.	N.A.					
1983	0.007	N.A.	N.A.	N.A.					
1984	0.007	0.001 (1)	0.001 (1)	N.A.					
1985	0.007	0.102 (4)	0.005 (2)	0.200 (2)					
1986	0.007	0.004 (4)	0.002 (2)	0.005 (2)	1975-1986	0.030	0.015 (1)	N.A.	0.015 (1)
1987-1997	0.004	0.008 (34)	0.005 (25)	0.015 (9)	1987+	0.017	N.A.	N.A.	N.A.

Table 22. Continued

Vehicle Type / Calendar Year		Catalyst-Equipped				Non-Catalyst			
Medium-Duty Gasoline-Fueled Trucks (6,000 – 8,500 Lbs. GVWR)		EMFAC7G	CE-CERT			EMFAC7G	CE-CERT		
		(g/mi) Non-I/M PMEX EF	All	(g/mi) Normal Emitters	High Emitters	(g/mi) Non-I/M PMEX EF	All	(g/mi) Normal Emitters	High Emitters
Pre-1976		0.025	N.A.	N.A.	N.A.	pre-1979	0.370	0.021 (2)	0.013 (1)
1976-77		0.025	N.A.	N.A.	N.A.				
1978-80		0.022	0.059 (2)	N.A.	0.059 (2)				
1981		0.023	0.022 (1)	N.A.	0.022 (1)				
1982		0.022	N.A.	N.A.	N.A.				
1983		0.016	0.008 (1)	0.008 (1)	N.A.	1979-1986	0.068	N.A.	N.A.
1984-86		0.006	0.033 (2)	0.022 (1)	0.044 (1)				
1987+		0.004	0.006 (7)	0.006 (6)	0.002 (1)				
						1987+	0.030	N.A.	N.A.

Table 23. Comparison of Gasoline Carbon Particulate Emission Factors with PART5

Vehicle Type/ Model Year	Catalyst (No-Air)				Catalyst (Air)				Non-Catalyst			
	PART5	CE-CERT			PART5	CE-CERT			PART5	CE-CERT		
	(g/mi)	All	(g/mi) Normal Emitters	High Emitters	(g/mi)	All	(g/mi) Normal Emitters	High Emitters	(g/mi)	All	(g/mi) Normal Emitters	High Emitters
Light-Duty Gasoline-Fueled Autos (<6,000 Lbs.)												
Pre-1970	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	0.030	0.045 (1)	N.A.	0.045 (1)
1970-1974	0.006	N.A.	N.A.	N.A.	0.250	N.A.	N.A.	N.A.	0.030	0.048 (1)	N.A.	0.048 (1)
1975-1980	0.006	0.007 (1)	0.007 (1)	N.A.	0.250	0.018 (4)	0.029 (1)	0.014 (3)	0.030	0.010 (1)	N.A.	0.010 (1)
1981+	0.004	0.002 (47)	0.001 (43)	0.010 (4)	0.004	0.041 (12)	0.003 (5)	0.068 (7)	0.017	N.A.	N.A.	N.A.
Light-Duty Gasoline Trucks (1) (<6,000 Lbs.)												
pre-1970	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	0.030	N.A.	N.A.	N.A.
1970-1974	0.006	N.A.	N.A.	N.A.	0.250	N.A.	N.A.	N.A.	0.030	0.033 (1)	0.033 (1)	N.A.
1975-1986	0.006	0.006 (3)	0.004 (1)	0.008 (2)	0.250	0.039 (8)	0.002 (4)	0.075 (4)	0.030	0.011 (1)	N.A.	0.011 (1)
1987+	0.004	0.007 (23)	0.004 (16)	0.013 (7)	0.004	0.002 (11)	0.002 (9)	0.003 (2)	0.017	N.A.	N.A.	N.A.
Light-Duty Gasoline Trucks (2) (6,000-8,500 Lbs.)												
pre-1979	N.A.	N.A.	N.A.	N.A.	N.A.	0.051 (1)	N.A.	0.051 (1)	0.054	0.015 (2)	0.010 (1)	0.020 (1)
1979-1986	0.006	N.A.	N.A.	N.A.	0.250	0.020 (5)	0.011 (2)	0.026 (3)	0.030	N.A.	N.A.	N.A.
1987+	0.004	0.003 (3)	0.003 (3)	N.A.	0.004	0.005 (4)	0.006 (3)	0.002 (1)	0.017	N.A.	N.A.	N.A.

note: PART5 emission factors are for unleaded gasoline : CE-CERT emission factors are for total carbon only

**Table 24. Comparison of Diesel Particulate Emission Factors
with EMFAC7G and PART5**

Vehicle Type / Model Year	EMFAC7G (g/mi)	CE-CERT (g/mi)	PART5 (carbon) (g/mi)	CE-CERT (carbon) (g/mi)
Light-Duty Diesel-Fueled Auto (<6,000 Lbs.)	(<6,000 Lbs.)	(<6,000 Lbs.)	(<6,000 Lbs.)	(<6,000 Lbs.)
Pre-81	0.700	0.877 (6)	0.700	0.640 (6)
1981	0.259	0.462 (1)	0.259	0.337 (1)
1982-1983	0.256	0.469 (5)	0.256	0.342 (5)
1984	0.259	0.653 (3)	0.256	0.477 (3)
1985-1986	0.255	0.043 (2)	0.255	0.031 (2)
1987	0.134	N.A.	0.134	N.A.
1988-1990	0.132	N.A.	0.132	N.A.
1991-1993	0.131	0.087 (1)	0.131	0.063 (1)
1994-1995	0.128	N.A.	0.128	N.A.
1996+	0.100	N.A.	0.100	N.A.

PART5 factors are for particulate carbon

**Table 25. Comparison of Emission Inventory Estimates for South Coast Air Basin
(tons/day)**

	Light-Duty Passenger Cars				Light-Duty Trucks			
	Gasoline		Diesel	LDPC Total	Gasoline		Diesel	LDT Total
	Non-Cat	Catalyst			Non-Cat	Catalyst		
EMFAC7G Baseline	0.59	0.96	0.42	1.96	0.06	0.40	0.21	0.67
CE-CERT	0.33	2.59	0.50	3.42	0.04	0.62	0.23	0.89
Total Fleet (weighted by emitter level)								
CE-CERT	0.59	0.55	0.50	1.64	0.05	0.44	0.23	0.72
Normal Emitter								

* Calendar year 1997

6.0 SUMMARY AND CONCLUSIONS

Results have been presented on the exhaust particulate emission rates for a fleet of 129 light-duty gasoline and 19 light-duty diesel vehicles. The major conclusions from this study are:

- Particulate emission rates from newer 1991-1997 model year gasoline vehicles are low (<3 mg/mi) with modest increases in emission rates found for older model years and emission control technologies.
- High gaseous emitter gasoline vehicles are found to have approximately 5-10 times the particulate emission rates of normal emitter vehicles.
- Older diesel vehicles have particulate emission rates approximately an order of magnitude higher than gasoline vehicles studied in this project. There is some indication, however, that newer diesel vehicles can have considerably lower emission rates than the average observed for this study.
- Poor correlation was found between THC and CO and particulate emission rates for the light-duty gasoline vehicles.
- The majority (73.6-95.1%) of the total mass particulate emissions from light-duty vehicles was found to have an aerodynamic diameter less than 2.5 μm .
- Particle count measurements showed good correlation with the driving cycle, with higher counts observed when the engine was under load or accelerating. Higher particulate counts were measured for diesel than gasoline test vehicles.
- Elemental and organic carbon were the primary constituents for the gasoline and diesel particulates. On average, organic carbon composed a larger fraction of the total carbon for the gasoline vehicles, while elemental carbon represented the larger fraction of the total carbon for the diesel vehicles.
- Inorganic species, including ions and trace elements, composed an average of 6.9% and 1.4% of the total particulate composition for gasoline and diesel vehicles, respectively. The most prominent inorganic species included Fe, Si, SO_4^{2-} , NH_4^+ , S, Cl, Ca, and Zn for gasoline vehicles, and SO_4^{2-} , Si, S, Ca, Fe, and Zn, for diesel vehicles.
- Total PAH emission rates for gasoline and diesel vehicles are comparable, with an average emission rate of 16.5 mg/mi for the gasoline vehicles and an average emission rate of 8.5 mg/mi for the diesel vehicles. The distribution of PAHs for the diesel vehicles differs from that of the gasoline vehicle primarily in that it includes lower relative concentrations of naphthalene and methyl-naphthalene. It should be noted that these gasoline vehicles had relatively high particulate emission rates and the diesel vehicles were primarily pre-1986 technology. As such, these data are probably more useful in developing PAH source profiles than providing an absolute comparison between PAH mass emission rates for gasoline and diesel vehicles in the modern fleet.
- The fleet average total hopane and sterane emission rate was 23.6 $\mu\text{g}/\text{mi}$ for the gasoline vehicles and 314.1 $\mu\text{g}/\text{mi}$ for the diesel vehicles. The species distributions of hopanes and steranes were similar for the gasoline and diesel vehicles.
- There is a need to expand the number of emission categories in EMFAC7G and PART5 for light-duty gasoline vehicles and consideration should be given to separate categories for normal and high emitter vehicles.
- More data would allow a better assessment of the emission factors now used in EMFAC7G and PART5 for light-duty diesel vehicles and older light-duty gasoline vehicles. These data

should be evaluated in the context of data from the other coordinated studies in Colorado and at SwRI.

- Emission inventory estimates in the South Coast Air Basin based on the fleet emission rates were higher (3.42 tons/day of PM for light-duty passenger cars) than those obtained using the default values in EMFAC7G (1.96 tons/day of PM). A better comparison was obtained, however, when only the results from the normal emitting vehicles in the test fleet were considered, resulting in an inventory estimate of 1.64 tons/day of PM for light-duty passenger cars.
- The emission factors from PART5 provided a relatively good comparison with the overall fleet averages. The contribution of sulfate to the exhaust particulate emission factor, however, was significantly greater than that obtained in this work. It is suggested that the contribution of sulfate particulate in the PART5 model be reevaluated.

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Appendix A. Correlation Exercise with Southwest Research Institute

Introduction

Prior to the initiation of particulate testing on the main light-duty vehicle fleet, the CRC Committee overseeing Project E-24-2 requested that a particulate emission correlation exercise be conducted between Southwest Research Institute (SwRI) and the College of Engineering-Center for Environmental Research and Technology (CE-CERT). The protocol for this correlation exercise required that CE-CERT recruit two vehicles and SwRI recruit one vehicle. Each laboratory conducted at least three emission tests (in several cases more than three tests were run to answer specific questions which arose during the correlation exercise) on each vehicle while operating over the Urban Dynamometer Driving Schedule (UDDS) of the Federal Test Procedure (FTP).

CE-CERT Test Procedures

Vehicle Selection

The following vehicles were tested in this program:

- 1988 Ford Festiva (initial mileage 65,904)
- 1986 Ford Tempo (initial mileage 50,283)
- 1996 Buick LeSabre (mileage at initial test at CE-CERT 22,756)

Each vehicle was filled with fuel so all testing could be completed without a fuel change. The Festiva and Tempo which were recruited by CE-CERT used California Phase II Reformulated Gasoline. Prior to the initiation of testing on each vehicle and when emission tests were not conducted on consecutive days for a specific vehicle, vehicles were preconditioned using the LA-4 driving schedule. Following preconditioning, vehicles were soaked at a temperature of 70 ± 2 °F for 12-24 hours before conducting emission tests.

Emission Testing

Gaseous and particulate emission rates were determined using the FTP protocol for light-duty vehicles as outlined in the Code of Federal Regulations (CFR), Title 40, Part 86, Subpart B except for procedures pertaining to refueling and evaporative testing.

Emission testing was performed using CE-CERT's 10 inch gasoline dilution tunnel with a CVS flow rate of 350 SCFM. Particulate samples for mass emission rates were collected on 47 mm, 2.0 μ m Gelman Teflon membrane filters using a primary and secondary filter. In order to determine the effect of filter media, some duplicate sample studies were conducted using 47 mm Pallflex T60A20 PTFE-coated glass fiber filters. Details and results of these experiments are described in the results section. Nominal filter flow rates for testing of the Ford Tempo and the initial tests on the Ford Festiva were 70 lpm. Due to the lower expected particulate emission rate of the Buick LeSabre, filter flow rates were increased to 88 lpm. During repeat testing of the Ford Festiva, multiple filter samples were also collected at nominal flow rates between 30 and 60 lpm. Isokinetic sampling was maintained for all tests by changing probe tip size. Details of these experiments and results are presented in the results section.

Dilution tunnel background samples were taken each day of testing. Particulate backgrounds were calculated in terms of mg/mi equivalent based upon CVS flow rate, filter flow rate, and duration of sampling and averaged 0.29 mg/mi with a range of 0.08 to 0.75 mg/mi. Results presented are uncorrected for tunnel background.

Results

CE-CERT Test Results

CE-CERT test results for the Buick LeSabre, Ford Tempo, and Ford Festiva (prior to shipment to SwRI), are presented in Tables A1-A3, respectively. These results are compared with the initial test results from SwRI in Table A4. These results showed relatively good correlation between the laboratories for the Ford Tempo with particulate emission rates of 10.1 for CE-CERT and 14.2 for SwRI. The differences of particulate emission rates between the laboratories were initially greater, however, for the Buick LeSabre and Ford Festiva. For the Buick LeSabre, particulate emission rates of 1.5 and 7.5, respectively, were reported by CE-CERT and SwRI. For the Ford Festiva, particulate emission rates of 21.6 and 113.4, respectively, were reported by CE-CERT and SwRI. In order to further investigate the differences in emissions between the two laboratories several additional tests were conducted at both CE-CERT and SwRI.

For the Buick LeSabre, additional tests were performed to determine the impact of filter flow rate, filter media, and dynamometer load. Table A5 presents results on the Buick LeSabre using an 8 and a 70% increase in dynamometer load. The higher dynamometer loadings result in significant increases in NO_x and CO₂ emissions but little, if any, impact on HC, CO, and particulate emission rates. In two tests, multiple filter samples were collected to determine the effect of filter flow rate and filter type. The two filter media used were 47 mm, 2.0 µm Gelman Teflon membrane and Pallflex T60A20 fiber (this is the same filter media used by SwRI). These results are summarized in Table A6. The initial test, conducted on 11/20/96, indicated that a filter flow rate change from 88 to 30 lpm did not have an effect on measured emission rate using the PTFE membrane filter while sampling with the PTFE-coated glass fiber filter at 30 lpm resulted in a 1.0 mg/mi higher emission rate. It should be noted that SwRI used a flow rate of approximately 30 lpm in their testing. The second test, conducted on 12/6/96, showed a difference of 1.8 mg/mi between the membrane and fiber filters at the flow rates utilized by the two groups. Although these differences were noted, they were not large enough to explain the emission rate differences measured by the two groups for the LeSabre, and the vehicle was returned to SwRI. Upon returning to SwRI in January of 1997, several additional tests were conducted on the Buick LeSabre by SwRI. These tests showed much lower particulate emissions (average=3.5 mg/mi), and better agreement with the CE-CERT results, compared to tests conducted in October of 1996 (average=7.5 mg/mi). This indicates that some changes in the particulate emission characteristics of the vehicle may have occurred after it was initially tested at SwRI.

Larger differences in particulate emission rates were observed for the Ford Festiva. For this vehicle, SwRI also measured significantly higher HC and CO and lower NO_x emission rates than those found at CE-CERT. It was speculated based on these results that a major shift in vehicle emission characteristics occurred between testing at the two laboratories. To determine if this was indeed the case, additional testing was performed on this vehicle upon its return to CE-CERT. These results are presented in Table A7. As suspected, the results confirm a change in emission characteristics and showed an average particulate emission rate of 101.2 mg/mi during the retests. HC and CO emissions also increased while NO_x emissions decreased during the CE-CERT Ford Festiva retesting.

Multiple particulate sampling studies were performed during these retests to examine the effects of filter media and filter flow rates on measured particulate emission rates. In these studies, CE-CERT Gelman Teflon membrane and Pallflex PTFE-coated glass-fiber filters obtained from SwRI were used. Results are summarized in Table A8. Results obtained during FTP testing on 1/28/97 showed an approximate 4% difference in measured mass emission rates with two PTFE membrane filter systems operating at different flow rates. Mass emission rates determined with the Pallflex filters from SwRI were 4 to 9% higher than those determined with the PTFE membrane filters. An additional experiment on filter flow rate and media effects was run on 1/28/97 while the Festiva was operated over a Hot 505 driving cycle. These results do not indicate any significant effect of flow rate using the PTFE membrane filters; and, as opposed to the previous test, 2 to 4% lower emission rates with the SwRI Pallflex filters compared to the membrane filters. The additional results do not show any significant effects of either filter type (1/30/97 test) or filter flow rates (2/4/97 test). Based upon the results presented in Tables A6 and A8, it is concluded that there are not any systematic effects of filter media or flow rates in the ranges tested.

Comparison of SwRI and CE-CERT Emission Results

Table A9 presents a summary of the average and standard deviation of the emission results obtained by SwRI and CE-CERT. The results for the Ford Festiva are separated into initial and retest results since there was a dramatic change in the emission characteristics after it was shipped to SwRI and then returned. Results for the Buick LeSabre are also separated into initial and retest results since lower particulate emissions were measured by SwRI after the vehicle was shipped to CE-CERT and then returned. Overall, particulate emission rates for SwRI are slightly higher than those reported for CE-CERT. These differences are relatively small, however, in comparison with the test-to-test variability, as well as the differences observed for Ford Festiva and Buick LeSabre when these vehicles were retested at their original laboratories.

Table A1. CE-CERT Test Results for 1988 Ford Festiva prior to shipment to SwRI

	1988 Ford Festiva				
	Test #1 9/27/966	Test #2 10/2/96	Test #3 10/17/96	Ave.	Stand.Dev
Particles (mg/mi)					
Phase 1	50.9	31.4	36.5	39.6	10.1
Phase 2	10.3	7.2	9.5	9.0	1.6
Phase 3	30.3	27.2	38.1	31.9	5.6
Weighted	24.2	17.7	22.9	21.6	3.4
THC (g/mi)					
Phase 1	0.767	0.743	0.716	0.742	0.026
Phase 2	0.092	0.081	0.083	0.085	0.006
Phase 3	0.279	0.237	0.248	0.255	0.022
Weighted	0.283	0.261	0.259	0.268	0.013
NMHC (g/mi)					
Phase 1	0.678	0.673	0.642	0.664	0.020
Phase 2	0.041	0.032	0.029	0.034	0.006
Phase 3	0.207	0.171	0.178	0.185	0.019
Weighted	0.218	0.203	0.196	0.206	0.011
NOx (g/mi)					
Phase 1	1.11	1.364	1.315	1.263	0.135
Phase 2	0.781	0.85	0.808	0.813	0.035
Phase 3	0.787	0.707	0.738	0.744	0.040
Weighted	0.851	0.917	0.893	0.887	0.033
CO (g/mi)					
Phase 1	7.466	6.303	6.191	6.653	0.706
Phase 2	1.682	1.688	1.648	1.673	0.022
Phase 3	3.359	3.021	2.603	2.994	0.379
Weighted	3.339	3.007	2.847	3.064	0.251
CO2 (g/mi)					
Phase 1	264.0	245.9	246.4	252.1	10.3
Phase 2	238.7	227.1	233.8	233.2	5.8
Phase 3	226.1	221.8	224.0	223.9	2.2
Weighted	240.5	229.5	233.7	234.6	5.5

Table A2. CE-CERT Test Results for 1986 Ford Tempo

	1986 Ford Tempo				
	Test #1 10/1/96	Test #2 10/2/96	Test #3 10/3/96	Ave.	Stand.Dev
Particles (mg/mi)					
Phase 1	6.4	5.1	4.5	5.3	1.0
Phase 2	12.1	11.6	10.9	11.5	0.6
Phase 3	11.7	10.4	10.5	10.9	0.7
Weighted	10.8	10	9.4	10.1	0.7
THC (g/mi)					
Phase 1	0.763	0.721	0.789	0.758	0.034
Phase 2	0.251	0.235	0.234	0.240	0.010
Phase 3	0.314	0.37	0.36	0.348	0.030
Weighted	0.374	0.373	0.383	0.377	0.006
NMHC (g/mi)					
Phase 1	0.681	0.637	0.707	0.675	0.035
Phase 2	0.16	0.141	0.144	0.148	0.010
Phase 3	0.239	0.292	0.279	0.270	0.028
Weighted	0.29	0.286	0.297	0.291	0.006
NOx (g/mi)					
Phase 1	1.184	1.167	1.131	1.161	0.027
Phase 2	0.565	0.55	0.541	0.552	0.012
Phase 3	0.907	0.801	0.818	0.842	0.057
Weighted	0.787	0.747	0.739	0.758	0.026
CO (g/mi)					
Phase 1	8.173	8.211	7.924	8.103	0.156
Phase 2	1.984	1.85	1.786	1.873	0.101
Phase 3	2.096	3.802	3.561	3.153	0.923
Weighted	3.298	3.704	3.544	3.515	0.205
CO2 (g/mi)					
Phase 1	382.8	381.5	376.4	380.3	3.4
Phase 2	367.9	366.8	363.1	365.9	2.5
Phase 3	330.8	327.8	325.7	328.1	2.5
Weighted	360.8	359.1	355.6	358.5	2.7

Table A3. CE-CERT Test Results for 1996 Buick LeSabre

	1996 Buick LeSabre				
	Test #1 11/15/96	Test #2 11/19/96	Test #3 11/20/96	Ave.	Stand.Dev
Particles (mg/mi)					
Phase 1	3.8	3	2.8	3.2	0.5
Phase 2	0.7	0.9	1.1	0.9	0.2
Phase 3	1.8	1.3	1.7	1.6	0.3
Weighted	1.6	1.4	1.6	1.5	0.1
THC (g/mi)					
Phase 1	0.415	0.54	0.448	0.468	0.065
Phase 2	0.015	0.021	0.017	0.018	0.003
Phase 3	0.025	0.044	0.03	0.033	0.010
Weighted	0.101	0.134	0.11	0.115	0.017
NMHC (g/mi)					
Phase 1	0.384	0.504	0.417	0.435	0.062
Phase 2	0.012	0.019	0.01	0.014	0.005
Phase 3	0.013	0.033	0.016	0.021	0.011
Weighted	0.089	0.123	0.096	0.103	0.018
NOx (g/mi)					
Phase 1	0.325	0.278	0.342	0.315	0.033
Phase 2	0.023	0.032	0.03	0.028	0.005
Phase 3	0.149	0.12	0.151	0.140	0.017
Weighted	0.119	0.107	0.128	0.118	0.011
CO (g/mi)					
Phase 1	4.259	5.253	4.274	4.595	0.570
Phase 2	0.145	0.149	0.177	0.157	0.017
Phase 3	0.101	0.241	0.122	0.155	0.078
Weighted	0.983	1.229	1.01	1.074	0.135
CO2 (g/mi)					
Phase 1	407.5	412.4	413.7	411.2	3.3
Phase 2	417	419.8	419.9	418.9	1.6
Phase 3	351.6	348.1	353.7	351.1	2.8
Weighted	397.1	398.6	400.5	398.7	1.7

Table A4. Averages and Standard Deviations of Initial CE-CERT and SwRI Results

	1988 Ford Festiva				1996 Ford Taurus				1996 Buick LeSabre			
	CE-CERT		SwRI		CE-CERT		SwRI		CE-CERT		SwRI	
	Initial n=3		n=3		N=3		n=3		n=3		initial n=4	
	Ave.	(s.d.)	Ave.	(s.d.)	Ave.	(s.d.)	ave.	(s.d.)	ave.	(s.d.)	ave.	(s.d.)
Particles (mg/mi)	21.6	(3.4)	113.4	(12.1)	10.1	(0.7)	14.2	(3.9)	1.5	(0.1)	7.5	(1.0)
THC (g/mi)	0.268	(0.013)	0.493	(0.035)	0.377	(0.006)	0.332	(0.008)	0.115	(0.017)	0.092	(0.003)
NMHC (g/mi)	0.206	(0.011)	N.A.		0.291	(0.006)	N.A.		0.103	(0.018)	N.A.	
NOx (g/mi)	0.887	(0.033)	0.759	(0.006)	0.758	(0.026)	0.637	(0.015)	0.118	(0.011)	0.198	(0.010)
CO (g/mi)	3.064	(0.251)	6.693	(0.710)	3.615	(0.205)	3.469	(0.012)	1.074	(0.136)	0.849	(0.053)
CO2 (g/mi)	234.6	(5.5)	266.4	(6.7)	399.5	(2.7)	336.0	(1.6)	398.7	(1.7)	424.2	(2.2)

Table A5. CE-CERT Test of 1996 Buick LeSabre at increased dynamometer loadings

	1986 Buick LeSabre Extra Tests	
	Dyno Load +8%	Dyno Load +70%
Particles (mg/mi)		
Phase 1	3.3	3.2
Phase 2	1.2	1
Phase 3	1.5	1.5
Weighted	1.7	1.6
THC (g/mi)		
Phase 1	0.488	0.489
Phase 2	0.015	0.025
Phase 3	0.026	0.032
Weighted	0.107	0.123
NMHC (g/mi)		
Phase 1	0.411	0.455
Phase 2	0.009	0.02
Phase 3	0.016	0.021
Weighted	0.094	0.11
NOx (g/mi)		
Phase 1	0.483	0.655
Phase 2	0.057	0.059
Phase 3	0.178	0.452
Weighted	0.178	0.29
CO (g/mi)		
Phase 1	4.417	4.547
Phase 2	0.156	0.171
Phase 3	0.187	0.19
Weighted	1.043	1.08
CO2 (g/mi)		
Phase 1	424.3	451.3
Phase 2	430.9	468.3
Phase 3	362.3	398.1
Weighted	410.8	445.5

Table A6. Effects of filter media and flow rate during testing of Buick LeSabre

Test Date Sample Probe	Filter Type	Sampling Flow	Collection Cycle	Emission Rate (mg/mi)
11/20/96				
Probe 1	PTFE 2.0µm	88 lpm	Phase 1	2.8
			Phase 2	0.9
			Phase 3	1.1
			Cumulative	1.6
Probe 2	PTFE 2.0µm	30 lpm	Cumulative	1.6
Probe 3	T60A20	30 lpm	Cumulative	2.6
12/6/96				
Probe 1	PTFE 2.0µm	88 lpm	Phase 1	3.2
			Phase 2	1.0
			Phase 3	1.5
			Cumulative	1.9
Probe 2	T60A20	30 lpm	Cumulative	3.7

Table A7. CE-CERT Retests of 1988 Ford Festiva

	1988 Ford Festiva				
	Retest #1 1/28/97	Retest #2 1/30/97	Retest #3 2/4/97	Ave.	Stand.Dev
Particles (mg/mi)					
Phase 1	96.7	172.6	159.9	143.1	40.7
Phase 2	65.4	105	61	77.1	24.2
Phase 3	113.3	126.3	105.8	115.1	10.4
Weighted	85	124.8	93.8	101.2	20.9
THC (g/mi)					
Phase 1	1.133	1.254	1.18	1.189	0.061
Phase 2	0.361	0.603	0.291	0.418	0.164
Phase 3	0.393	0.389	0.371	0.384	0.012
Weighted	0.529	0.679	0.497	0.568	0.097
NMHC (g/mi)					
Phase 1	1.022	1.114	1.059	1.065	0.046
Phase 2	0.252	0.456	0.199	0.302	0.136
Phase 3	0.289	0.287	0.276	0.284	0.007
Weighted	0.421	0.546	0.398	0.455	0.080
NOx (g/mi)					
Phase 1	1.18	1.037	1.051	1.089	0.079
Phase 2	0.483	0.483	0.503	0.490	0.012
Phase 3	0.555	0.534	0.578	0.556	0.022
Weighted	0.647	0.612	0.637	0.632	0.018
CO (g/mi)					
Phase 1	8.668	9.031	9.579	9.093	0.459
Phase 2	4.431	6.586	3.275	4.764	1.680
Phase 3	3.839	4.028	3.704	3.857	0.163
Weighted	5.145	6.39	4.697	5.411	0.877
CO2 (g/mi)					
Phase 1	238.2	240.8	236.2	238.4	2.3
Phase 2	246.9	252.2	239.7	246.3	6.3
Phase 3	216.0	214.9	213.9	214.9	1.1
Weighted	236.6	239.6	231.9	236.0	3.9

Table A8. Effects of filter media and flow rate during testing of Ford Festiva

Test Date Sample Probe	Filter Type	Sampling Flow	Collection Cycle	Emission Rate (mg/mi)
1/28/97				
Probe 1	PTFE 2.0µm	59 lpm	Phase 1	96.7
			Phase 2	65.4
			Phase 3	113.3
			Cumulative	91.3
Probe 2	PTFE 2.0µm	32 lpm	Phase 1	101.6
			Phase 2	67.3
			Phase 3	119.1
			Cumulative	95.4
Probe 3	SwRI Pallflex	32 lpm	Cumulative	99.5
1/28/97				
Probe 1	SwRI Pallflex	29 lpm	Hot 505	124.5
Probe 1	PTFE 2.0µm	32 lpm	Hot 505	129.9
Probe 2	SwRI Pallflex	55 lpm	Hot 505	128.2
Probe 2	PTFE 2.0µm	54 lpm	Hot 505	130.1
1/30/97				
Probe 1	PTFE 2.0µm	29 lpm	Phase 1	172.6
			Phase 2	105.0
			Phase 3	126.3
			Weighted	124.8
Probe 2	SwRI Pallflex	30 lpm	Phase 1	171.0
			Phase 2	106.7
			Phase 3	129.2
			Weighted	126.2
2/4/97				
Probe 1	PTFE 2.0µm	46 lpm	Phase 1	159.9
			Phase 2	61.0
			Phase 3	105.8
			Weighted	93.8
Probe 2	PTFE 2.0µm	30 lpm	Phase 1	161.6
			Phase 2	59.7
			Phase 3	108.6
			Weighted	94.2

Table A9. Averages and Standard Deviations of CE-CERT and SwRI Results

	1988 Ford Festiva				1996 Ford Taurus			1996 Buick LeSabre		
	CE-CERT Initial n=3	CE-CERT Retest n=3	SwRI n=4		CE-CERT n=3	SwRI n=3		CE-CERT n=3	SwRI Initial n=4	SwRI Retest n=2
	Ave. (s.d.)	Ave. (s.d.)	Ave. (s.d.)		Av. (s.d.)	ave. (s.d.)		ave. (s.d.)	ave. (s.d.)	ave. (s.d.)
Particles (mg/mi)	21.6 (3.4)	101.2 (20.9)	113.4 (12.1)		10.1 (0.7)	14.2 (3.9)		1.5 (0.1)	7.5 (1.5)	3.5 (0.1)
THC (g/mi)	0.268 (0.013)	0.568 (0.097)	0.493 (0.035)		0.377 (0.006)	0.332 (0.008)		0.115 (0.017)	0.092 (0.003)	0.104 (0.001)
NMHC (g/mi)	0.206 (0.011)	0.455 (0.080)	N.A.		0.291 (0.006)	N.A.		0.103 (0.018)	N.A.	N.A.
NOx (g/mi)	0.887 (0.033)	0.632 (0.018)	0.759 (0.006)		0.758 (0.026)	0.637 (0.015)		0.118 (0.011)	0.198 (0.010)	0.161 (0.021)
CO (g/mi)	3.064 (0.251)	5.411 (0.877)	6.693 (0.710)		3.515 (0.205)	3.469 (0.012)		1.074 (0.135)	0.849 (0.053)	0.902 (0.112)
CO2 (g/mi)	234.6 (5.5)	236.0 (3.9)	266.4 (6.7)		358.5 (2.7)	338.0 (1.6)		398.7 (1.7)	424.2 (2.2)	417.3 (0.5)

