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Gaseous and Particulate Emissions from Gasoline- and Diesel-Powered Heavy-Duty Trucks

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by

James N. Braddock
and
Ned Perry

ATMOSPHERIC SCIENCES RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

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ABSTRACT

Gaseous and particulate emission rates from seven class 2B, one class 5 and six class 6 heavy-duty gasoline- and diesel-powered trucks were determined using transient chassis dynamometer test procedures. All vehicles were tested at approximately 70% of their rated gross vehicle weight over the Heavy-Duty Transient Cycle and the Durham Road Route driving cycles. The sensitivity of emission rates to vehicle configuration, engine design, and driving cycle characteristics was examined. Emissions characterization included total hydrocarbons, carbon monoxide, oxides of nitrogen, fuel economy, total particulate matter, CH_2Cl_2 %-extractables, particulate organics, inert material, particle size less than 2μ, and lead, bromine, and chlorine analyses. All class 2B truck emission rates were less than class 5 or 6 truck emission rates. Hydrocarbon and carbon monoxide emissions and fuel consumption were significantly higher with the gasoline trucks than with the diesel trucks. Total particulate, particulate organics, and inert material emissions were significantly greater with the diesel trucks. Hydrocarbons, carbon monoxide, total particulate emissions, and fuel consumption were sensitive to the characteristics of the transient driving cycles.

THIS STUDY IS A CONTINUATION OF WORK begun at EPA-Research Triangle Park in 1982 that investigated gaseous and particulate emissions from in-use heavy-duty gasoline trucks. This initial gasoline truck investigation was subsequently reported by Black et al. in 1984 (1)*. The current study is also a follow-up to other EPA-sponsored transient chassis truck studies (2-4) that are designed to enhance our knowledge of heavy-duty mobile source emissions and their contributions to national ambient air quality degradation (5). Heavy-duty highway vehicles have significant impact upon the gaseous and particulate emissions totals from all highway mobile sources. That is, with respect to gaseous emissions, heavy-duty vehicles were responsible for an estimated 10% of total hydrocarbon (HC) emissions, 15% of carbon monoxide (CO) emissions, and 34% of oxides of nitrogen (NO_x) emissions from highway mobile sources in 1980 (6). With respect to particulate emissions, heavy-duty vehicles were responsible for an estimated 44% of all engine-related particulate matter from highway mobile sources in 1977 (7). Clearly, then, the pollution contribution from heavy-duty vehicles is important and this study will expand the limited data base on which air quality impact estimates are based.

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*Numbers in parentheses designate references at end of paper.

EXPERIMENTAL PROCEDURE

VEHICLE SELECTION--The trucks selected for this study normally operate in stop-and-go (i.e., transient mode) driving patterns in urban environments as delivery vehicles and include seven class 2B, one class 5, and six class 6 trucks. Trucks are commonly classified according to the Motor Vehicle Manufacturers' Association (MVMA) truck classification scheme that divides trucks into various classes based on their rated gross vehicle weights (GVW). For example, a class 2B truck has a GVW rating of 8501 to 10,000 lb; a class 5 truck has a GVW rating of 16,001 to 19,500 lb; and a class 6 truck has a GVW rating of 19,501 to 26,000 lb. The class 2B vehicles (pickups and small vans) are usually employed in lighter-duty commercial operation than the class 5 or 6 vehicles, which are generally involved in more medium-duty commercial applications. On a sales-weighted basis, class 2B and class 6 trucks are among the most popular, and, therefore were acquired for test pruposes in this investigation. The test fleet was composed of six gasoline trucks and eight diesel trucks, all of which were local rental or loan vehicles. The dynamometer inertia setting for all vehicles was approximately 70% of rated GVW, and all vehicles were tested as received (i.e., no maintenance was performed on them).

The gasoline truck fleet, described in Table 1, was comprised of four class 2B vans, one class 5 van, and one class 6 stake-bed truck. All were equipped with medium-size V-8 engines equipped with two-barrel carburetors. The class 2B Ford 350 delivery vans had aerodynamically designed chassis (i.e., rounded vertical and horizontal edges). This type of design reduced the aerodynamic-drag component of road load relative to that of a nonaerodynamically designed (i.e., squared edges on a large frontal area)

Table 1. Gasoline Test Vehicle Description

Manufacturer	Vehicle ID	Class Type	Chassis Type	Engine Type	Odometer miles	GVW, lbs	Dynamometer: Inertia setting, lbs	Dynamometer: Road Load HP @ 50 mph	Special Comments
Ford F350	FUH413	2B	1979 Van	V-8, 330 in^3 (5.4ℓ) 2bbl carburetor	38,061	9,900	7,080	41.0	Aerodynamic design
Ford F350	F2H411	2B	1978 Van	V-8, 330 in^3 (5.4ℓ) 2bbl carburetor	54,415	9,900	7,080	41.0	Aerodynamic design
Plymouth Voyager	VOY285	2B	1982 Van	V-8, 360 in^3 (5.9ℓ) 2bbl carburetor	47,386	8,510	6,032	35.5	
Plymouth Voyager	VOY338	2B	1983 Van	V-8, 360 in^3 (5.9ℓ) 2bbl carburetor	23,561	8,510	6,032	35.5	
Ford 600	F3H633	5	1972 Van	V-8, 330 in^3 (5.4ℓ) 2bbl carburetor	5,327	17,900	12,830	67.5	Large frontal area (non-aerodynamic)
General Motors	G63333	6	1975 Stake-bed	V-8, 350 in^3 (5.7ℓ) 2bbl carburetor	37,000	25,080	16,378	50.4	

chassis. The two class 2B Plymouth vans had a 15-passenger carrying capacity. The class 5 Ford 600 van had the largest frontal area (i.e., greatest aerodynamic drag) of any vehicle tested, hence its dynamometer road-load horsepower setting was also the greatest. Coupled with its relatively large inertia weight setting of 12,830 lbs, the motor in the Ford 600 Van, a small 330 in^3 V-8, had to work very hard to maintain the prescribed speed of the truck driving cycles.

The diesel truck fleet, described in Table 2, was comprised of three class 2B vehicles (one van and two pickups) and five class 6 vehicles (four stake-beds and one flat-bed). It should be noted that one of the stake-beds, vehicle CDW786, was tested twice in the test program, approximately 2 months apart. Hence, the test designations are CDW786A and CDW786B. The vehicle behaved or drove differently during the second test; it seemed harder to drive, had less power, and used a fair amount of coolant. When the second set of tests was completed, an engine teardown of this vehicle indicated a leaking head gasket. The class 2B van, FDW112, had a very high lubricant consumption rate, especially in view of its newness (1983 model) and low mileage (2,040 mi). Compared to the gasoline V-8 engines, the diesel V-8 engines were quite a bit larger and, therefore, had significantly more reserve horsepower for keeping up with the driving cycles (none had any problem). All the diesel vehicles, except for the Ford 7000 flat-bed (FDB420), had naturally aspirated, indirect-injection-type diesel engines. FDB420 had the only naturally aspirated, direct-injection, heavy-duty diesel engine in the test fleet.

TEST FUEL--Table 3 lists the properties of the two test fuels. Vehicle operation with their respective fuel(s) was satisfactory over the two driving

Table 2. Diesel Test Vehicle Description

Manufacturer	Vehicle ID	Class Type	Chassis Type	Engine type and manufacturer*	Odometer miles	GVW, lbs	Dynamometer Inertia setting, lbs	Dynamometer Road Load HP @ 50 mph	Special Comments
Ford	FDW112	2B	1983 Van	V-8, 425 in^3 (6.9ℓ) International Harvester	2,040	9,100	6,445	35.0	High lubricant consumption
Chevrolet	CDR734	2B	1984 Pick-up	V-8, 379 in^3 (6.2ℓ) Detroit Diesel Allison	2,662	8,600	6,095	31.6	
Ford 250	FDP387	2B	1984 Pick-up	V-8, 425 in^3 (6.9ℓ) International Harvester	11,342	8,600	6,095	32.6	
Chevrolet	CDW786A	6	1981 Stake-bed	V-8, 500 in^3 (8.2ℓ) Detroit Diesel Allison	63,914	23,160	16,512	56.0	
Chevrolet	CDW780	6	1981 Stake-bed	V-8, 500 in^3 (8.2ℓ) Detroit Diesel Allison	68,235	23,160	16,512	56.0	
Ford F600	FDW161	6	1984 Stake-bed	V-8, 500 in^3 (8.2ℓ) Detroit Diesel Allison	6,948	19,700	13,940	59.9	
Ford 7000	FDB420	6	1977 Flat-bed	V-8, 636 in^3 (10.4ℓ) Caterpillar 3208	85,244	24,000	16,930	61.4	Direct injection engine
Chevrolet	CDW786B	6	1981 Stake-bed	V-8, 500 in^3 (8.2ℓ) Detroit Diesel Allison	68,330	23,160	16,512	56.0	Leaking head gasket

* All vehicles, except FDB420, had naturally aspirated, indirect-injection type diesel engines. FDB420 had a naturally aspirated, direct-injection diesel engine.