Appendix B. Description of Gasoline Vehicle Test Fleet

	Model Year	Make	Model	Odometer	Engine Size	Catalyst Type	Air	Vehicle Class*	Emitter	Certification
1	1997	Ford	Windstar	19743	3.8L	3 Way		LDGT1	High	CA
2	1997	Ford	F-150 pick-up	13599	4.6L	3 Way		LDGT2	Normal	CA
3	1996	Chevrolet	Camaro	25877	3.8L	3 Way		LDGV	Normal	CA
4	1996	Dodge	Dakota	3722	2.5L	3 Way		LDGT1	Normal	CA
5	1996	Ford	Escort	13719	2.0L	3 Way		LDGV	Normal	CA
6	1996	Nissan	Altima	14212	2.4L	3 Way		LDGV	Normal	CA
7	1996	Acura	Integra	4280	1.8L	3 Way		LDGV	Normal	CA
8	1996	Dodge	Ram 1500	24104	5.2L	3 Way		LDGT2	Normal	CA
9	1996	Ford	Explorer	15164	4.0L	3 Way		LDGT1	Normal	CA
10	1996	Nissan	Sentra	13845	1.6L	3 Way		LDGV	Normal	CA
11	1996	Ford	F-150 pick-up	24595	5.0L	3 Way	yes	LDGT2	Normal	FED
12	1995	Toyota	Camry	29209	2.2L	3 Way		LDGV	Normal	CA
13	1995	Chrysler	LeBaron GTC	22197	3.0L	3 Way		LDGV	Normal	CA
14	1995	Honda	Accord LX	37161	2.2L	3 Way		LDGV	Normal	CA
15	1995	Honda	Civic DX	52111	1.5L	3 Way		LDGV	Normal	CA
16	1995	Toyota	pick-up	52322	2.4L	3 Way	yes	LDGT1	Normal	CA
17	1995	Ford	Ranger pick-up	43551	2.3L	3 Way		LDGT1	Normal	CA
18	1995	Dodge	Dakota SLT	44432	5.2L	3 Way		LDGT1	Normal	CA
19	1995	Dodge	Intrepid	62007	3.3L	3 Way		LDGV	Normal	CA
20	1995	Isuzu	Rodeo	14067	2.6L	3 Way		LDGT1	Normal	CA
21	1994	Toyota	Camry	22258	3.0L	3 Way		LDGV	Normal	CA
22	1994	Mazda	Protégé	40201	1.8L	3 Way		LDGV	Normal	CA
23	1994	Honda	Civic LX	78056	1.5L	3 Way		LDGV	Normal	CA
24	1994	Chevrolet	C1500 Suburban	36449	5.7L	3 Way		LDGT2	Normal	CA
25	1994	Ford	Escort LX	31924	1.9L	3 Way		LDGV	Normal	CA
26	1994	Honda	Civic DX	57742	1.5L	3 Way		LDGV	Normal	CA
27	1994	Dodge	Spirit	57407	3.0L	3 Way		LDGV	Normal	CA
28	1994	Dodge	Spirit	56300	3.0L	3 Way		LDGV	Normal	CA
29	1994	Dodge	Caravan	77603	3.0L	3 Way		LDGT1	High	CA
30	1994	Ford	Thunderbird	72691	4.6L	3 Way		LDGV	Normal	CA
31	1994	Honda	Accord	57192	2.2L	3 Way		LDGV	Normal	CA
32	1994	Toyota	Pick-up	40216	2.4L	3 Way	yes	LDGT1	Normal	CA
33	1994	Mitsubishi	Eclipse	40526	1.8L	3 Way		LDGV	Normal	CA
34	1993	Saturn	SL2	63125	1.9L	3 Way		LDGV	Normal	CA
35	1993	Ford	Festiva	16938	1.3L	3 Way		LDGV	Normal	CA
36	1993	Toyota	Terrel	52789	1.5L	3 Way		LDGV	Normal	CA
37	1993	Honda	Civic LX	61032	1.6L	3 Way		LDGV	Normal	CA
38	1993	Ford	Ranger pick-up	74635	4.0L	3 Way		LDGT1	Normal	CA
39	1993	Saturn	SL2	42264	2.0L	3 Way		LDGV	Normal	FED
40	1993	Nissan	Altima	32058	2.4L	3 Way		LDGV	Normal	CA
41	1993	Saturn	SL2	64967	1.9L	3 Way		LDGV	Normal	CA
42	1992	Ford	Aerostar	67620	3.0L	3 Way		LDGT1	Normal	CA
43	1992	Honda	Accord EX	80394	2.2L	3 Way		LDGV	Normal	CA
44	1992	Saturn	SL	94427	1.9L	3 Way		LDGV	Normal	CA
45	1992	Dodge	Dakota LE	76384	3.9L	3 Way		LDGT1	High	FED
46	1992	GMC	1500	66270	5.7L	3 Way	yes	LDGT2	Normal	CA
47	1992	Ford	Explorer	92324	4.0L	3 Way		LDGT1	Normal	CA

Appendix B. cont. Description of Gasoline Vehicle Test Fleet

	Model Year	Make	Model	Odometer	Engine Size	Catalyst Type	Air	Vehicle Class*	Emitter	Certification
48	1992	Ford	Ranger pick-up	61976	2.3L	3 Way		LDGT1	Normal	CA
49	1992	Chevrolet	S-10 pick-up	82519	2.5L	3 Way		LDGT1	High	CA
50	1992	Toyota	Pick-up	58773	2.4L	3 Way	yes	LDGT1	Normal	CA
51	1992	Toyota	Pick-up	58159	2.4L	3 Way	yes	LDGT1	Normal	CA
52	1992	Hyundai	Elantra	50107	1.6L	3 Way		LDGV	High	CA
53	1992	Honda	Prelude	90621	2.3L	3 Way		LDGV	Normal	CA
54	1992	Jeep	Wrangler	71204	2.5L	3 Way		LDGT1	Normal	CA
55	1992	Geo	Tracker	69008	1.6L	3 Way		LDGT1	Normal	CA
56	1991	Toyota	Tercel	104710	1.5L	3 Way		LDGV	Normal	CA
57	1991	Nissan	Sentra	75800	1.6L	3 Way		LDGV	Normal	CA
58	1991	Toyota	pick-up	30440	2.4L	3 Way	yes	LDGT1	Normal	CA
59	1991	Mercury	Tracer LTS	6025	1.8L	3 Way		LDGV	Normal	FED
60	1991	Toyota	pick-up	92828	2.4L	3 Way	yes	LDGT1	Normal	CA
61	1991	Pontiac	Transport	123618	3.1L	3 Way		LDGT1	Normal	CA
62	1990	Nissan	Sentra	141134	1.6L	3 Way	yes	LDGV	Normal	CA
63	1990	Dodge	Spirit	183392	2.5L	3 Way		LDGV	Normal	CA
64	1990	Nissan	pick-up	114720	2.4L	3 Way	yes	LDGT1	Normal	CA
65	1990	Dodge	Ram 250 pick-up	60753	5.9L	3 Way	yes	LDGT2	Normal	CA
66	1990	Nissan	pick-up	130600	2.4L	3 Way	yes	LDGT1	Normal	CA
67	1990	Honda	Accord EX	109713	2.2L	3 Way		LDGV	Normal	FED
68	1990	Ford	Mustang	11302	5.0L	3 Way + 2 Way	yes	LDGV	Normal	CA
69	1990	Jeep	Wrangler	73210	2.5L	3 Way		LDGT1	High	CA
70	1990	Pontiac	LeMans	85012	1.6L	3 Way		LDGV	Normal	FED
71	1990	Geo/Isuzu	Storm	109951	1.6L	3 Way		LDGV	Normal	FED
72	1989	Ford	T-Bird	30800	3.8L	3 Way		LDGV	Normal	CA
73	1989	Hyundai	Excel	61058	1.5L	3 Way	yes	LDGV	High	CA
74	1989	GMC	Sierra 1500	100863	5.7L	3 Way		LDGT1	Normal	CA
75	1989	Dodge	Caravan	83057	3.0L	3 Way		LDGT1	Normal	CA
76	1989	Jeep	Wrangler	111622	4.2L	3 Way		LDGT1	High	FED
77	1988	Dodge	Ram Royal PU	139526	3.0L	3 Way		LDGT1	Normal	CA
78	1988	Toyota	pick-up	194021	2.4L	3 Way	yes	LDGT1	High	CA
79	1988	Toyota	pick-up	162245	2.4L	3 Way + 2 Way		LDGT1	Normal	FED
80	1988	Mazda	MX-6	151512	2.2L	3 Way		LDGV	Normal	CA
81	1988	Dodge	Caravan	101045	3.0L	3 Way		LDGT1	High	CA
82	1988	Toyota	Pick-up	86911	2.4L	3 Way		LDGT1	Normal	CA
83	1988	Chevrolet	Pick-up	208028	4.3L	3 Way	yes	LDGT2	High	CA
84	1988	Buick	Park Avenue	116544	3.8L	3 Way		LDGV	Normal	CA
85	1988	Nissan	Pick-Up	102556	2.4L	3 Way	yes	LDGT1	High	CA
86	1987	Chevrolet	Corsica	124806	2.0L	3 Way		LDGV	Normal	CA
87	1986	Subaru	GL	96879	1.8L	3 Way		LDGV	High	CA
88	1986	Ford	F-150 pick-up	22001	4.9L	3 Way	yes	LDGT1	High	CA
89	1986	Alfa Romeo	Spider	46495	2.0L	3 Way		LDGV	High	FED
90	1986	Nissan	Pick-up	221760	2.4L	3 Way	yes	LDGT1	Normal	CA
91	1986	Chrysler	5th Ave.	87798	5.2L	3 Way	yes	LDGV	Normal	CA
92	1986	Ford	Bronco	45327	2.9L	3 Way		LDGT1	High	FED
93	1986	Mazda	Pick-up	166511	2.0L	3 Way	yes	LDGT1	Normal	CA
94	1986	Nissan	Sentra XE	228988	1.6L	3 Way	yes	LDGV	Normal	CA
95	1985	Toyota	Pick-up	162398	2.4L	3 Way		LDGT1	Normal	CA

Appendix B. cont. Description of Gasoline Vehicle Test Fleet

	Model Year	Make	Model	Odometer	Engine Size	Catalyst Type	Air	Vehicle Class *	Emitter	Certification
96	1985	BMW	735i	141715	3.4L	3 Way		LDGV	High	CA
97	1985	Dodge	Ram 50 pick-up	93385	2.0L	3 Way	yes	LDGT1	High	CA
98	1985	Chevrolet	Sprint	55719	1.0L	3 Way	yes	LDGV	High	CA
99	1985	Dodge	Caravan	55665	2.2L	3 Way	yes	LDGT1	High	FED
100	1985	Chevrolet	Caprice Classic	93486	5.0L	3 Way	yes	LDGV	Normal	CA
101	1985	Toyota	Celica	52520	2.4L	3 Way		LDGV	Normal	CA
102	1985	Mitsubishi	pick-up	52296	2.0L	3 Way	yes	LDGT1	Normal	CA
103	1984	Cadillac	Coupe de Ville	94221	4.1L	3 Way	yes	LDGV	High	CA
104	1984	Buick	Regal LTD	46057	3.8L	3 Way	yes	LDGV	High	CA
105	1984	Toyota	pick-up	138310	2.4L	3 Way	yes	LDGT1	Normal	CA
106	1984	Chevrolet	C-10 pick-up	39533	5.0L	3 Way	yes	LDGT2	Normal	CA
107	1984	Dodge	Ram pick-up	14672	5.9L	2 Way	yes	LDGT2	High	CA
108	1984	Nissan	Sentra	163270	1.6L	3 Way + 2 Way		LDGV	High	FED
109	1984	Honda	Accord LX	122391	1.8L	3 Way		LDGV	Normal	CA
110	1983	Jeep	CJ-5	51544	4.2L	No Catalyst		LDGT1	High	CA
111	1983	Ford	E150 Van	8254.9	4.9L	3 Way + 2 Way	yes	LDGT2	Normal	CA
112	1983	Mazda	626	166000	2.0L	3 Way	yes	LDGV	High	CA
113	1981	Chevrolet	C-10 pick-up	41322	4.1L	2 Way	yes	LDGT1	High	CA
114	1981	Chevrolet	G-10 van	206341	5.0L	2 Way	yes	LDGT2	High	FED
115	1981	Chevrolet	Monte Carlo	43254	3.8L	3 Way	yes	LDGV	High	FED
116	1980	Ford	E350 Van	75463	6.6L	2 Way	yes	LDGT2	High	CA
117	1979	Honda	Civic	48372	1.5L	No Catalyst		LDGV	High	CA
118	1979	Nissan	280ZX	35355	2.8L	2 Way		LDGV	Normal	CA
119	1979	Ford	Mustang	18631	2.3L	3 Way + 2 Way	yes	LDGV	High	CA
120	1978	Chevrolet	C-20 pick-up	974	5.7L	2 Way	yes	LDGT2	High	CA
121	1978	Chevrolet	El Camino	67974	5.7L	2 Way		LDGT1	High	FED
122	1978	Toyota	Corolla	14836	1.6L	2 Way	yes	LDGV	High	CA
123	1978	Pontiac	LeMans	50041	5.0L	2 Way	yes	LDGV	High	CA
124	1977	Datsun	200 SX	30224	2.0L	2 Way	yes	LDGV	Normal	CA
125	1973	Ford	Ranger pick-up	18037	7.5L	No Catalyst		LDGT1	Normal	CA
126	1972	Chevrolet	Chevelle	15639	7.4L	No Catalyst		LDGV	High	CA
127	1972	Chevrolet	Custom 20	51170	5.7L	No Catalyst		LDGT2	High	FED
128	1972	Ford	F250 Pick-up	15731	5.9L	No Catalyst		LDGT2	Normal	CA
129	1965	Ford	Mustang	25426	4.7L	No Catalyst		LDGV	High	CA

LDGV=light-duty gasoline vehicle

LDGT1=light-duty gasoline truck GVW <6,000 lbs

LDGT2=light-duty gasoline truck GVW 6,001-8,500

Appendix C. Description of Diesel Vehicle Test Fleet

Model Year	Make	Model	Odometer	Engine Displacement	Certification
1993	Mercedes	300D	43007	2.5L	FED
1985	Mercedes	300D Turbo	119310	3.0L	CA
1985	Mercedes	300SD	172633	3.0L	FED
1984	Volkswagen	Rabbit	269387	1.6L	CA
1984	Toyota	Corolla	197309	1.8L	CA
1984	Mercedes	300D	201312	3.0L	CA
1982	Isuzu	I-mark	156224	1.8L	CA
1982	Volkswagen	Vanagon	58530	1.6L	CA
1982	Mercedes	300TD Turbo	184851	3.0L	CA
1982	Volkswagen	Rabbit	120569	1.6L	CA
1982	Mercedes	300 TD	113077	3.0L	CA
1981	Peugeot	505TD	161559	2.0L	CA
1981	Mercedes	300SD	241044	3.0L	CA
1980	Mercedes	300TD	171621	3.0L	CA
1980	Volkswagen	Rabbit	116378	1.5L	CA
1980	Mercedes	240D	196026	2.4L	CA
1979	Volkswagen	Rabbit	52065	1.5L	CA
1979	Cadillac	Seville	18557	5.7L	CA
1977	Mercedes	300D	113952	3.0L	CA

* equipped w/ particulate trap

Appendix D. Gas Phase and Particle Emissions Results for Gasoline Vehicles

Model Year	Make	Model	bag 1				bag 2				bag 3				Weighted			
			HC g/mi	CO g/mi	NOx g/mi	Particles mg/mi	HC g/mi	CO g/mi	NOx g/mi	Particles mg/mi	HC g/mi	CO g/mi	NOx g/mi	Particles mg/mi	HC g/mi	CO g/mi	NOx g/mi	Particles mg/mi
1 1997	Ford	Windstar	0.70	2.80	3.84	44.67	0.04	0.08	5.91	3.50	0.07	0.28	3.62	8.27	0.18	0.70	4.85	13.31
2 1997	Ford	F-150 XLT PU	0.61	6.23	0.41	1.95	0.02	0.04	0.02	0.78	0.11	1.00	0.12	1.31	0.17	1.59	0.13	1.17
3 1996	Chevrolet	Camaro	0.46	6.66	0.38	1.34	0.01	0.05	0.04	0.08	0.07	0.52	0.38	0.31	0.12	1.55	0.20	0.40
4 1996	Dodge	Dakota	0.45	3.87	0.45	2.20	0.02	0.08	0.03	2.16	0.03	0.19	0.04	1.26	0.11	0.89	0.12	1.92
5 1996	Ford	Escort	0.27	3.63	0.15	2.15	0.01	0.07	0.04	0.01	0.01	0.30	0.10	0.02	0.06	0.87	0.08	0.46
6 1996	Nissan	Altima	0.65	13.09	0.37	3.27	0.06	1.24	0.39	0.24	0.09	2.04	0.36	0.14	0.19	3.91	0.37	0.84
7 1996	Acura	Integra	0.46	2.62	0.55	0.54	0.01	0.13	0.08	0.19	0.02	0.14	0.14	-0.12	0.11	0.65	0.19	0.18
8 1996	Dodge	Ram 1500	0.90	8.01	0.86	2.24	0.06	0.38	0.47	0.88	0.09	0.70	0.88	0.72	0.24	2.05	0.66	1.12
9 1996	Ford	Explorer	0.49	3.47	0.32	3.63	0.01	0.13	0.02	2.67	0.02	0.07	0.29	1.29	0.11	0.80	0.16	2.49
10 1996	Nissan	Sentra	0.36	2.97	0.52	1.41	0.10	0.36	0.02	0.26	0.08	0.34	0.25	0.21	0.15	0.89	0.19	0.48
11 1996	Ford	F-150	0.40	4.38	0.21	1.75	0.02	0.05	0.03	0.78	0.06	0.26	0.27	0.46	0.11	1.00	0.13	0.89
12 1995	Toyota	Camry	0.39	1.36	0.60	1.02	0.02	0.10	0.32	0.50	0.06	1.46	0.16	0.08	0.11	0.73	0.34	0.49
13 1995	Chrysler	LeBaron GTC	0.86	6.52	0.49	3.04	0.02	0.10	0.27	1.11	0.05	0.29	0.34	1.46	0.20	1.48	0.34	1.60
14 1995	Honda	Accord LX	0.30	4.05	0.56	0.95	0.02	0.27	0.09	0.37	0.03	0.39	0.10	-0.19	0.08	1.09	0.19	0.34
15 1995	Honda	Civic DX	0.51	5.56	0.38	1.46	0.04	0.91	0.12	0.70	0.06	1.00	0.20	0.74	0.14	1.90	0.20	0.87
16 1995	Toyota	pick-up	0.73	4.96	1.06	21.59	0.06	0.23	0.54	4.59	0.06	0.23	0.24	2.18	0.20	1.21	0.56	7.42
17 1995	Ford	Ranger	0.51	3.72	0.93	1.36	0.04	0.35	0.17	1.57	0.10	2.49	0.41	0.33	0.15	1.64	0.40	1.19
18 1995	Dodge	Dakota SLT	1.22	11.56	1.57	2.12	0.13	2.65	0.40	0.47	0.46	6.00	1.41	0.39	0.45	5.42	0.92	0.79
19 1995	Dodge	Intrepid	0.98	4.58	0.43	3.15	0.09	0.17	0.12	0.31	0.24	1.09	0.28	0.79	0.32	1.34	0.23	1.03
20 1995	Isuzu	Rodeo	0.60	10.46	0.74	1.52	0.03	0.80	0.05	1.50	0.05	1.18	0.24	1.46	0.15	2.90	0.25	1.49
21 1994	Toyota	Camry	0.73	11.61	0.46	1.28	0.01	0.08	0.07	0.49	0.02	0.08	0.08	-0.05	0.16	2.47	0.15	0.51
22 1994	Mazda	Protégé	1.09	9.41	1.01	1.48	0.05	0.98	0.50	0.18	0.03	0.67	0.35	0.27	0.26	2.64	0.57	0.47
23 1994	Honda	Civic LX	0.41	3.56	0.60	1.08	0.03	0.34	0.11	0.81	0.05	0.50	0.12	0.03	0.12	1.05	0.22	0.65
24 1994	Chevrolet	C1500 Suburban	1.27	17.93	1.47	24.77	0.09	1.43	0.21	5.13	0.24	3.32	0.53	4.91	0.38	5.37	0.56	9.13
25 1994	Ford	Escort LX	0.42	2.56	0.38	3.53	0.04	0.22	0.10	0.32	0.04	0.27	0.24	0.54	0.12	0.72	0.20	1.04
26 1994	Honda	Civic DX	0.53	5.23	0.59	1.15	0.04	1.21	0.33	0.45	0.07	2.34	0.30	0.01	0.15	2.35	0.38	0.47
27 1994	Dodge	Spirit	0.81	6.09	0.68	3.84	0.03	0.14	0.21	1.52	0.06	0.54	0.40	0.47	0.20	1.48	0.36	1.72
28 1994	Dodge	Spirit	0.63	6.60	0.72	2.03	0.03	0.13	0.19	0.19	0.06	0.38	0.41	0.20	0.16	1.54	0.36	0.58
29 1994	Dodge	Caravan	6.72	17.25	0.35	19.22	2.71	12.35	0.03	3.00	2.56	11.53	0.07	2.32	3.50	13.14	0.11	6.17
30 1994	Ford	Thunderbird	0.41	3.59	0.46	0.78	0.04	0.08	0.34	-0.19	0.05	0.30	0.41	-0.19	0.12	0.87	0.38	0.01
31 1994	Honda	Accord	0.46	8.16	0.41	2.05	0.04	0.53	0.05	0.51	0.04	0.87	0.08	0.08	0.13	2.20	0.13	0.71
32 1994	Toyota	Pick-up	0.54	6.82	0.55	3.03	0.05	0.54	0.11	0.70	0.05	0.52	0.11	1.14	0.15	1.84	0.20	1.30
33 1994	Mitsubishi	Eclipse	0.93	5.00	1.02	5.66	0.04	0.02	0.35	-0.13	0.07	0.19	0.45	0.75	0.23	1.10	0.52	1.31
34 1993	Saturn	SL2	0.92	7.26	0.37	9.20	0.03	0.31	0.27	-0.19	0.09	0.92	0.34	-0.06	0.23	1.92	0.31	1.79

Appendix D. cont. Gas Phase and Particle Emissions Results for Gasoline Vehicles

Model Year	Make	Model	bag 1				bag 2				bag 3				Weighted				
			HC	CO	NOx	Particles	HC	CO	NOx	Particles	HC	CO	NOx	Particles	HC	CO	NOx	Particles	
			g/mi	g/mi	g/mi	mg/mi	g/mi	g/mi	g/mi	mg/mi	g/mi	g/mi	g/mi	mg/mi	g/mi	g/mi	g/mi	mg/mi	
35	1993	Ford	Festiva	0.73	4.75	0.42	2.46	0.08	0.61	0.05	1.39	0.06	0.79	0.06	0.91	0.21	1.52	0.13	1.48
36	1993	Toyota	Tercel	0.91	5.56	0.53	2.08	0.15	1.11	0.29	1.05	0.23	1.28	0.33	-0.12	0.33	2.08	0.35	0.94
37	1993	Honda	Civic LX	0.43	4.56	0.48	4.29	0.07	0.42	0.15	2.79	0.06	0.79	0.18	0.28	0.14	1.38	0.23	2.41
38	1993	Ford	Ranger XCAB	0.46	4.20	0.39	0.79	0.05	0.03	0.12	0.43	0.08	0.88	0.17	0.33	0.14	1.13	0.19	0.48
39	1993	Saturn	SL2	0.54	6.34	0.57	3.08	0.05	1.03	0.10	0.40	0.07	1.48	0.11	0.43	0.16	2.25	0.20	0.96
40	1993	Nissan	Altima	0.80	8.91	1.02	2.02	0.02	0.06	0.18	0.00	0.04	0.62	0.32	0.22	0.19	2.04	0.39	0.48
41	1993	Saturn	SL2	0.64	4.93	0.42	3.58	0.02	0.34	0.12	1.71	0.08	1.27	0.26	0.88	0.16	1.55	0.22	1.87
42	1992	Ford	Aerostar	0.70	8.99	1.00	1.82	0.03	0.37	0.48	3.13	0.13	1.38	0.65	0.80	0.20	2.43	0.63	2.22
43	1992	Honda	Accord EX	0.67	6.29	0.67	2.08	0.03	0.26	0.11	0.23	0.04	0.41	0.06	0.03	0.17	1.55	0.21	0.56
44	1992	Saturn	SL	0.70	10.22	0.98	2.88	0.05	0.51	0.76	1.00	0.13	0.72	0.71	1.87	0.21	2.58	0.80	1.63
45	1992	Dodge	Dakota LE	2.62	13.91	2.94	8.37	1.27	6.76	1.72	6.42	1.88	9.60	3.65	8.62	1.72	9.02	2.50	7.43
46	1992	GMC	1500	2.15	28.97	3.46	1.99	0.45	2.81	0.62	0.47	0.63	4.79	1.15	0.72	0.86	8.77	1.35	0.85
47	1992	Ford	Explorer	0.86	14.55	1.24	1.29	0.04	1.72	0.43	0.60	0.13	2.73	0.84	0.20	0.23	4.65	0.71	0.63
48	1992	Ford	Ranger	0.93	5.61	0.78	1.31	0.11	1.00	0.25	0.18	0.25	1.43	0.58	0.47	0.32	2.07	0.45	0.49
49	1992	Chevrolet	S10	1.34	9.35	1.15	3.05	0.94	4.55	0.48	1.62	1.01	5.06	0.83	1.61	1.04	5.68	0.71	1.91
50	1992	Toyota	PU	0.82	7.65	0.49	21.13	0.06	0.20	0.15	0.44	0.07	0.35	0.13	1.51	0.22	1.78	0.21	5.01
51	1992	Toyota	Pick-up	0.73	7.94	0.52	3.53	0.29	0.47	0.09	1.07	0.21	0.28	0.37	0.60	0.36	1.96	0.26	1.45
52	1992	Hyundai	Elantra	2.74	17.55	1.56	61.97	0.68	4.84	0.29	12.83	1.15	8.50	0.58	30.17	1.24	8.48	0.63	27.73
53	1992	Honda	Prelude	0.70	5.18	0.87	1.31	0.15	0.49	0.13	-0.19	0.16	0.68	0.25	-0.06	0.27	1.51	0.32	0.16
54	1992	Jeep	Wrangler	1.14	15.71	0.45	2.94	0.05	0.94	0.03	4.89	0.06	2.01	0.11	2.82	0.28	4.29	0.14	3.91
55	1992	Geo	Tracker	1.24	16.34	0.89	3.89	0.19	7.77	0.31	1.42	0.36	11.76	0.60	3.43	0.45	10.64	0.51	2.48
56	1991	Toyota	Tercel	1.24	6.78	0.75	9.99	0.43	2.64	0.24	1.30	0.30	1.84	0.49	2.34	0.56	3.28	0.41	3.38
57	1991	Nissan	Sentra	1.27	17.09	0.83	1.63	0.08	1.90	0.12	-0.05	0.13	1.54	0.26	0.67	0.34	4.94	0.31	0.50
58	1991	Toyota	pick-up	0.66	4.36	0.81	17.68	0.02	0.05	0.19	0.98	0.90	1.18	0.22	3.58	0.40	1.25	0.33	5.26
59	1991	Mercury	Tracer LTS	1.56	7.07	1.70	1.86	0.23	1.65	0.69	1.43	0.22	1.55	1.06	1.02	0.50	2.74	1.00	1.41
60	1991	Toyota	pick-up	0.82	10.13	0.56	5.16	0.05	0.53	0.17	0.36	0.07	0.78	0.19	0.20	0.21	2.59	0.26	1.31
61	1991	Pontiac	Transport	0.90	9.09	2.11	25.65	0.11	4.03	0.57	11.80	0.29	4.67	0.86	3.18	0.32	5.25	0.97	12.30
62	1990	Nissan	Sentra	1.44	22.37	0.66	15.74	0.25	11.34	0.15	1.66	0.26	6.73	0.28	3.48	0.50	12.36	0.29	5.07
63	1990	Dodge	Spirit	1.11	19.55	1.22	4.55	0.41	14.72	0.37	0.71	0.37	6.86	0.72	1.53	0.54	13.56	0.64	1.73
64	1990	Nissan	pick-up	1.08	30.72	1.17	3.69	0.24	8.66	0.79	1.33	0.35	9.69	0.90	1.78	0.44	13.51	0.90	1.94
65	1990	Dodge	Ram250	0.94	21.56	0.90	17.53	0.29	2.55	0.53	36.43	0.39	4.71	0.76	6.39	0.45	7.08	0.67	24.30
66	1990	Nissan	pick-up	1.12	11.98	0.59	3.03	0.19	4.30	0.14	1.45	0.27	4.73	0.28	0.93	0.40	6.01	0.27	1.64
67	1990	Honda	Accord EX	0.60	7.03	0.92	3.78	0.10	1.13	0.13	4.09	0.10	1.04	0.12	1.65	0.20	2.33	0.29	3.36
68	1990	Ford	Mustang	0.37	2.13	1.16	0.79	0.17	0.04	0.84	0.86	0.18	0.28	1.09	0.33	0.21	0.54	0.97	0.70

Appendix D. cont. Gas Phase and Particle Emissions Results for Gasoline Vehicles

Model Year	Make	Model	bag 1				bag 2				bag 3				Weighted				
			HC g/mi	CO g/mi	NOx g/mi	Particles mg/mi	HC g/mi	CO g/mi	NOx g/mi	Particles mg/mi	HC g/mi	CO g/mi	NOx g/mi	Particles mg/mi	HC g/mi	CO g/mi	NOx g/mi	Particles mg/mi	
69	1990	Jeep	Wrangler	2.61	78.24	0.31	32.77	0.43	20.87	0.39	20.45	0.64	15.88	0.53	18.88	0.94	31.37	0.41	22.57
70	1990	Pontiac	LeMans	1.49	8.99	0.88	1.19	0.05	0.49	0.25	0.05	0.05	0.47	0.46	0.82	0.35	2.24	0.44	0.50
71	1990	Geo/Isuzu	Storm	1.34	12.08	1.16	6.95	0.15	4.07	0.57	0.17	0.30	7.23	0.59	1.50	0.44	6.60	0.70	1.93
72	1989	Ford	T-Bird	1.10	8.71	0.71	5.51	0.05	0.49	0.26	0.28	0.16	1.55	0.49	1.81	0.30	2.49	0.42	1.78
73	1989	Hyundai	Excel GL	2.04	12.95	1.94	263.15	0.78	4.28	0.50	167.53	1.16	5.80	1.16	214.61	1.15	6.50	0.98	200.10
74	1989	GMC	Sierra 1500	2.29	21.40	2.72	19.90	0.50	3.83	0.44	0.05	0.75	4.10	1.00	0.52	0.94	7.54	1.07	4.30
75	1989	Dodge	Caravan	2.01	7.71	2.34	87.65	0.43	4.33	1.02	38.85	0.61	5.23	1.81	34.90	0.81	5.28	1.51	47.87
76	1989	Jeep	Wrangler	4.86	21.37	8.48	41.27	6.77	9.34	6.19	17.83	5.64	9.62	7.95	20.32	6.06	11.91	7.15	23.35
77	1988	Dodge	Ram Royal	2.14	9.32	1.32	10.49	0.54	3.68	0.60	3.02	1.45	4.06	1.39	6.31	1.12	4.95	0.97	5.47
78	1988	Toyota	pick-up	2.14	39.68	0.84	0.70	1.78	28.73	0.07	0.23	1.66	29.26	0.08	0.56	1.82	31.14	0.23	0.41
79	1988	Toyota	pick-up	0.78	6.21	2.08	2.38	0.42	0.96	0.89	0.90	0.58	1.66	1.08	0.01	0.54	2.24	1.19	0.96
80	1988	Mazda	MX-6	1.41	14.95	1.36	19.82	0.15	3.67	0.19	7.67	0.17	2.90	0.44	9.67	0.42	5.79	0.50	10.73
81	1988	Dodge	Caravan	1.76	10.34	1.33	49.01	1.16	8.29	1.00	63.25	1.03	7.19	1.64	42.14	1.25	8.41	1.24	54.52
82	1988	Toyota	Pick-up	0.91	12.00	1.41	15.08	0.24	2.64	0.33	2.69	0.30	3.44	0.32	3.96	0.40	4.80	0.55	5.60
83	1988	Chevrolet	Pick-up	2.81	17.73	1.19	3.84	0.93	5.26	0.64	1.21	1.38	8.11	1.07	2.53	1.44	8.63	0.87	2.11
84	1988	Buick	Park Avenue	0.68	4.40	0.61	0.68	0.02	0.67	0.03	0.19	0.19	2.54	0.30	1.09	0.20	1.96	0.22	0.54
85	1988	Nissan	Pick-Up	3.07	30.38	2.43	11.86	2.14	15.25	2.04	9.97	2.14	14.29	3.10	5.79	2.33	18.12	2.41	9.22
86	1987	Chevrolet	Corsica	1.18	9.27	2.30	3.88	0.22	3.51	0.98	0.19	0.36	3.61	1.27	1.10	0.46	4.73	1.33	1.20
87	1986	Subaru	GL	1.62	35.61	1.09	6.77	1.10	21.47	0.11	0.70	1.19	27.21	0.63	3.40	1.23	25.98	0.46	2.70
88	1986	Ford	F-150	1.38	5.98	3.14	3.07	0.54	0.46	2.30	3.50	0.91	3.54	3.13	1.94	0.82	2.45	2.70	2.98
89	1986	Alfa Romeo	Spider	2.54	17.53	1.85	21.67	1.49	15.74	1.10	16.27	1.50	15.11	1.61	23.40	1.71	15.94	1.40	19.35
90	1986	Nissan	PU	0.86	17.51	0.67	0.53	0.09	1.83	0.38	0.50	0.27	6.09	0.44	0.54	0.30	6.25	0.46	0.51
91	1986	Chrysler	5th Ave.	1.75	47.47	1.46	29.37	0.32	1.89	0.97	1.26	0.35	3.48	1.41	1.94	0.62	11.76	1.19	7.23
92	1986	Ford	Bronco	2.25	13.73	2.54	16.33	2.13	11.62	1.24	6.33	2.41	13.73	2.73	2.74	2.23	12.64	1.92	7.41
93	1986	Mazda	B2000	1.82	22.06	1.02	11.33	0.29	3.00	0.46	1.89	0.52	11.71	1.03	4.23	0.67	9.34	0.73	4.35
94	1986	Nissan	Sentra XE	1.34	22.97	0.75	0.76	0.16	3.56	0.59	0.24	0.32	6.76	0.56	-0.06	0.45	8.46	0.61	0.27
95	1985	Toyota	Pick-up	0.87	14.02	1.09	9.70	0.20	7.01	0.47	5.68	0.21	5.69	0.68	2.04	0.34	8.10	0.66	5.52
96	1985	BMW	735i	3.60	18.78	5.75	13.63	0.95	6.71	4.26	5.53	1.70	2.78	6.24	2.06	1.71	8.13	5.11	6.25
97	1985	Dodge	Ram50 Sport	1.76	49.61	1.52	21.60	0.68	18.37	1.52	10.42	0.40	8.37	2.58	8.61	0.83	22.09	1.81	12.24
98	1985	Chevrolet	Sprint	9.86	88.31	0.56	459.73	3.96	18.28	1.65	270.80	3.03	17.35	1.81	327.46	4.93	32.52	1.47	325.33
99	1985	Dodge	Caravan	10.08	134.92	0.59	626.87	9.04	117.28	0.45	323.47	7.04	105.79	0.53	328.48	8.71	117.77	0.50	387.64
100	1985	Chevrolet	Caprice Classic	1.08	10.43	1.86	26.64	0.53	5.94	1.11	2.05	0.76	7.84	1.73	5.47	0.71	7.39	1.44	8.06
101	1985	Toyota	Celica	1.14	7.89	0.93	4.93	0.08	1.06	0.48	1.29	0.09	0.77	0.59	1.45	0.30	2.39	0.60	2.09
102	1985	Mitsubishi	Mighty Max	1.39	36.33	1.08	7.12	0.07	4.41	0.16	2.02	0.15	4.40	0.67	2.45	0.37	11.01	0.49	3.19