Table 3. Test Fuel Description

Leaded Regular Gasoline		Premium Diesel Fuel	
Lead, g/gal	1.29	Type	2-D
Sulfur, wt. %	0.060	Sulfur, wt. %	0.18
Density, g/cc	0.7208	Density, g/cc	0.8551
RVP, PSI	10.5	API Gravity	33.9
Octane, (R+M)/2	88.8	Cetane number	46.0
Distillation Temp., (°F)		Distillation Temp., (°F)	
30%	149	IBP	357
38%	171	10%	428
68%	244	50%	509
90%	374	90%	597
EP	540	EP	638
% Recovery	98.0	FIA Analysis	
% Residue	1.0	Aromatics %	39.9
		Olefins %	2.0
GC Analysis:		Saturates %	58.1
Aromatics %	19.5		
Olefins %	18.6	Carbon, wt. %	86.8
Saturates %	61.9	Hydrogen, wt. %	12.8
Carbon, wt. %	86.6		
Hydrogen, wt. %	13.4		

cycles. These fuels are typical of fuels used in normal vehicle operation and were obtained locally.

TEST PROCEDURES

DRIVING CYCLE AND TEST SCHEDULE--The heavy-duty transient chassis dynamometer test procedure is based on the EPA Recommended Practice of France et al. (8). The EPA Recommended Practice identifies a heavy-duty transient cycle (HDTC) that is derived from New York Nonfreeway (NYNF), Los Angeles Nonfreeway (LANF),and Los Angeles Freeway (LAF) driving patterns. Subsequent smoothing of unrealistic speed-time trace fluctuations were made according to the procedure of Black et al. (1). The smoothed HDTC speed-time trace is depicted in Figure 1. The HDTC consists of a cold start followed by a 20-minute soak and then a hot start. Four individual driving schedules or "bags" (NYNF, LANF, LAF, and NYNF) are included in both the cold-start and hot-start portions of the test as described in Table 4. Characteristics of the HDTC include an overall length of 5.55 mi, an average speed of 18.9 mph and 32.9% of time spent at idle. Another driving cycle, the locally derived Durham Road Route (DRR), was also used in this study (1). A complete description of the DRR is provided in Figure 1 and Table 4. Characteristics of the DRR include an overall length of 6.37 mi, an average speed of 24.7 mph, and 11.8% of time spent at idle.

The truck study test schedule is described in Table 5. Each truck needed a minimum period of two weeks to complete the desired test schedule: the first week for the HDTC and the second week for the DRR.

CHASSIS DYNAMOMETER AND FACILITY--A Burke Porter Model 1059 electric drive chassis dynamometer was used for inertia and road-load simulation. The

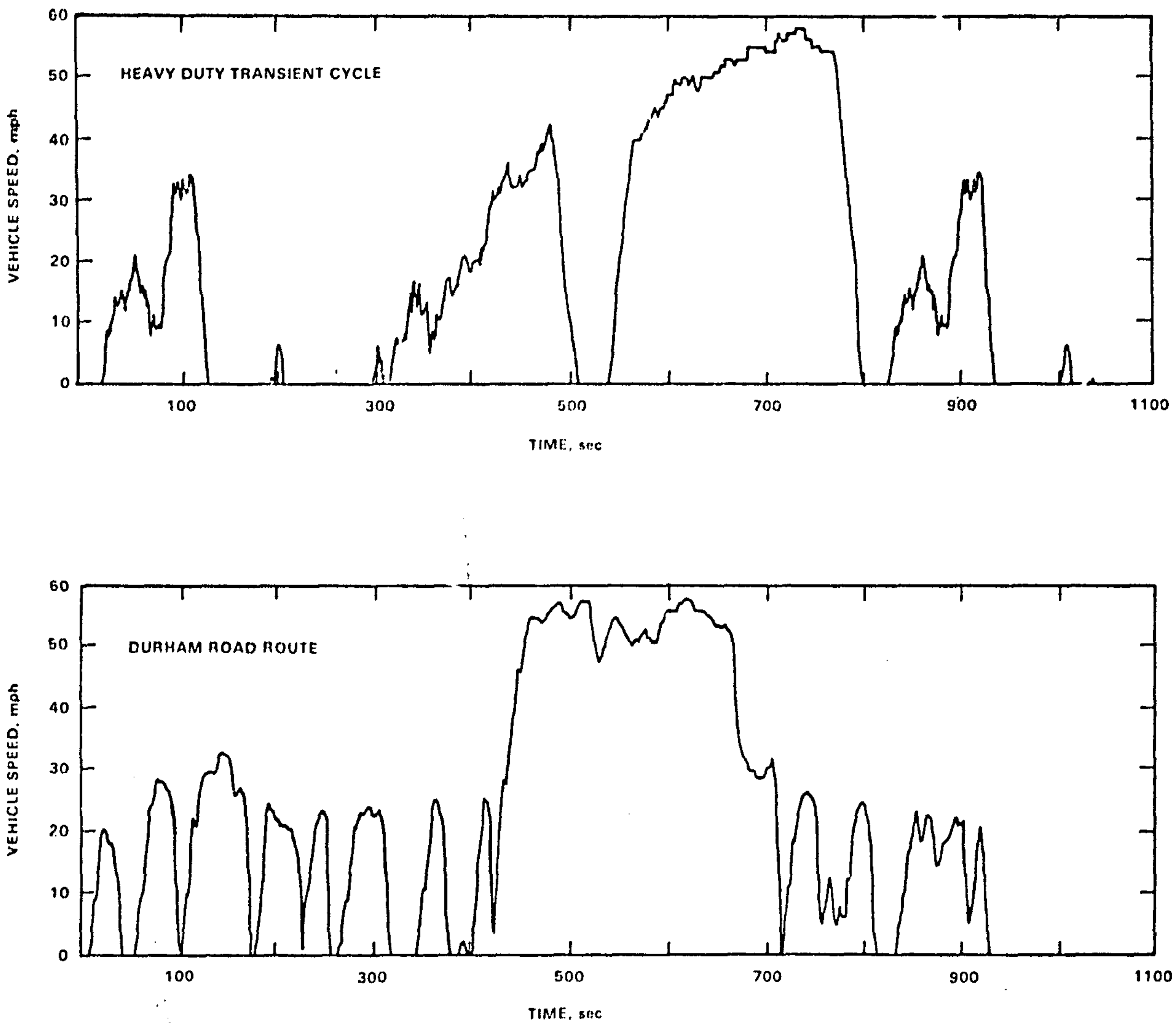


Figure 1. HDTC and DRR Driving Cycles

Table 4. Driving Cycle Specifications

Cycle Description	Length, miles	Cumulative distance traveled, miles	Average speed, mph	Cumulative average speed, mph	Maximum speed, mph	Time, minutes	Cumulative time, minutes	Number of stops per cycle	Cumulative stops	Time at idle %
Heavy Duty Transient Cycle (HDTC)	5.55	--	18.9	--	58	17.7	--	15	--	32.9
HDTC composite driving schedules (8 Bags): New York Nonfreeway (NYNF, Bags 1 and 5)	0.53	0.53	7.6	7.6	34	4.2	4.2	6	6	52.0
Los Angeles Nonfreeway (LANF, Bags 2 and 6)	1.15	1.68	14.6	11.2	42	4.8	9.0	2	8	28.4
Los Angeles Freeway (LAF, Bags 3 and 7)	[illegible]	5.01	44.9	22.3	58	4.5	13.5	1	9	2.2
New York Nonfreeway (NYNF, Bags 4 and 8)	0.53	5.55	7.6	18.9	34	4.2	17.7	6	15	52.0
Durham Road Route (DRR)	6.37	--	24.7	--	58	15.5	--	10	--	11.8

Table 5. Test Schedule

Day	Schedule
1	Vehicle preparation and HDTC
2,3,4,5	Cold start HDTC followed by a hot start HDTC followed by a hot start HDTC (replicate)
6	Vehicle preparation and DRR
7,8,9,10	Cold start DRR followed by a hot start DRR followed by a hot start DRR (replicate)

system used 9.5-in diameter rolls, flywheels, and a DC electric motor with a Reliance digital microprocessor controller for inertia simulation in 1-lb increments from 1,000 to 18,200 lb and for simulation of the aerodynamic and frictional components of road load. A Horiba Constant Volume Sampling (CVS) system with selectable flow rate from 200 to 5000 cubic feet per minute (ft^3/min) was used to dilute and sample exhaust for subsequent analysis. This system was operated at 1400 ft^3/min to maintain the diluted exhaust temperatures below 125°F as required for particulate sampling (9). The CVS included an 8-in diameter dilution tunnel with approximately 25 ft from the point of initial dilution air mixing to the particulate filtration four-probe system. All dynamometer facilities, including the dilution tube, CVS, regulated exhaust emission analyzers, and particulate emissions analyzers, met Federal Register specifications.

GASEOUS AND PARTICULATE EMISSIONS METHODS--Exhaust characterization included HC, CO, NO_x, fuel economy, total particulate mass, methylene chloride (CH_2Cl_2) %-extractables, particulate organics, inert material, particulate size less than 2μ, and lead, bromine, and chlorine analyses. Inert material is defined as the insoluble material remaining on the filter after CH_2Cl_2 extraction of the total particulate (i.e., the total particulate emission rate minus the particulate organic emission rate). With diesel trucks, inert material primarily consists of elemental carbon; with gasoline trucks burning leaded gasoline, it primarily consists of carbon, lead, bromine, and chlorine. Either hot flame ionization (diesel trucks) or standard flame ionization (gasoline trucks) detection procedures were used for HC, nondispersive infrared procedures for CO and carbon dioxide (CO_2), and chemiluminescence procedures for NO_x. Total particulate mass and CH_2Cl_2-extractable particulate-phase organic mass were determined using previously described filtration-gravimetric and solvent-extraction procedures (10), and the particulate mass less than 2μ was determined using the cyclone size-selective sampling procedure of John et al. (11). Individual bag and composite particulate emission rates were measured with 47mm filters. Pallflex T60A20 Telfon-coated glass fiber filters were used for all particulate filtration and extraction procedures except for Fluoropore FA Teflon membrane filters, which were used for X-ray fluorescence analysis of particulate lead, bromine, and chlorine with the gasoline trucks (12). Due to analytical equipment failure, no X-ray analyses were performed on the diesel truck filters. A summary of the test procedures for gaseous and particulate sample acquisition during HDTC and DRR operation for the gasoline and diesel trucks are listed in Tables 6 and 7, respectively.

Table 6. Test Procedure for Gasoline Truck Gaseous and Particulate Sample Acquisition during HDTC and DRR Operation [a]

Exhaust Measurement	Cold start (Bags 1,2,3,4)	Hot start (Bags 5,6,7,8)	Hot start (Replicate) (Bags 1,2,3,4)
HC	integrated per bag	integrated per bag	integrated per bag
CO	integrated per bag	integrated per bag	integrated per bag
CO_2	integrated per bag	integrated per bag	integrated per bag
NO_x	integrated per bag	integrated per bag	integrated per bag
47mm Pallflex (gravimetric)	one composite filter per 4 bags	one composite filter per 4 bags	one composite filter per 4 bags
47mm Pallflex (size distribution)	one composite filter per 4 bags	one composite filter per 4 bags	one composite filter per 4 bags
47mm Fluoropore (X-ray analysis)	one composite filter per 4 bags	one composite filter per 4 bags	one composite filter per 4 bags

[a] Because the DRR is a one-bag driving cycle, integrated-per-bag test procedures were used. That is, gaseous emissions (HC, CO, CO_2, and NO_x) were analyzed from the single sample bag collected and single composite filters were collected for particulate analysis.

Table 7. Test Procedure for Diesel Truck Gaseous and Particulate Sample Acquisition during HDTC and DRR Operation[a]

Exhaust Measurement	Cold start (Bags 1,2,3,4)	Hot start (Bags 5,6,7,8)	Hot start (Replicate) (Bags 1,2,3,4)
HC	continuous per bag	continuous per bag	continuous per bag
CO	integrated per bag	integrated per bag	integrated per bag
CO_2	integrated per bag	integrated per bag	integrated per bag
NO_x	integrated per bag	integrated per bag	integrated per bag
47mm Pallflex (Gravimetric)	one integrated filter filter per bag	one integrated filter filter per bag	one integrated filter filter per bag
47mm Pallflex (size distribution)	one composite filter per 4 bags	one composite filter per 4 bags	one composite filter per 4 bags
47mm Pallflex (extra gravimetric)	one composite filter per 4 bags	one composite filter per 4 bags	one composite filter per 4 bags

[a] Because the DRR is a one-bag driving cycle, integrated-per-bag test procedures were used. That is, gaseous emissions (HC, CO, CO_2, and NO_x) were analyzed from the single sample bag collected and single composite filters were collected for particulate analysis.

RESULTS AND DISCUSSION

The main objective of this study was to measure and characterize the gaseous and particulate emissions from heavy-duty gasoline- and diesel-powered trucks using transient chassis dynamometer test procedures. All vehicles were tested at approximately 70% of their rated GVW over the HDTC and DRR driving cycles. The summary results presented herein are divided according to four subsections: (1) weighted gasoline truck emissions; (2) weighted diesel truck emissions; (3) individual bag/cycle results from gasoline trucks; and (4) individual bag/cycle results from diesel trucks. The underlying data, are listed in Appendices A, B, and C. Appendix A lists the integrated and weighted gaseous and particulate emission rates by individual trucks over the HDTC and DRR driving cycles. The integrated emissions rates are those from either the cold start or hot start tests; the weighted emission rates are a composite result, based on a 1/7 cold-start and 6/7 hot-start relative weighting. Appendix B lists by truck the individual bag gaseous emission rates of the HDTC. Appendix C lists the individual bag particulate emission rates of the HDTC for the diesel trucks; gasoline truck particle emissions generally had insufficient mass for individual bag analysis.

WEIGHTED GASOLINE TRUCK EMISSIONS--Summaries of the individual gaseous and particulate emission rates are presented in Table 8 for the HDTC and Table 9 for the DRR. Graphical representations of weighted gaseous emissions (HC, CO, NO_x, and fuel economy) and weighted particulate emissions (total particulate, CH_2Cl_2 %-extractable, particulate organics, and inert material) are depicted in Figures 2 and 3, respectively.

HDTC HC and CO emission rates were greater than DRR HC and CO emission rates. That is, HC emission rates ranged from 4.11 to 33.99 g/mi during the

Table 8. Heavy Duty Transient Cycle Weighted Emissions - Gasoline Trucks

Truck ID	Truck Class	HC g/mi	CO g/mi	NO_x g/mi	Fuel Economy MPG	Total Particulate g/mi	Particulate Organics g/mi	Inert Material g/mi	CH_2Cl_2 Extract. %	Size Fraction <2μ,%
FUH413	2B	12.86	80.30	6.66	9.66	0.092	0.023	0.069	25.1	86.8
F2H411	2B	22.54	69.52	10.90	8.77	0.110	0.031	0.078	29.2	81.6
VOY285	2B	4.29	82.70	3.67	9.49	0.133	0.074	0.059	53.1	80.9
VOY338	2B	4.11	44.09	4.99	9.29	0.118	0.062	0.057	50.1	86.1
F3H633	5	33.99	370.75	5.91	5.35	0.405	0.104	0.299	25.8	77.2
G63333	6	31.93	220.52	9.44	5.15	0.516	0.228	0.291	43.4	96.0

Table 9. Durham Road Route Weighted Emissions - Gasoline Trucks

Truck ID	Truck Class	HC g/mi	CO g/mi	NO_x g/mi	Fuel Economy MPG	Total Particulate g/mi	Particulate Organics g/mi	Inert Material g/mi	CH_2Cl_2 Extract. %	Size Fraction <2μ,%
FUH413	2B	7.14	45.10	8.75	11.03	0.091	0.026	0.066	28.4	84.2
F2H411	2B	9.60	47.81	12.41	10.28	0.101	0.028	0.072	28.0	77.1
VOY285	2B	1.90	42.66	4.30	11.99	0.119	0.064	0.055	52.6	86.4
VOY338	2B	1.87	23.77	5.25	12.04	0.088	0.043	0.045	48.2	81.5
F3H633	5	19.56	344.48	6.17	5.74	0.340	0.096	0.241	28.4	96.2
G63333	6	16.99	198.99	10.66	5.66	0.460	0.180	0.293	38.3	93.7