Appendix D. cont. Gas Phase and Particle Emissions Results for Gasoline Vehicles

Model Year	Make	Model	bag 1				bag 2				bag 3				Weighted				
			HC g/mi	CO g/mi	NOx g/mi	Particles mg/mi	HC g/mi	CO g/mi	NOx g/mi	Particles mg/mi	HC g/mi	CO g/mi	NOx g/mi	Particles mg/mi	HC g/mi	CO g/mi	NOx g/mi	Particles mg/mi	
103	1984	Cadillac	Coupe de Ville	3.00	56.36	3.77	43.96	1.24	8.23	5.27	19.32	1.41	10.27	5.63	32.22	1.65	18.75	5.06	27.91
104	1984	Buick	Regal LTD	8.00	27.47	0.49	68.87	0.49	8.86	0.12	44.19	1.37	13.88	0.27	40.83	2.29	14.09	0.24	48.34
105	1984	Toyota	pick-up	1.34	12.38	2.46	4.40	0.53	1.69	1.14	0.12	0.84	4.39	1.23	1.23	0.78	4.65	1.44	1.31
106	1984	Chevrolet	Silverado C-10	0.98	10.36	1.67	64.44	0.22	2.43	1.55	10.64	0.26	2.16	1.67	10.38	0.39	4.00	1.61	21.67
107	1984	Dodge	Ram	6.25	198.06	2.05	119.97	3.07	37.24	1.29	29.23	1.35	25.42	4.29	14.77	3.26	67.28	2.27	44.04
108	1984	Nissan	Sentra	1.77	22.24	1.56	71.64	0.98	15.86	0.86	28.62	2.02	39.20	0.94	40.93	1.43	23.60	1.03	40.90
109	1984	Honda	Accord LX	1.26	16.73	0.73	0.63	0.10	2.87	0.78	0.12	0.12	3.81	0.91	0.64	0.35	6.00	0.81	0.37
110	1983	Jeep	CJ-5	2.25	43.80	1.43	6.51	0.59	17.40	0.71	24.63	0.70	12.87	1.03	3.60	0.96	21.62	0.95	15.14
111	1983	Ford	E150 Van	2.98	23.65	2.40	10.92	1.90	2.81	1.54	8.69	2.46	8.76	1.92	4.82	2.28	8.76	1.82	8.10
112	1983	Mazda	626	3.55	103.11	0.18	14.09	2.37	81.69	0.08	8.84	2.38	80.85	0.12	15.15	2.62	85.89	0.11	11.64
113	1981	Chevrolet	C-10	10.77	89.04	2.13	79.78	1.76	8.54	1.43	3.34	2.29	20.99	1.54	12.50	3.77	28.63	1.61	21.53
114	1981	Chevrolet	G-10	3.96	88.37	0.86	43.06	3.93	55.23	0.57	21.08	2.83	74.24	0.58	7.71	3.63	67.32	0.63	21.95
115	1981	Chevrolet	Monte Carlo	3.79	82.89	1.13	52.92	1.70	47.92	1.03	2.42	1.61	69.23	0.93	9.24	2.11	61.02	1.02	14.69
116	1980	Ford	E350 Van	5.69	57.23	2.22	196.17	1.58	5.35	2.60	6.37	3.58	18.28	2.90	4.97	2.98	19.64	2.60	45.09
117	1979	Honda	Civic	7.23	38.11	1.24	3.66	1.81	12.14	0.86	2.90	1.50	8.97	1.40	40.76	2.85	16.65	1.09	13.42
118	1979	Nissan	280ZX	2.89	41.04	2.98	26.56	0.19	1.38	1.92	4.74	0.81	8.49	3.45	4.93	0.92	11.54	2.56	9.28
119	1979	Ford	Mustang	5.98	144.13	0.69	71.80	4.50	130.17	0.31	32.04	4.47	139.32	0.46	34.91	4.80	135.58	0.43	40.98
120	1978	Chevrolet	C-20 PU	4.43	23.13	3.06	200.24	1.04	3.51	2.77	43.26	1.28	4.54	3.50	31.31	1.81	7.85	3.03	72.51
121	1978	Chevrolet	El Camino	8.19	178.10	0.75	30.10	8.57	195.55	0.42	8.37	4.80	138.51	0.73	13.87	7.45	176.25	0.57	14.36
122	1978	Toyota	Corolla	4.05	17.94	1.79	12.34	1.29	3.44	1.34	3.22	2.09	15.94	1.87	7.98	2.08	9.85	1.58	6.40
123	1978	Pontiac	LeMans	3.37	42.56	3.82	42.14	1.08	18.34	2.62	3.33	1.17	15.42	4.27	2.53	1.58	22.55	3.32	11.11
124	1977	Datsun	200 SX	1.16	13.83	1.21	107.78	0.19	1.61	1.25	25.48	0.36	9.01	0.63	17.59	0.44	6.17	1.07	40.34
125	1973	Ford	Ranger	2.83	31.52	2.72	57.01	2.57	54.03	0.91	56.83	2.20	24.99	1.54	20.29	2.52	41.38	1.46	46.84
126	1972	Chevrolet	Chevelle	19.78	290.71	1.25	78.91	29.73	371.06	0.52	66.59	18.48	288.64	0.92	60.69	24.58	331.76	0.78	67.50
127	1972	Chevrolet	Custom 20	9.71	25.19	7.73	55.85	10.02	32.18	4.73	16.04	7.90	23.98	7.66	30.55	9.37	28.48	6.16	28.26
128	1972	Ford	F250 Pick-up	6.00	126.64	4.60	34.84	3.19	45.43	2.46	8.08	2.90	31.61	4.87	7.50	3.69	58.44	3.57	13.46
129	1965	Ford	Mustang	11.82	91.53	1.44	138.52	3.44	7.81	1.55	40.89	5.79	17.29	2.18	50.49	5.82	27.75	1.70	63.21

Appendix E. Gas Phase and Particle Emissions Results for Diesel Vehicles

Model Year	Make	Model	Bag 1			Bag 2			Bag 3			Weighted						
			THC g/mi	CO g/mi	NOx g/mi	THC g/mi	CO g/mi	NOx g/mi	THC g/mi	CO g/mi	NOx g/mi	THC g/mi	CO g/mi	NOx g/mi	Particles mg/mi			
1	1993	Mercedes	0.17	1.12	1.47	113.2	0.10	0.90	1.50	78.0	0.08	0.75	1.41	83.1	0.11	0.90	1.47	86.6
2	1985	Mercedes	1.89	6.89	1.46	165.9	1.67	9.18	1.00	48.8	0.62	5.92	1.32	38.4	1.43	7.81	1.19	70.1
3	1985	Mercedes	0.25	1.91	1.22	14.5	0.47	1.73	1.18	15.5	0.22	1.35	1.28	16.4	0.36	1.66	1.22	15.5
4	1984	Volkswagen	0.73	2.73	0.64	936.6	0.55	1.56	0.74	283.7	1.13	6.52	0.61	1099.8	0.74	3.13	0.69	636.6
5	1984	Toyota	0.32	1.36	0.98	1354.4	0.21	1.38	0.88	323.9	0.21	1.82	0.70	448.0	0.23	1.50	0.85	572.4
6	1984	Mercedes	0.31	1.39	1.72	2442.5	0.28	1.05	1.70	342.3	0.17	0.87	1.68	241.7	0.25	1.07	1.70	748.7
7	1982	Isuzu	0.80	1.28	1.37	421.1	0.62	0.70	1.91	198.1	0.04	0.86	1.46	283.7	0.50	0.86	1.67	267.7
8	1982	Volkswagen	0.43	1.98	1.72	721.1	0.40	1.57	2.00	393.2	0.30	1.63	1.81	448.2	0.38	1.67	1.89	475.6
9	1982	Mercedes	0.34	1.38	1.52	842.5	0.26	1.29	1.63	441.0	0.23	1.02	1.59	916.1	0.27	1.23	1.60	654.0
10	1982	Volkswagen	0.21	0.90	1.28	661.6	0.20	0.95	1.74	419.5	0.19	0.80	1.45	475.9	0.20	0.90	1.56	485.1
11	1982	Mercedes	0.36	1.25	1.67	911.7	0.27	1.13	1.65	304.1	0.14	0.92	1.50	430.2	0.25	1.10	1.61	464.4
12	1981	Peugeot	0.40	2.03	2.71	1188.4	0.21	1.28	2.97	509.4	0.24	1.34	2.64	614.0	0.26	1.45	2.83	677.4
13	1981	Mercedes	0.36	1.14	1.57	272.6	0.30	1.06	1.61	251.5	0.21	0.83	1.54	220.6	0.29	1.01	1.58	247.3
14	1980	Mercedes	1.64	3.53	2.07	2338.4	1.30	2.84	2.04	1253.2	1.19	2.82	2.08	1727.0	1.34	2.98	2.06	1608.3
15	1980	Volkswagen	0.72	1.85	0.79	685.8	0.40	1.05	0.82	174.9	0.52	1.62	0.74	384.9	0.50	1.37	0.79	338.2
16	1980	Mercedes	0.49	1.61	1.36	331.4	0.43	1.40	1.39	258.2	0.37	1.49	1.47	315.9	0.43	1.47	1.41	289.0
17	1979	Volkswagen	1.54	3.62	0.77	1859.2	0.79	1.74	1.00	686.0	0.98	2.58	0.81	911.4	1.00	2.36	0.90	991.2
18	1979	Cadillac	1.78	2.20	1.80	1784.0	1.43	2.11	1.99	1120.2	0.85	1.79	1.77	1649.9	1.34	2.04	1.89	1402.4
19	1977	Mercedes	0.60	1.98	2.17	747.7	0.39	1.63	2.38	619.8	0.35	1.42	2.09	575.5	0.42	1.65	2.26	633.8

* equipped w/ particulate trap

Appendix F. Gasoline Vehicle Particulate Size Distribution

	Model Year	Make	Model	Particulate Emission Rate mg/mi	Particle Size <10µm	<2.5µm
1	1997	Ford	Windstar	13.31	32.3%	32.3%
2	1997	Ford	F-150 XLT PU	1.17	N.A	N.A
3	1996	Chevrolet	Camaro	0.40	100.0%	93.8%
4	1996	Dodge	Dakota	1.92	89.5%	84.2%
5	1996	Ford	Escort	0.46	81.0%	61.9%
6	1996	Nissan	Altima	0.84	87.2%	80.8%
7	1996	Acura	Integra	0.18	59.1%	40.9%
8	1996	Dodge	Ram 1500	1.12	70.8%	60.4%
9	1996	Ford	Explorer	2.49	100.0%	90.7%
10	1996	Nissan	Sentra	0.48	N.A	N.A
11	1996	Ford	F-150	0.89	N.A	N.A
12	1995	Toyota	Camry	0.49	83.3%	83.3%
13	1995	Chrysler	LeBaron GTC	1.60	73.1%	57.5%
14	1995	Honda	Accord LX	0.34	N.A	N.A
15	1995	Honda	Civic DX	0.87	82.9%	75.7%
16	1995	Toyota	pick-up	7.42	100.0%	97.8%
17	1995	Ford	Ranger	1.19	100.0%	90.9%
18	1995	Dodge	Dakota SLT	0.79	79.3%	63.8%
19	1995	Dodge	Intrepid	1.03	92.5%	83.0%
20	1995	Isuzu	Rodeo	1.49	N.A	N.A
21	1994	Toyota	Camry	0.51	66.7%	55.6%
22	1994	Mazda	Protégé	0.47	81.8%	72.7%
23	1994	Honda	Civic LX	0.65	73.3%	50.0%
24	1994	Chevrolet	C1500 Suburban	9.13	N.A	N.A
25	1994	Ford	Escort LX	1.04	88.1%	69.5%
26	1994	Honda	Civic DX	0.47	100.0%	100.0%
27	1994	Dodge	Spirit	1.72	100.0%	100.0%
28	1994	Dodge	Spirit	0.58	N.A	N.A
29	1994	Dodge	Caravan	6.17	81.2%	78.0%
30	1994	Ford	Thunderbird	0.01	N.A	N.A
31	1994	Honda	Accord	0.71	N.A	N.A
32	1994	Toyota	Pick-up	1.30	N.A	N.A
33	1994	Mitsubishi	Eclipse	1.31	N.A	N.A
34	1993	Saturn	SL2	1.79	N.A	N.A
35	1993	Ford	Festiva	1.48	100.0%	88.5%
36	1993	Toyota	Tercel	0.94	N.A	N.A
37	1993	Honda	Civic LX	2.41	N.A	N.A
38	1993	Ford	Ranger XCAB	0.48	N.A	N.A
39	1993	Saturn	SL2	0.96	N.A	N.A
40	1993	Nissan	Altima	0.48	N.A	N.A
41	1993	Saturn	SL2	1.87	N.A	N.A
42	1992	Ford	Aerostar	2.22	72.2%	54.2%
43	1992	Honda	Accord EX	0.56	84.6%	80.8%
44	1992	Saturn	SL	1.63	94.6%	83.0%

Appendix F. cont. Gasoline Vehicle Particulate Size Distribution

	Model Year	Make	Model	Particulate	Particle Size	
				Emission Rate mg/mi	<10µm	<2.5µm
45	1992	Dodge	DAKOTA LE	7.43	91.5%	85.7%
46	1992	GMC	1500	0.85	79.4%	58.8%
47	1992	Ford	Explorer	0.63	68.4%	53.9%
48	1992	Ford	Ranger	0.49	51.5%	45.5%
49	1992	Chevrolet	S10	1.91	92.5%	88.7%
50	1992	Toyota	PU	5.01	97.1%	95.0%
51	1992	Toyota	Pick-up	1.45	N.A	N.A
52	1992	Hyundai	Elantra	27.73	N.A	N.A
53	1992	Honda	Prelude	0.16	N.A	N.A
54	1992	Jeep	Wrangler	3.91	N.A	N.A
55	1992	Geo	Tracker	2.48	N.A	N.A
56	1991	Toyota	Tercel	3.38	85.5%	77.6%
57	1991	Nissan	Sentra	0.50	86.1%	83.3%
58	1991	Toyota	pick-up	5.26	97.5%	92.8%
59	1991	Mercury	Tracer LTS	1.41	86.7%	73.3%
60	1991	Toyota	pick-up	1.31	58.6%	25.9%
61	1991	Pontiac	Transport	12.30	92.1%	85.8%
62	1990	Nissan	Sentra	5.07	96.7%	96.7%
63	1990	Dodge	Spirit	1.73	85.3%	79.4%
64	1990	Nissan	pick-up	1.94	81.3%	75.3%
65	1990	Dodge	Ram250	24.30	96.2%	94.1%
66	1990	Nissan	pick-up	1.64	88.0%	79.3%
67	1990	Honda	Accord EX	3.36	79.3%	62.9%
68	1990	Ford	Mustang	0.70	77.4%	67.7%
69	1990	Jeep	Wrangler	22.57	N.A	N.A
70	1990	Pontiac	LeMans	0.50	92.4%	86.4%
71	1990	Geo/Isuzu	Storm	1.93	97.8%	88.3%
72	1989	Ford	T-Bird	1.78	90.9%	83.5%
73	1989	Hyundai	Excel GL	200.10	99.8%	99.4%
74	1989	GMC	Sierra 1500	4.30	100.0%	100.0%
75	1989	Dodge	Caravan	47.87	99.7%	99.0%
76	1989	Jeep	Wrangler	23.35	N.A	N.A
77	1988	Dodge	Ram Royal	5.47	95.2%	94.1%
78	1988	Toyota	pick-up	0.41	100.0%	88.5%
79	1988	Toyota	pick-up	0.96	85.3%	85.3%
80	1988	Mazda	MX-6	10.73	94.6%	90.0%
81	1988	Dodge	Caravan	54.52	99.0%	98.5%
82	1988	Toyota	Pick-up	5.60	98.2%	96.0%
83	1988	Chevrolet	Pick-up	2.11	78.7%	68.0%
84	1988	Buick	Park Avenue	0.54	N.A	N.A
85	1988	Nissan	Pick-Up	9.22	N.A	N.A
86	1987	Chevrolet	Corsica	1.20	90.7%	80.6%
87	1986	Subaru	GL	2.70	N.A	N.A
88	1986	Ford	F-150	2.98	74.6%	54.2%
89	1986	Alfa Romeo	Spider	19.35	97.5%	95.8%

Appendix F. cont. Gasoline Vehicle Particulate Size Distribution

	Model Year	Make	Model	Particulate Emission Rate mg/mi	Particle Size	
					<10µm	<2.5µm
90	1986	Nissan	PU	0.51	61.1%	54.2%
91	1986	Chrysler	5th Ave.	7.23	96.0%	93.2%
92	1986	Ford	Bronco	7.41	92.2%	78.0%
93	1986	Mazda	B2000	4.35	100.0%	93.8%
94	1986	Nissan	Sentra XE	0.27	76.9%	71.8%
95	1985	Toyota	Pick-up	5.52	N.A	N.A
96	1985	BMW	735i	6.25	88.9%	82.1%
97	1985	Dodge	Ram50 Sport	12.24	96.1%	94.2%
98	1985	Chevrolet	Sprint	325.33	99.5%	98.8%
99	1985	Dodge	Caravan	387.64	100.0%	99.8%
100	1985	Chevrolet	Caprice Classic	8.06	87.7%	86.3%
101	1985	Toyota	Celica	2.09	N.A	N.A
102	1985	Mitsubishi	Mighty Max	3.19	100.0%	97.2%
103	1984	Cadillac	Coupe de Ville	27.91	97.3%	94.6%
104	1984	Buick	Regal LTD	48.34	90.7%	82.0%
105	1984	Toyota	pick-up	1.31	82.4%	76.5%
106	1984	Chevrolet	Silverado C-10	21.67	98.2%	97.5%
107	1984	Dodge	Ram	44.04	92.9%	91.9%
108	1984	Nissan	Sentra	40.90	100.0%	62.2%
109	1984	Honda	Accord LX	0.37	85.7%	85.7%
110	1983	Jeep	CJ-5	15.14	95.2%	91.0%
111	1983	Ford	E150 Van	8.10	89.3%	73.1%
112	1983	Mazda	626	11.64	98.2%	91.1%
113	1981	Chevrolet	C-10	21.53	99.2%	97.0%
114	1981	Chevrolet	G-10	21.95	96.8%	91.3%
115	1981	Chevrolet	Monte Carlo	14.69	96.6%	95.6%
116	1980	Ford	E350 Van	45.09	96.9%	95.0%
117	1979	Honda	Civic	13.42	N.A	N.A
118	1979	Nissan	280ZX	9.28	89.7%	77.6%
119	1979	Ford	Mustang	40.98	99.4%	98.0%
120	1978	Chevrolet	C-20 PU	72.51	N.A	N.A
121	1978	Chevrolet	El Camino	14.36	93.9%	89.6%
122	1978	Toyota	Corolla	6.40	97.4%	94.8%
123	1978	Pontiac	LeMans	11.11	98.0%	97.2%
124	1977	Datsun	200 SX	40.34	96.2%	79.2%
125	1973	Ford	Ranger	46.84	97.1%	95.0%
126	1972	Chevrolet	Chevelle	67.50	94.8%	90.5%
127	1972	Chevrolet	Custom 20	28.26	97.8%	96.8%
128	1972	Ford	F250 Pick-up	13.46	96.2%	92.6%
129	1965	Ford	Mustang	63.21	96.0%	94.1%

Appendix F. cont. Diesel Vehicle Particulate Size Distribution

	Model Year	Make	Model	Particulate Emission Rate mg/mi	Particle Size	
					<10.0	<2.5
1	1993	Mercedes	300D	86.6	96.8%	89.3%
2	1985	Mercedes	300D Turbo	70.1	97.8%	93.7%
3	1985	Mercedes	300SD	15.5	100.0%	93.6%
4	1984	Volkswagen	Rabbit	636.6	98.6%	89.8%
5	1984	Toyota	Corolla	572.4	99.7%	94.0%
6	1984	Mercedes	300D	748.7	100.0%	96.0%
7	1982	Isuzu	I-mark	267.7	100.0%	96.0%
8	1982	Volkswagen	Vanagon	475.6	99.6%	97.8%
9	1982	Mercedes	300TD Turbo	654.0	99.8%	93.5%
10	1982	Volkswagen	Rabbit	485.1	99.9%	94.1%
11	1982	Mercedes	300 TD	464.4	99.9%	98.5%
12	1981	Peugeot	505TD	677.4	99.6%	96.8%
13	1981	Mercedes	300SD	247.3	100.0%	99.8%
14	1980	Mercedes	300TD	1608.3	99.3%	96.8%
15	1980	Volkswagen	Rabbit	338.2	99.1%	95.6%
16	1980	Mercedes	240D	289.0	99.8%	99.0%
17	1979	Volkswagen	Rabbit	991.2	99.5%	96.3%
18	1979	Cadillac	Seville	1402.4	98.7%	87.8%
19	1977	Mercedes	300D	633.8	99.8%	97.9%

Appendix G. cont. MOUDI Spectra for Individual Gasoline Vehicles

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Appendix G. cont. MOUDI Spectra for Individual Gasoline Vehicles

Appendix H. MOUDI Spectra for Individual Diesel Vehicles

Appendix H. cont. MOUDI Spectra for Individual Diesel Vehicles

Appendix H. cont. MOUDI Spectra for Individual Diesel Vehicles

Appendix H. cont. MOUDI Spectra for Individual Diesel Vehicles

Appendix H. cont. MOUDI Spectra for Individual Diesel Vehicles

Appendix I. Chemical Mass Emission Rate for Gasoline Vehicles (mg/mi)

	1997 Ford Windstar 13.3 mg/mi		1994 Chevrolet C1500 Suburban 9.1 mg/mi		1994 Dodge Spirit 1.7 mg/mi		1994 Dodge Caravan 6.2 mg/mi		1992 Dodge Dakota LE 7.4 mg/mi						
FTP Weight PM															
Organic Carbon	0.85	+/-	0.21	0.99	+/-	0.23	0.87	+/-	0.14	1.37	+/-	0.23	1.57	+/-	0.30
Elemental Carbon	14.45	+/-	2.12	2.06	+/-	0.31	0.99	+/-	0.10	3.13	+/-	0.31	4.27	+/-	0.63
Total Carbon	15.29	+/-	2.14	3.05	+/-	0.50	1.87	+/-	0.22	4.49	+/-	0.53	5.84	+/-	0.87
NO ₃ ⁻	-0.01	+/-	0.02	-0.01	+/-	0.02	0.02	+/-	0.02	0.00	+/-	0.02	-0.01	+/-	0.02
SO ₄ ²⁻	0.02	+/-	0.02	0.12	+/-	0.02	0.03	+/-	0.02	0.04	+/-	0.02	0.01	+/-	0.02
Cl ⁻	0.00	+/-	0.02	0.14	+/-	0.02	0.02	+/-	0.02	0.02	+/-	0.02	0.00	+/-	0.02
NH ₄ ⁺	0.04	+/-	0.02	0.09	+/-	0.02	0.06	+/-	0.02	0.07	+/-	0.02	0.02	+/-	0.01
Na	0.02	+/-	0.01	-0.01	+/-	0.07	0.01	+/-	0.03	-0.01	+/-	0.04	-0.01	+/-	0.03
Mg	0.00	+/-	0.01	0.06	+/-	0.01	0.01	+/-	0.01	0.03	+/-	0.01	0.04	+/-	0.01
Al	0.01	+/-	0.00	0.27	+/-	0.03	0.01	+/-	0.01	0.06	+/-	0.01	0.14	+/-	0.01
Si	0.33	+/-	0.03	0.07	+/-	0.01	0.04	+/-	0.00	0.25	+/-	0.02	0.20	+/-	0.02
P	0.00	+/-	0.00	0.13	+/-	0.01	0.01	+/-	0.00	0.03	+/-	0.00	0.03	+/-	0.00
S	0.04	+/-	0.00	0.07	+/-	0.01	0.01	+/-	0.00	0.05	+/-	0.01	0.04	+/-	0.00
Cl	0.03	+/-	0.00	0.37	+/-	0.03	0.00	+/-	0.00	0.02	+/-	0.00	0.01	+/-	0.00
K	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.00	0.02	+/-	0.00	0.01	+/-	0.01
Ca	0.01	+/-	0.01	0.08	+/-	0.01	0.01	+/-	0.00	0.05	+/-	0.00	0.03	+/-	0.01
Ti	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.02	0.01	+/-	0.02	0.01	+/-	0.01
V	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.01	0.01	+/-	0.00
Cr	0.00	+/-	0.00	0.01	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Mn	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Fe	0.03	+/-	0.00	0.53	+/-	0.05	0.04	+/-	0.00	0.20	+/-	0.02	0.45	+/-	0.04
Co	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01
Ni	0.00	+/-	0.00	0.01	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.01	+/-	0.00
Cu	0.01	+/-	0.00	0.01	+/-	0.00	0.00	+/-	0.00	0.01	+/-	0.00	0.01	+/-	0.00
Zn	0.00	+/-	0.00	0.23	+/-	0.02	0.01	+/-	0.00	0.05	+/-	0.00	0.05	+/-	0.00
Ga	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
As	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Se	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Br	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Rb	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Sr	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Y	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Zr	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Mo	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Pd	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Ag	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Cd	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
In	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Sn	0.00	+/-	0.03	0.00	+/-	0.03	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.03
Sb	0.01	+/-	0.04	0.00	+/-	0.04	0.00	+/-	0.02	0.00	+/-	0.01	0.00	+/-	0.04
Ba	-0.01	+/-	0.03	-0.01	+/-	0.03	0.01	+/-	0.06	-0.01	+/-	0.04	-0.01	+/-	0.03
La	0.01	+/-	0.04	-0.01	+/-	0.04	0.00	+/-	0.07	-0.01	+/-	0.06	-0.01	+/-	0.04
Au	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.04	0.00	+/-	0.00	0.00	+/-	0.00
Hg	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Tl	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Pb	0.00	+/-	0.01	0.01	+/-	0.00	0.00	+/-	0.00	0.01	+/-	0.00	0.00	+/-	0.00
U	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00

Appendix I. cont. Chemical Mass Emission Rate for Gasoline Vehicles (mg/mi)

	1992 Toyota Pick-Up 5.0 mg/mi			1991 Toyota Tercel 3.4 mg/mi			1991 Toyota Pick-Up 5.3 mg/mi			1991 Pontiac Transport 12.3 mg/mi			1990 Dodge Ram 250 24.3 mg/mi		
FTP Weight PM	2.61	+/-	0.43	1.32	+/-	0.27	0.69	+/-	0.19	10.11	+/-	1.41	8.19	+/-	1.15
Organic Carbon	3.49	+/-	0.52	1.79	+/-	0.27	4.27	+/-	0.63	0.76	+/-	0.12	1.07	+/-	0.17
Elemental Carbon	6.10	+/-	0.91	3.11	+/-	0.51	4.96	+/-	0.76	10.88	+/-	1.55	9.25	+/-	1.33
Total Carbon	-0.02	+/-	0.02	-0.02	+/-	0.02	0.00	+/-	0.02	-0.01	+/-	0.02	-0.02	+/-	0.02
NO ₃ ⁻	-0.01	+/-	0.01	0.00	+/-	0.02	0.07	+/-	0.02	0.01	+/-	0.02	0.60	+/-	0.07
SO ₄ ²⁻	0.00	+/-	0.02	0.01	+/-	0.02	0.00	+/-	0.02	0.00	+/-	0.02	0.01	+/-	0.02
Cl ⁻	0.02	+/-	0.01	0.02	+/-	0.01	0.04	+/-	0.01	0.02	+/-	0.01	0.21	+/-	0.03
NH ₄ ⁺	0.00	+/-	0.02	-0.01	+/-	0.03	-0.01	+/-	0.03	0.00	+/-	0.03	-0.01	+/-	0.04
Na	0.01	+/-	0.02	0.02	+/-	0.00	0.01	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.02
Mg	0.00	+/-	0.03	0.00	+/-	0.01	0.02	+/-	0.00	0.01	+/-	0.00	0.01	+/-	0.01
Al	0.06	+/-	0.01	0.01	+/-	0.00	0.10	+/-	0.01	0.04	+/-	0.00	2.29	+/-	0.21
P	0.02	+/-	0.00	0.04	+/-	0.00	0.02	+/-	0.00	0.03	+/-	0.00	0.02	+/-	0.00
S	0.02	+/-	0.01	0.02	+/-	0.00	0.05	+/-	0.01	0.02	+/-	0.00	0.21	+/-	0.02
Cl	0.01	+/-	0.00	0.00	+/-	0.00	0.01	+/-	0.00	0.02	+/-	0.00	0.03	+/-	0.00
K	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.01	+/-	0.01
Ca	0.02	+/-	0.00	0.07	+/-	0.01	0.05	+/-	0.01	0.05	+/-	0.01	0.03	+/-	0.01
Ti	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
V	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.00
Cr	0.00	+/-	0.02	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Mn	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Fe	0.07	+/-	0.00	0.01	+/-	0.00	0.37	+/-	0.03	0.07	+/-	0.01	0.06	+/-	0.01
Co	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00
Ni	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Cu	0.00	+/-	0.00	0.00	+/-	0.00	0.01	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Zn	0.03	+/-	0.00	0.06	+/-	0.01	0.03	+/-	0.00	0.05	+/-	0.00	0.02	+/-	0.00
Ga	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
As	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Se	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Br	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Rb	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Sr	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Y	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Zr	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Mo	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Pd	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Ag	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Cd	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
In	0.00	+/-	0.01	0.00	+/-	0.01	0.01	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Sn	0.00	+/-	0.03	0.00	+/-	0.03	0.00	+/-	0.03	0.00	+/-	0.03	0.00	+/-	0.03
Sb	0.00	+/-	0.04	0.00	+/-	0.04	0.00	+/-	0.04	0.00	+/-	0.04	0.00	+/-	0.04
Ba	-0.01	+/-	0.03	-0.01	+/-	0.03	-0.01	+/-	0.04	-0.01	+/-	0.03	-0.01	+/-	0.03
La	0.01	+/-	0.05	0.01	+/-	0.03	0.01	+/-	0.05	0.01	+/-	0.04	-0.01	+/-	0.03
Au	0.00	+/-	0.02	0.00	+/-	0.00	0.00	+/-	0.02	0.00	+/-	0.00	0.00	+/-	0.01
Hg	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Tl	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Pb	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
U	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00

Appendix I. cont. Chemical Mass Emission Rate for Gasoline Vehicles (mg/mi)

	1990 Nissan Sentra 5.1 mg/mi			1990 Honda Accord EX 3.4 mg/mi			1989 Hyundai Excel GL 200 mg/mi			1989 GMC Sierra 1500 4.3 mg/mi			1989 Dodge Caravan 47.9 mg/mi		
FTP Weight PM	0.64	+/-	0.19	2.09	+/-	0.31	114.3	+/-	15.13	4.80	+/-	0.71	41.75	+/-	5.57
Organic Carbon	4.67	+/-	0.69	0.54	+/-	0.06	2.16	+/-	0.33	0.32	+/-	0.06	1.30	+/-	0.20
Elemental Carbon	5.31	+/-	0.80	2.62	+/-	0.35	116.4	+/-	15.75	5.12	+/-	0.78	43.05	+/-	5.87
Total Carbon	-0.01	+/-	0.02	0.00	+/-	0.02	0.01	+/-	0.02	-0.01	+/-	0.02	-0.01	+/-	0.02
NO ₃ ⁻	-0.02	+/-	0.02	-0.02	+/-	0.02	0.04	+/-	0.02	0.00	+/-	0.02	0.05	+/-	0.02
SO ₄ ²⁻	0.00	+/-	0.02	0.00	+/-	0.02	0.01	+/-	0.02	0.02	+/-	0.02	0.01	+/-	0.02
Cl ⁻	0.03	+/-	0.01	0.04	+/-	0.02	0.03	+/-	0.01	0.03	+/-	0.01	0.02	+/-	0.01
NH ₄ ⁺	0.00	+/-	0.02	-0.01	+/-	0.03	-0.01	+/-	0.13	0.02	+/-	0.01	-0.01	+/-	0.04
Na	0.01	+/-	0.00	0.02	+/-	0.01	0.11	+/-	0.01	0.00	+/-	0.00	0.05	+/-	0.01
Mg	0.00	+/-	0.01	0.00	+/-	0.00	0.01	+/-	0.00	0.01	+/-	0.00	0.02	+/-	0.00
Al	0.08	+/-	0.01	0.02	+/-	0.00	0.10	+/-	0.01	0.07	+/-	0.01	0.06	+/-	0.01
Si	0.00	+/-	0.00	0.05	+/-	0.01	0.23	+/-	0.02	0.01	+/-	0.00	0.05	+/-	0.01
P	0.01	+/-	0.00	0.03	+/-	0.00	0.35	+/-	0.03	0.01	+/-	0.00	0.09	+/-	0.01
S	0.01	+/-	0.00	0.01	+/-	0.00	0.02	+/-	0.00	0.01	+/-	0.00	0.02	+/-	0.00
Cl	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
K	0.00	+/-	0.01	0.07	+/-	0.01	0.49	+/-	0.04	0.02	+/-	0.01	0.16	+/-	0.02
Ca	0.00	+/-	0.01	0.00	+/-	0.02	0.00	+/-	0.02	0.00	+/-	0.01	0.00	+/-	0.01
Ti	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00
V	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Cr	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Mn	0.02	+/-	0.00	0.04	+/-	0.00	0.37	+/-	0.03	0.03	+/-	0.00	0.05	+/-	0.00
Fe	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00
Co	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Ni	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Cu	0.01	+/-	0.00	0.07	+/-	0.01	0.56	+/-	0.05	0.02	+/-	0.00	0.10	+/-	0.01
Zn	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Ga	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
As	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Se	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Br	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Rb	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Sr	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Y	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Zr	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Mo	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Pd	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Ag	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Cd	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
In	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Sn	0.00	+/-	0.03	0.00	+/-	0.01	0.00	+/-	0.03	0.00	+/-	0.03	0.00	+/-	0.03
Sb	0.01	+/-	0.04	0.00	+/-	0.01	0.00	+/-	0.04	0.00	+/-	0.04	0.00	+/-	0.04
Ba	-0.01	+/-	0.03	0.00	+/-	0.04	0.03	+/-	0.03	-0.01	+/-	0.03	-0.01	+/-	0.02
La	-0.01	+/-	0.04	0.00	+/-	0.06	0.00	+/-	0.04	0.00	+/-	0.04	0.00	+/-	0.03
Au	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00
Hg	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Tl	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Pb	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00
U	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00