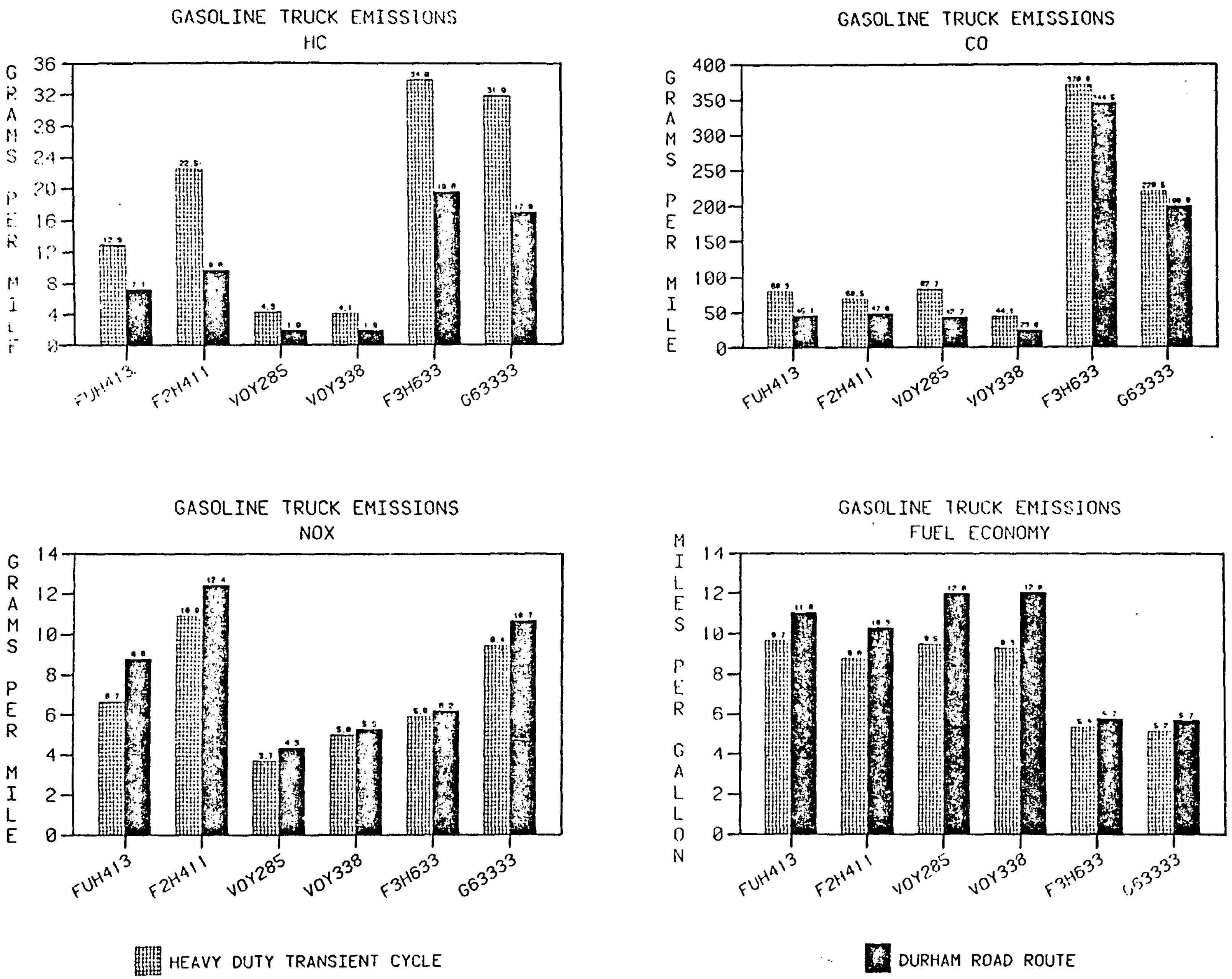


Figure 2. Gasoline Truck Weighted Gaseous Emissions

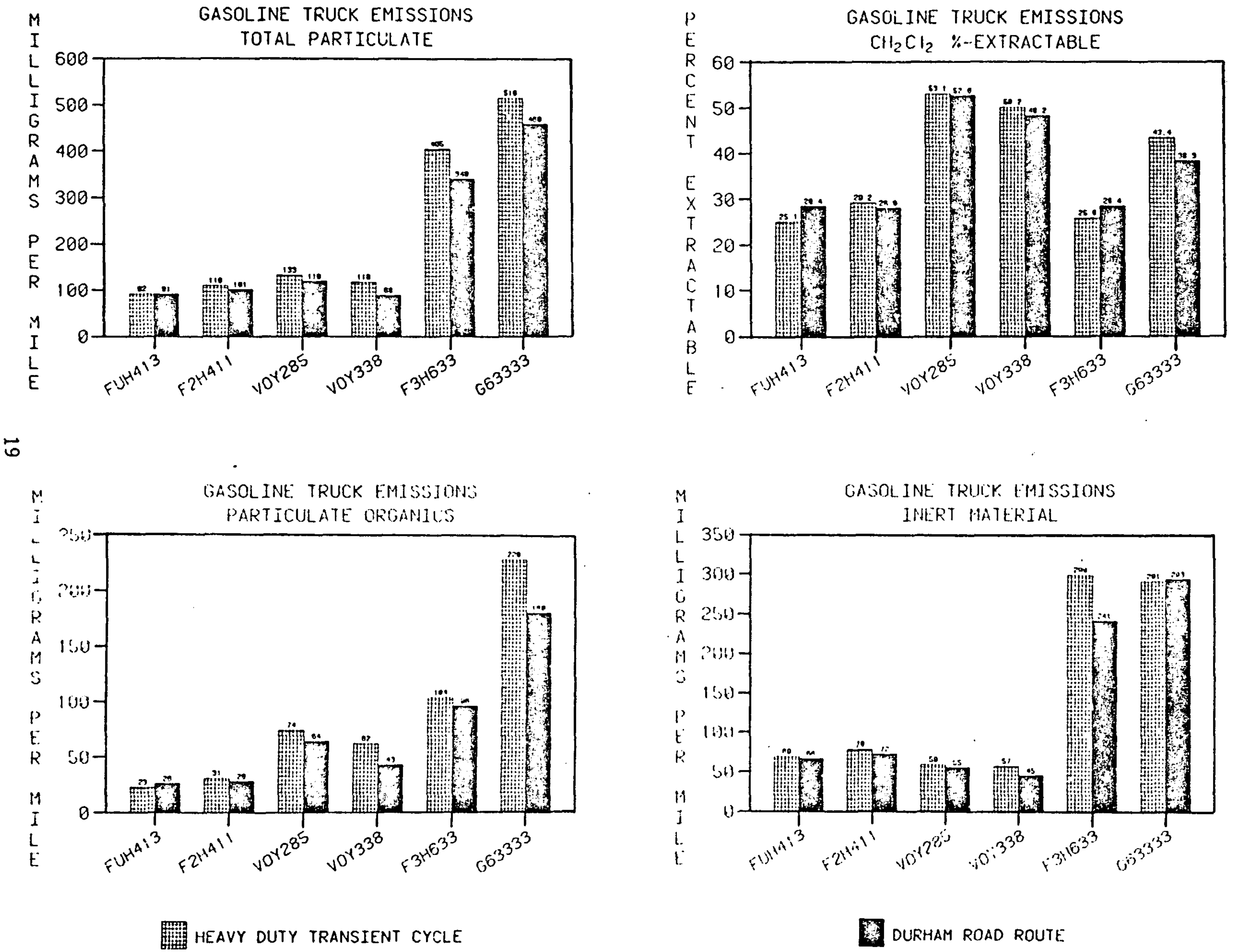


Figure 3. Gasoline Truck Weighted Particulate Emissions

HDTC, compared to 1.87 to 19.56 g/mi during the DRR; CO emission rates ranged from 44.09 to 370.75 g/mi during the HDTC, compared to 23.77 to 344.48 g/mi during the DRR. DRR NO_x emission rates and fuel economies were greater than HDTC NO_x emission rates and fuel economies. That is, NO_x emission rates ranged from 4.30 to 12.41 g/mi during the DRR, compared to 3.67 to 10.90 g/mi during the HDTC. Fuel economy ranged from 5.66 to 12.04 mi/gal during the DRR, compared to 5.15 to 9.66 mi/gal during the HDTC.

The class 5 Ford 600 (F3H633) was, by far, the greatest HDTC HC and CO emitter, with 33.99 and 370.75 g/mi emission rates, respectively. It also was the oldest vehicle, a 1972 model, had a relatively small 330 in^3 V-8 engine, and had the highest dynamometer road-load horsepower setting (67.5 HP @ 50 mph). In order to maintain the prescribed speed and acceleration rates of the driving cycle(s), this truck had to be driven at wide-open throttle a good deal of the time. This, combined with the older pre-emission control design of its engine, accounts for its high emissions rate and low fuel economy. The class 6 GM stake-bed (G63333) was the next greatest HC and CO emitter, with 31.93 and 220.52 g/mi emission rates, respectively. It was the next oldest vehicle, a 1975 model, and had the highest rated GVW. Of the class 2B trucks, the 1978 Ford F350 (F2H411) was the highest HC and NO_x emitter, at 22.54 and 10.90 g/mi, respectively, although the 1982 Plymouth Voyager (VOY285) was the highest CO emitter at 82.70 g/mi. The newest vehicle, the 1983 Plymouth Voyager (VOY3[illegible]8), was the lowest emitter of the class 2B trucks. Thus, there appeared to be a positive correlation between vehicle age and emissions: the newer the vehicle, in both age and design, the lower the emissions.

Particulate emissions (Tables 8 and 9, Figure 3) followed a pattern similar to that found for gaseous emissions: HDTC particle emissions were greater than DRR particle emissions, and the class 5 and 6 truck emission rates were greater than the class 2B truck emission rates (as expected, because the class 5 and 6 trucks burn more fuel per unit distance than do the class 2B trucks). The CH_2Cl_2 %-extractable rates ranged from a low of 25% to a high of 53%; there was no real difference between the HDTC and DRR %-extractable rates. The %-extractables varied among vehicles: FUH413, F2H411, and F3H633 (all Ford 330 CID V-8 engines) averaged 27.5 ± 1.6% extractable; VOY285 and VOY338 (all Plymouth 360 CID V-8 engines) averaged 51.0 ± 2.3% extractable; G63333 (a GM 350 CID V-8) averaged 40.9 ± 3.6% extractable. Particulate organic emissions (the product of the percentage extractable with CH_2Cl_2 and the total particulate emission rate) were greatest from the class 5 and 6 trucks. The inert material emission rates displayed a pattern similar to that of the %-extractable rates.

An observation concerning particle emissions from these trucks was that the particle size fraction/percentage less than 2μ averaged 85.6 ± 6.7%. This percentage is typical of engines emitting excessive organic aerosol that is characterized by fine liquid droplets (13). It should be recognized, however, that the total particulate emission rate was defined by use of a laboratory dilution tunnel and that very large particles (greater than 300μ) were probably lost due to gravitational settling on the walls of this tunnel and thus, were not counted in the calculation of total particulate matter.(14) Figure 4 displays both gasoline and diesel fine particulate fractions (less than 2μ) for the HDTC and DRR driving cycles.

Table 10 presents the leaded particulate analyses for the gasoline trucks over the HDTC and DRR and includes lead, bromine, chlorine, and total leaded fraction weight percentage data. There was no real difference bewteen the HDTC and DRR leaded particulate emission percentages. These emission fractions did appear dependent on engine type: FUH413, F2H411, and F3H633

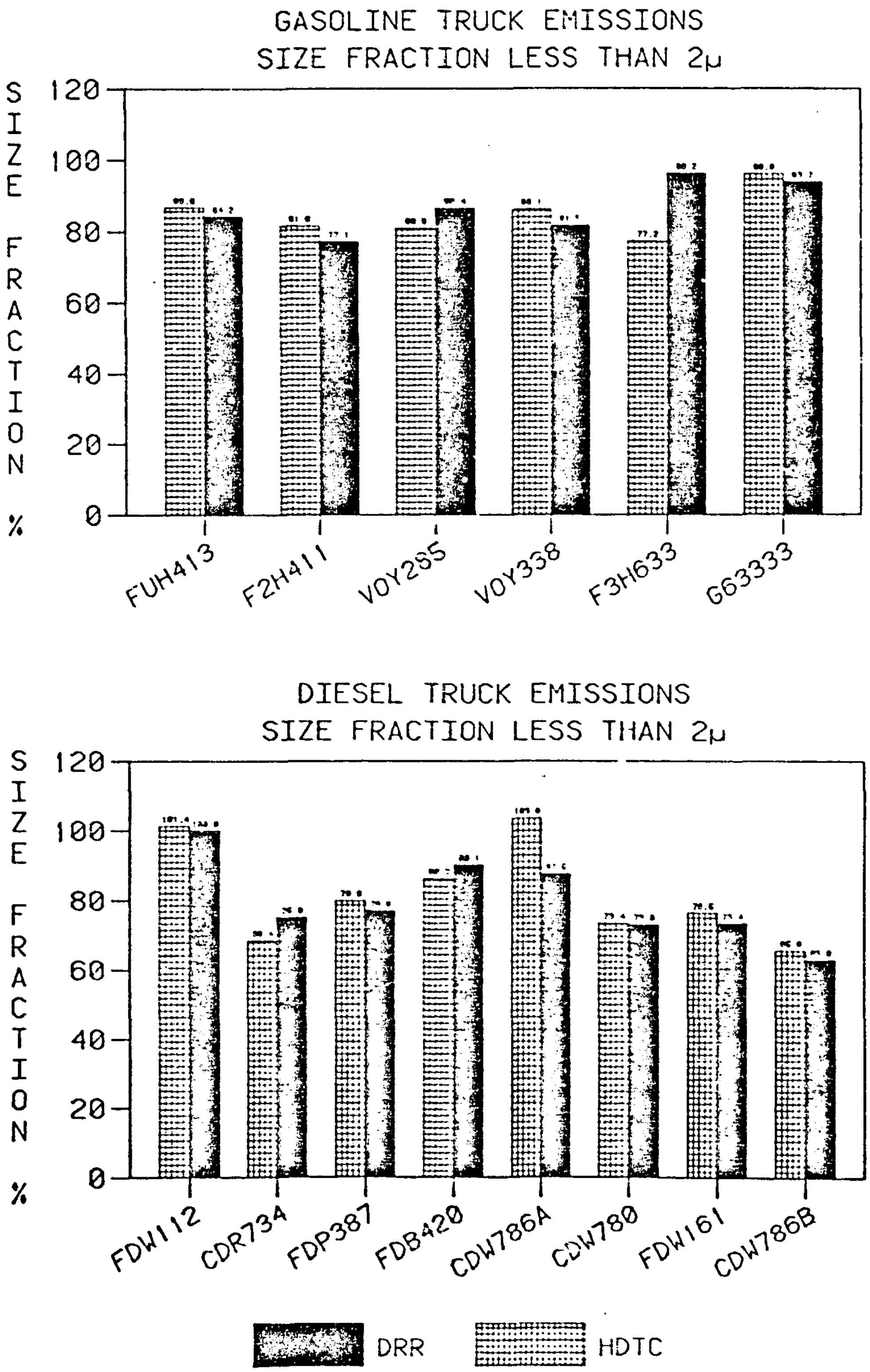


Figure 4. Gasoline and Diesel Truck Size Fraction Less Than 2μ

Table 10. Gasoline Trucks Leaded Particulate Analysis

Vehicle	Driving Cycle	Pb, wt.%	Br, wt. %	Cl, wt. %	Total Leaded fraction[a]
FUH413	HDTC	31.2 ± 4.5	16.7 ± 2.7	5.3 ± 0.6	53.2 ± 7.7
	DRR	32.1 ± 2.3	18.8 ± 1.5	5.1 ± 0.3	55.9 ± 3.9
F2H411	HDTC	28.8 ± 1.1	14.7 ± 0.9	4.7 ± 0.4	48.3 ± 2.2
	DRR	32.2 ± 1.8	17.2 ± 1.1	4.7 ± 0.2	54.0 ± 3.1
VOY285	HDTC	12.3 ± 1.6	7.8 ± 0.7	1.6 ± 0.1	24.5 ± 1.7
	DRR	15.9 ± 2.7	9.1 ± 1.7	1.8 ± 0.4	25.7 ± 4.7
VOY338	HDTC	18.4 ± 2.4	10.1 ± 1.3	2.5 ± 0.5	30.9 ± 3.8
	DRR	19.0 ± 1.9	10.9 ± 1.2	2.5 ± 0.4	32.3 ± 3.4
F3H633	HDTC	28.3 ± 2.9	13.8 ± 1.4	2.9 ± 0.4	44.8 ± 4.6
	DRR	31.0 ± 2.4	14.9 ± 0.7	2.9 ± 0.4	48.7 ± 2.3
G63333	HDTC	19.7 ± 1.4	9.7 ± 1.1	2.2 ± 0.3	31.5 ± 2.6
	DRR	23.0 ± 2.6	11.7 ± 1.6	2.8 ± 0.3	36.9 ± 4.3

[a] Total leaded fraction is the sum of Pb, Br, and Cl weight %'s. It represents the fraction of the total particulate. All values listed in this table are weighted averages.

(all Ford 330 CID V-8 engines) averaged ~50% total leaded fraction; VOY285 and VOY338 (both Plymouth 360 CID V-8 engines) averaged ~28% total leaded fraction; and G63333 (a GM 350 CID V-8) averaged ~34% total leaded fraction. Lead is emitted primarily as the compound PbBrCl from engine exhaust (15). The Pb content of this compound is 64.2% by mass and its emission is due to the presence of ethylene dichloride and ethylene dibromide scavengers in normal leaded fuel. PbBrCl has theoretical mass ratios for lead, bromine, and chlorine of 0.64, 0.25, and 0.11, respectively. The particle compositional data in Table 10 indicate that mass ratios for lead, bromine, and chlorine were approximately 0.60, 0.32, and 0.09, respectively, closely reflecting the theoretical mass rations. Data from the previous EPA truck study reported by Black et al. that involved six 1973 to 1983 vehicles, indicated similar mass ratios for lead, bromine, and chlorine: 0.59, 0.33, and 0.08, respectively (1).

Figure 5 puts into perspective the relative contributions of the three particulate components (leaded fraction, particulate organic fraction, and the remaining inert material fraction) to the total particulate emission rates for each vehicle. The remaining inert material fraction consists of non-CH_2Cl_2 extractable carbonaceous material and various trace elements (e.g., sulfur, phosphorous, clacium, zinc, ion, sodium, aluminum, chrominum, manganese, nickel, copper, etc.). The three Ford engine-equipped trucks (FUH413, F2H411, and F3H633) had the highest leaded particulate fraction of 50%, the lowest particulate organic fraction of 28%, and a remaining inert material fraction of 22%. The two Plymouth engine-equipped vans (VOY285 and VOY338) had the lowest leaded particulate fraction of 28%, the highest particulate organic fraction of 51%, and a remaining inert material fraction of 21%. The