Appendix I. cont. Chemical Mass Emission Rate for Gasoline Vehicles (mg/mi)

	1988 Mazda MX-6 10.7 mg/mi			1988 Dodge Ram Royal 5.5 mg/mi			1988 Dodge Caravan 54.5 mg/mi			1986 Alfa Romeo Spider 19.4 mg/mi			1986 Chrysler 5th Ave. 7.2 mg/mi		
FTP Weight PM	2.78	+/-	0.45	3.14	+/-	0.50	48.04	+/-	6.40	12.21	+/-	1.68	3.38	+/-	0.45
Organic Carbon	5.50	+/-	0.81	2.17	+/-	0.33	3.86	+/-	0.57	4.01	+/-	0.60	5.66	+/-	0.56
Elemental Carbon	8.28	+/-	1.20	5.32	+/-	0.80	51.89	+/-	7.06	16.22	+/-	2.26	9.04	+/-	0.99
Total Carbon	0.03	+/-	0.02	-0.01	+/-	0.02	0.00	+/-	0.02	-0.02	+/-	0.02	0.00	+/-	0.02
NO ₃ ⁻	0.11	+/-	0.02	0.00	+/-	0.02	0.18	+/-	0.03	0.03	+/-	0.02	0.03	+/-	0.02
SO ₄ ²⁻	0.02	+/-	0.02	0.00	+/-	0.02	0.01	+/-	0.02	0.01	+/-	0.02	0.01	+/-	0.02
Cl ⁻	0.05	+/-	0.02	0.01	+/-	0.01	0.02	+/-	0.01	0.04	+/-	0.01	0.02	+/-	0.02
NH ₄ ⁺	-0.01	+/-	0.03	-0.01	+/-	0.03	-0.01	+/-	0.05	-0.01	+/-	0.04	0.00	+/-	0.03
Na	0.03	+/-	0.01	0.01	+/-	0.00	0.04	+/-	0.01	0.02	+/-	0.01	0.01	+/-	0.01
Mg	0.02	+/-	0.00	0.00	+/-	0.00	0.04	+/-	0.01	0.00	+/-	0.01	0.01	+/-	0.00
Al	0.16	+/-	0.02	0.08	+/-	0.01	0.06	+/-	0.01	0.07	+/-	0.01	0.08	+/-	0.01
Si	0.05	+/-	0.01	0.03	+/-	0.00	0.09	+/-	0.01	0.06	+/-	0.01	0.01	+/-	0.00
P	0.06	+/-	0.01	0.02	+/-	0.00	0.19	+/-	0.02	0.07	+/-	0.01	0.05	+/-	0.01
S	0.04	+/-	0.00	0.01	+/-	0.00	0.02	+/-	0.00	0.02	+/-	0.00	0.02	+/-	0.00
Cl	0.00	+/-	0.01	0.01	+/-	0.01	0.02	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.00
K	0.11	+/-	0.01	0.06	+/-	0.01	0.37	+/-	0.03	0.10	+/-	0.01	0.03	+/-	0.00
Ca	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.02
Ti	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
V	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Cr	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Mn	0.80	+/-	0.07	0.06	+/-	0.01	0.15	+/-	0.01	0.05	+/-	0.00	0.10	+/-	0.01
Fe	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Co	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Ni	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Cu	0.08	+/-	0.01	0.04	+/-	0.00	0.16	+/-	0.01	0.09	+/-	0.01	0.03	+/-	0.00
Zn	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Ga	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
As	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Se	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Br	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Rb	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Sr	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Y	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Zr	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00
Mo	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.02	0.00	+/-	0.00	0.00	+/-	0.01
Pd	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.03	0.00	+/-	0.00	0.00	+/-	0.01
Ag	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.03	0.00	+/-	0.01	0.00	+/-	0.01
Cd	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.04	0.00	+/-	0.01	0.00	+/-	0.01
In	0.00	+/-	0.03	0.00	+/-	0.03	0.00	+/-	0.05	0.00	+/-	0.01	0.00	+/-	0.01
Sn	0.00	+/-	0.04	0.00	+/-	0.04	0.00	+/-	0.07	0.00	+/-	0.01	0.00	+/-	0.01
Sb	0.00	+/-	0.03	0.01	+/-	0.03	0.01	+/-	0.20	0.00	+/-	0.01	0.00	+/-	0.04
Ba	0.01	+/-	0.04	0.01	+/-	0.04	0.01	+/-	0.26	0.01	+/-	0.01	-0.01	+/-	0.06
La	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.04	0.00	+/-	0.04	0.00	+/-	0.00
Au	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.05	0.00	+/-	0.00
Hg	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00
Tl	0.02	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Pb	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00
U	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00

Appendix I. cont. Chemical Mass Emission Rate for Gasoline Vehicles (mg/mi)

	1985 Toyota Pick-up 5.5 mg/mi			1985 Chevrolet Sprint 325 mg/mi			1985 Dodge Caravan 388 mg/mi			1985 Chevy Caprice 8.1 mg/mi			1984 Buick Regal LTD 48.3 mg/mi		
FTP Weight PM	2.83	+/-	0.45	225.5	+/-	29.78	220.7	+/-	29.15	5.79	+/-	0.61	15.14	+/-	2.07
Organic Carbon	0.91	+/-	0.14	41.61	+/-	6.10	21.8	+/-	3.20	0.82	+/-	0.13	5.77	+/-	0.85
Elemental Carbon	3.74	+/-	0.59	267.1	+/-	36.01	242.5	+/-	32.70	6.62	+/-	0.71	20.91	+/-	2.89
Total Carbon	-0.02	+/-	0.02	0.07	+/-	0.08	0.17	+/-	0.06	0.06	+/-	0.02	0.01	+/-	0.02
NO ₃ ⁻	-0.01	+/-	0.02	0.18	+/-	0.08	0.50	+/-	0.07	0.03	+/-	0.02	1.87	+/-	0.20
SO ₄ ²⁻	0.00	+/-	0.02	0.11	+/-	0.08	0.08	+/-	0.05	0.00	+/-	0.02	0.01	+/-	0.02
Cl ⁻	0.02	+/-	0.01	0.19	+/-	0.08	0.36	+/-	0.06	0.03	+/-	0.02	0.74	+/-	0.08
NH ₄ ⁺	-0.01	+/-	0.02	-0.01	+/-	0.28	-0.01	+/-	0.29	-0.01	+/-	0.04	-0.01	+/-	0.07
Na	0.02	+/-	0.00	0.15	+/-	0.04	0.13	+/-	0.14	0.00	+/-	0.02	0.02	+/-	0.03
Mg	0.02	+/-	0.00	0.20	+/-	0.03	0.10	+/-	0.02	0.02	+/-	0.00	0.00	+/-	0.02
Al	0.42	+/-	0.04	0.55	+/-	0.05	1.05	+/-	0.10	0.02	+/-	0.00	6.44	+/-	0.58
Si	0.02	+/-	0.00	0.50	+/-	0.05	0.49	+/-	0.05	0.02	+/-	0.00	0.01	+/-	0.00
P	0.01	+/-	0.00	0.63	+/-	0.06	1.26	+/-	0.12	0.03	+/-	0.00	0.55	+/-	0.05
S	0.01	+/-	0.00	0.08	+/-	0.01	0.17	+/-	0.02	0.01	+/-	0.00	0.11	+/-	0.01
Cl	0.00	+/-	0.01	0.01	+/-	0.02	0.03	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.01
K	0.05	+/-	0.01	0.61	+/-	0.06	0.57	+/-	0.05	0.03	+/-	0.00	0.05	+/-	0.01
Ca	0.00	+/-	0.01	0.00	+/-	0.07	0.00	+/-	0.05	0.00	+/-	0.02	0.00	+/-	0.01
Ti	0.00	+/-	0.00	0.00	+/-	0.03	0.00	+/-	0.02	0.00	+/-	0.01	0.00	+/-	0.01
V	0.00	+/-	0.00	0.01	+/-	0.00	0.01	+/-	0.01	0.00	+/-	0.00	0.01	+/-	0.00
Cr	0.00	+/-	0.00	0.00	+/-	0.01	0.04	+/-	0.00	0.00	+/-	0.00	0.01	+/-	0.00
Mn	0.02	+/-	0.00	0.36	+/-	0.03	4.09	+/-	0.37	0.18	+/-	0.02	1.09	+/-	0.10
Fe	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.06	0.00	+/-	0.00	0.00	+/-	0.02
Co	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Ni	0.00	+/-	0.00	0.00	+/-	0.00	0.01	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Cu	0.03	+/-	0.00	0.87	+/-	0.08	1.11	+/-	0.10	0.04	+/-	0.00	0.06	+/-	0.01
Zn	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00
Ga	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.15	0.00	+/-	0.00	0.00	+/-	0.01
As	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Se	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00
Br	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Rb	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Sr	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Y	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00
Zr	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Mo	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Pd	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Ag	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Cd	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
In	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Sn	0.00	+/-	0.03	0.00	+/-	0.03	0.02	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.03
Sb	0.00	+/-	0.04	0.03	+/-	0.04	0.02	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.04
Ba	-0.01	+/-	0.03	0.02	+/-	0.03	-0.01	+/-	0.04	0.00	+/-	0.04	-0.01	+/-	0.03
La	0.00	+/-	0.04	0.00	+/-	0.04	-0.01	+/-	0.05	0.00	+/-	0.06	0.01	+/-	0.04
Au	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00
Hg	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Tl	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Pb	0.00	+/-	0.00	0.01	+/-	0.00	0.95	+/-	0.00	0.01	+/-	0.00	0.03	+/-	0.00
U	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00

Appendix I. cont. Chemical Mass Emission Rate for Gasoline Vehicles (mg/mi)

	1984 Dodge Ram 44.0 mg/mi			1984 Nissan Sentra 40.9 mg/mi			1981 Chevrolet C-10 21.5 mg/mi			1981 Chevrolet G-10 22.0 mg/mi			1980 Ford E350 Van 45.1 mg/mi		
FTP Weight PM	30.69	+/-	3.49	13.65	+/-	1.35	5.10	+/-	0.76	17.13	+/-	2.33	39.98	+/-	4.52
Organic Carbon	5.19	+/-	0.52	14.61	+/-	2.19	20.10	+/-	2.95	2.27	+/-	0.34	3.63	+/-	0.36
Elemental Carbon	35.88	+/-	3.71	28.26	+/-	2.83	25.20	+/-	3.47	19.40	+/-	2.69	43.61	+/-	4.50
Total Carbon	0.03	+/-	0.03	0.03	+/-	0.02	0.00	+/-	0.02	0.00	+/-	0.02	0.04	+/-	0.02
NO ₃ ⁻	0.10	+/-	0.03	0.26	+/-	0.03	0.05	+/-	0.02	0.07	+/-	0.02	0.15	+/-	0.03
SO ₄ ²⁻	0.01	+/-	0.02	0.03	+/-	0.02	0.01	+/-	0.02	0.01	+/-	0.02	0.03	+/-	0.02
Cl ⁻	0.03	+/-	0.02	0.07	+/-	0.02	0.04	+/-	0.02	0.05	+/-	0.02	0.09	+/-	0.02
NH ₄ ⁺	0.24	+/-	0.03	-0.01	+/-	0.10	-0.01	+/-	0.08	0.01	+/-	0.03	0.01	+/-	0.04
Na	0.01	+/-	0.01	0.16	+/-	0.02	0.12	+/-	0.01	0.03	+/-	0.01	0.01	+/-	0.01
Mg	0.01	+/-	0.00	0.00	+/-	0.01	0.01	+/-	0.00	0.03	+/-	0.01	0.01	+/-	0.00
Al	0.31	+/-	0.03	0.25	+/-	0.02	0.39	+/-	0.04	0.47	+/-	0.04	0.10	+/-	0.01
P	0.01	+/-	0.00	0.20	+/-	0.02	0.20	+/-	0.02	0.04	+/-	0.01	0.02	+/-	0.00
S	0.06	+/-	0.01	0.24	+/-	0.02	0.11	+/-	0.01	0.07	+/-	0.01	0.11	+/-	0.01
Cl	0.03	+/-	0.00	0.05	+/-	0.01	0.05	+/-	0.01	0.07	+/-	0.01	0.05	+/-	0.01
K	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.01	+/-	0.01	0.01	+/-	0.00
Ca	0.03	+/-	0.00	0.17	+/-	0.02	0.18	+/-	0.02	0.07	+/-	0.01	0.04	+/-	0.00
Ti	0.00	+/-	0.02	0.00	+/-	0.02	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.02
V	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Cr	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Mn	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.02	+/-	0.00	0.00	+/-	0.00
Fe	0.06	+/-	0.01	0.13	+/-	0.01	0.15	+/-	0.01	0.45	+/-	0.04	0.11	+/-	0.01
Co	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00
Ni	0.00	+/-	0.00	0.00	+/-	0.00	0.01	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Cu	0.00	+/-	0.00	0.03	+/-	0.00	0.02	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Zn	0.02	+/-	0.00	0.31	+/-	0.03	0.31	+/-	0.03	0.06	+/-	0.01	0.04	+/-	0.00
Ga	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
As	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Se	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Br	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Rb	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Sr	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Y	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Zr	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Mo	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Pd	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Ag	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Cd	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
In	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Sn	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.03	0.00	+/-	0.03	0.00	+/-	0.01
Sb	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.04	0.00	+/-	0.04	0.00	+/-	0.01
Ba	0.00	+/-	0.04	0.01	+/-	0.05	-0.01	+/-	0.04	0.00	+/-	0.03	-0.01	+/-	0.04
La	-0.01	+/-	0.06	-0.01	+/-	0.07	-0.01	+/-	0.05	0.01	+/-	0.04	0.00	+/-	0.06
Au	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Hg	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Tl	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Pb	0.00	+/-	0.00	0.01	+/-	0.00	0.01	+/-	0.00	0.01	+/-	0.00	0.01	+/-	0.00
U	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00

Appendix I. cont. Chemical Mass Emission Rate for Gasoline Vehicles (mg/mi)

	1979 Honda Civic 13.4 mg/mi			1979 Ford Mustang 41.0 mg/mi			1979 Nissan 280ZX 9.3 mg/mi			1978 Chevrolet C-20 PU 72.5 mg/mi			1978 Toyota Corolla 6.4 mg/mi		
FTP Weight PM	5.26	+/-	0.77	28.38	+/-	3.81	3.93	+/-	0.51	55.36	+/-	7.36	4.44	+/-	0.48
Organic Carbon	2.66	+/-	0.40	9.29	+/-	1.37	3.97	+/-	0.40	2.80	+/-	0.42	2.36	+/-	0.36
Elemental Carbon	7.92	+/-	1.15	37.68	+/-	5.15	7.90	+/-	0.87	58.16	+/-	7.90	6.81	+/-	0.73
Total Carbon	-0.02	+/-	0.02	-0.01	+/-	0.02	0.02	+/-	0.02	0.09	+/-	0.03	0.08	+/-	0.02
NO ₃ ⁻	0.02	+/-	0.02	0.06	+/-	0.02	0.07	+/-	0.02	0.41	+/-	0.05	0.10	+/-	0.02
SO ₄ ²⁻	0.00	+/-	0.02	0.00	+/-	0.02	0.01	+/-	0.02	0.12	+/-	0.02	0.02	+/-	0.02
Cl ⁻	0.02	+/-	0.02	0.03	+/-	0.01	0.02	+/-	0.02	0.06	+/-	0.02	0.04	+/-	0.02
NH ₄ ⁺	-0.01	+/-	0.04	-0.01	+/-	0.07	-0.01	+/-	0.05	-0.01	+/-	0.12	-0.01	+/-	0.05
Na	0.06	+/-	0.01	0.05	+/-	0.01	0.03	+/-	0.01	0.22	+/-	0.02	0.04	+/-	0.01
Mg	0.03	+/-	0.00	0.07	+/-	0.01	0.01	+/-	0.00	0.00	+/-	0.02	0.01	+/-	0.00
Al	0.18	+/-	0.02	0.26	+/-	0.02	0.32	+/-	0.03	3.11	+/-	0.28	0.31	+/-	0.03
Si	0.09	+/-	0.01	0.16	+/-	0.01	0.09	+/-	0.01	0.41	+/-	0.04	0.05	+/-	0.01
S	0.02	+/-	0.00	0.10	+/-	0.01	0.05	+/-	0.01	0.21	+/-	0.02	0.05	+/-	0.01
Cl	0.01	+/-	0.00	0.02	+/-	0.00	0.02	+/-	0.00	0.20	+/-	0.02	0.02	+/-	0.00
K	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00
Ca	0.04	+/-	0.01	0.22	+/-	0.02	0.11	+/-	0.01	0.87	+/-	0.08	0.03	+/-	0.00
Ti	0.00	+/-	0.01	0.00	+/-	0.02	0.00	+/-	0.02	0.00	+/-	0.01	0.00	+/-	0.02
V	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Cr	0.05	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Mn	0.01	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Fe	0.64	+/-	0.06	0.10	+/-	0.01	0.15	+/-	0.01	0.17	+/-	0.02	0.04	+/-	0.00
Co	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Ni	0.14	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Cu	0.01	+/-	0.00	0.01	+/-	0.00	0.01	+/-	0.00	0.01	+/-	0.00	0.01	+/-	0.00
Zn	0.11	+/-	0.01	0.25	+/-	0.02	0.14	+/-	0.01	0.49	+/-	0.04	0.08	+/-	0.01
Ga	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
As	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00
Se	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Br	0.00	+/-	0.00	0.01	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Rb	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Sr	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Y	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Zr	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Mo	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Pd	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.01
Ag	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Cd	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
In	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Sn	0.00	+/-	0.03	0.01	+/-	0.03	0.00	+/-	0.01	0.00	+/-	0.03	0.00	+/-	0.01
Sb	0.00	+/-	0.04	0.01	+/-	0.04	0.00	+/-	0.01	0.01	+/-	0.04	0.00	+/-	0.01
Ba	-0.01	+/-	0.04	0.01	+/-	0.03	0.01	+/-	0.04	-0.01	+/-	0.04	-0.01	+/-	0.05
La	0.00	+/-	0.05	0.03	+/-	0.04	-0.01	+/-	0.05	0.01	+/-	0.05	-0.01	+/-	0.06
Au	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.01
Hg	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Tl	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Pb	0.05	+/-	0.00	0.01	+/-	0.00	0.01	+/-	0.00	0.04	+/-	0.00	0.01	+/-	0.00
U	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00

Appendix I. cont. Chemical Mass Emission Rate for Gasoline Vehicles (mg/mi)

	1978 Pontiac LeMans 11.1 mg/mi			1977 Datsun 200 SX 40.3 mg/mi			1973 Ford Ranger 46.8 mg/mi			1972 Chevy C-20 Pick-Up 28.3 mg/mi			1965 Ford Mustang 63.2 mg/mi		
FTP Weight PM	10.49	+/-	1.05	14.84	+/-	1.72	38.75	+/-	5.18	19.56	+/-	2.25	46.14	+/-	6.15
Organic Carbon	0.88	+/-	0.14	13.53	+/-	1.34	1.47	+/-	0.23	1.39	+/-	0.14	2.66	+/-	0.40
Elemental Carbon	11.37	+/-	1.18	28.37	+/-	2.95	40.23	+/-	5.49	20.94	+/-	2.19	48.80	+/-	6.64
Total Carbon	0.02	+/-	0.02	0.04	+/-	0.03	0.00	+/-	0.02	0.01	+/-	0.02	0.00	+/-	0.02
NO ₃ ⁻	0.08	+/-	0.02	0.39	+/-	0.06	0.09	+/-	0.02	0.12	+/-	0.03	0.05	+/-	0.02
SO ₄ ²⁻	0.01	+/-	0.02	0.03	+/-	0.02	0.02	+/-	0.02	0.00	+/-	0.02	2.60	+/-	0.32
Cl ⁻	0.01	+/-	0.02	0.15	+/-	0.03	0.06	+/-	0.02	0.08	+/-	0.02	1.37	+/-	0.14
NH ₄ ⁺	0.01	+/-	0.04	-0.01	+/-	0.24	-0.01	+/-	0.03	-0.01	+/-	0.03	-0.01	+/-	0.08
Na	0.03	+/-	0.01	0.06	+/-	0.01	0.00	+/-	0.02	-0.01	+/-	0.01	0.10	+/-	0.02
Mg	0.03	+/-	0.01	0.08	+/-	0.01	0.02	+/-	0.00	0.02	+/-	0.01	0.04	+/-	0.01
Al	0.03	+/-	0.00	0.70	+/-	0.06	0.92	+/-	0.08	0.08	+/-	0.01	0.47	+/-	0.04
Si	0.02	+/-	0.00	0.15	+/-	0.01	0.01	+/-	0.00	0.03	+/-	0.00	0.14	+/-	0.01
P	0.03	+/-	0.00	0.34	+/-	0.03	0.04	+/-	0.01	0.06	+/-	0.01	0.07	+/-	0.01
S	0.01	+/-	0.00	0.09	+/-	0.01	0.08	+/-	0.01	0.02	+/-	0.00	3.20	+/-	0.29
Cl	0.00	+/-	0.00	0.00	+/-	0.01	0.01	+/-	0.01	0.01	+/-	0.00	0.00	+/-	0.01
K	0.04	+/-	0.00	0.18	+/-	0.02	0.02	+/-	0.01	0.04	+/-	0.00	0.12	+/-	0.01
Ca	0.00	+/-	0.02	0.00	+/-	0.02	0.00	+/-	0.01	0.00	+/-	0.02	0.00	+/-	0.01
Ti	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
V	0.00	+/-	0.00	0.01	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Cr	0.01	+/-	0.00	0.01	+/-	0.00	0.01	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Mn	0.15	+/-	0.01	5.93	+/-	0.53	0.43	+/-	0.04	0.11	+/-	0.01	0.26	+/-	0.02
Fe	0.00	+/-	0.00	0.00	+/-	0.09	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00
Co	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Ni	0.00	+/-	0.00	0.01	+/-	0.00	0.00	+/-	0.00	0.01	+/-	0.00	0.03	+/-	0.00
Cu	0.03	+/-	0.00	1.16	+/-	0.10	0.02	+/-	0.00	0.04	+/-	0.00	0.15	+/-	0.01
Zn	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Ga	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.02
As	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Se	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.02	+/-	0.00
Br	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Rb	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Sr	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Y	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Zr	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00
Mo	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.02	0.00	+/-	0.01	0.00	+/-	0.01
Pd	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.02	0.00	+/-	0.01	0.00	+/-	0.01
Ag	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.02	0.00	+/-	0.01	0.00	+/-	0.01
Cd	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.02	0.00	+/-	0.01	0.00	+/-	0.01
In	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.02	0.00	+/-	0.01	0.00	+/-	0.01
Sn	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.04	0.00	+/-	0.01	0.01	+/-	0.03
Sb	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.05	0.00	+/-	0.01	0.00	+/-	0.04
Ba	-0.01	+/-	0.00	0.02	+/-	0.04	-0.01	+/-	0.13	-0.01	+/-	0.05	-0.01	+/-	0.03
La	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.04	0.00	+/-	0.00	0.00	+/-	0.00
Au	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00
Hg	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.03	0.00	+/-	0.00	0.00	+/-	0.00
Tl	0.00	+/-	0.00	0.05	+/-	0.00	0.08	+/-	0.09	0.01	+/-	0.00	0.15	+/-	0.00
Pb	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00
U	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00

Appendix J. Chemical Mass Emission Rate for Diesel Vehicles (mg/mi)

	1993 Mercedes 300D			1985 Mercedes 300D			1985 Mercedes 300SD			1984 Volkswagen Rabbit			1984 Toyota Corolla		
	86.6 mg/mi			70.1 mg/mi			15.5 mg/mi			636.6 mg/mi			572.4 mg/mi		
FTP Weight PM	10.91	+/-	1.55	61.61	+/-	7.11	8.21	+/-	10.02	91.06	+/-	10.40	50.00	+/-	5.82
Organic Carbon	60.59	+/-	5.99	62.35	+/-	6.17	16.39	+/-	16.67	388.0	+/-	38.20	435.5	+/-	42.88
Elemental Carbon	71.51	+/-	7.52	124.0	+/-	12.85	24.59	+/-	26.68	479.0	+/-	48.96	485.5	+/-	49.62
Total Carbon	0.07	+/-	0.11	-0.03	+/-	0.09	-0.06	+/-	0.09	0.39	+/-	0.14	0.28	+/-	0.12
NO ₃ ⁻	0.31	+/-	0.11	0.11	+/-	0.10	-0.08	+/-	0.18	0.61	+/-	0.15	1.15	+/-	0.20
SO ₄ ²⁻	-0.03	+/-	0.09	-0.08	+/-	0.09	-0.05	+/-	0.12	0.54	+/-	0.14	0.11	+/-	0.10
Cl ⁻	0.20	+/-	0.10	0.13	+/-	0.09	0.03	+/-	0.13	0.79	+/-	0.13	0.60	+/-	0.12
NH ₄ ⁺	-0.28	+/-	0.12	-0.24	+/-	0.08	-0.26	+/-	0.04	-0.28	+/-	0.27	-0.28	+/-	0.21
Na	0.03	+/-	0.07	0.01	+/-	0.07	-0.02	+/-	0.07	0.03	+/-	0.12	0.08	+/-	0.07
Mg	0.01	+/-	0.02	-0.03	+/-	0.01	-0.03	+/-	0.02	0.08	+/-	0.03	-0.03	+/-	0.04
Al	0.88	+/-	0.08	0.55	+/-	0.05	0.23	+/-	0.25	3.18	+/-	0.29	1.25	+/-	0.12
Si	0.10	+/-	0.02	0.01	+/-	0.02	0.03	+/-	0.03	0.33	+/-	0.04	0.32	+/-	0.03
P	0.48	+/-	0.05	0.19	+/-	0.02	0.07	+/-	0.10	1.31	+/-	0.12	1.30	+/-	0.12
S	0.11	+/-	0.02	0.03	+/-	0.02	0.00	+/-	0.02	1.70	+/-	0.16	0.34	+/-	0.04
Cl	0.00	+/-	0.02	0.00	+/-	0.02	-0.01	+/-	0.02	0.03	+/-	0.02	-0.01	+/-	0.02
K	0.11	+/-	0.02	0.02	+/-	0.02	0.02	+/-	0.05	0.61	+/-	0.06	0.54	+/-	0.05
Ca	0.00	+/-	0.09	0.00	+/-	0.09	0.00	+/-	0.09	0.00	+/-	0.10	0.00	+/-	0.10
Ti	0.00	+/-	0.05	0.02	+/-	0.05	0.00	+/-	0.05	0.00	+/-	0.06	0.00	+/-	0.05
V	0.01	+/-	0.02	0.00	+/-	0.02	0.00	+/-	0.02	0.05	+/-	0.02	0.00	+/-	0.02
Cr	0.02	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.02	+/-	0.01	0.00	+/-	0.01
Mn	0.59	+/-	0.06	0.13	+/-	0.01	0.11	+/-	0.14	1.65	+/-	0.15	0.17	+/-	0.02
Fe	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.03	0.00	+/-	0.01
Co	0.12	+/-	0.01	0.02	+/-	0.00	0.01	+/-	0.01	0.01	+/-	0.00	0.00	+/-	0.00
Ni	0.01	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.01	+/-	0.00	0.03	+/-	0.00
Cu	0.14	+/-	0.01	0.03	+/-	0.00	0.03	+/-	0.03	0.62	+/-	0.06	0.58	+/-	0.05
Zn	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Ga	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
As	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00
Se	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.01	+/-	0.00	0.00	+/-	0.00
Br	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.01	+/-	0.00	0.00	+/-	0.00
Rb	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Sr	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.01
Y	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Zr	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Mo	0.00	+/-	0.03	0.00	+/-	0.03	0.00	+/-	0.03	0.00	+/-	0.03	0.00	+/-	0.03
Pd	-0.01	+/-	0.03	0.00	+/-	0.04	-0.01	+/-	0.03	-0.01	+/-	0.04	-0.01	+/-	0.04
Ag	-0.02	+/-	0.03	-0.02	+/-	0.04	-0.02	+/-	0.03	-0.02	+/-	0.04	-0.02	+/-	0.04
Cd	0.00	+/-	0.04	0.00	+/-	0.04	0.00	+/-	0.04	0.00	+/-	0.05	0.00	+/-	0.05
In	-0.01	+/-	0.06	-0.01	+/-	0.06	0.00	+/-	0.05	0.01	+/-	0.06	0.00	+/-	0.06
Sn	-0.01	+/-	0.07	-0.01	+/-	0.07	0.00	+/-	0.06	0.00	+/-	0.07	-0.01	+/-	0.07
Sb	0.06	+/-	0.24	0.00	+/-	0.24	0.04	+/-	0.22	0.08	+/-	0.27	0.00	+/-	0.26
Ba	-0.07	+/-	0.32	-0.11	+/-	0.32	-0.11	+/-	0.29	-0.11	+/-	0.37	-0.11	+/-	0.35
La	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.03	0.00	+/-	0.02
Au	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Hg	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Tl	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Pb	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.02	+/-	0.01	0.00	+/-	0.01
U	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01

Appendix J. cont. Chemical Mass Emission Rate for Diesel Vehicles (mg/mi)