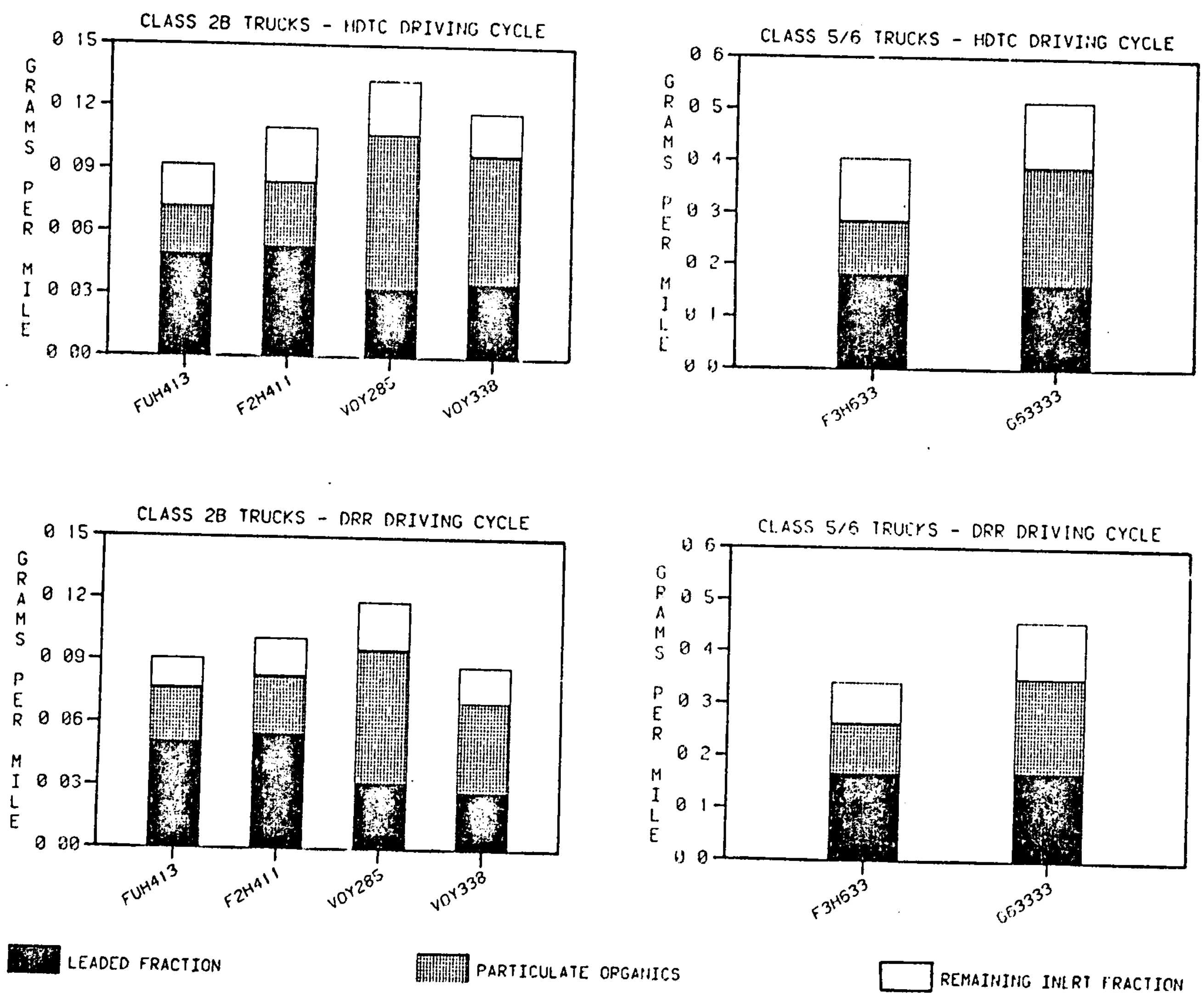


Figure 5. Gasoline Truck Particulate Composition

remaining GM engine-equipped truck (G63333) had a leaded particulate fraction of 34%, a particulate organic fraction of 41%, and a remaining inert material fraction of 25%.

WEIGHTED DIESEL TRUCK EMISSIONS--Summaries of the individual gaseous and particulate emission rates are presented in Table 11 for the HDTC and Table 12 for the DRR. Graphical representations of weighted gaseous emissions (HC, CO, NO_x, and fuel economy) and weighted particulate emissions (total particulate, CH_2Cl_2 %-extractable, particulate organics, and inert material) are depicted in Figures 6 and 7, respectively.

The HDTC HC, CO, and NO_x emission rates were greater than the DRR HC, CO, and NO_x rates; DRR fuel economies were greater than HDTC fuel economies. HC emission rates ranged from 0.45 to 6.24 g/mi during the HDTC, compared to 0.28 to 4.69 g/mi during the DRR; CO emission rates ranged from 1.88 to 9.70 g/mi during the HDTC, compared to 1.17 to 7.09 g/mi during the DRR; NO_x emission rates ranged from 3.30 to 13.36 g/mi during the HDTC, compared to 2.70 to 11.41 g/mi during the DRR. DRR fuel economy ranged from 9.66 to 16.90 mi/gal, compared to 8.83 to 15.80 mi/gal during the HDTC.

The class 6 Ford 7000 (FDB420), possessing the only direct-injection-type heavy-duty diesel engine in the truck fleet, was the greatest HDTC HC and NO_x emitter with 6.24 and 13.36 g/mi emission rates, respectively. The class 6 Chevrolet stake-bed (CDW786B) was the greatest HDTC CO emitter, with 9.87 g/mi. The four similar class 6 diesel trucks (CDW786A, CDW780, FDW161, and CDW786B), all equipped with Detroit Diesel 500 CID V-8 engines, had fairly similar HDTC emissions patterns: HC emissions ranged from 2.24 to 4.18 g/mi, CO emissions ranged from 5.64 to 9.87 g/mi, NO_x emissions ranged from 8.86 to 10.87 g/mi, and fuel economy ranged from 8.83 to 10.89 mi/gal. The newest and lowest mileage class 6 vehicle, the 1984 Ford F600 stake-bed (FDW161), was the

Table 11. Heavy Duty Transient Cycle Weighted Emissions - Diesel Trucks

Truck ID	Truck Class	HC g/mi	CO g/mi	NO_x g/mi	Fuel Economy MPG	Total Particulate g/mi	Particulate Organics g/mi	Inert Material g/mi	CH_2Cl_2 Extract. %	Size Fraction <2μ,%
FDW112	2B	4.11	7.54	3.30	12.65	1.202	1.029	0.173	85.2	101.4
CDR734	2B	0.45	1.88	4.15	15.80	0.422	0.189	0.286	39.4	68.4
FDP387	2B	0.47	2.24	6.46	14.00	0.545	0.378	0.168	69.8	79.9
FDB420	6	6.24	8.10	13.36	10.16	2.218	1.702	0.516	78.8	86.2
CDW786A	6	4.18	9.70	9.30	8.83	1.708	0.823	0.883	50.3	103.6
CDW780	6	2.90	5.69	8.86	9.72	1.404	0.646	0.760	45.8	73.4
FDW161	6	2.24	5.64	10.87	10.89	0.762	0.360	0.401	46.0	76.5
CDW786B	6	3.96	9.87	9.46	9.48	1.916	0.923	0.993	47.6	65.6

Table 12. Durham Road Route Weighted Emissions - Diesel Trucks

Truck ID	Truck Class	HC g/mi	CO g/mi	NO_x g/mi	Fuel Economy MPG	Total Particulate g/mi	Particulate Organics g/mi	Inert Material g/mi	CH_2Cl_2 Extract. %	Size Fraction <2μ,%
FDW112	2B	2.70	4.37	2.70	15.27	0.887	0.809	0.078	91.1	100.0
CDR734	2B	0.28	1.17	4.25	16.90	0.287	0.129	0.158	45.3	75.0
FDP387	2B	0.42	1.60	4.48	16.12	0.495	0.342	0.154	69.5	76.8
FDB420	6	4.69	6.57	11.41	10.49	1.941	1.647	0.294	84.9	90.1
CDW786A	6	2.84	7.09	7.32	10.67	1.497	0.510	0.994	34.1	87.5
CDW780	6	1.91	5.47	9.25	9.81	1.184	0.390	0.785	29.1	73.0
FDW161	6	1.21	4.36	9.71	11.06	0.666	0.251	0.415	36.8	73.4
CDW786B	6	1.99	6.94	8.72	9.66	1.547	0.456	1.091	30.0	63.0

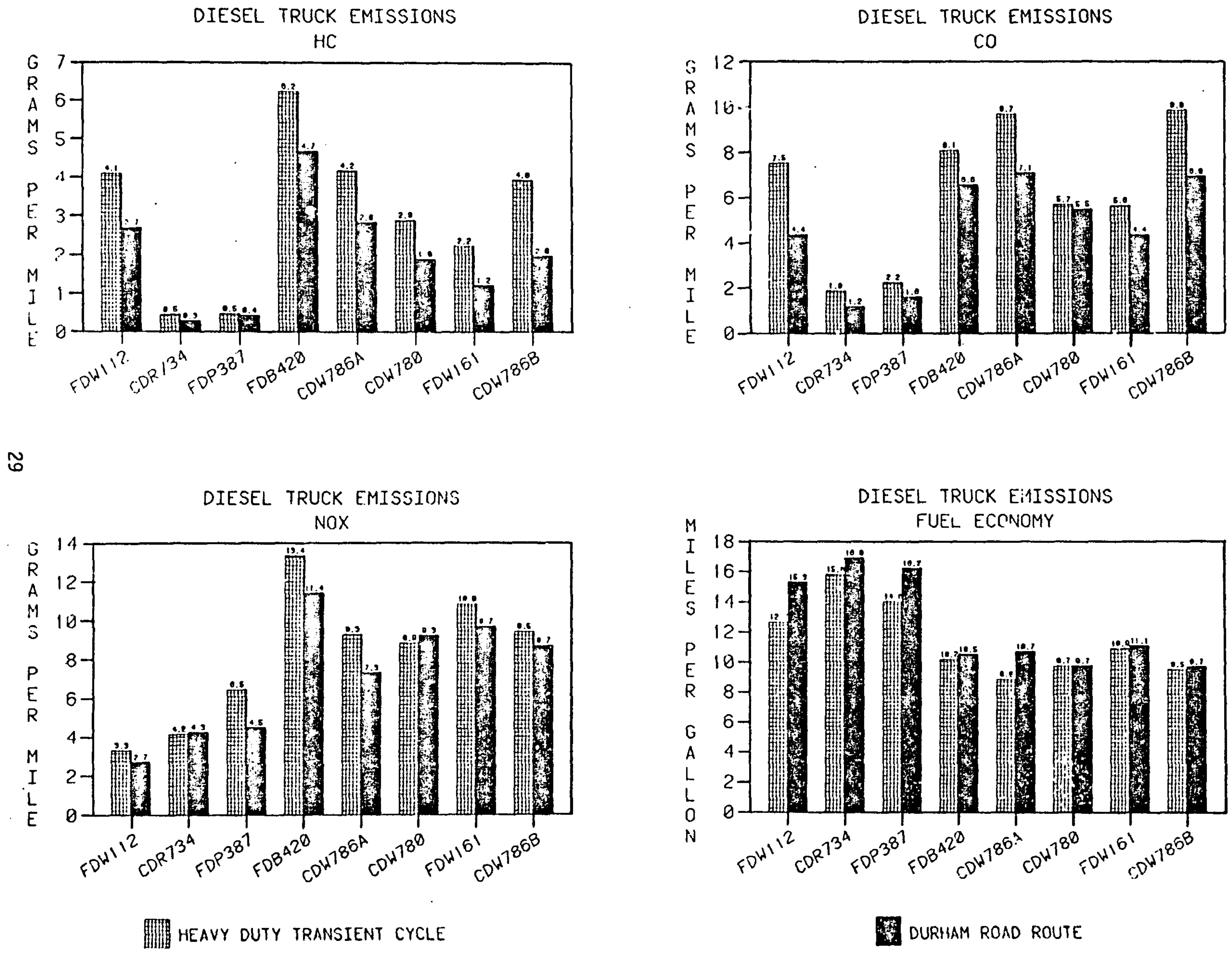


Figure 6. Diesel Truck Weighted Gaseous Emissions

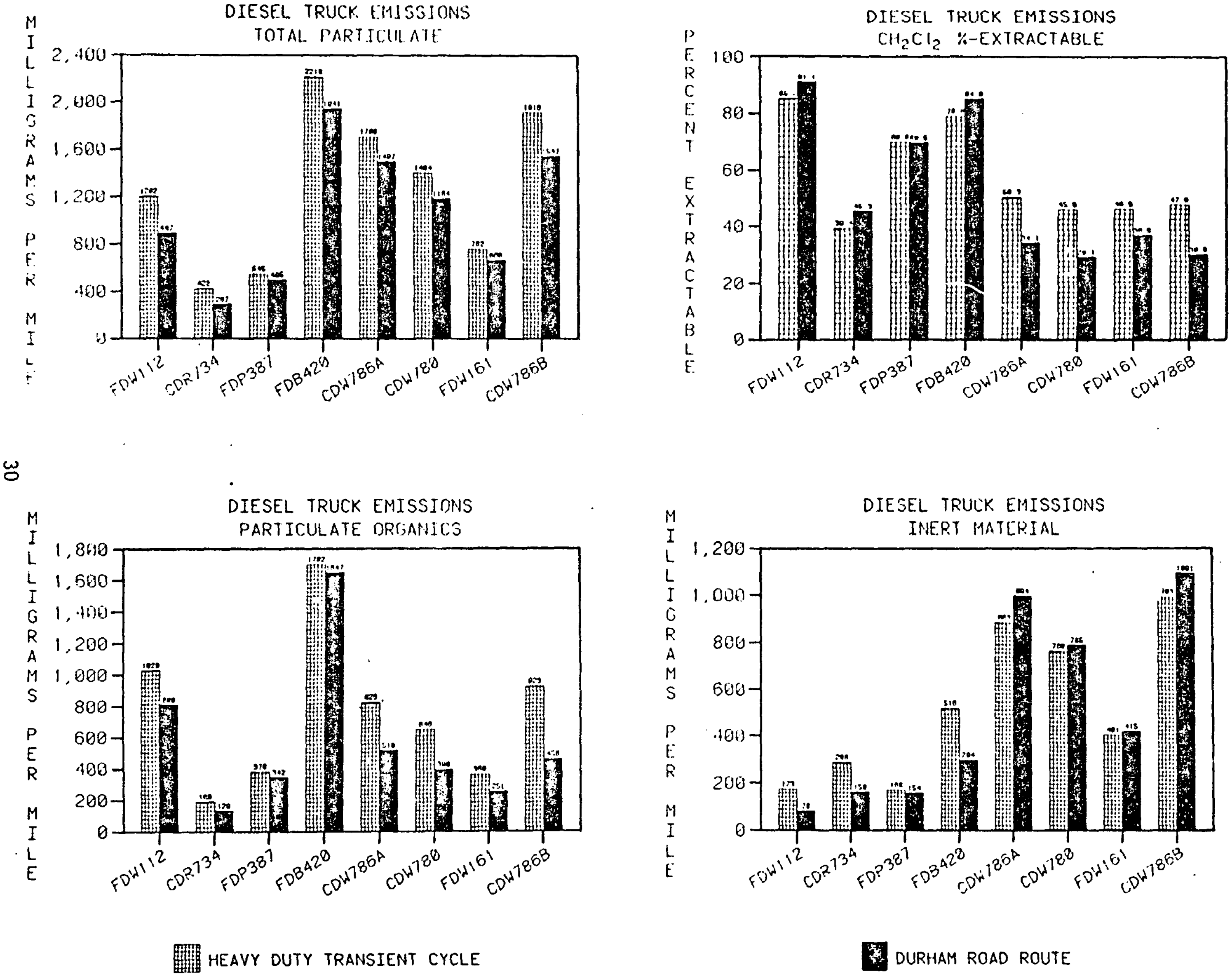


Figure 7. Diesel Truck Weighted Particulate Emissions

lowest overall emitter of the class 6 trucks. Thus, there again appeared to be a positive correlation between vehicle age and emissions: the newer the vehicle, the lower the emissions. Of the class 2B diesel trucks, the malfunctioning (i.e., oil burning) Ford van FDW112 was the highest HC and CO emitter, at 4.11 and 7.54 g/mi, respectively. The two 1984 class 2B pickup trucks (CDR734 and FDP387) were the lowest gaseous emitters of the entire truck fleet, with HC, CO, and NO_x averaging 0.46, 2.06, and 5.31 g/mi, respectively, over the HDTC.

Particulate emissions (Tables 11 and 12, Figure 7) followed the pattern found for gaseous emissions: HDTC particle emissions were greater than DRR particle emissions, and the class 6 truck emission rates were, with one exception, greater than the class 2B truck emission rates. The exception was FDW112. It had a HDTC total particulate emission rate of 1.202 g/mi, more than twice the particle emission rates of the other class 2B trucks: CDR734 had a 0.422 g/mi emission rate, and FDP387 had a 0.545 g/mi emission rate. FDW112 also had the highest HDTC and DRR combined CH_2Cl_2 %-extractable rate of 88.2%. The four similar-engined class 6 trucks, CDW786A, CDW780, FDW161, and CDW786B, averaged 47.4 ± 2.1 %-extractable during the HDTC and 32.8 ± 3.4% during the DRR. It is not known why the HDTC %-extractables were significantly greater than the DRR %-extractables, unless it is a characteristic peculiar to this Detroit Diesel engine family and/or these driving cycle(s). With the other four diesel trucks, FDW112, CDR734, FDP387, and FDB420, there was no significant difference between their respective HDTC and DRR %-extractable rates. The HDTC and DRR combined %-extractable rate for FDW112 was 88.2%, for CDR734 was 42.2%, for FDP387 was 69.7%, and for FDB420 was 81.9%. As expected, the particulate organic emissions results parallel the %-extractable results: different engines emit differing amounts of particulate organics, with newer engines and vehicles (e.g., FDW161) emitting less material than older engines and vehicles.

The inert diesel material primarily consists of non-CH_2Cl_2 extractable elemental carbon. Inert material emissions from class 6 trucks were greater than those from the class 2B trucks, and, other than that, there were no other identifiable emissions patterns with respect to inert material emissions. The particle size fraction less than 2μ averaged 80.9 ± 12.7% for all diesel trucks over both the HDTC and DRR. This size fraction <2μ ranged from a low of ~64% with CDW786B to a high of ~96% with CDW786A. CDW786A/B, it should be noted, is the same 1981 Chevrolet stake-bed that was tested twice in the test program. CDW786A experienced no driving or mechanical problems during its initial testing. However, during its retest two months later, CDW786B experienced both coolant use and lack-of-power problems (that were later diagnosed as the result of a leaky head gasket). The emissions patterns from both CDW786A and CDW786B were remarkably similar, except for the particle size fraction <2μ. The reason for this is not known; perhaps the coolant leak helped cause the agglomeration of carbon particles greater than 2μ in the exhaust.