	1984 Mercedes 300D 748.7 mg/mi			1982 Isuzu I-Mark 267.7 mg/mi			1982 Volkswagen Vanagon 475.6 mg/mi			1982 Mercedes Benz 654.0 mg/mi			1982 Volkswagen Rabbit 485.1 mg/mi		
FTP Weight PM	65.94	+/-	7.59	45.50	+/-	5.32	101.9	+/-	11.60	182.0	+/-	20.53	154.6	+/-	17.27
Organic Carbon	664.7	+/-	65.43	157.9	+/-	15.57	268.4	+/-	26.44	250.5	+/-	24.68	180.0	+/-	17.71
Elemental Carbon	730.6	+/-	74.56	203.4	+/-	20.92	370.3	+/-	37.90	432.5	+/-	44.22	334.6	+/-	34.06
Total Carbon	0.68	+/-	0.19	0.03	+/-	0.10	0.07	+/-	0.11	0.20	+/-	0.11	0.46	+/-	0.13
NO ₃ ⁻	3.64	+/-	0.50	0.42	+/-	0.12	0.14	+/-	0.10	0.99	+/-	0.18	1.06	+/-	0.16
SO ₄ ²⁻	0.13	+/-	0.10	-0.09	+/-	0.09	0.00	+/-	0.09	0.10	+/-	0.10	0.27	+/-	0.10
Cl ⁻	2.83	+/-	0.32	0.30	+/-	0.10	0.30	+/-	0.10	0.41	+/-	0.10	0.63	+/-	0.11
NH ₄ ⁺	-0.28	+/-	0.37	-0.28	+/-	0.13	-0.28	+/-	0.21	-0.28	+/-	0.21	0.00	+/-	0.30
Na	0.10	+/-	0.07	0.02	+/-	0.08	-0.03	+/-	0.10	0.07	+/-	0.07	0.15	+/-	0.07
Mg	0.05	+/-	0.02	-0.03	+/-	0.03	0.00	+/-	0.02	0.00	+/-	0.02	0.03	+/-	0.05
Al	1.75	+/-	0.16	0.97	+/-	0.09	1.86	+/-	0.17	0.87	+/-	0.08	0.86	+/-	0.08
Si	0.89	+/-	0.08	0.11	+/-	0.02	0.28	+/-	0.03	0.33	+/-	0.03	0.48	+/-	0.05
P	3.14	+/-	0.28	0.69	+/-	0.06	0.89	+/-	0.08	1.36	+/-	0.13	2.11	+/-	0.19
S	0.44	+/-	0.05	0.12	+/-	0.02	0.44	+/-	0.05	0.34	+/-	0.04	0.35	+/-	0.04
Cl	0.02	+/-	0.02	-0.01	+/-	0.02	0.00	+/-	0.02	0.02	+/-	0.02	0.02	+/-	0.02
K	1.56	+/-	0.14	0.15	+/-	0.03	0.66	+/-	0.06	0.59	+/-	0.06	0.69	+/-	0.07
Ca	0.00	+/-	0.11	0.00	+/-	0.09	0.00	+/-	0.10	0.00	+/-	0.10	0.00	+/-	0.10
Ti	0.00	+/-	0.06	0.00	+/-	0.05	0.00	+/-	0.05	0.00	+/-	0.05	0.00	+/-	0.05
V	0.02	+/-	0.02	0.00	+/-	0.02	0.00	+/-	0.02	0.03	+/-	0.02	0.00	+/-	0.02
Cr	0.02	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Mn	5.90	+/-	0.53	0.10	+/-	0.01	1.20	+/-	0.11	0.84	+/-	0.08	0.32	+/-	0.03
Fe	0.00	+/-	0.09	0.00	+/-	0.01	0.00	+/-	0.02	0.00	+/-	0.01	0.00	+/-	0.01
Co	0.07	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00	0.02	+/-	0.00	0.00	+/-	0.01
Ni	0.02	+/-	0.00	0.00	+/-	0.00	0.01	+/-	0.00	0.00	+/-	0.00	0.03	+/-	0.00
Cu	1.45	+/-	0.13	0.21	+/-	0.02	0.54	+/-	0.05	0.70	+/-	0.06	1.16	+/-	0.10
Zn	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Ga	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
As	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Se	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00
Br	0.01	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00
Rb	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Sr	0.01	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00
Y	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Zr	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Mo	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Pd	0.00	+/-	0.03	0.00	+/-	0.03	0.00	+/-	0.03	0.00	+/-	0.03	0.00	+/-	0.03
Ag	-0.01	+/-	0.04	-0.01	+/-	0.03	0.00	+/-	0.04	-0.01	+/-	0.04	0.00	+/-	0.04
Cd	-0.02	+/-	0.04	-0.02	+/-	0.03	-0.02	+/-	0.04	-0.02	+/-	0.04	0.00	+/-	0.04
In	0.00	+/-	0.05	0.00	+/-	0.04	0.00	+/-	0.05	0.00	+/-	0.04	0.00	+/-	0.04
Sn	0.02	+/-	0.06	-0.01	+/-	0.06	-0.01	+/-	0.06	-0.01	+/-	0.06	0.01	+/-	0.06
Sb	0.00	+/-	0.07	-0.01	+/-	0.07	0.01	+/-	0.07	0.00	+/-	0.07	0.00	+/-	0.07
Ba	0.36	+/-	0.22	0.08	+/-	0.24	0.00	+/-	0.26	0.02	+/-	0.26	0.00	+/-	0.26
La	-0.06	+/-	0.37	-0.08	+/-	0.32	-0.11	+/-	0.35	-0.11	+/-	0.34	0.02	+/-	0.35
Au	0.00	+/-	0.05	0.00	+/-	0.01	0.00	+/-	0.02	0.00	+/-	0.03	0.00	+/-	0.04
Hg	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Tl	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.02	0.00	+/-	0.01
Pb	0.00	+/-	0.02	0.00	+/-	0.01	0.01	+/-	0.01	0.44	+/-	0.04	0.00	+/-	0.01
U	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01

Appendix J. cont. Chemical Mass Emission Rate for Diesel Vehicles (mg/mi)

	1982 Mercedes 300 TD			1981 Peugeot 505 TD			1981 Mercedes 300SD			1980 Mercedes 300TD			1980 Volkswagen Rabbit		
FTP Weight PM	464.4 mg/mi			677.4 mg/mi			247.3 mg/mi			1608.3 mg/mi			338.2 mg/mi		
Organic Carbon	50.94	+/-	5.93	77.73	+/-	8.90	30.24	+/-	3.64	679.2	+/-	76.05	72.81	+/-	8.35
Elemental Carbon	471.6	+/-	46.43	323.0	+/-	31.81	178.1	+/-	17.55	272.5	+/-	26.84	192.6	+/-	18.98
Total Carbon	522.5	+/-	53.39	400.7	+/-	40.99	208.3	+/-	21.43	951.7	+/-	97.06	265.4	+/-	27.22
NO ₃ ⁻	0.27	+/-	0.12	0.60	+/-	0.17	0.05	+/-	0.10	2.78	+/-	0.67	0.22	+/-	0.11
SO ₄ ²⁻	1.67	+/-	0.26	0.55	+/-	0.13	0.43	+/-	0.12	4.34	+/-	0.62	0.62	+/-	0.14
Cl ⁻	-0.01	+/-	0.09	-0.07	+/-	0.09	-0.03	+/-	0.09	0.64	+/-	0.25	-0.04	+/-	0.09
NH ₄ ⁺	0.96	+/-	0.14	0.16	+/-	0.09	0.23	+/-	0.10	2.53	+/-	0.36	0.48	+/-	0.11
Na	-0.19	+/-	0.16	-0.28	+/-	0.52	-0.17	+/-	0.12	-0.28	+/-	2.41	-0.28	+/-	0.16
Mg	0.13	+/-	0.07	0.25	+/-	0.08	-0.01	+/-	0.08	1.44	+/-	0.21	0.08	+/-	0.07
Al	0.03	+/-	0.02	0.07	+/-	0.02	-0.02	+/-	0.02	0.21	+/-	0.08	-0.01	+/-	0.02
Si	1.89	+/-	0.17	1.38	+/-	0.13	1.13	+/-	0.10	2.59	+/-	0.25	0.97	+/-	0.09
P	0.11	+/-	0.02	1.26	+/-	0.11	0.05	+/-	0.02	5.67	+/-	0.51	0.13	+/-	0.02
S	1.23	+/-	0.11	1.79	+/-	0.16	0.58	+/-	0.06	7.23	+/-	0.65	1.16	+/-	0.11
Cl	0.25	+/-	0.03	0.32	+/-	0.04	0.11	+/-	0.02	0.80	+/-	0.10	0.11	+/-	0.02
K	0.01	+/-	0.02	-0.01	+/-	0.03	0.00	+/-	0.02	0.14	+/-	0.04	0.00	+/-	0.02
Ca	0.28	+/-	0.03	2.86	+/-	0.26	0.21	+/-	0.03	6.34	+/-	0.57	0.30	+/-	0.04
Ti	0.00	+/-	0.10	0.00	+/-	0.10	0.00	+/-	0.10	0.00	+/-	0.27	0.00	+/-	0.10
V	0.00	+/-	0.06	0.00	+/-	0.05	0.00	+/-	0.05	0.00	+/-	0.17	0.00	+/-	0.05
Cr	0.00	+/-	0.02	0.00	+/-	0.02	0.00	+/-	0.02	0.00	+/-	0.06	0.00	+/-	0.02
Mn	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.03	0.00	+/-	0.01
Fe	1.45	+/-	0.13	2.09	+/-	0.19	0.13	+/-	0.01	3.30	+/-	0.30	0.28	+/-	0.03
Co	0.00	+/-	0.02	0.00	+/-	0.03	0.00	+/-	0.01	0.00	+/-	0.06	0.00	+/-	0.01
Ni	0.06	+/-	0.01	0.01	+/-	0.00	0.02	+/-	0.00	0.00	+/-	0.02	0.00	+/-	0.00
Cu	0.01	+/-	0.00	0.03	+/-	0.00	0.01	+/-	0.00	0.15	+/-	0.02	0.01	+/-	0.00
Zn	0.27	+/-	0.02	2.39	+/-	0.21	0.10	+/-	0.01	10.95	+/-	0.98	0.31	+/-	0.03
Ga	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.03	0.00	+/-	0.01
As	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.03	0.00	+/-	0.01
Se	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00
Br	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.01	+/-	0.01	0.00	+/-	0.00
Rb	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00
Sr	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00
Y	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.02	0.00	+/-	0.01
Zr	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.02	0.00	+/-	0.01
Mo	0.00	+/-	0.01	0.05	+/-	0.01	0.00	+/-	0.01	0.05	+/-	0.02	0.00	+/-	0.01
Pd	0.00	+/-	0.03	0.00	+/-	0.03	0.00	+/-	0.03	0.00	+/-	0.08	0.00	+/-	0.03
Ag	-0.01	+/-	0.04	-0.01	+/-	0.04	0.00	+/-	0.04	0.02	+/-	0.09	-0.01	+/-	0.04
Cd	-0.02	+/-	0.04	-0.02	+/-	0.04	-0.02	+/-	0.04	-0.01	+/-	0.10	-0.02	+/-	0.04
In	0.01	+/-	0.05	0.00	+/-	0.04	0.00	+/-	0.04	0.05	+/-	0.12	0.00	+/-	0.04
Sn	-0.01	+/-	0.06	-0.01	+/-	0.06	0.00	+/-	0.06	-0.01	+/-	0.15	-0.01	+/-	0.06
Sb	-0.01	+/-	0.07	-0.01	+/-	0.07	-0.01	+/-	0.07	0.07	+/-	0.19	-0.01	+/-	0.07
Ba	0.20	+/-	0.22	0.07	+/-	0.25	0.07	+/-	0.25	0.37	+/-	0.67	0.12	+/-	0.25
La	-0.06	+/-	0.35	-0.09	+/-	0.34	-0.11	+/-	0.34	0.38	+/-	0.91	-0.05	+/-	0.34
Au	0.00	+/-	0.02	0.00	+/-	0.09	0.00	+/-	0.01	0.00	+/-	0.39	0.00	+/-	0.02
Hg	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.05	0.00	+/-	0.01
Tl	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.03	0.00	+/-	0.01
Pb	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.05	+/-	0.02	0.00	+/-	0.01
U	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.03	0.00	+/-	0.01

Appendix J. cont. Chemical Mass Emission Rate for Diesel Vehicles (mg/mi)

	1980 Mercedes 240D 289.0 mg/mi			1979 Cadillac Seville 1402.4 mg/mi			1979 VW Rabbit 991.2 mg/mi			1977 Mercedes 300D 633.8 mg/mi		
FTP Weight PM	64.05	+/-	7.38	2345	+/-	262.1	501.5	+/-	56.13	113.4	+/-	12.88
Organic Carbon	129.8	+/-	12.79	428.3	+/-	42.18	131.7	+/-	12.02	250.6	+/-	24.68
Elemental Carbon	193.8	+/-	19.95	2773	+/-	282.4	633.2	+/-	61.43	364.0	+/-	37.25
Total Carbon	0.17	+/-	0.11	0.49	+/-	0.32	0.62	+/-	0.12	0.33	+/-	0.13
NO ₃ ⁻	0.50	+/-	0.13	5.20	+/-	0.73	1.28	+/-	0.16	0.67	+/-	0.15
SO ₄ ²⁻	0.03	+/-	0.09	0.72	+/-	0.27	0.13	+/-	0.09	0.02	+/-	0.09
Cl ⁻	0.37	+/-	0.10	2.30	+/-	0.35	0.27	+/-	0.11	0.40	+/-	0.10
NH ₄ ⁺	-0.28	+/-	0.19	-0.28	+/-	0.74	-0.28	+/-	0.73	-0.28	+/-	0.27
Na	0.11	+/-	0.07	0.21	+/-	0.28	0.30	+/-	0.08	0.11	+/-	0.07
Mg	-0.03	+/-	0.04	0.45	+/-	0.07	0.22	+/-	0.03	-0.05	+/-	0.04
Al	0.97	+/-	0.09	1.36	+/-	0.13	1.30	+/-	0.12	1.21	+/-	0.11
Si	0.24	+/-	0.03	0.71	+/-	0.08	1.37	+/-	0.12	0.41	+/-	0.04
P	0.81	+/-	0.08	4.30	+/-	0.39	2.44	+/-	0.22	1.15	+/-	0.11
S	0.18	+/-	0.03	5.67	+/-	0.52	0.48	+/-	0.05	0.28	+/-	0.03
Cl	0.00	+/-	0.02	0.17	+/-	0.03	1.21	+/-	0.11	0.01	+/-	0.02
K	0.45	+/-	0.05	1.41	+/-	0.13	2.18	+/-	0.20	0.74	+/-	0.07
Ca	0.00	+/-	0.10	0.00	+/-	0.24	0.00	+/-	0.10	0.00	+/-	0.10
Ti	0.00	+/-	0.06	0.00	+/-	0.11	0.00	+/-	0.06	0.00	+/-	0.06
V	0.00	+/-	0.02	0.05	+/-	0.02	0.01	+/-	0.02	0.00	+/-	0.02
Cr	0.00	+/-	0.01	0.03	+/-	0.01	0.01	+/-	0.01	0.00	+/-	0.01
Mn	0.13	+/-	0.02	4.35	+/-	0.39	2.52	+/-	0.23	0.19	+/-	0.02
Fe	0.00	+/-	0.01	0.00	+/-	0.07	0.00	+/-	0.04	0.00	+/-	0.01
Co	0.00	+/-	0.00	0.01	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.00
Ni	0.00	+/-	0.00	0.21	+/-	0.02	0.07	+/-	0.01	0.02	+/-	0.00
Cu	0.48	+/-	0.04	1.10	+/-	0.10	2.74	+/-	0.25	1.06	+/-	0.10
Zn	0.00	+/-	0.01	0.00	+/-	0.02	0.00	+/-	0.01	0.00	+/-	0.01
Ga	0.00	+/-	0.01	0.00	+/-	0.03	0.00	+/-	0.02	0.00	+/-	0.01
As	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00
Se	0.00	+/-	0.00	0.01	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00
Br	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00
Rb	0.00	+/-	0.00	0.00	+/-	0.01	0.00	+/-	0.00	0.00	+/-	0.00
Sr	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01	0.00	+/-	0.01
Y	0.00	+/-	0.01	0.00	+/-	0.02	0.00	+/-	0.01	0.00	+/-	0.01
Zr	0.00	+/-	0.01	0.00	+/-	0.03	0.01	+/-	0.01	0.01	+/-	0.01
Mo	0.00	+/-	0.03	0.03	+/-	0.08	0.00	+/-	0.03	0.00	+/-	0.03
Pd	0.00	+/-	0.04	0.04	+/-	0.09	0.00	+/-	0.04	-0.01	+/-	0.04
Ag	-0.02	+/-	0.04	-0.02	+/-	0.10	-0.02	+/-	0.04	-0.02	+/-	0.04
Cd	0.00	+/-	0.04	0.01	+/-	0.12	0.00	+/-	0.05	0.00	+/-	0.04
In	-0.01	+/-	0.06	-0.01	+/-	0.15	0.02	+/-	0.06	-0.01	+/-	0.06
Sn	0.00	+/-	0.07	0.02	+/-	0.18	0.01	+/-	0.07	-0.01	+/-	0.07
Sb	0.00	+/-	0.26	0.34	+/-	0.66	0.07	+/-	0.26	0.12	+/-	0.25
Ba	-0.04	+/-	0.35	-0.11	+/-	0.90	0.01	+/-	0.35	-0.04	+/-	0.34
La	0.00	+/-	0.02	0.00	+/-	0.05	0.00	+/-	0.10	0.00	+/-	0.04
Au	0.00	+/-	0.01	0.00	+/-	0.03	0.00	+/-	0.01	0.00	+/-	0.01
Hg	0.00	+/-	0.01	0.00	+/-	0.03	0.00	+/-	0.01	0.00	+/-	0.01
Tl	0.00	+/-	0.01	0.04	+/-	0.02	0.09	+/-	0.01	0.00	+/-	0.01
Pb	0.00	+/-	0.01	0.00	+/-	0.03	0.00	+/-	0.01	0.00	+/-	0.01
U	0.00	+/-	0.01	0.00	+/-	0.03	0.00	+/-	0.01	0.00	+/-	0.01

Appendix K. PAH Emission Rates for Gasoline Vehicles (mg/mi)

	1997 Ford Windstar +		1990 Dodge Ram +		1989 Hyundai Excel		1989 Dodge Caravan		1988 Mazda 626 +		1988 Dodge	
FTP Weighted PM	1994 Chevy Suburban 11.2 mg/mi (ave)		1989 GMC Sierra 14.3 mg/mi (ave)		200 mg/mi		47.9 mg/mi		1986 Alfa Romeo 15.1 mg/mi (ave)		54.5 mg/mi	
Naphthalene	2.065	+/- 0.226	1.703	+/- 0.186	2.884	+/- 0.316	4.263	+/- 0.466	4.567	+/- 0.499	5.379	+/- 0.588
2-Methylnaphthalene	0.568	+/- 0.061	0.499	+/- 0.053	1.341	+/- 0.143	1.815	+/- 0.193	1.797	+/- 0.192	2.696	+/- 0.287
1-Methylnaphthalene	0.306	+/- 0.032	0.321	+/- 0.034	0.791	+/- 0.083	0.973	+/- 0.102	1.049	+/- 0.109	1.460	+/- 0.152
2,6+2,7-Dimethylnaphthalene	0.080	+/- 0.009	0.084	+/- 0.009	0.198	+/- 0.021	0.252	+/- 0.026	0.239	+/- 0.025	0.400	+/- 0.041
1,7+1,3+1,6-Dimethylnaphthalene	0.110	+/- 0.012	0.130	+/- 0.014	0.282	+/- 0.029	0.344	+/- 0.036	0.366	+/- 0.038	0.554	+/- 0.057
2,3+1,4+1,5-Dimethylnaphthalene	0.031	+/- 0.006	0.044	+/- 0.007	0.096	+/- 0.011	0.100	+/- 0.012	0.131	+/- 0.015	0.171	+/- 0.019
1,2-Dimethylnaphthalene	0.012	+/- 0.003	0.018	+/- 0.004	0.046	+/- 0.006	0.037	+/- 0.005	0.055	+/- 0.007	0.069	+/- 0.008
1,8-Dimethylnaphthalene	0.000	+/- 0.003	0.000	+/- 0.003	0.001	+/- 0.003	0.001	+/- 0.003	0.002	+/- 0.003	0.002	+/- 0.003
Biphenyl	0.039	+/- 0.004	0.021	+/- 0.002	0.052	+/- 0.006	0.068	+/- 0.007	0.071	+/- 0.008	0.097	+/- 0.010
2-Methylbiphenyl	-0.007	+/- 0.001	-0.009	+/- 0.001	-0.004	+/- 0.001	0.001	+/- 0.001	-0.002	+/- 0.001	0.004	+/- 0.002
3-Methylbiphenyl	0.010	+/- 0.001	0.006	+/- 0.001	0.029	+/- 0.003	0.035	+/- 0.004	0.048	+/- 0.005	0.067	+/- 0.007
4-Methylbiphenyl	0.004	+/- 0.001	0.003	+/- 0.001	0.014	+/- 0.002	0.015	+/- 0.002	0.024	+/- 0.003	0.033	+/- 0.004
A-Trimethylnaphthalene	0.017	+/- 0.002	0.020	+/- 0.002	0.057	+/- 0.006	0.073	+/- 0.008	0.069	+/- 0.007	0.124	+/- 0.013
1-Ethyl-2-methylnaphthalene	0.004	+/- 0.001	0.007	+/- 0.001	0.020	+/- 0.003	0.018	+/- 0.002	0.022	+/- 0.003	0.032	+/- 0.004
B-Trimethylnaphthalene	0.013	+/- 0.002	0.017	+/- 0.002	0.053	+/- 0.006	0.060	+/- 0.007	0.075	+/- 0.008	0.106	+/- 0.012
C-Trimethylnaphthalene	0.013	+/- 0.002	0.019	+/- 0.002	0.056	+/- 0.006	0.057	+/- 0.006	0.079	+/- 0.009	0.102	+/- 0.011
2-Ethyl-1-methylnaphthalene	0.000	+/- 0.001	0.001	+/- 0.001	0.004	+/- 0.001	0.002	+/- 0.001	0.004	+/- 0.001	0.005	+/- 0.001
E-Trimethylnaphthalene	0.008	+/- 0.001	0.011	+/- 0.002	0.035	+/- 0.004	0.035	+/- 0.004	0.054	+/- 0.007	0.062	+/- 0.008
F-Trimethylnaphthalene	0.008	+/- 0.001	0.012	+/- 0.001	0.035	+/- 0.004	0.035	+/- 0.004	0.054	+/- 0.006	0.063	+/- 0.007
G-Trimethylnaphthalene	0.004	+/- 0.001	0.007	+/- 0.001	0.021	+/- 0.003	0.018	+/- 0.002	0.029	+/- 0.004	0.032	+/- 0.004
H-Trimethylnaphthalene	0.001	+/- 0.001	0.003	+/- 0.001	0.012	+/- 0.001	0.006	+/- 0.001	0.012	+/- 0.001	0.015	+/- 0.002
1,2,8-Trimethylnaphthalene	0.000	+/- 0.000	0.000	+/- 0.000	0.000	+/- 0.001	0.000	+/- 0.001	0.000	+/- 0.000	0.000	+/- 0.001
Acenaphthylene	0.073	+/- 0.009	0.026	+/- 0.004	0.073	+/- 0.009	0.181	+/- 0.022	0.171	+/- 0.020	0.130	+/- 0.016
Acenaphthene	0.006	+/- 0.002	0.004	+/- 0.002	0.013	+/- 0.002	0.012	+/- 0.002	0.015	+/- 0.002	0.028	+/- 0.003
Phenanthrene	0.047	+/- 0.005	0.016	+/- 0.002	0.067	+/- 0.007	0.084	+/- 0.009	0.125	+/- 0.013	0.089	+/- 0.010
Fluorene	0.011	+/- 0.001	0.008	+/- 0.001	0.039	+/- 0.004	0.045	+/- 0.005	0.066	+/- 0.007	0.060	+/- 0.006
A-Methylfluorene	0.002	+/- 0.001	0.003	+/- 0.001	0.022	+/- 0.003	0.013	+/- 0.002	0.029	+/- 0.004	0.030	+/- 0.004
1-Methylfluorene	0.001	+/- 0.001	0.001	+/- 0.001	0.010	+/- 0.001	0.006	+/- 0.001	0.011	+/- 0.002	0.011	+/- 0.002
B-Methylfluorene	0.000	+/- 0.000	0.001	+/- 0.001	0.005	+/- 0.001	0.003	+/- 0.001	0.006	+/- 0.001	0.007	+/- 0.001
C-Methylfluorene	0.022	+/- 0.003	0.007	+/- 0.001	0.026	+/- 0.003	0.015	+/- 0.002	0.050	+/- 0.006	0.040	+/- 0.005
A-Methylphenanthrene	0.002	+/- 0.001	0.003	+/- 0.001	0.015	+/- 0.003	0.007	+/- 0.001	0.016	+/- 0.003	0.017	+/- 0.003
2-Methylphenanthrene	0.002	+/- 0.001	0.003	+/- 0.001	0.018	+/- 0.002	0.007	+/- 0.001	0.017	+/- 0.002	0.016	+/- 0.002
B-Methylphenanthrene	0.001	+/- 0.001	0.002	+/- 0.001	0.007	+/- 0.002	0.003	+/- 0.001	0.007	+/- 0.002	0.010	+/- 0.002
C-Methylphenanthrene	0.002	+/- 0.001	0.002	+/- 0.001	0.012	+/- 0.003	0.005	+/- 0.001	0.011	+/- 0.002	0.013	+/- 0.003
1-Methylphenanthrene	0.002	+/- 0.001	0.002	+/- 0.001	0.011	+/- 0.002	0.005	+/- 0.001	0.010	+/- 0.001	0.009	+/- 0.001
3,6-Dimethylphenanthrene	0.000	+/- 0.001	0.001	+/- 0.001	0.004	+/- 0.001	0.001	+/- 0.001	0.002	+/- 0.001	0.004	+/- 0.001
A-Dimethylphenanthrene	0.001	+/- 0.000	0.001	+/- 0.001	0.006	+/- 0.001	0.002	+/- 0.001	0.003	+/- 0.001	0.005	+/- 0.001
B-Dimethylphenanthrene	0.000	+/- 0.000	0.000	+/- 0.000	0.003	+/- 0.001	0.001	+/- 0.001	0.002	+/- 0.001	0.002	+/- 0.001
C-Dimethylphenanthrene	0.001	+/- 0.001	0.002	+/- 0.001	0.010	+/- 0.001	0.003	+/- 0.001	0.006	+/- 0.001	0.010	+/- 0.001
1,7-Dimethylphenanthrene	0.001	+/- 0.001	0.001	+/- 0.001	0.006	+/- 0.001	0.002	+/- 0.001	0.005	+/- 0.001	0.006	+/- 0.002
D-Dimethylphenanthrene	0.000	+/- 0.000	0.000	+/- 0.001	0.002	+/- 0.001	0.001	+/- 0.001	0.001	+/- 0.001	0.002	+/- 0.001
E-Dimethylphenanthrene	0.001	+/- 0.000	0.001	+/- 0.001	0.005	+/- 0.001	0.001	+/- 0.001	0.002	+/- 0.001	0.003	+/- 0.001
Anthracene	0.009	+/- 0.002	0.005	+/- 0.001	0.019	+/- 0.005	0.022	+/- 0.005	0.038	+/- 0.009	0.033	+/- 0.008
9-Methylanthracene	0.000	+/- 0.001	0.000	+/- 0.001	0.002	+/- 0.001	0.001	+/- 0.001	0.001	+/- 0.001	0.002	+/- 0.001
Fluoranthene	0.014	+/- 0.002	0.004	+/- 0.001	0.013	+/- 0.002	0.023	+/- 0.003	0.026	+/- 0.003	0.018	+/- 0.002
Pyrene	0.016	+/- 0.002	0.006	+/- 0.001	0.019	+/- 0.002	0.028	+/- 0.003	0.032	+/- 0.004	0.022	+/- 0.003
A-Methylpyrene	0.000	+/- 0.001	0.000	+/- 0.001	0.002	+/- 0.001	0.001	+/- 0.001	0.000	+/- 0.001	0.001	+/- 0.001
B-Methylpyrene	0.000	+/- 0.000	0.000	+/- 0.000	0.003	+/- 0.001	0.001	+/- 0.001	0.002	+/- 0.001	0.002	+/- 0.001
C-Methylpyrene	0.001	+/- 0.001	0.001	+/- 0.000	0.005	+/- 0.001	0.003	+/- 0.001	0.004	+/- 0.001	0.005	+/- 0.001
D-Methylpyrene	0.001	+/- 0.000	0.000	+/- 0.000	0.002	+/- 0.001	0.002	+/- 0.001	0.002	+/- 0.001	0.003	+/- 0.001
E-Methylpyrene	0.000	+/- 0.000	0.000	+/- 0.000	0.003	+/- 0.001	0.001	+/- 0.001	0.001	+/- 0.001	0.002	+/- 0.001
F-Methylpyrene	0.000	+/- 0.000	0.000	+/- 0.000	0.002	+/- 0.001	0.001	+/- 0.001	0.001	+/- 0.001	0.002	+/- 0.001
Retene	0.000	+/- 0.001	0.000	+/- 0.001	0.000	+/- 0.001	0.000	+/- 0.001	0.000	+/- 0.001	0.000	+/- 0.001
Benzonaphthothiophene	0.000	+/- 0.001	0.000	+/- 0.001	0.001	+/- 0.001	0.000	+/- 0.001	0.000	+/- 0.001	0.000	+/- 0.001
Benz(a)anthracene	0.002	+/- 0.002	0.001	+/- 0.001	0.003	+/- 0.002	0.004	+/- 0.002	0.002	+/- 0.002	0.004	+/- 0.002
7-Methylbenz(a)anthracene	0.000	+/- 0.000	0.000	+/- 0.000	0.000	+/- 0.001	0.000	+/- 0.001	0.000	+/- 0.000	0.000	+/- 0.001
Chrysene	0.002	+/- 0.001	0.001	+/- 0.001	0.003	+/- 0.001	0.003	+/- 0.001	0.002	+/- 0.001	0.003	+/- 0.001
Benzo(b+j+k)fluoranthene	0.004	+/- 0.001	0.002	+/- 0.001	0.004	+/- 0.001	0.008	+/- 0.002	0.003	+/- 0.001	0.006	+/- 0.001
Benzo(e)pyrene	0.001	+/- 0.001	0.001	+/- 0.001	0.002	+/- 0.001	0.002	+/- 0.001	0.001	+/- 0.001	0.002	+/- 0.001
Benzo(a)pyrene	0.001	+/- 0.002	0.000	+/- 0.002	0.002	+/- 0.002	0.003	+/- 0.002	0.001	+/- 0.002	0.002	+/- 0.002
7-Methylbenzo(a)pyrene	0.000	+/- 0.000	0.000	+/- 0.000	0.000	+/- 0.001	0.000	+/- 0.001	0.000	+/- 0.000	0.000	+/- 0.001
Indeno[1,2,3-cd]pyrene	0.001	+/- 0.001	0.000	+/- 0.001	0.001	+/- 0.001	0.002	+/- 0.001	0.001	+/- 0.001	0.001	+/- 0.001
Dibenz(ah+ac)anthracene	0.000	+/- 0.002	0.000	+/- 0.002	0.000	+/- 0.002	0.000	+/- 0.002	0.000	+/- 0.002	0.000	+/- 0.002
Benzo(b)chrysene	0.000	+/- 0.001	0.000	+/- 0.001	0.000	+/- 0.001	0.000	+/- 0.001	0.000	+/- 0.001	0.000	+/- 0.001
Benzo(ghi)perylene	0.002	+/- 0.002	0.001	+/- 0.002	0.004	+/- 0.002	0.004	+/- 0.002	0.002	+/- 0.002	0.003	+/- 0.002
Coronene	0.001	+/- 0.001	0.000	+/- 0.001	0.001	+/- 0.002	0.002	+/- 0.002	0.001	+/- 0.001	0.001	+/- 0.002
Sum	3.516		3.028		6.469		8.719		9.424		12.076	

Appendix K. cont. PAH Emission Rates for Gasoline Vehicles (mg/mi)

	1985 Chevvr Sorint	1985 Dodge Caravan	1984 Buick Regal	1984 Dodge Ram	1984 Nissan Sentra	1981 Chevvr G-10 + 1981 Chevy C-10 21.8 mg/mi (ave.)
FTP Weighted PM	325 mg/mi	388 mg/mi	48.3 mg/mi	44.0 mg/mi	40.9 mg/mi	
Naphthalene	17.624 +/- 1.925	15.563 +/- 1.700	4.827 +/- 0.528	5.655 +/- 0.618	4.566 +/- 0.499	7.015 +/- 0.767
2-Methylnaphthalene	6.134 +/- 0.654	9.517 +/- 1.015	1.671 +/- 0.178	1.713 +/- 0.183	1.165 +/- 0.124	2.384 +/- 0.254
1-Methylnaphthalene	3.531 +/- 0.369	5.277 +/- 0.551	0.830 +/- 0.087	0.871 +/- 0.091	0.630 +/- 0.066	1.457 +/- 0.152
2,6+2,7-Dimethylnaphthalene	0.878 +/- 0.091	1.349 +/- 0.139	0.222 +/- 0.023	0.404 +/- 0.042	0.301 +/- 0.031	0.368 +/- 0.038
1,7+1,3+1,6-	1.336 +/- 0.138	1.965 +/- 0.202	0.276 +/- 0.029	0.570 +/- 0.059	0.444 +/- 0.046	0.594 +/- 0.061
2,3+1,4+1,5-	0.468 +/- 0.049	0.725 +/- 0.075	0.074 +/- 0.010	0.177 +/- 0.019	0.148 +/- 0.016	0.221 +/- 0.024
1,2-Dimethylnaphthalene	0.143 +/- 0.016	0.278 +/- 0.030	0.023 +/- 0.004	0.064 +/- 0.008	0.053 +/- 0.007	0.116 +/- 0.013
1,8-Dimethylnaphthalene	0.007 +/- 0.004	0.008 +/- 0.004	0.001 +/- 0.003	0.002 +/- 0.003	0.003 +/- 0.003	0.001 +/- 0.003
Biphenyl	0.340 +/- 0.036	0.224 +/- 0.024	0.072 +/- 0.008	0.207 +/- 0.022	0.230 +/- 0.024	0.097 +/- 0.010
2-Methylbiphenyl	0.035 +/- 0.004	0.044 +/- 0.005	0.003 +/- 0.001	0.016 +/- 0.002	0.015 +/- 0.002	0.001 +/- 0.001
3-Methylbiphenyl	0.207 +/- 0.022	0.176 +/- 0.018	0.035 +/- 0.004	0.099 +/- 0.010	0.103 +/- 0.011	0.063 +/- 0.007
4-Methylbiphenyl	0.101 +/- 0.011	0.077 +/- 0.008	0.016 +/- 0.002	0.044 +/- 0.005	0.043 +/- 0.005	0.031 +/- 0.003
A-Trimethylnaphthalene	0.286 +/- 0.030	0.526 +/- 0.056	0.034 +/- 0.004	0.090 +/- 0.009	0.067 +/- 0.007	0.100 +/- 0.011
1-Ethyl-2-methylnaphthalene	0.082 +/- 0.011	0.135 +/- 0.018	0.008 +/- 0.001	0.031 +/- 0.004	0.021 +/- 0.003	0.039 +/- 0.005
B-Trimethylnaphthalene	0.329 +/- 0.036	0.514 +/- 0.057	0.032 +/- 0.004	0.089 +/- 0.010	0.065 +/- 0.007	0.125 +/- 0.014
C-Trimethylnaphthalene	0.329 +/- 0.036	0.504 +/- 0.055	0.035 +/- 0.004	0.093 +/- 0.010	0.067 +/- 0.007	0.134 +/- 0.015
2-Ethyl-1-methylnaphthalene	0.012 +/- 0.003	0.017 +/- 0.004	0.001 +/- 0.001	0.004 +/- 0.001	0.004 +/- 0.001	0.007 +/- 0.002
E-Trimethylnaphthalene	0.209 +/- 0.026	0.345 +/- 0.042	0.022 +/- 0.003	0.055 +/- 0.007	0.043 +/- 0.005	0.091 +/- 0.011
F-Trimethylnaphthalene	0.210 +/- 0.022	0.304 +/- 0.032	0.023 +/- 0.002	0.063 +/- 0.007	0.045 +/- 0.005	0.087 +/- 0.009
G-Trimethylnaphthalene	0.108 +/- 0.014	0.178 +/- 0.023	0.010 +/- 0.001	0.029 +/- 0.004	0.021 +/- 0.003	0.046 +/- 0.006
H-Trimethylnaphthalene	0.065 +/- 0.007	0.084 +/- 0.009	0.002 +/- 0.001	0.011 +/- 0.001	0.006 +/- 0.001	0.028 +/- 0.003
1,2,8-Trimethylnaphthalene	0.001 +/- 0.001	0.001 +/- 0.001	0.000 +/- 0.001	0.004 +/- 0.001	0.003 +/- 0.001	0.000 +/- 0.001
Acenaphthylene	1.482 +/- 0.175	0.552 +/- 0.065	0.067 +/- 0.009	0.482 +/- 0.057	0.656 +/- 0.077	0.289 +/- 0.034
Acenaphthene	0.079 +/- 0.009	0.079 +/- 0.009	0.083 +/- 0.009	0.117 +/- 0.013	0.069 +/- 0.008	0.055 +/- 0.006
Phenanthrene	0.907 +/- 0.096	0.283 +/- 0.030	0.046 +/- 0.005	0.221 +/- 0.024	0.400 +/- 0.042	0.174 +/- 0.019
Fluorene	0.424 +/- 0.045	0.204 +/- 0.022	0.016 +/- 0.002	0.179 +/- 0.019	0.215 +/- 0.023	0.074 +/- 0.008
A-Methylfluorene	0.098 +/- 0.012	0.078 +/- 0.010	0.004 +/- 0.001	0.042 +/- 0.005	0.034 +/- 0.004	0.036 +/- 0.004
1-Methylfluorene	0.078 +/- 0.010	0.018 +/- 0.003	0.001 +/- 0.001	0.018 +/- 0.003	0.015 +/- 0.002	0.010 +/- 0.001
B-Methylfluorene	0.051 +/- 0.008	0.017 +/- 0.003	0.001 +/- 0.001	0.008 +/- 0.001	0.007 +/- 0.001	0.007 +/- 0.001
C-Methylfluorene	0.047 +/- 0.006	0.061 +/- 0.007	0.011 +/- 0.002	0.112 +/- 0.013	0.206 +/- 0.024	0.085 +/- 0.010
A-Methylphenanthrene	0.059 +/- 0.010	0.039 +/- 0.007	0.002 +/- 0.001	0.026 +/- 0.004	0.028 +/- 0.005	0.018 +/- 0.003
2-Methylphenanthrene	0.085 +/- 0.009	0.024 +/- 0.003	0.002 +/- 0.001	0.033 +/- 0.004	0.036 +/- 0.004	0.021 +/- 0.002
B-Methylphenanthrene	0.042 +/- 0.009	0.023 +/- 0.005	0.000 +/- 0.001	0.012 +/- 0.003	0.004 +/- 0.001	0.010 +/- 0.002
C-Methylphenanthrene	0.081 +/- 0.017	0.037 +/- 0.008	0.001 +/- 0.001	0.020 +/- 0.004	0.012 +/- 0.003	0.015 +/- 0.003
1-Methylphenanthrene	0.082 +/- 0.011	0.026 +/- 0.004	0.001 +/- 0.001	0.017 +/- 0.002	0.018 +/- 0.002	0.011 +/- 0.002
3,6-Dimethylphenanthrene	0.015 +/- 0.003	0.009 +/- 0.002	0.000 +/- 0.001	0.005 +/- 0.001	0.003 +/- 0.001	0.003 +/- 0.001
A-Dimethylphenanthrene	0.019 +/- 0.002	0.012 +/- 0.002	0.001 +/- 0.001	0.007 +/- 0.001	0.005 +/- 0.001	0.005 +/- 0.001
B-Dimethylphenanthrene	0.011 +/- 0.002	0.005 +/- 0.001	0.000 +/- 0.001	0.004 +/- 0.001	0.003 +/- 0.001	0.002 +/- 0.001
C-Dimethylphenanthrene	0.053 +/- 0.006	0.026 +/- 0.003	0.001 +/- 0.001	0.012 +/- 0.002	0.007 +/- 0.001	0.008 +/- 0.001
1,7-Dimethylphenanthrene	0.029 +/- 0.007	0.017 +/- 0.004	0.001 +/- 0.001	0.007 +/- 0.002	0.004 +/- 0.001	0.005 +/- 0.001
D-Dimethylphenanthrene	0.007 +/- 0.002	0.007 +/- 0.002	0.000 +/- 0.001	0.004 +/- 0.001	0.003 +/- 0.001	0.002 +/- 0.001
E-Dimethylphenanthrene	0.028 +/- 0.003	0.011 +/- 0.001	0.000 +/- 0.001	0.005 +/- 0.001	0.004 +/- 0.001	0.003 +/- 0.001
Anthracene	0.368 +/- 0.085	0.093 +/- 0.022	0.004 +/- 0.001	0.059 +/- 0.014	0.094 +/- 0.022	0.050 +/- 0.012
9-Methylanthracene	0.006 +/- 0.003	0.006 +/- 0.003	0.000 +/- 0.001	0.003 +/- 0.002	0.002 +/- 0.001	0.001 +/- 0.001
Fluoranthene	0.379 +/- 0.041	0.122 +/- 0.014	0.005 +/- 0.001	0.109 +/- 0.012	0.188 +/- 0.021	0.054 +/- 0.006
Pyrene	0.502 +/- 0.052	0.155 +/- 0.016	0.008 +/- 0.001	0.199 +/- 0.021	0.226 +/- 0.024	0.075 +/- 0.008
A-Methylpyrene	0.002 +/- 0.001	0.001 +/- 0.001	0.001 +/- 0.001	0.001 +/- 0.001	0.001 +/- 0.001	0.002 +/- 0.001
B-Methylpyrene	0.016 +/- 0.002	0.006 +/- 0.001	0.000 +/- 0.001	0.005 +/- 0.001	0.006 +/- 0.001	0.002 +/- 0.001
C-Methylpyrene	0.057 +/- 0.006	0.021 +/- 0.002	0.001 +/- 0.001	0.010 +/- 0.001	0.012 +/- 0.001	0.003 +/- 0.001
D-Methylpyrene	0.042 +/- 0.005	0.013 +/- 0.002	0.000 +/- 0.001	0.004 +/- 0.001	0.003 +/- 0.001	0.001 +/- 0.001
E-Methylpyrene	0.016 +/- 0.002	0.006 +/- 0.001	0.000 +/- 0.001	0.006 +/- 0.001	0.006 +/- 0.001	0.002 +/- 0.001
F-Methylpyrene	0.030 +/- 0.003	0.010 +/- 0.001	0.000 +/- 0.001	0.007 +/- 0.001	0.005 +/- 0.001	0.001 +/- 0.001
Retene	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001
Benzonaphthothiophene	0.002 +/- 0.001	0.005 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.001 +/- 0.001	0.000 +/- 0.001
Benz(a)anthracene	0.049 +/- 0.013	0.013 +/- 0.004	0.001 +/- 0.002	0.006 +/- 0.002	0.017 +/- 0.005	0.003 +/- 0.002
7-Methylbenz(a)anthracene	0.001 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001
Chrysene	0.053 +/- 0.010	0.017 +/- 0.003	0.001 +/- 0.001	0.004 +/- 0.001	0.015 +/- 0.003	0.002 +/- 0.001
Benzo(b+j+k)fluoranthene	0.131 +/- 0.020	0.033 +/- 0.005	0.004 +/- 0.001	0.012 +/- 0.002	0.051 +/- 0.008	0.006 +/- 0.001
Benzo(e)pyrene	0.044 +/- 0.007	0.014 +/- 0.002	0.002 +/- 0.001	0.009 +/- 0.002	0.016 +/- 0.003	0.004 +/- 0.001
Benzo(a)pyrene	0.066 +/- 0.011	0.016 +/- 0.003	0.001 +/- 0.002	0.007 +/- 0.002	0.011 +/- 0.002	0.004 +/- 0.002
7-Methylbenzo(a)pyrene	0.003 +/- 0.002	0.001 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001
Indeno(1,2,3-cd)pyrene	0.053 +/- 0.006	0.014 +/- 0.002	0.001 +/- 0.001	0.004 +/- 0.001	0.007 +/- 0.002	0.003 +/- 0.001
Dibenz(ah+ac)anthracene	0.005 +/- 0.002	0.001 +/- 0.002	0.000 +/- 0.002	0.000 +/- 0.002	0.001 +/- 0.002	0.000 +/- 0.002
Benzo(b)chrysene	0.003 +/- 0.001	0.001 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001
Benzo(ghi)perylene	0.145 +/- 0.018	0.050 +/- 0.006	0.007 +/- 0.002	0.034 +/- 0.005	0.027 +/- 0.004	0.015 +/- 0.003
Coronene	0.101 +/- 0.013	0.035 +/- 0.005	0.007 +/- 0.002	0.034 +/- 0.005	0.015 +/- 0.003	0.013 +/- 0.002
	38.182	39.971	8.506	12.133	10.473	14.078

Appendix K. cont. PAH Emission Rates for Gasoline Vehicles (mg/mi)

	1980 Ford E350	1979 Ford Mustang	1978 Chevy C-20	1978 Pontiac LeMans	1977 Datsun 200 SX	1973 Ford Ranger
FTP Weighted PM	45.1 mg/mi	41.0 mg/mi	72.5 mg/mi	11.1 mg/mi	40.3 mg/mi	46.8 mg/mi
Naphthalene	8.287 +/- 0.906	18.638 +/- 2.035	1.656 +/- 0.182	2.698 +/- 0.295	1.963 +/- 0.215	6.571 +/- 0.718
2-Methylnaphthalene	5.879 +/- 0.627	11.370 +/- 1.212	0.641 +/- 0.068	1.042 +/- 0.111	0.411 +/- 0.044	2.816 +/- 0.300
1-Methylnaphthalene	2.989 +/- 0.312	6.367 +/- 0.664	0.358 +/- 0.037	0.549 +/- 0.057	0.246 +/- 0.026	1.445 +/- 0.151
2,6+2,7-Dimethylnaphthalene	1.375 +/- 0.142	1.268 +/- 0.131	0.117 +/- 0.012	0.282 +/- 0.029	0.144 +/- 0.015	0.315 +/- 0.033
1,7+1,3+1,6-Dimethylnaphthalene	1.942 +/- 0.200	1.835 +/- 0.189	0.166 +/- 0.018	0.407 +/- 0.042	0.213 +/- 0.022	0.427 +/- 0.044
2,3+1,4+1,5-Dimethylnaphthalene	0.647 +/- 0.067	0.713 +/- 0.074	0.052 +/- 0.008	0.127 +/- 0.014	0.059 +/- 0.009	0.128 +/- 0.014
1,2-Dimethylnaphthalene	0.228 +/- 0.025	0.221 +/- 0.024	0.019 +/- 0.004	0.050 +/- 0.006	0.023 +/- 0.005	0.050 +/- 0.006
1,8-Dimethylnaphthalene	0.003 +/- 0.003	0.011 +/- 0.005	0.001 +/- 0.003	0.001 +/- 0.003	0.000 +/- 0.003	0.002 +/- 0.003
Biphenyl	0.240 +/- 0.026	0.332 +/- 0.035	0.040 +/- 0.004	0.089 +/- 0.010	0.096 +/- 0.010	0.083 +/- 0.009
2-Methylbiphenyl	0.047 +/- 0.005	0.048 +/- 0.006	-0.005 +/- 0.001	-0.014 +/- 0.002	0.006 +/- 0.002	0.002 +/- 0.001
3-Methylbiphenyl	0.154 +/- 0.016	0.203 +/- 0.021	0.023 +/- 0.003	0.048 +/- 0.005	0.027 +/- 0.003	0.052 +/- 0.006
4-Methylbiphenyl	0.065 +/- 0.007	0.091 +/- 0.010	0.010 +/- 0.001	0.022 +/- 0.003	0.011 +/- 0.001	0.019 +/- 0.002
A-Trimethylnaphthalene	0.419 +/- 0.044	0.483 +/- 0.051	0.034 +/- 0.004	0.060 +/- 0.006	0.034 +/- 0.004	0.068 +/- 0.007
1-Ethyl-2-methylnaphthalene	0.099 +/- 0.013	0.114 +/- 0.015	0.010 +/- 0.001	0.020 +/- 0.003	0.009 +/- 0.001	0.019 +/- 0.003
B-Trimethylnaphthalene	0.368 +/- 0.041	0.433 +/- 0.048	0.036 +/- 0.004	0.065 +/- 0.007	0.027 +/- 0.003	0.059 +/- 0.007
C-Trimethylnaphthalene	0.380 +/- 0.041	0.426 +/- 0.046	0.037 +/- 0.004	0.070 +/- 0.008	0.028 +/- 0.003	0.059 +/- 0.006
2-Ethyl-1-methylnaphthalene	0.013 +/- 0.003	0.016 +/- 0.004	0.001 +/- 0.001	0.003 +/- 0.001	0.002 +/- 0.001	0.002 +/- 0.001
E-Trimethylnaphthalene	0.247 +/- 0.030	0.291 +/- 0.036	0.025 +/- 0.003	0.043 +/- 0.005	0.015 +/- 0.002	0.033 +/- 0.004
F-Trimethylnaphthalene	0.238 +/- 0.025	0.275 +/- 0.029	0.026 +/- 0.003	0.050 +/- 0.005	0.016 +/- 0.002	0.037 +/- 0.004
G-Trimethylnaphthalene	0.123 +/- 0.016	0.152 +/- 0.020	0.014 +/- 0.002	0.023 +/- 0.003	0.007 +/- 0.001	0.020 +/- 0.003
H-Trimethylnaphthalene	0.035 +/- 0.004	0.058 +/- 0.006	0.005 +/- 0.001	0.006 +/- 0.001	0.003 +/- 0.001	0.007 +/- 0.001
1,2,8-Trimethylnaphthalene	0.007 +/- 0.002	0.002 +/- 0.001	0.000 +/- 0.001	0.002 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001
Acenaphthylene	0.553 +/- 0.065	0.610 +/- 0.072	0.051 +/- 0.007	0.147 +/- 0.018	0.194 +/- 0.023	0.066 +/- 0.008
Acenaphthene	0.105 +/- 0.011	0.110 +/- 0.012	0.022 +/- 0.003	0.033 +/- 0.004	0.153 +/- 0.017	0.009 +/- 0.002
Phenanthrene	0.227 +/- 0.024	0.532 +/- 0.056	0.065 +/- 0.007	0.105 +/- 0.011	0.125 +/- 0.013	0.044 +/- 0.005
Fluorene	0.182 +/- 0.019	0.254 +/- 0.027	0.023 +/- 0.003	0.092 +/- 0.010	0.061 +/- 0.006	0.034 +/- 0.004
A-Methylfluorene	0.049 +/- 0.006	0.086 +/- 0.011	0.014 +/- 0.002	0.029 +/- 0.004	0.007 +/- 0.001	0.015 +/- 0.002
1-Methylfluorene	0.024 +/- 0.003	0.061 +/- 0.008	0.006 +/- 0.001	0.015 +/- 0.002	0.003 +/- 0.001	0.001 +/- 0.001
B-Methylfluorene	0.009 +/- 0.002	0.036 +/- 0.006	0.002 +/- 0.001	0.006 +/- 0.001	0.002 +/- 0.001	0.003 +/- 0.001
C-Methylfluorene	0.093 +/- 0.011	0.234 +/- 0.027	0.026 +/- 0.003	0.029 +/- 0.004	0.044 +/- 0.005	0.064 +/- 0.007
A-Methylphenanthrene	0.028 +/- 0.005	0.031 +/- 0.005	0.015 +/- 0.003	0.025 +/- 0.004	0.008 +/- 0.002	0.007 +/- 0.001
2-Methylphenanthrene	0.032 +/- 0.004	0.066 +/- 0.007	0.017 +/- 0.002	0.030 +/- 0.003	0.009 +/- 0.001	0.002 +/- 0.001
B-Methylphenanthrene	0.014 +/- 0.003	0.030 +/- 0.006	0.003 +/- 0.001	0.006 +/- 0.001	0.004 +/- 0.001	0.004 +/- 0.001
C-Methylphenanthrene	0.025 +/- 0.005	0.056 +/- 0.011	0.009 +/- 0.002	0.011 +/- 0.002	0.007 +/- 0.002	0.006 +/- 0.001
1-Methylphenanthrene	0.018 +/- 0.003	0.066 +/- 0.009	0.009 +/- 0.001	0.013 +/- 0.002	0.007 +/- 0.001	0.004 +/- 0.001
3,6-Dimethylphenanthrene	0.008 +/- 0.002	0.007 +/- 0.002	0.004 +/- 0.001	0.005 +/- 0.001	0.002 +/- 0.001	0.001 +/- 0.001
A-Dimethylphenanthrene	0.011 +/- 0.001	0.009 +/- 0.001	0.006 +/- 0.001	0.007 +/- 0.001	0.002 +/- 0.001	0.001 +/- 0.001
B-Dimethylphenanthrene	0.006 +/- 0.001	0.006 +/- 0.001	0.003 +/- 0.001	0.004 +/- 0.001	0.001 +/- 0.001	0.001 +/- 0.001
C-Dimethylphenanthrene	0.018 +/- 0.002	0.029 +/- 0.003	0.008 +/- 0.001	0.010 +/- 0.001	0.004 +/- 0.001	0.003 +/- 0.001
1,7-Dimethylphenanthrene	0.013 +/- 0.003	0.010 +/- 0.002	0.005 +/- 0.001	0.005 +/- 0.001	0.002 +/- 0.001	0.002 +/- 0.001
D-Dimethylphenanthrene	0.005 +/- 0.001	0.012 +/- 0.003	0.003 +/- 0.001	0.003 +/- 0.001	0.001 +/- 0.001	0.001 +/- 0.001
E-Dimethylphenanthrene	0.009 +/- 0.001	0.015 +/- 0.002	0.004 +/- 0.001	0.004 +/- 0.001	0.002 +/- 0.001	0.001 +/- 0.001
Anthracene	0.058 +/- 0.013	0.203 +/- 0.047	0.013 +/- 0.003	0.025 +/- 0.006	0.032 +/- 0.007	0.015 +/- 0.004
9-Methylanthracene	0.003 +/- 0.002	0.003 +/- 0.002	0.001 +/- 0.001	0.001 +/- 0.001	0.001 +/- 0.001	0.001 +/- 0.001
Fluoranthene	0.130 +/- 0.014	0.129 +/- 0.014	0.023 +/- 0.003	0.022 +/- 0.003	0.050 +/- 0.006	0.006 +/- 0.001
Pyrene	0.200 +/- 0.021	0.171 +/- 0.018	0.039 +/- 0.004	0.035 +/- 0.004	0.055 +/- 0.006	0.009 +/- 0.001
A-Methylpyrene	0.001 +/- 0.001	0.001 +/- 0.001	0.001 +/- 0.001	0.000 +/- 0.001	0.001 +/- 0.001	0.001 +/- 0.001
B-Methylpyrene	0.006 +/- 0.001	0.007 +/- 0.001	0.002 +/- 0.001	0.005 +/- 0.001	0.002 +/- 0.001	0.000 +/- 0.001
C-Methylpyrene	0.012 +/- 0.001	0.020 +/- 0.002	0.004 +/- 0.001	0.007 +/- 0.001	0.005 +/- 0.001	0.001 +/- 0.001
D-Methylpyrene	0.006 +/- 0.001	0.013 +/- 0.002	0.001 +/- 0.001	0.002 +/- 0.001	0.003 +/- 0.001	0.001 +/- 0.001
E-Methylpyrene	0.007 +/- 0.001	0.007 +/- 0.001	0.002 +/- 0.001	0.004 +/- 0.001	0.002 +/- 0.001	0.000 +/- 0.001
F-Methylpyrene	0.007 +/- 0.001	0.008 +/- 0.001	0.002 +/- 0.001	0.003 +/- 0.001	0.002 +/- 0.001	0.000 +/- 0.001
Retene	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001
Benzonaphthothiophene	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001
Benz(a)anthracene	0.007 +/- 0.002	0.015 +/- 0.004	0.002 +/- 0.002	0.002 +/- 0.002	0.007 +/- 0.002	0.001 +/- 0.002
7-Methylbenz(a)anthracene	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001
Chrysene	0.006 +/- 0.001	0.017 +/- 0.003	0.002 +/- 0.001	0.003 +/- 0.001	0.006 +/- 0.001	0.001 +/- 0.001
Benzo(b+j+k)fluoranthene	0.020 +/- 0.003	0.035 +/- 0.005	0.004 +/- 0.001	0.005 +/- 0.001	0.017 +/- 0.003	0.001 +/- 0.001
Benzo(e)pyrene	0.013 +/- 0.002	0.012 +/- 0.002	0.002 +/- 0.001	0.004 +/- 0.001	0.005 +/- 0.001	0.000 +/- 0.001
Benzo(a)pyrene	0.011 +/- 0.002	0.014 +/- 0.003	0.001 +/- 0.002	0.002 +/- 0.002	0.004 +/- 0.002	0.000 +/- 0.002
7-Methylbenzo(a)pyrene	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001
Indeno(1,2,3-cd)pyrene	0.006 +/- 0.002	0.010 +/- 0.002	0.001 +/- 0.001	0.001 +/- 0.001	0.002 +/- 0.002	0.000 +/- 0.001
Dibenz(ah+ac)anthracene	0.000 +/- 0.002	0.001 +/- 0.002	0.000 +/- 0.002	0.000 +/- 0.002	0.000 +/- 0.002	0.000 +/- 0.002
Benzo(b)chrysene	0.000 +/- 0.001	0.001 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001
Benzo(ghi)perylene	0.030 +/- 0.004	0.041 +/- 0.005	0.004 +/- 0.002	0.004 +/- 0.002	0.005 +/- 0.002	0.000 +/- 0.002
Coronene	0.020 +/- 0.003	0.032 +/- 0.004	0.003 +/- 0.002	0.003 +/- 0.002	0.003 +/- 0.002	0.000 +/- 0.002
	25.761	46.343	3.668	6.350	4.178	12.519

Appendix K. cont. PAH Emission Rates for Gasoline Vehicles (mg/mi)

	1972 Chevy C-20		1965 Ford Mustang	
FTP Weighted PM	28.3 mg/mi		63.2 mg/mi	
Naphthalene	14.421	+/- 1.575	11.131	+/- 1.216
2-Methylnaphthalene	10.404	+/- 1.109	4.339	+/- 0.463
1-Methylnaphthalene	5.291	+/- 0.552	2.501	+/- 0.261
2,6+2,7-Dimethylnaphthalene	1.814	+/- 0.187	0.251	+/- 0.026
1,7+1,3+1,6-Dimethylnaphthalene	2.660	+/- 0.274	0.768	+/- 0.079
2,3+1,4+1,5-Dimethylnaphthalene	0.965	+/- 0.100	0.302	+/- 0.032
1,2-Dimethylnaphthalene	0.418	+/- 0.045	0.158	+/- 0.017
1,8-Dimethylnaphthalene	0.000	+/- 0.003	0.004	+/- 0.003
Biphenyl	0.222	+/- 0.024	0.109	+/- 0.012
2-Methylbiphenyl	0.052	+/- 0.006	0.011	+/- 0.002
3-Methylbiphenyl	0.236	+/- 0.025	0.114	+/- 0.012
4-Methylbiphenyl	0.106	+/- 0.011	0.062	+/- 0.007
A-Trimethylnaphthalene	0.572	+/- 0.061	0.170	+/- 0.018
1-Ethyl-2-methylnaphthalene	0.160	+/- 0.021	0.071	+/- 0.009
B-Trimethylnaphthalene	0.671	+/- 0.074	0.227	+/- 0.025
C-Trimethylnaphthalene	0.696	+/- 0.076	0.248	+/- 0.027
2-Ethyl-1-methylnaphthalene	0.024	+/- 0.006	0.010	+/- 0.003
E-Trimethylnaphthalene	0.448	+/- 0.055	0.159	+/- 0.020
F-Trimethylnaphthalene	0.472	+/- 0.050	0.160	+/- 0.017
G-Trimethylnaphthalene	0.213	+/- 0.028	0.106	+/- 0.014
H-Trimethylnaphthalene	0.102	+/- 0.011	0.062	+/- 0.007
1,2,8-Trimethylnaphthalene	0.013	+/- 0.004	0.002	+/- 0.001
Acenaphthylene	0.400	+/- 0.047	0.213	+/- 0.025
Acenaphthene	0.126	+/- 0.014	0.028	+/- 0.003
Phenanthrene	0.250	+/- 0.027	0.162	+/- 0.017
Fluorene	0.278	+/- 0.029	0.101	+/- 0.011
A-Methylfluorene	0.134	+/- 0.017	0.058	+/- 0.007
1-Methylfluorene	0.068	+/- 0.009	0.019	+/- 0.003
B-Methylfluorene	0.031	+/- 0.005	0.010	+/- 0.002
C-Methylfluorene	0.054	+/- 0.006	0.092	+/- 0.011
A-Methylphenanthrene	0.085	+/- 0.014	0.043	+/- 0.007
2-Methylphenanthrene	0.104	+/- 0.012	0.043	+/- 0.005
B-Methylphenanthrene	0.044	+/- 0.009	0.026	+/- 0.005
C-Methylphenanthrene	0.046	+/- 0.010	0.028	+/- 0.006
1-Methylphenanthrene	0.044	+/- 0.006	0.024	+/- 0.003
3,6-Dimethylphenanthrene	0.022	+/- 0.005	0.010	+/- 0.002
A-Dimethylphenanthrene	0.032	+/- 0.004	0.012	+/- 0.002
B-Dimethylphenanthrene	0.018	+/- 0.003	0.007	+/- 0.001
C-Dimethylphenanthrene	0.049	+/- 0.006	0.027	+/- 0.003
1,7-Dimethylphenanthrene	0.029	+/- 0.007	0.017	+/- 0.004
D-Dimethylphenanthrene	0.011	+/- 0.003	0.007	+/- 0.002
E-Dimethylphenanthrene	0.019	+/- 0.002	0.012	+/- 0.002
Anthracene	0.104	+/- 0.024	0.073	+/- 0.017
9-Methylanthracene	0.006	+/- 0.004	0.004	+/- 0.003
Fluoranthene	0.060	+/- 0.007	0.045	+/- 0.005
Pyrene	0.088	+/- 0.009	0.053	+/- 0.006
A-Methylpyrene	0.002	+/- 0.001	0.002	+/- 0.001
B-Methylpyrene	0.011	+/- 0.001	0.006	+/- 0.001
C-Methylpyrene	0.020	+/- 0.002	0.012	+/- 0.001
D-Methylpyrene	0.010	+/- 0.001	0.007	+/- 0.001
E-Methylpyrene	0.014	+/- 0.002	0.005	+/- 0.001
F-Methylpyrene	0.010	+/- 0.001	0.005	+/- 0.001
Retene	0.000	+/- 0.001	0.000	+/- 0.001
Benzonaphthothiophene	0.000	+/- 0.001	0.001	+/- 0.001
Benz(a)anthracene	0.009	+/- 0.003	0.008	+/- 0.003
7-Methylbenz(a)anthracene	0.000	+/- 0.001	0.000	+/- 0.001
Chrysene	0.007	+/- 0.002	0.007	+/- 0.002
Benzo(b+j+k)fluoranthene	0.012	+/- 0.002	0.011	+/- 0.002
Benzo(c)pyrene	0.007	+/- 0.001	0.005	+/- 0.001
Benzo(a)pyrene	0.006	+/- 0.002	0.004	+/- 0.002
7-Methylbenzo(a)pyrene	0.000	+/- 0.001	0.000	+/- 0.001
Indeno[1,2,3-cd]pyrene	0.002	+/- 0.001	0.002	+/- 0.001
Dibenz(ah+ac)anthracene	0.000	+/- 0.002	0.000	+/- 0.002
Benzo(b)chrysene	0.000	+/- 0.001	0.000	+/- 0.001
Benzo(ghi)perylene	0.008	+/- 0.002	0.009	+/- 0.002
Coronene	0.004	+/- 0.002	0.004	+/- 0.002
	42.185		22.169	

Appendix L. PAH Emission Rates for Diesel Vehicles (mg/mi)

FTP Weighted PM	1993 Mercedes 300D		1985 Mercedes 300		1985 Mercedes 300		1984 Volkswagen Rabbits		1984 Toyota Corolla						
	86.6 mg/mi		70.1 mg/mi		15.5 mg/mi		636.6 mg/mi		572.4 mg/mi						
Naphthalene	0.501	+/-	0.056	7.444	+/-	0.814	1.256	+/-	0.140	5.258	+/-	0.578	1.563	+/-	0.173
2-Methylnaphthalene	0.138	+/-	0.015	0.807	+/-	0.086	0.308	+/-	0.034	0.986	+/-	0.106	0.405	+/-	0.044
1-Methylnaphthalene	0.110	+/-	0.012	0.739	+/-	0.077	0.253	+/-	0.027	0.747	+/-	0.078	0.290	+/-	0.031
2,6+2,7-Dimethylnaphthalene	0.078	+/-	0.009	0.358	+/-	0.037	0.155	+/-	0.018	0.364	+/-	0.040	0.267	+/-	0.029
1,7+1,3+1,6-Dimethylnaphthalene	0.165	+/-	0.018	0.767	+/-	0.079	0.346	+/-	0.038	0.722	+/-	0.076	0.488	+/-	0.052
2,3+1,4+1,5-Dimethylnaphthalene	0.057	+/-	0.011	0.299	+/-	0.032	0.124	+/-	0.022	0.264	+/-	0.036	0.155	+/-	0.024
1,2-Dimethylnaphthalene	0.020	+/-	0.006	0.117	+/-	0.014	0.045	+/-	0.012	0.098	+/-	0.018	0.061	+/-	0.013
1,8-Dimethylnaphthalene	0.001	+/-	0.005	0.009	+/-	0.006	0.001	+/-	0.009	0.003	+/-	0.012	0.001	+/-	0.009
Biphenyl	0.093	+/-	0.010	0.735	+/-	0.078	0.248	+/-	0.027	0.594	+/-	0.063	0.194	+/-	0.021
2-Methylbiphenyl	0.008	+/-	0.002	0.063	+/-	0.007	0.043	+/-	0.005	0.098	+/-	0.011	0.044	+/-	0.006
3-Methylbiphenyl	0.069	+/-	0.007	0.258	+/-	0.027	0.155	+/-	0.016	0.378	+/-	0.040	0.131	+/-	0.014
4-Methylbiphenyl	0.024	+/-	0.003	0.077	+/-	0.008	0.048	+/-	0.005	0.139	+/-	0.015	0.048	+/-	0.005
A-Trimethylnaphthalene	0.034	+/-	0.004	0.167	+/-	0.018	0.066	+/-	0.007	0.170	+/-	0.018	0.112	+/-	0.012
1-Ethyl-2-methylnaphthalene	0.011	+/-	0.002	0.063	+/-	0.008	0.022	+/-	0.003	0.057	+/-	0.008	0.031	+/-	0.004
B-Trimethylnaphthalene	0.046	+/-	0.005	0.207	+/-	0.023	0.076	+/-	0.009	0.208	+/-	0.023	0.143	+/-	0.016
C-Trimethylnaphthalene	0.061	+/-	0.007	0.275	+/-	0.030	0.104	+/-	0.011	0.272	+/-	0.030	0.168	+/-	0.018
2-Ethyl-1-methylnaphthalene	0.004	+/-	0.001	0.019	+/-	0.005	0.006	+/-	0.002	0.017	+/-	0.005	0.012	+/-	0.003
E-Trimethylnaphthalene	0.043	+/-	0.005	0.163	+/-	0.020	0.059	+/-	0.008	0.185	+/-	0.023	0.107	+/-	0.013
F-Trimethylnaphthalene	0.033	+/-	0.004	0.148	+/-	0.016	0.053	+/-	0.006	0.149	+/-	0.016	0.102	+/-	0.011
G-Trimethylnaphthalene	0.017	+/-	0.002	0.087	+/-	0.011	0.028	+/-	0.004	0.075	+/-	0.010	0.058	+/-	0.008
H-Trimethylnaphthalene	0.005	+/-	0.001	0.033	+/-	0.004	0.005	+/-	0.002	0.028	+/-	0.004	0.014	+/-	0.002
1,2,8-Trimethylnaphthalene	0.002	+/-	0.001	0.020	+/-	0.005	0.002	+/-	0.002	0.009	+/-	0.003	0.004	+/-	0.002
Acenaphthylene	0.070	+/-	0.010	1.136	+/-	0.134	0.096	+/-	0.015	2.483	+/-	0.293	0.374	+/-	0.045
Acenaphthene	0.009	+/-	0.003	0.056	+/-	0.007	0.009	+/-	0.005	0.142	+/-	0.017	0.038	+/-	0.006
Phenanthrene	0.122	+/-	0.013	1.371	+/-	0.145	0.226	+/-	0.024	1.195	+/-	0.127	0.447	+/-	0.048
Fluorene	0.035	+/-	0.004	0.221	+/-	0.023	0.041	+/-	0.005	0.699	+/-	0.074	0.166	+/-	0.018
A-Methylfluorene	0.010	+/-	0.002	0.037	+/-	0.005	0.008	+/-	0.002	0.069	+/-	0.009	0.023	+/-	0.003
1-Methylfluorene	0.010	+/-	0.002	0.033	+/-	0.005	0.010	+/-	0.002	0.050	+/-	0.007	0.023	+/-	0.004
B-Methylfluorene	0.003	+/-	0.001	0.011	+/-	0.002	0.002	+/-	0.002	0.015	+/-	0.003	0.006	+/-	0.002
C-Methylfluorene	0.032	+/-	0.004	0.774	+/-	0.089	0.154	+/-	0.018	0.102	+/-	0.012	0.081	+/-	0.010
A-Methylphenanthrene	0.013	+/-	0.002	0.055	+/-	0.009	0.012	+/-	0.003	0.065	+/-	0.011	0.037	+/-	0.006
2-Methylphenanthrene	0.016	+/-	0.002	0.074	+/-	0.008	0.013	+/-	0.002	0.066	+/-	0.008	0.041	+/-	0.005
B-Methylphenanthrene	0.000	+/-	0.001	0.001	+/-	0.001	0.000	+/-	0.002	0.006	+/-	0.003	0.002	+/-	0.002
C-Methylphenanthrene	0.014	+/-	0.003	0.056	+/-	0.012	0.016	+/-	0.004	0.058	+/-	0.012	0.029	+/-	0.006
1-Methylphenanthrene	0.011	+/-	0.002	0.054	+/-	0.007	0.011	+/-	0.002	0.055	+/-	0.008	0.027	+/-	0.004
3,6-Dimethylphenanthrene	0.003	+/-	0.001	0.011	+/-	0.003	0.001	+/-	0.002	0.011	+/-	0.003	0.006	+/-	0.002
A-Dimethylphenanthrene	0.003	+/-	0.001	0.013	+/-	0.002	0.002	+/-	0.002	0.013	+/-	0.003	0.008	+/-	0.002
B-Dimethylphenanthrene	0.002	+/-	0.001	0.006	+/-	0.001	0.001	+/-	0.002	0.007	+/-	0.003	0.004	+/-	0.002
C-Dimethylphenanthrene	0.010	+/-	0.001	0.025	+/-	0.003	0.005	+/-	0.002	0.035	+/-	0.005	0.018	+/-	0.003
1,7-Dimethylphenanthrene	0.005	+/-	0.001	0.014	+/-	0.003	0.003	+/-	0.002	0.017	+/-	0.005	0.010	+/-	0.003
D-Dimethylphenanthrene	0.003	+/-	0.001	0.011	+/-	0.003	0.002	+/-	0.002	0.012	+/-	0.004	0.006	+/-	0.002
E-Dimethylphenanthrene	0.003	+/-	0.001	0.011	+/-	0.002	0.002	+/-	0.002	0.011	+/-	0.003	0.006	+/-	0.002
Anthracene	0.038	+/-	0.009	0.192	+/-	0.044	0.019	+/-	0.005	0.253	+/-	0.059	0.082	+/-	0.019
9-Methylanthracene	0.002	+/-	0.001	0.003	+/-	0.002	0.002	+/-	0.002	0.009	+/-	0.006	0.001	+/-	0.002
Fluoranthene	0.041	+/-	0.005	0.369	+/-	0.040	0.032	+/-	0.005	1.034	+/-	0.113	0.242	+/-	0.027
Pyrene	0.054	+/-	0.006	0.285	+/-	0.030	0.028	+/-	0.004	1.422	+/-	0.148	0.305	+/-	0.032
A-Methylpyrene	0.005	+/-	0.001	0.006	+/-	0.001	0.011	+/-	0.002	0.013	+/-	0.003	0.010	+/-	0.002
B-Methylpyrene	0.001	+/-	0.001	0.005	+/-	0.001	0.001	+/-	0.002	0.025	+/-	0.004	0.007	+/-	0.002
C-Methylpyrene	0.003	+/-	0.001	0.013	+/-	0.002	0.002	+/-	0.002	0.088	+/-	0.010	0.017	+/-	0.002
D-Methylpyrene	0.000	+/-	0.001	0.002	+/-	0.001	0.000	+/-	0.002	0.041	+/-	0.005	0.004	+/-	0.002
E-Methylpyrene	0.004	+/-	0.001	0.011	+/-	0.002	0.001	+/-	0.002	0.048	+/-	0.006	0.009	+/-	0.002
F-Methylpyrene	0.003	+/-	0.001	0.007	+/-	0.001	0.001	+/-	0.002	0.077	+/-	0.009	0.012	+/-	0.002
Retene	0.000	+/-	0.001	0.000	+/-	0.001	0.000	+/-	0.002	0.000	+/-	0.003	0.000	+/-	0.002
Benzonaphthothiophene	0.000	+/-	0.002	0.001	+/-	0.002	0.000	+/-	0.003	0.001	+/-	0.004	0.001	+/-	0.003
Benz(a)anthracene	0.002	+/-	0.003	0.014	+/-	0.005	0.001	+/-	0.005	0.090	+/-	0.025	0.033	+/-	0.010
7-Methylbenz(a)anthracene	0.000	+/-	0.001	0.000	+/-	0.001	0.000	+/-	0.002	0.001	+/-	0.002	0.000	+/-	0.002
Chrysene	0.002	+/-	0.001	0.011	+/-	0.002	0.002	+/-	0.002	0.095	+/-	0.018	0.027	+/-	0.006
Benzo(b+j+k)fluoranthene	0.006	+/-	0.002	0.017	+/-	0.003	0.003	+/-	0.003	0.395	+/-	0.059	0.098	+/-	0.015
Benzo(e)pyrene	0.003	+/-	0.001	0.007	+/-	0.001	0.001	+/-	0.002	0.121	+/-	0.019	0.033	+/-	0.005
Benzo(a)pyrene	0.001	+/-	0.002	0.002	+/-	0.002	0.001	+/-	0.002	0.161	+/-	0.026	0.027	+/-	0.005
7-Methylbenzo(a)pyrene	0.000	+/-	0.001	0.000	+/-	0.001	0.000	+/-	0.002	0.003	+/-	0.003	0.000	+/-	0.002
Indeno[1,2,3-cd]pyrene	0.000	+/-	0.002	0.001	+/-	0.003	0.000	+/-	0.004	0.084	+/-	0.011	0.014	+/-	0.005
Dibenz(ah+ac)anthracene	0.000	+/-	0.003	0.000	+/-	0.004	0.000	+/-	0.006	0.006	+/-	0.009	0.000	+/-	0.007
Benzo(b)chrysene	0.000	+/-	0.002	0.000	+/-	0.002	0.000	+/-	0.003	0.000	+/-	0.004	0.000	+/-	0.003
Benzo(ghi)perylene	0.002	+/-	0.003	0.004	+/-	0.003	0.000	+/-	0.006	0.213	+/-	0.027	0.035	+/-	0.007
Coronene	0.000	+/-	0.005	0.002	+/-	0.006	0.000	+/-	0.011	0.122	+/-	0.022	0.014	+/-	0.011
Sum	2.061			17.770			4.124			20.240			6.721		

Appendix L. cont. PAH Emission Rates for Diesel Vehicles (mg/mi)

	1984 Mercedes 300D			1982 Isuzu 1-Mark			1982 Volkswagen Vanagon			1982 Mercedes 300 TD			1982 Volkswagen Rabbit		
FTP Weighted PM	748.7 mg/mi			268 mg/mi			475.6 mg/mi			654.0 mg/mi			485.1 mg/mi		
Naphthalene	1.244	+/-	0.139	0.557	+/-	0.062	1.402	+/-	0.155	1.514	+/-	0.167	0.469	+/-	0.054
2-Methylnaphthalene	0.335	+/-	0.037	0.100	+/-	0.011	0.249	+/-	0.027	0.437	+/-	0.047	0.105	+/-	0.013
1-Methylnaphthalene	0.244	+/-	0.026	0.079	+/-	0.009	0.185	+/-	0.020	0.346	+/-	0.036	0.089	+/-	0.010
2,6+2,7-Dimethylnaphthalene	0.158	+/-	0.019	0.044	+/-	0.007	0.083	+/-	0.010	0.253	+/-	0.027	0.055	+/-	0.011
1,7+1,3+1,6-Dimethylnaphthalene	0.311	+/-	0.034	0.091	+/-	0.012	0.169	+/-	0.019	0.503	+/-	0.052	0.129	+/-	0.018
2,3+1,4+1,5-Dimethylnaphthalene	0.112	+/-	0.021	0.034	+/-	0.011	0.061	+/-	0.013	0.177	+/-	0.021	0.046	+/-	0.018
1,2-Dimethylnaphthalene	0.043	+/-	0.012	0.014	+/-	0.006	0.025	+/-	0.007	0.069	+/-	0.010	0.020	+/-	0.011
1,8-Dimethylnaphthalene	0.003	+/-	0.009	0.000	+/-	0.005	0.001	+/-	0.006	0.003	+/-	0.006	0.001	+/-	0.009
Biphenyl	0.183	+/-	0.020	0.074	+/-	0.008	0.155	+/-	0.017	0.251	+/-	0.027	0.070	+/-	0.008
2-Methylbiphenyl	0.042	+/-	0.005	0.027	+/-	0.004	0.025	+/-	0.003	0.038	+/-	0.005	0.055	+/-	0.007
3-Methylbiphenyl	0.118	+/-	0.013	0.047	+/-	0.005	0.087	+/-	0.009	0.182	+/-	0.019	0.088	+/-	0.010
4-Methylbiphenyl	0.044	+/-	0.005	0.018	+/-	0.002	0.033	+/-	0.004	0.064	+/-	0.007	0.033	+/-	0.004
A-Trimethylnaphthalene	0.067	+/-	0.007	0.020	+/-	0.002	0.039	+/-	0.004	0.125	+/-	0.013	0.032	+/-	0.004
1-Ethyl-2-methylnaphthalene	0.026	+/-	0.004	0.007	+/-	0.001	0.018	+/-	0.003	0.040	+/-	0.005	0.012	+/-	0.002
B-Trimethylnaphthalene	0.080	+/-	0.009	0.026	+/-	0.003	0.042	+/-	0.005	0.157	+/-	0.017	0.047	+/-	0.006
C-Trimethylnaphthalene	0.098	+/-	0.011	0.037	+/-	0.004	0.054	+/-	0.006	0.197	+/-	0.021	0.062	+/-	0.007
2-Ethyl-1-methylnaphthalene	0.006	+/-	0.002	0.002	+/-	0.001	0.004	+/-	0.001	0.012	+/-	0.003	0.003	+/-	0.002
E-Trimethylnaphthalene	0.062	+/-	0.008	0.024	+/-	0.003	0.031	+/-	0.004	0.125	+/-	0.015	0.046	+/-	0.006
F-Trimethylnaphthalene	0.056	+/-	0.006	0.022	+/-	0.003	0.030	+/-	0.003	0.111	+/-	0.012	0.035	+/-	0.004
G-Trimethylnaphthalene	0.033	+/-	0.005	0.013	+/-	0.002	0.016	+/-	0.002	0.062	+/-	0.008	0.022	+/-	0.003
H-Trimethylnaphthalene	0.008	+/-	0.002	0.004	+/-	0.001	0.007	+/-	0.001	0.019	+/-	0.002	0.008	+/-	0.002
1,2,8-Trimethylnaphthalene	0.003	+/-	0.002	0.002	+/-	0.001	0.006	+/-	0.002	0.005	+/-	0.002	0.002	+/-	0.002
Acenaphthylene	0.221	+/-	0.028	0.148	+/-	0.018	0.452	+/-	0.054	0.408	+/-	0.049	0.184	+/-	0.024
Acenaphthene	0.024	+/-	0.005	0.012	+/-	0.003	0.028	+/-	0.004	0.032	+/-	0.005	0.016	+/-	0.005
Phenanthrene	0.365	+/-	0.039	0.174	+/-	0.019	0.423	+/-	0.045	0.396	+/-	0.042	0.332	+/-	0.035
Fluorene	0.101	+/-	0.011	0.059	+/-	0.006	0.147	+/-	0.016	0.140	+/-	0.015	0.095	+/-	0.010
A-Methylfluorene	0.018	+/-	0.003	0.007	+/-	0.001	0.015	+/-	0.002	0.035	+/-	0.004	0.020	+/-	0.003
1-Methylfluorene	0.016	+/-	0.003	0.006	+/-	0.001	0.011	+/-	0.002	0.033	+/-	0.005	0.019	+/-	0.003
B-Methylfluorene	0.005	+/-	0.002	0.002	+/-	0.001	0.004	+/-	0.001	0.011	+/-	0.002	0.005	+/-	0.002
C-Methylfluorene	0.138	+/-	0.016	0.034	+/-	0.004	0.123	+/-	0.014	0.093	+/-	0.011	0.039	+/-	0.005
A-Methylphenanthrene	0.028	+/-	0.005	0.011	+/-	0.002	0.027	+/-	0.005	0.042	+/-	0.007	0.028	+/-	0.005
2-Methylphenanthrene	0.036	+/-	0.004	0.013	+/-	0.002	0.033	+/-	0.004	0.048	+/-	0.005	0.036	+/-	0.004
B-Methylphenanthrene	0.002	+/-	0.002	0.001	+/-	0.001	0.003	+/-	0.001	0.003	+/-	0.001	0.001	+/-	0.002
C-Methylphenanthrene	0.031	+/-	0.007	0.009	+/-	0.002	0.024	+/-	0.005	0.049	+/-	0.010	0.023	+/-	0.005
1-Methylphenanthrene	0.025	+/-	0.004	0.009	+/-	0.002	0.020	+/-	0.003	0.036	+/-	0.005	0.019	+/-	0.003
3,6-Dimethylphenanthrene	0.005	+/-	0.002	0.002	+/-	0.001	0.005	+/-	0.002	0.009	+/-	0.002	0.006	+/-	0.002
A-Dimethylphenanthrene	0.006	+/-	0.002	0.003	+/-	0.001	0.008	+/-	0.001	0.011	+/-	0.002	0.011	+/-	0.002
B-Dimethylphenanthrene	0.003	+/-	0.002	0.002	+/-	0.001	0.005	+/-	0.001	0.005	+/-	0.001	0.006	+/-	0.002
C-Dimethylphenanthrene	0.017	+/-	0.003	0.006	+/-	0.001	0.013	+/-	0.002	0.029	+/-	0.004	0.019	+/-	0.003
1,7-Dimethylphenanthrene	0.008	+/-	0.003	0.004	+/-	0.001	0.007	+/-	0.002	0.015	+/-	0.003	0.010	+/-	0.003
D-Dimethylphenanthrene	0.005	+/-	0.002	0.003	+/-	0.001	0.004	+/-	0.001	0.010	+/-	0.003	0.006	+/-	0.002
E-Dimethylphenanthrene	0.007	+/-	0.002	0.003	+/-	0.001	0.005	+/-	0.001	0.011	+/-	0.002	0.006	+/-	0.002
Anthracene	0.071	+/-	0.017	0.037	+/-	0.009	0.082	+/-	0.019	0.067	+/-	0.016	0.077	+/-	0.018
9-Methylanthracene	0.001	+/-	0.002	0.001	+/-	0.001	0.001	+/-	0.001	0.002	+/-	0.002	0.002	+/-	0.002
Fluoranthene	0.188	+/-	0.021	0.092	+/-	0.010	0.231	+/-	0.025	0.168	+/-	0.019	0.117	+/-	0.013
Pyrene	0.211	+/-	0.022	0.125	+/-	0.013	0.315	+/-	0.033	0.202	+/-	0.021	0.173	+/-	0.018
A-Methylpyrene	0.010	+/-	0.002	0.006	+/-	0.001	0.006	+/-	0.001	0.006	+/-	0.001	0.010	+/-	0.002
B-Methylpyrene	0.005	+/-	0.002	0.003	+/-	0.001	0.006	+/-	0.001	0.007	+/-	0.001	0.005	+/-	0.002
C-Methylpyrene	0.014	+/-	0.002	0.008	+/-	0.001	0.015	+/-	0.002	0.015	+/-	0.002	0.011	+/-	0.002
D-Methylpyrene	0.002	+/-	0.002	0.003	+/-	0.001	0.005	+/-	0.001	0.003	+/-	0.001	0.004	+/-	0.002
E-Methylpyrene	0.008	+/-	0.002	0.005	+/-	0.001	0.016	+/-	0.002	0.012	+/-	0.002	0.012	+/-	0.002
F-Methylpyrene	0.010	+/-	0.002	0.006	+/-	0.001	0.015	+/-	0.002	0.011	+/-	0.002	0.010	+/-	0.002
Retene	0.000	+/-	0.002	0.000	+/-	0.001	0.000	+/-	0.001	0.001	+/-	0.001	0.000	+/-	0.002
Benzonaphthothiophene	0.001	+/-	0.003	0.000	+/-	0.002	0.001	+/-	0.002	0.000	+/-	0.002	0.001	+/-	0.003
Benz(a)anthracene	0.010	+/-	0.006	0.012	+/-	0.004	0.021	+/-	0.006	0.011	+/-	0.004	0.014	+/-	0.006
7-Methylbenz(a)anthracene	0.000	+/-	0.002	0.000	+/-	0.001	0.000	+/-	0.001	0.000	+/-	0.001	0.000	+/-	0.002
Chrysene	0.011	+/-	0.003	0.009	+/-	0.002	0.026	+/-	0.005	0.011	+/-	0.003	0.011	+/-	0.003
Benzo(b+j+k)fluoranthene	0.036	+/-	0.006	0.030	+/-	0.005	0.078	+/-	0.012	0.038	+/-	0.006	0.028	+/-	0.005
Benzo(e)pyrene	0.015	+/-	0.003	0.011	+/-	0.002	0.029	+/-	0.005	0.015	+/-	0.003	0.011	+/-	0.002
Benzo(a)pyrene	0.008	+/-	0.002	0.011	+/-	0.002	0.020	+/-	0.004	0.009	+/-	0.002	0.005	+/-	0.002
7-Methylbenzo(a)pyrene	0.000	+/-	0.002	0.000	+/-	0.001	0.000	+/-	0.001	0.000	+/-	0.001	0.000	+/-	0.002
Indeno[1,2,3-cd]pyrene	0.002	+/-	0.004	0.003	+/-	0.003	0.008	+/-	0.003	0.002	+/-	0.003	0.003	+/-	0.005
Dibenz(ah+ac)anthracene	0.000	+/-	0.006	0.000	+/-	0.004	0.000	+/-	0.004	0.000	+/-	0.004	0.000	+/-	0.006
Benzo(b)chrysene	0.000	+/-	0.003	0.000	+/-	0.002	0.000	+/-	0.002	0.000	+/-	0.002	0.000	+/-	0.003
Benzo(ghi)perylene	0.008	+/-	0.006	0.008	+/-	0.003	0.023	+/-	0.005	0.008	+/-	0.004	0.011	+/-	0.006
Coronene	0.002	+/-	0.011	0.002	+/-	0.006	0.007	+/-	0.007	0.001	+/-	0.007	0.003	+/-	0.011
	4.952			2.122			4.984			6.694			2.822		

Appendix L. cont. PAH Emission Rates for Diesel Vehicles (mg/mi)

	1982 Mercedes 300TD		1981 Peugeot 505 TD		1981 Mercedes 300SD		1980 Mercedes 300 TD		1980 Volkswagen Rabbit	
FTP Weighted PM	464.4 mg/mi		677.4 mg/mi		247.3 mg/mi		1608.3 mg/mi		338.2 mg/mi	
Naphthalene	1.560	+/- 0.173	0.655	+/- 0.073	1.294	+/- 0.144	2.743	+/- 0.302	1.977	+/- 0.218
2-Methylnaphthalene	0.396	+/- 0.043	0.120	+/- 0.014	0.359	+/- 0.039	0.840	+/- 0.090	0.363	+/- 0.039
1-Methylnaphthalene	0.319	+/- 0.034	0.097	+/- 0.011	0.287	+/- 0.030	0.650	+/- 0.068	0.326	+/- 0.034
2,6+2,7-Dimethylnaphthalene	0.250	+/- 0.028	0.056	+/- 0.008	0.201	+/- 0.023	0.596	+/- 0.062	0.256	+/- 0.027
1,7+1,3+1,6-Dimethylnaphthalene	0.532	+/- 0.056	0.119	+/- 0.015	0.427	+/- 0.046	1.130	+/- 0.117	0.565	+/- 0.059
2,3+1,4+1,5-Dimethylnaphthalene	0.188	+/- 0.028	0.042	+/- 0.012	0.151	+/- 0.024	0.388	+/- 0.044	0.201	+/- 0.024
1,2-Dimethylnaphthalene	0.072	+/- 0.014	0.016	+/- 0.007	0.058	+/- 0.012	0.131	+/- 0.018	0.079	+/- 0.011
1,8-Dimethylnaphthalene	0.002	+/- 0.010	0.000	+/- 0.006	0.001	+/- 0.009	0.004	+/- 0.009	0.003	+/- 0.006
Biphenyl	0.207	+/- 0.022	0.081	+/- 0.009	0.236	+/- 0.025	0.444	+/- 0.047	0.299	+/- 0.032
2-Methylbiphenyl	0.040	+/- 0.005	0.020	+/- 0.003	0.029	+/- 0.004	0.112	+/- 0.012	0.035	+/- 0.004
3-Methylbiphenyl	0.140	+/- 0.015	0.055	+/- 0.006	0.181	+/- 0.019	0.440	+/- 0.046	0.214	+/- 0.022
4-Methylbiphenyl	0.050	+/- 0.006	0.019	+/- 0.002	0.065	+/- 0.007	0.168	+/- 0.018	0.074	+/- 0.008
A-Trimethylnaphthalene	0.113	+/- 0.012	0.027	+/- 0.003	0.095	+/- 0.010	0.283	+/- 0.030	0.136	+/- 0.014
1-Ethyl-2-methylnaphthalene	0.041	+/- 0.006	0.009	+/- 0.002	0.034	+/- 0.005	0.090	+/- 0.012	0.047	+/- 0.006
B-Trimethylnaphthalene	0.153	+/- 0.017	0.036	+/- 0.004	0.136	+/- 0.015	0.372	+/- 0.041	0.191	+/- 0.021
C-Trimethylnaphthalene	0.216	+/- 0.024	0.048	+/- 0.005	0.171	+/- 0.019	0.484	+/- 0.053	0.255	+/- 0.028
2-Ethyl-1-methylnaphthalene	0.009	+/- 0.003	0.003	+/- 0.001	0.009	+/- 0.003	0.027	+/- 0.007	0.013	+/- 0.003
E-Trimethylnaphthalene	0.139	+/- 0.017	0.032	+/- 0.004	0.105	+/- 0.013	0.311	+/- 0.038	0.174	+/- 0.021
F-Trimethylnaphthalene	0.108	+/- 0.012	0.028	+/- 0.003	0.090	+/- 0.010	0.265	+/- 0.028	0.142	+/- 0.015
G-Trimethylnaphthalene	0.063	+/- 0.008	0.016	+/- 0.002	0.048	+/- 0.006	0.155	+/- 0.020	0.099	+/- 0.013
H-Trimethylnaphthalene	0.014	+/- 0.002	0.004	+/- 0.001	0.013	+/- 0.002	0.044	+/- 0.005	0.028	+/- 0.003
1,2,8-Trimethylnaphthalene	0.004	+/- 0.002	0.001	+/- 0.001	0.003	+/- 0.002	0.017	+/- 0.005	0.007	+/- 0.002
Acenaphthylene	0.258	+/- 0.033	0.102	+/- 0.014	0.167	+/- 0.023	0.642	+/- 0.076	0.740	+/- 0.088
Acenaphthene	0.027	+/- 0.006	0.013	+/- 0.003	0.025	+/- 0.005	0.073	+/- 0.009	0.067	+/- 0.008
Phenanthrene	0.367	+/- 0.039	0.185	+/- 0.020	0.281	+/- 0.030	0.743	+/- 0.079	0.689	+/- 0.073
Fluorene	0.122	+/- 0.013	0.050	+/- 0.006	0.114	+/- 0.012	0.342	+/- 0.036	0.313	+/- 0.033
A-Methylfluorene	0.030	+/- 0.004	0.010	+/- 0.002	0.025	+/- 0.004	0.089	+/- 0.011	0.069	+/- 0.009
1-Methylfluorene	0.031	+/- 0.005	0.008	+/- 0.002	0.030	+/- 0.004	0.091	+/- 0.012	0.067	+/- 0.009
B-Methylfluorene	0.006	+/- 0.002	0.003	+/- 0.001	0.007	+/- 0.002	0.023	+/- 0.004	0.015	+/- 0.002
C-Methylfluorene	0.096	+/- 0.011	0.035	+/- 0.004	0.061	+/- 0.007	0.219	+/- 0.025	0.119	+/- 0.014
A-Methylphenanthrene	0.031	+/- 0.005	0.010	+/- 0.002	0.031	+/- 0.006	0.084	+/- 0.014	0.074	+/- 0.012
2-Methylphenanthrene	0.039	+/- 0.005	0.013	+/- 0.002	0.038	+/- 0.004	0.087	+/- 0.010	0.085	+/- 0.009
B-Methylphenanthrene	0.001	+/- 0.002	0.000	+/- 0.001	0.001	+/- 0.002	0.005	+/- 0.002	0.002	+/- 0.001
C-Methylphenanthrene	0.039	+/- 0.008	0.011	+/- 0.003	0.035	+/- 0.007	0.085	+/- 0.018	0.068	+/- 0.014
1-Methylphenanthrene	0.030	+/- 0.004	0.010	+/- 0.002	0.029	+/- 0.004	0.066	+/- 0.009	0.051	+/- 0.007
3,6-Dimethylphenanthrene	0.007	+/- 0.002	0.003	+/- 0.001	0.006	+/- 0.002	0.018	+/- 0.004	0.017	+/- 0.004
A-Dimethylphenanthrene	0.009	+/- 0.002	0.003	+/- 0.001	0.007	+/- 0.002	0.024	+/- 0.003	0.025	+/- 0.003
B-Dimethylphenanthrene	0.004	+/- 0.002	0.001	+/- 0.001	0.004	+/- 0.002	0.013	+/- 0.003	0.013	+/- 0.002
C-Dimethylphenanthrene	0.025	+/- 0.004	0.007	+/- 0.001	0.027	+/- 0.004	0.061	+/- 0.008	0.043	+/- 0.005
1,7-Dimethylphenanthrene	0.011	+/- 0.003	0.004	+/- 0.001	0.013	+/- 0.003	0.031	+/- 0.007	0.024	+/- 0.005
D-Dimethylphenanthrene	0.011	+/- 0.003	0.003	+/- 0.001	0.010	+/- 0.003	0.025	+/- 0.006	0.017	+/- 0.004
E-Dimethylphenanthrene	0.009	+/- 0.002	0.003	+/- 0.001	0.009	+/- 0.002	0.026	+/- 0.004	0.017	+/- 0.002
Anthracene	0.055	+/- 0.013	0.056	+/- 0.013	0.053	+/- 0.013	0.111	+/- 0.026	0.143	+/- 0.033
9-Methylanthracene	0.002	+/- 0.002	0.001	+/- 0.001	0.003	+/- 0.002	0.001	+/- 0.002	0.003	+/- 0.002
Fluoranthene	0.157	+/- 0.018	0.112	+/- 0.013	0.097	+/- 0.011	0.342	+/- 0.038	0.311	+/- 0.034
Pyrene	0.210	+/- 0.022	0.156	+/- 0.016	0.136	+/- 0.014	0.451	+/- 0.047	0.408	+/- 0.043
A-Methylpyrene	0.011	+/- 0.002	0.006	+/- 0.001	0.010	+/- 0.002	0.012	+/- 0.002	0.006	+/- 0.001
B-Methylpyrene	0.006	+/- 0.002	0.003	+/- 0.001	0.005	+/- 0.002	0.013	+/- 0.002	0.012	+/- 0.002
C-Methylpyrene	0.014	+/- 0.002	0.009	+/- 0.001	0.011	+/- 0.002	0.035	+/- 0.004	0.031	+/- 0.003
D-Methylpyrene	0.002	+/- 0.002	0.003	+/- 0.001	0.001	+/- 0.002	0.010	+/- 0.002	0.010	+/- 0.002
E-Methylpyrene	0.013	+/- 0.002	0.006	+/- 0.001	0.013	+/- 0.002	0.041	+/- 0.005	0.029	+/- 0.003
F-Methylpyrene	0.012	+/- 0.002	0.008	+/- 0.001	0.012	+/- 0.002	0.039	+/- 0.005	0.026	+/- 0.003
Retene	0.001	+/- 0.003	0.000	+/- 0.002	0.000	+/- 0.002	0.001	+/- 0.002	0.000	+/- 0.001
Benzonaphthothiophene	0.000	+/- 0.004	0.000	+/- 0.002	0.000	+/- 0.003	0.002	+/- 0.003	0.002	+/- 0.002
Benz(a)anthracene	0.009	+/- 0.006	0.010	+/- 0.004	0.008	+/- 0.005	0.026	+/- 0.008	0.024	+/- 0.007
7-Methylbenz(a)anthracene	0.000	+/- 0.002	0.000	+/- 0.001	0.000	+/- 0.002	0.000	+/- 0.002	0.000	+/- 0.001
Chrysene	0.014	+/- 0.004	0.010	+/- 0.002	0.009	+/- 0.003	0.036	+/- 0.007	0.074	+/- 0.014
Benzo(b+j+k)fluoranthene	0.040	+/- 0.007	0.019	+/- 0.003	0.026	+/- 0.005	0.101	+/- 0.015	0.113	+/- 0.017
Benzo(e)pyrene	0.018	+/- 0.003	0.009	+/- 0.002	0.011	+/- 0.002	0.041	+/- 0.007	0.036	+/- 0.006
Benzo(a)pyrene	0.009	+/- 0.003	0.002	+/- 0.002	0.003	+/- 0.002	0.025	+/- 0.004	0.038	+/- 0.006
7-Methylbenzo(a)pyrene	0.000	+/- 0.002	0.000	+/- 0.001	0.000	+/- 0.002	0.000	+/- 0.002	0.000	+/- 0.001
Indeno[1,2,3-cd]pyrene	0.002	+/- 0.005	0.000	+/- 0.003	0.001	+/- 0.005	0.008	+/- 0.005	0.018	+/- 0.003
Dibenz(ah+ac)anthracene	0.000	+/- 0.007	0.000	+/- 0.004	0.000	+/- 0.007	0.000	+/- 0.006	0.002	+/- 0.004
Benzo(b)chrysene	0.000	+/- 0.004	0.000	+/- 0.002	0.000	+/- 0.003	0.000	+/- 0.003	0.000	+/- 0.002
Benzo(ghi)perylene	0.008	+/- 0.006	0.003	+/- 0.004	0.005	+/- 0.006	0.031	+/- 0.007	0.035	+/- 0.006
Coronene	0.002	+/- 0.012	0.000	+/- 0.007	0.000	+/- 0.011	0.008	+/- 0.011	0.014	+/- 0.007
	6.354		2.374		5.318		13.777		9.335	

Appendix L. cont. PAH Emission Rates for Diesel Vehicles (mg/mi)

	1980 Mercedes 240			1979 Cadillac Seville			1979 Volkswagen Rabbit			1977 Mercedes 300D		
FTP Weighted PM	289.0 mg/mi			1402.4 mg/mi			991.2 mg/mi			633.8 mg/mi		
Naphthalene	1.056	±	0.118	2.383	±	0.265	5.417	±	0.593	0.768	±	0.086
2-Methylnaphthalene	0.404	±	0.044	0.775	±	0.084	0.893	±	0.095	0.160	±	0.018
1-Methylnaphthalene	0.308	±	0.032	0.630	±	0.066	0.756	±	0.079	0.128	±	0.014
2,6+2,7-Dimethylnaphthalene	0.290	±	0.031	0.587	±	0.063	0.466	±	0.048	0.081	±	0.010
1,7+1,3+1,6-Dimethylnaphthalene	0.591	±	0.062	1.157	±	0.121	0.908	±	0.094	0.179	±	0.020
2,3+1,4+1,5-Dimethylnaphthalene	0.202	±	0.027	0.450	±	0.055	0.351	±	0.038	0.064	±	0.013
1,2-Dimethylnaphthalene	0.074	±	0.013	0.179	±	0.027	0.126	±	0.015	0.027	±	0.007
1,8-Dimethylnaphthalene	0.003	±	0.009	0.004	±	0.015	0.006	±	0.006	0.002	±	0.006
Biphenyl	0.188	±	0.020	0.534	±	0.057	0.601	±	0.064	0.136	±	0.015
2-Methylbiphenyl	0.031	±	0.004	0.149	±	0.016	0.073	±	0.008	0.021	±	0.003
3-Methylbiphenyl	0.170	±	0.018	0.591	±	0.062	0.327	±	0.034	0.091	±	0.010
4-Methylbiphenyl	0.063	±	0.007	0.221	±	0.024	0.117	±	0.013	0.032	±	0.004
A-Trimethylnaphthalene	0.135	±	0.014	0.397	±	0.042	0.232	±	0.025	0.043	±	0.005
1-Ethyl-2-methylnaphthalene	0.040	±	0.005	0.125	±	0.017	0.091	±	0.012	0.017	±	0.002
B-Trimethylnaphthalene	0.190	±	0.021	0.523	±	0.058	0.303	±	0.034	0.059	±	0.007
C-Trimethylnaphthalene	0.253	±	0.028	0.716	±	0.078	0.402	±	0.044	0.079	±	0.009
2-Ethyl-1-methylnaphthalene	0.010	±	0.003	0.034	±	0.009	0.021	±	0.005	0.005	±	0.002
E-Trimethylnaphthalene	0.164	±	0.020	0.504	±	0.062	0.270	±	0.033	0.050	±	0.006
F-Trimethylnaphthalene	0.137	±	0.015	0.432	±	0.046	0.234	±	0.025	0.044	±	0.005
G-Trimethylnaphthalene	0.083	±	0.011	0.251	±	0.033	0.132	±	0.017	0.024	±	0.003
H-Trimethylnaphthalene	0.019	±	0.003	0.091	±	0.010	0.051	±	0.006	0.009	±	0.001
1,2,8-Trimethylnaphthalene	0.007	±	0.002	0.051	±	0.014	0.022	±	0.006	0.004	±	0.002
Acenaphthylene	0.154	±	0.021	0.662	±	0.080	1.876	±	0.221	0.186	±	0.023
Acenaphthene	0.027	±	0.006	0.117	±	0.015	0.179	±	0.020	0.017	±	0.004
Phenanthrene	0.342	±	0.036	1.764	±	0.187	1.599	±	0.169	0.272	±	0.029
Fluorene	0.123	±	0.013	0.485	±	0.051	0.745	±	0.079	0.074	±	0.008
A-Methylfluorene	0.037	±	0.005	0.241	±	0.030	0.115	±	0.014	0.017	±	0.002
1-Methylfluorene	0.043	±	0.006	0.233	±	0.031	0.096	±	0.013	0.017	±	0.003
B-Methylfluorene	0.010	±	0.002	0.051	±	0.008	0.026	±	0.004	0.005	±	0.001
C-Methylfluorene	0.115	±	0.013	0.413	±	0.048	0.242	±	0.028	0.077	±	0.009
A-Methylphenanthrene	0.040	±	0.007	0.408	±	0.067	0.111	±	0.018	0.025	±	0.004
2-Methylphenanthrene	0.051	±	0.006	0.481	±	0.053	0.131	±	0.015	0.032	±	0.004
B-Methylphenanthrene	0.001	±	0.002	0.017	±	0.005	0.020	±	0.004	0.001	±	0.001
C-Methylphenanthrene	0.049	±	0.010	0.402	±	0.082	0.120	±	0.025	0.030	±	0.006
1-Methylphenanthrene	0.043	±	0.006	0.232	±	0.031	0.093	±	0.013	0.023	±	0.003
3,6-Dimethylphenanthrene	0.011	±	0.003	0.145	±	0.033	0.020	±	0.005	0.007	±	0.002
A-Dimethylphenanthrene	0.012	±	0.002	0.175	±	0.021	0.027	±	0.003	0.009	±	0.002
B-Dimethylphenanthrene	0.007	±	0.002	0.106	±	0.015	0.016	±	0.002	0.005	±	0.001
C-Dimethylphenanthrene	0.039	±	0.005	0.375	±	0.045	0.067	±	0.008	0.021	±	0.003
1,7-Dimethylphenanthrene	0.020	±	0.005	0.241	±	0.053	0.030	±	0.007	0.011	±	0.003
D-Dimethylphenanthrene	0.014	±	0.004	0.142	±	0.034	0.027	±	0.007	0.007	±	0.002
E-Dimethylphenanthrene	0.013	±	0.002	0.128	±	0.016	0.022	±	0.003	0.008	±	0.001
Anthracene	0.032	±	0.008	0.248	±	0.058	0.288	±	0.067	0.039	±	0.009
9-Methylanthracene	0.001	±	0.002	0.010	±	0.007	0.012	±	0.007	0.001	±	0.001
Fluoranthene	0.107	±	0.012	1.133	±	0.123	0.782	±	0.085	0.168	±	0.019
Pyrene	0.135	±	0.014	1.504	±	0.157	0.997	±	0.104	0.233	±	0.024
A-Methylpyrene	0.010	±	0.002	0.025	±	0.004	0.006	±	0.001	0.006	±	0.001
B-Methylpyrene	0.004	±	0.002	0.070	±	0.009	0.029	±	0.004	0.006	±	0.001
C-Methylpyrene	0.012	±	0.002	0.145	±	0.016	0.088	±	0.009	0.015	±	0.002
D-Methylpyrene	0.002	±	0.002	0.044	±	0.006	0.035	±	0.004	0.003	±	0.001
E-Methylpyrene	0.012	±	0.002	0.127	±	0.014	0.057	±	0.006	0.017	±	0.002
F-Methylpyrene	0.011	±	0.002	0.125	±	0.015	0.072	±	0.008	0.014	±	0.002
Retene	0.001	±	0.002	0.009	±	0.004	0.001	±	0.002	0.000	±	0.001
Benzonaphthothiophene	0.001	±	0.003	0.009	±	0.006	0.003	±	0.002	0.001	±	0.002
Benz(a)anthracene	0.009	±	0.005	0.080	±	0.023	0.117	±	0.031	0.014	±	0.005
7-Methylbenz(a)anthracene	0.000	±	0.002	0.001	±	0.003	0.001	±	0.001	0.000	±	0.001
Chrysene	0.009	±	0.003	0.130	±	0.024	0.114	±	0.021	0.015	±	0.003
Benzo(b+j+k)fluoranthene	0.025	±	0.005	0.233	±	0.035	0.350	±	0.052	0.041	±	0.006
Benzo(e)pyrene	0.010	±	0.002	0.076	±	0.012	0.108	±	0.017	0.018	±	0.003
Benzo(a)pyrene	0.004	±	0.002	0.027	±	0.005	0.108	±	0.017	0.009	±	0.002
7-Methylbenzo(a)pyrene	0.000	±	0.002	0.000	±	0.003	0.002	±	0.002	0.000	±	0.001
Indeno[1,2,3-cd]pyrene	0.001	±	0.004	0.017	±	0.008	0.063	±	0.008	0.002	±	0.003
Dibenz(ah+ac)anthracene	0.000	±	0.006	0.001	±	0.011	0.006	±	0.004	0.000	±	0.004
Benzo(b)chrysene	0.000	±	0.003	0.000	±	0.006	0.000	±	0.002	0.000	±	0.002
Benzo(ghi)perylene	0.006	±	0.006	0.037	±	0.011	0.120	±	0.015	0.009	±	0.004
Coronene	0.001	±	0.011	0.009	±	0.019	0.053	±	0.009	0.000	±	0.006
	5.961			21.661			20.770			3.476		

Appendix M. Hopane and Sterane Emission Rates for Gasoline Vehicles (µg/mi)

	1997 Ford Windstar			1990 Dodge Ram			1989 Hyundai			1989 Dodge Caravan		
	1994 Chevrolet Suburban			1989 GMC Sierra			Excel					
FTP Weighted PM	11.2 mg/mi ave			14.3 mg/mi (ave)			200 mg/mi			47.9 mg/mi		
Ergostane	-0.22	+/-	1.22	-1.23	+/-	1.19	2.77	+/-	1.48	-0.88	+/-	1.22
Sitostane	-1.06	+/-	1.16	-0.99	+/-	1.16	1.98	+/-	1.34	-0.71	+/-	1.19
diasterane-1	0.16	+/-	0.59	-0.02	+/-	0.58	2.80	+/-	0.95	0.33	+/-	0.63
diasterane-2	0.23	+/-	0.58	0.05	+/-	0.58	2.11	+/-	0.81	0.29	+/-	0.62
cholestane-1	0.10	+/-	0.82	0.13	+/-	0.82	3.72	+/-	1.50	-0.11	+/-	0.83
cholestane-2	-0.34	+/-	0.58	-0.54	+/-	0.57	0.61	+/-	0.71	-0.31	+/-	0.62
cholestane-3	1.15	+/-	0.84	0.70	+/-	0.82	3.18	+/-	1.07	0.81	+/-	0.85
trisnorhopane-1	0.08	+/-	0.56	0.13	+/-	0.56	1.03	+/-	0.72	0.42	+/-	0.61
trisnorhopane-2	0.08	+/-	0.49	0.09	+/-	0.49	0.85	+/-	0.60	0.25	+/-	0.54
norhopane-1	0.33	+/-	1.02	0.33	+/-	1.01	4.63	+/-	1.65	1.17	+/-	1.08
norhopane-2	-0.01	+/-	0.49	-0.01	+/-	0.49	0.24	+/-	0.55	0.06	+/-	0.54
hopane-1	0.04	+/-	0.85	-0.03	+/-	0.85	2.29	+/-	0.97	0.44	+/-	0.88
hopane-2	-0.01	+/-	0.49	-0.01	+/-	0.49	0.10	+/-	0.54	-0.04	+/-	0.54
homohopane-1	-0.30	+/-	0.71	-0.19	+/-	0.71	0.72	+/-	0.81	0.03	+/-	0.75
homohopane-2	0.03	+/-	0.59	0.12	+/-	0.59	0.76	+/-	0.71	0.25	+/-	0.64
hopane-3	0.01	+/-	0.49	0.03	+/-	0.49	0.02	+/-	0.54	0.00	+/-	0.54
bishomohopane-1	-0.09	+/-	0.59	-0.04	+/-	0.59	0.45	+/-	0.63	0.12	+/-	0.63
bishomohopane-2	0.00	+/-	0.56	0.51	+/-	0.58	0.37	+/-	0.61	0.10	+/-	0.60
Sum	0.18			-0.96			28.63			2.21		

	1988 Mazda MX-6			1988 Dodge Caravan			1985 Chevy Sprint			1985 Dodge Caravan		
	1986 Alfa Romeo											
FTP Weighted PM	15.2 mg/mi ave			54.5 mg/mi			325 mg/mi			388 mg/mi		
Ergostane	-0.79	+/-	1.20	-0.11	+/-	1.24	0.77	+/-	1.32	13.02	+/-	3.07
Sitostane	-1.01	+/-	1.16	-0.09	+/-	1.20	0.81	+/-	1.27	8.61	+/-	2.28
diasterane-1	0.41	+/-	0.60	2.33	+/-	0.84	2.90	+/-	0.97	6.25	+/-	1.55
diasterane-2	0.40	+/-	0.59	1.77	+/-	0.75	1.95	+/-	0.82	6.26	+/-	1.53
cholestane-1	0.11	+/-	0.82	2.18	+/-	1.11	2.14	+/-	1.13	12.66	+/-	3.40
cholestane-2	-0.43	+/-	0.58	0.03	+/-	0.63	0.47	+/-	0.72	3.92	+/-	1.27
cholestane-3	0.83	+/-	0.82	2.51	+/-	0.96	3.39	+/-	1.07	10.81	+/-	2.14
trisnorhopane-1	0.17	+/-	0.56	0.46	+/-	0.61	0.93	+/-	0.69	3.91	+/-	1.16
trisnorhopane-2	0.15	+/-	0.49	0.29	+/-	0.55	0.34	+/-	0.59	2.20	+/-	0.86
norhopane-1	0.71	+/-	1.03	0.70	+/-	1.05	1.55	+/-	1.17	10.60	+/-	3.24
norhopane-2	-0.01	+/-	0.49	0.09	+/-	0.53	0.13	+/-	0.59	0.62	+/-	0.60
hopane-1	0.13	+/-	0.85	0.46	+/-	0.88	0.98	+/-	0.93	4.30	+/-	1.18
hopane-2	0.00	+/-	0.49	-0.01	+/-	0.53	0.06	+/-	0.59	0.31	+/-	0.55
homohopane-1	-0.14	+/-	0.71	-0.09	+/-	0.74	0.32	+/-	0.81	1.12	+/-	0.92
homohopane-2	0.14	+/-	0.60	0.16	+/-	0.64	0.39	+/-	0.69	0.96	+/-	0.78
hopane-3	0.01	+/-	0.49	0.03	+/-	0.53	0.03	+/-	0.59	0.00	+/-	0.53
bishomohopane-1	0.01	+/-	0.59	0.06	+/-	0.63	0.33	+/-	0.67	0.51	+/-	0.63
bishomohopane-2	0.04	+/-	0.56	0.06	+/-	0.60	0.27	+/-	0.65	0.44	+/-	0.61
Sum	0.73			10.83			17.77			86.49		

Appendix M. cont. Hopane and Sterane Emission Rates for Gasoline Vehicles (µg/mi)

	1984 Buick Regal			1984 Dodge Ram			1984 Nissan Sentra			1981 Chevy C-10 1981 Chevy G-10		
FTP Weighted PM	48.3 mg/mi			44.0 mg/mi			40.9 mg/mi			21.8 mg/mi		
Ergostane	0.53	+/-	1.27	0.11	+/-	1.25	14.51	+/-	3.33	-0.87	+/-	1.23
Sitostane	-0.34	+/-	1.19	-0.09	+/-	1.20	17.59	+/-	3.88	-0.24	+/-	1.20
diasterane-1	0.88	+/-	0.67	5.06	+/-	1.31	8.67	+/-	2.03	0.26	+/-	0.65
diasterane-2	0.88	+/-	0.66	1.19	+/-	0.68	4.56	+/-	1.21	0.46	+/-	0.63
cholestane-1	3.30	+/-	1.32	2.44	+/-	1.15	14.34	+/-	3.78	-0.15	+/-	0.91
cholestane-2	-0.18	+/-	0.63	0.03	+/-	0.63	4.10	+/-	1.29	-0.60	+/-	0.63
cholestane-3	0.38	+/-	0.84	2.25	+/-	0.93	12.26	+/-	2.38	0.50	+/-	0.87
trisnorhopane-1	0.23	+/-	0.59	0.55	+/-	0.61	2.77	+/-	0.93	0.00	+/-	0.59
trisnorhopane-2	2.37	+/-	0.91	0.44	+/-	0.55	0.77	+/-	0.59	0.29	+/-	0.54
norhopane-1	0.99	+/-	1.07	1.67	+/-	1.17	5.08	+/-	1.83	1.72	+/-	1.13
norhopane-2	0.05	+/-	0.53	0.06	+/-	0.52	0.72	+/-	0.63	0.15	+/-	0.54
hopane-1	0.41	+/-	0.88	0.70	+/-	0.89	5.84	+/-	1.36	0.90	+/-	0.89
hopane-2	0.03	+/-	0.53	0.26	+/-	0.55	0.69	+/-	0.62	0.07	+/-	0.53
homohopane-1	-0.06	+/-	0.74	0.11	+/-	0.75	2.70	+/-	1.28	0.18	+/-	0.75
homohopane-2	0.22	+/-	0.63	0.39	+/-	0.66	2.19	+/-	1.14	0.34	+/-	0.64
hopane-3	0.02	+/-	0.53	0.00	+/-	0.52	0.03	+/-	0.53	0.02	+/-	0.53
bishomohopane-1	0.01	+/-	0.62	0.59	+/-	0.63	1.52	+/-	0.69	0.28	+/-	0.62
bishomohopane-2	1.76	+/-	0.76	0.11	+/-	0.59	1.03	+/-	0.67	0.24	+/-	0.59
Sum	11.47			15.86			99.34			3.56		

	1980 Ford E350 Van			1979 Ford Mustang			1978 Chevy C-20 PU			1978 Pontiac LeMans			1977 Datsun 200 SX		
FTP Weighted PM	45.1 mg/mi			41.0 mg/mi			72.5 mg/mi			11.1 mg/mi			40.3 mg/mi		
Ergostane	0.40	+/-	1.27	7.22	+/-	2.09	0.50	+/-	1.27	-0.35	+/-	1.24	3.37	+/-	1.57
Sitostane	1.41	+/-	1.29	6.50	+/-	1.93	-0.09	+/-	1.20	-0.49	+/-	1.19	4.30	+/-	1.63
diasterane-1	3.94	+/-	1.10	3.91	+/-	1.11	1.65	+/-	0.75	1.59	+/-	0.75	1.63	+/-	0.78
diasterane-2	0.95	+/-	0.66	3.15	+/-	0.95	1.22	+/-	0.68	0.33	+/-	0.62	1.45	+/-	0.75
cholestane-1	1.13	+/-	0.95	9.38	+/-	2.66	1.94	+/-	1.07	0.41	+/-	0.88	7.32	+/-	2.20
cholestane-2	-0.20	+/-	0.62	1.80	+/-	0.86	0.24	+/-	0.65	-0.26	+/-	0.61	0.89	+/-	0.76
cholestane-3	5.73	+/-	1.34	8.98	+/-	1.85	0.77	+/-	0.84	0.84	+/-	0.85	12.25	+/-	2.40
trisnorhopane-1	0.96	+/-	0.64	1.39	+/-	0.70	0.33	+/-	0.59	0.25	+/-	0.60	1.69	+/-	0.79
trisnorhopane-2	0.50	+/-	0.55	0.52	+/-	0.55	1.42	+/-	0.69	0.34	+/-	0.55	1.45	+/-	0.74
norhopane-1	3.19	+/-	1.42	2.73	+/-	1.38	0.73	+/-	1.08	0.45	+/-	1.13	7.97	+/-	2.63
norhopane-2	0.03	+/-	0.52	0.27	+/-	0.55	0.08	+/-	0.52	0.03	+/-	0.53	0.46	+/-	0.61
hopane-1	1.81	+/-	0.94	3.09	+/-	1.06	0.30	+/-	0.88	-0.03	+/-	0.88	3.80	+/-	1.16
hopane-2	0.08	+/-	0.52	0.28	+/-	0.55	0.02	+/-	0.52	0.01	+/-	0.53	1.11	+/-	0.76
homohopane-1	0.93	+/-	0.86	0.97	+/-	0.88	-0.21	+/-	0.74	-0.16	+/-	0.77	1.22	+/-	1.00
homohopane-2	0.73	+/-	0.72	0.85	+/-	0.75	0.06	+/-	0.62	0.11	+/-	0.65	1.20	+/-	0.89
hopane-3	0.13	+/-	0.53	0.00	+/-	0.53	0.00	+/-	0.52	0.16	+/-	0.53	0.11	+/-	0.57
bishomohopane-1	0.70	+/-	0.64	0.62	+/-	0.63	0.00	+/-	0.62	-0.09	+/-	0.62	1.77	+/-	0.73
bishomohopane-2	0.36	+/-	0.60	0.53	+/-	0.61	1.30	+/-	0.69	-0.03	+/-	0.59	0.72	+/-	0.67
Sum	22.77			52.17			10.26			3.11			52.71		

Appendix M. cont. Hopane and Sterane Emission Rates for Gasoline Vehicles (µg/mi)

FTP Weighted PM	1973 Ford Ranger 46.8 mg/mi	1972 Chevy C-20 28.3 mg/mi	1965 Ford Mustang 63.2 mg/mi
Ergostane	-1.29 +/- 1.21	1.01 +/- 1.31	4.24 +/- 1.67
Sitostane	-1.25 +/- 1.17	-0.23 +/- 1.20	3.51 +/- 1.50
diasterane-1	-0.25 +/- 0.60	0.49 +/- 0.63	2.45 +/- 0.89
diasterane-2	-0.02 +/- 0.61	0.45 +/- 0.62	2.21 +/- 0.80
cholestane-1	2.67 +/- 1.21	-0.02 +/- 0.83	5.00 +/- 1.73
cholestane-2	-0.73 +/- 0.60	-0.44 +/- 0.61	1.48 +/- 0.83
cholestane-3	2.51 +/- 0.95	5.73 +/- 1.34	3.89 +/- 1.14
trisnorhopane-1	0.00 +/- 0.59	0.54 +/- 0.61	1.16 +/- 0.72
trisnorhopane-2	0.46 +/- 0.54	0.19 +/- 0.52	1.41 +/- 0.68
norhopane-1	0.00 +/- 1.02	1.85 +/- 1.20	7.39 +/- 2.27
norhopane-2	-0.01 +/- 0.52	0.08 +/- 0.52	0.42 +/- 0.56
hopane-1	-0.25 +/- 0.86	0.90 +/- 0.89	3.70 +/- 1.08
hopane-2	-0.04 +/- 0.52	0.01 +/- 0.52	0.28 +/- 0.54
homohopane-1	-0.34 +/- 0.73	0.51 +/- 0.80	1.32 +/- 0.91
homohopane-2	0.00 +/- 0.62	0.32 +/- 0.64	1.13 +/- 0.77
hopane-3	0.00 +/- 0.52	0.03 +/- 0.52	0.02 +/- 0.53
bishomohopane-1	-0.11 +/- 0.62	0.22 +/- 0.62	0.65 +/- 0.63
bishomohopane-2	0.05 +/- 0.59	0.08 +/- 0.59	0.59 +/- 0.61
Sum	1.40	11.70	40.84

Appendix N. Hopane and Sterane Emission Rates for Diesel Vehicles (µg/mi)

	1993 Mercedes 300D 86.6 mg/mi			1985 Mercedes 300 70.1 mg/mi			1985 Mercedes 300 15.5 mg/mi			1984 Volkswagen Rabbit 636.6 mg/mi		
FTP Weighted PM												
Ergostane	2.6	+/-	1.7	7.3	+/-	2.3	3.5	+/-	2.3	18.7	+/-	4.9
Sitostane	1.9	+/-	1.5	9.4	+/-	2.6	7.3	+/-	2.6	17.2	+/-	4.5
diasterane-1	1.4	+/-	1.0	5.1	+/-	1.6	3.7	+/-	1.9	9.8	+/-	3.3
diasterane-2	0.6	+/-	0.9	3.4	+/-	1.2	2.5	+/-	1.8	6.7	+/-	2.8
cholestane-1	3.3	+/-	1.5	10.8	+/-	3.1	5.0	+/-	2.4	21.0	+/-	5.9
cholestane-2	0.4	+/-	1.0	3.2	+/-	1.4	3.1	+/-	2.0	7.6	+/-	3.0
cholestane-3	5.8	+/-	1.5	10.5	+/-	2.2	17.2	+/-	3.6	12.5	+/-	3.2
Trisnorhopane-1	1.0	+/-	0.9	5.5	+/-	1.8	1.2	+/-	1.8	5.2	+/-	2.7
Trisnorhopane-2	0.6	+/-	0.9	4.4	+/-	1.7	1.9	+/-	1.8	1.2	+/-	2.2
norhopane-1	4.9	+/-	2.1	18.0	+/-	5.5	11.2	+/-	4.4	28.3	+/-	9.2
norhopane-2	0.5	+/-	0.9	1.5	+/-	1.2	0.5	+/-	1.6	0.1	+/-	2.2
hopane-1	3.6	+/-	1.3	9.1	+/-	2.0	5.8	+/-	2.2	16.2	+/-	4.0
hopane-2	1.0	+/-	1.0	2.4	+/-	1.4	1.0	+/-	1.7	0.7	+/-	2.2
Homohopane-1	1.5	+/-	1.3	4.2	+/-	2.0	3.7	+/-	2.3	8.1	+/-	4.1
Homohopane-2	1.2	+/-	1.1	3.9	+/-	2.1	2.7	+/-	2.3	7.1	+/-	4.0
hopane-3	2.5	+/-	2.0	0.3	+/-	1.0	6.3	+/-	4.6	0.2	+/-	2.2
Bishomohopane-1	2.2	+/-	1.0	3.0	+/-	1.2	2.9	+/-	1.9	6.8	+/-	2.6
Bishomohopane-2	0.2	+/-	0.9	1.7	+/-	1.1	0.2	+/-	1.7	5.7	+/-	2.9
Sum	35.0			103.4			79.7			173.2		

	1984 Toyota Corolla 572.4 mg/mi			1984 Mercedes 300D 748.7 mg/mi			1982 Isuzu I-Mark 267.7 mg/mi			1982 Volkswagen Vanagon 475.6 mg/mi		
FTP Weighted PM												
Ergostane	13.7	+/-	3.7	13.6	+/-	3.7	9.2	+/-	2.6	24.5	+/-	5.4
Sitostane	6.5	+/-	2.6	12.6	+/-	3.5	8.4	+/-	2.4	22.1	+/-	4.9
diasterane-1	4.8	+/-	2.1	5.1	+/-	2.1	5.1	+/-	1.6	19.1	+/-	4.3
diasterane-2	1.8	+/-	1.7	5.6	+/-	2.1	3.3	+/-	1.2	12.1	+/-	2.9
cholestane-1	6.0	+/-	2.5	7.1	+/-	2.8	7.3	+/-	2.3	30.5	+/-	7.8
cholestane-2	-0.4	+/-	1.7	2.6	+/-	1.9	1.3	+/-	1.1	7.9	+/-	2.4
cholestane-3	2.3	+/-	1.8	5.4	+/-	2.0	28.3	+/-	5.3	28.2	+/-	5.3
trisnorhopane-1	2.3	+/-	1.9	4.1	+/-	2.0	5.1	+/-	1.6	10.8	+/-	3.0
trisnorhopane-2	0.9	+/-	1.7	1.7	+/-	1.8	1.0	+/-	1.0	6.2	+/-	2.1
norhopane-1	9.2	+/-	3.9	20.3	+/-	6.8	17.6	+/-	5.4	41.4	+/-	11.9
norhopane-2	1.1	+/-	1.8	1.0	+/-	1.8	0.1	+/-	0.9	3.1	+/-	1.8
hopane-1	5.4	+/-	2.2	11.2	+/-	2.8	10.6	+/-	2.3	21.6	+/-	4.0
hopane-2	2.0	+/-	1.8	2.5	+/-	2.0	0.5	+/-	1.0	4.3	+/-	2.1
homohopane-1	4.6	+/-	2.7	7.1	+/-	3.3	7.0	+/-	2.8	9.4	+/-	3.6
homohopane-2	1.5	+/-	2.0	3.8	+/-	2.6	4.3	+/-	2.2	5.9	+/-	2.9
hopane-3	0.0	+/-	1.7	1.0	+/-	1.8	0.2	+/-	0.9	0.9	+/-	1.2
Bishomohopane-1	3.1	+/-	1.9	6.3	+/-	2.1	3.2	+/-	1.2	9.1	+/-	1.9
Bishomohopane-2	0.3	+/-	1.7	3.7	+/-	2.0	3.0	+/-	1.3	2.9	+/-	1.4
Sum	65.1			114.7			115.5			260.2		

Appendix N. cont. Hopane and Sterane Emission Rates for Diesel Vehicles (µg/mi)

	1982 Mercedes 300 TD			1982 Volkswagen Rabbit			1982 Mercedes 300TD			1981 Peugeot 505 TD		
FTP Weighted PM	654.0 mg/mi			485.1 mg/mi			464.4 mg/mi			677.4 mg/mi		
Ergostane	20.3	+/-	4.6	73.5	+/-	14.9	23.1	+/-	5.5	31.2	+/-	6.6
Sitostane	12.1	+/-	3.1	67.7	+/-	13.8	14.1	+/-	3.9	27.2	+/-	5.8
diasterane-1	16.8	+/-	3.8	20.6	+/-	4.8	3.3	+/-	2.1	16.5	+/-	3.8
diasterane-2	10.0	+/-	2.5	14.8	+/-	3.7	4.9	+/-	2.3	10.3	+/-	2.5
cholestane-1	30.2	+/-	7.6	54.4	+/-	13.5	14.5	+/-	4.3	32.3	+/-	8.2
cholestane-2	8.2	+/-	2.4	22.6	+/-	5.9	3.8	+/-	2.2	13.1	+/-	3.5
cholestane-3	18.4	+/-	3.6	45.6	+/-	8.5	8.3	+/-	2.4	26.8	+/-	5.0
trisorhopane-1	6.0	+/-	2.0	21.3	+/-	5.7	3.8	+/-	2.2	10.9	+/-	3.0
trisorhopane-2	1.7	+/-	1.1	10.7	+/-	3.7	2.8	+/-	2.0	2.3	+/-	1.3
norhopane-1	20.4	+/-	6.2	62.6	+/-	18.1	43.0	+/-	12.9	58.1	+/-	16.4
norhopane-2	0.5	+/-	1.1	6.6	+/-	3.5	3.3	+/-	2.4	6.8	+/-	3.3
hopane-1	13.3	+/-	2.7	31.8	+/-	5.9	22.7	+/-	4.5	29.1	+/-	5.2
hopane-2	1.1	+/-	1.1	0.7	+/-	1.7	1.2	+/-	2.0	2.7	+/-	1.5
homohopane-1	6.3	+/-	2.7	14.2	+/-	5.4	11.6	+/-	4.7	18.1	+/-	6.3
homohopane-2	3.7	+/-	2.1	8.1	+/-	4.1	11.9	+/-	5.7	13.6	+/-	5.8
hopane-3	0.5	+/-	1.1	0.1	+/-	1.7	14.7	+/-	10.2	0.5	+/-	1.2
bishomohopane-1	3.3	+/-	1.3	5.9	+/-	2.1	10.6	+/-	2.6	7.9	+/-	1.8
bishomohopane-2	2.0	+/-	1.3	4.9	+/-	2.2	3.7	+/-	2.2	5.9	+/-	2.0
Sum	174.7			466.3			201.1			313.3		

	1981 Mercedes 300SD			1980 Mercedes 300 TD			1980 Volkswagen Rabbit			1980 Mercedes 240		
FTP Weighted PM	247.3 mg/mi			1608.3 mg/mi			338.2 mg/mi			289.0 mg/mi		
Ergostane	15.6	+/-	4.1	51.5	+/-	10.7	28.9	+/-	6.2	6.0	+/-	2.6
Sitostane	8.6	+/-	2.8	40.1	+/-	8.5	24.6	+/-	5.3	8.8	+/-	2.9
diasterane-1	2.5	+/-	1.9	31.3	+/-	7.0	8.3	+/-	2.2	4.7	+/-	2.0
diasterane-2	2.2	+/-	1.9	25.2	+/-	5.7	4.6	+/-	1.5	1.7	+/-	1.7
cholestane-1	5.5	+/-	2.4	50.3	+/-	12.6	25.1	+/-	6.4	8.1	+/-	2.9
cholestane-2	1.2	+/-	1.7	12.1	+/-	3.6	9.2	+/-	2.6	1.1	+/-	1.7
cholestane-3	8.0	+/-	2.4	45.9	+/-	8.5	20.2	+/-	3.9	9.6	+/-	2.5
trisorhopane-1	4.2	+/-	2.0	13.6	+/-	3.9	8.4	+/-	2.4	4.6	+/-	2.2
trisorhopane-2	4.1	+/-	2.0	4.8	+/-	2.2	5.5	+/-	2.0	1.3	+/-	1.6
norhopane-1	15.1	+/-	5.4	54.6	+/-	15.9	33.3	+/-	9.7	11.2	+/-	4.3
norhopane-2	0.2	+/-	1.7	4.9	+/-	2.8	1.9	+/-	1.4	0.6	+/-	1.6
hopane-1	9.1	+/-	2.6	27.9	+/-	5.2	16.3	+/-	3.2	9.2	+/-	2.5
hopane-2	1.0	+/-	1.7	7.5	+/-	3.6	1.1	+/-	1.1	0.7	+/-	1.6
homohopane-1	7.8	+/-	3.5	15.5	+/-	5.8	7.4	+/-	3.0	4.0	+/-	2.5
homohopane-2	4.6	+/-	2.8	9.9	+/-	4.7	5.5	+/-	2.7	2.9	+/-	2.3
hopane-3	2.5	+/-	2.5	8.7	+/-	6.3	0.1	+/-	1.0	0.3	+/-	1.6
bishomohopane-1	3.7	+/-	1.9	8.0	+/-	2.3	3.6	+/-	1.3	2.7	+/-	1.8
bishomohopane-2	2.0	+/-	1.9	5.5	+/-	2.4	3.4	+/-	1.4	0.7	+/-	1.7
Sum	98.0			417.3			207.2			78.2		

Appendix N. cont. Hopane and Sterane Emission Rates for Diesel Vehicles (µg/mi)

	1979 Cadillac Seville	1979 Volkswagen Rabbit	1977 Mercedes 300D
FTP Weighted PM	1402.4 mg/mi	991.1 mg/mi	633.8 mg/mi
Ergostane	364.4 +/- 71.1	16.0 +/- 3.8	27.6 +/- 5.9
Sitostane	198.0 +/- 39.5	15.1 +/- 3.6	22.2 +/- 4.9
diasterane-1	341.9 +/- 72.5	10.6 +/- 2.6	16.9 +/- 3.9
diasterane-2	255.4 +/- 54.7	6.4 +/- 1.8	11.2 +/- 2.7
cholestane-1	367.4 +/- 89.1	16.4 +/- 4.4	29.7 +/- 7.6
cholestane-2	161.6 +/- 39.2	6.9 +/- 2.1	7.1 +/- 2.2
cholestane-3	391.1 +/- 70.5	26.3 +/- 4.9	21.9 +/- 4.1
trisnorhopane-1	75.7 +/- 19.1	5.2 +/- 1.8	8.6 +/- 2.5
trisnorhopane-2	48.6 +/- 15.0	3.3 +/- 1.5	6.6 +/- 2.3
norhopane-1	200.0 +/- 56.0	18.1 +/- 5.7	45.1 +/- 12.9
norhopane-2	9.4 +/- 5.1	0.9 +/- 1.2	3.4 +/- 1.8
hopane-1	110.8 +/- 19.3	12.5 +/- 2.6	24.4 +/- 4.4
hopane-2	22.3 +/- 9.7	2.9 +/- 1.6	3.6 +/- 1.8
homohopane-1	42.4 +/- 14.8	6.6 +/- 2.8	13.9 +/- 5.0
homohopane-2	24.3 +/- 10.8	4.5 +/- 2.3	8.9 +/- 4.0
hopane-3	2.9 +/- 3.6	1.7 +/- 1.6	0.1 +/- 1.0
bishomohopane-1	15.6 +/- 4.0	3.7 +/- 1.3	6.9 +/- 1.6
bishomohopane-2	10.2 +/- 4.1	2.6 +/- 1.4	5.0 +/- 1.8
Sum	2642.0	159.6	263.2