INDIVIDUAL BAG/CYCLE RESULTS FROM GASOLINE TRUCKS--The individual bag/cycle HDTC gaseous emissions results from all trucks are listed in Appendix B. Two vehicles, a class 2B Plymouth Voyager van, VOY285, and a class 5 Ford 600 van, F3H633, will be used in this section as representative examples of the gasoline truck fleet. HDTC emissions from VOY285 and F3H633 are depicted in Figures 8 and 9, respectively. In these figures, Bag 1 is the NYNF cycle (see Table 4), Bag 2 is the LANF cycle, Bag 3 is the LAF cycle, and Bag 4 is the NYNF cycle. Cold-start portions of the HDTC are depicted by the solid bars; hot-start portions, by the crosshatched bars. The overall

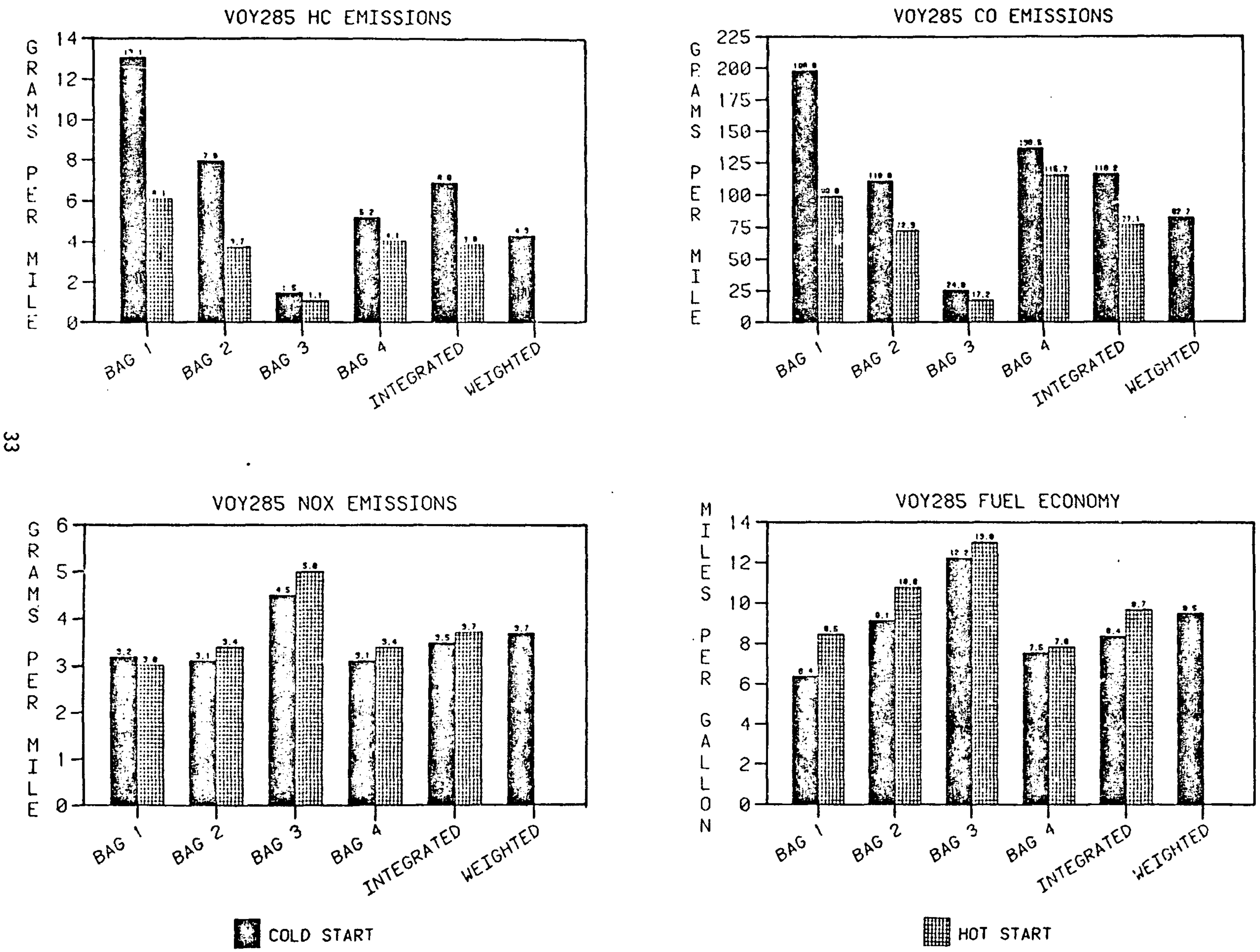


Figure 8. VOY285 - Class 2B Gasoline - HDTC Individual Bag Gaseous Emission Rates

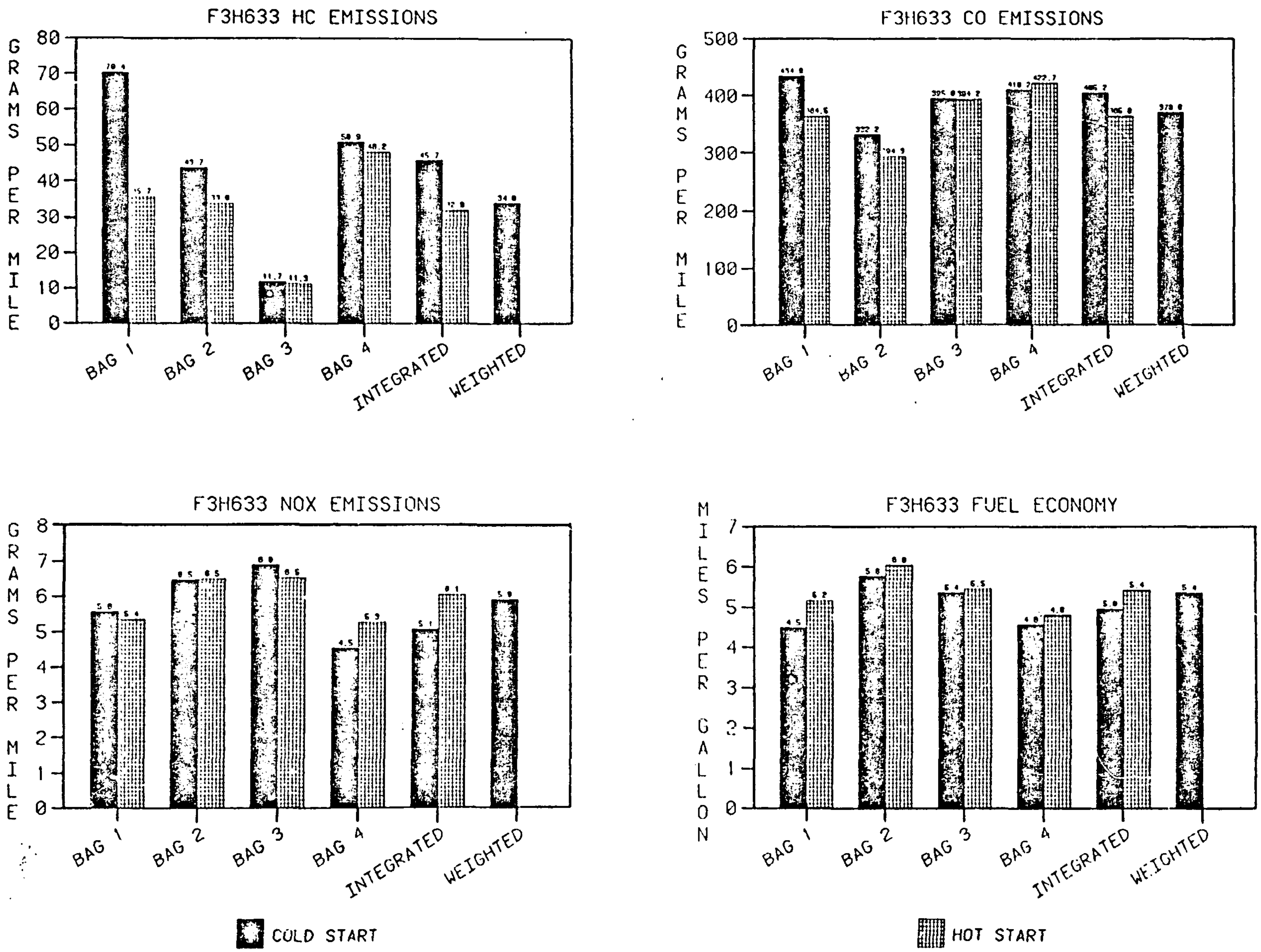


Figure 9. F3H633 - Class 5 Gasoline - HDTC Individual Bag Gaseous Emission Rates

weighted result is weighted 1/7 cold start and 6/7 hot start. Emissions sensitivity to individual bag/cycle and either cold start or hot start shall be discussed.

With regard to individual bag HC and CO emissions, there was significant variation among the four individual bag results, with the emission rate reaching its maximum during Bag 1 operation and its minimum during Bag 3 operation. Generally, for HC and CO for both cold-and hot-start results, Bag 1 > Bag 4 > Bag 2 > Bag 3. Bag 1 is the New York Nonfreeway stop-and-go driving schedule with a low average speed of 7.6 mph, while Bag 3 is the Los Angeles Freeway nonstop driving schedule with a high average speed of 44.9 mph. HC and CO emissions and fuel consumption (the inverse of fuel economy) are directly related to the rigorousness of the driving cycle: the more rigorous (i.e., more stop-and-go-type driving with lower average speeds) the driving cycle, the greater the emissions and fuel consumption (1). This relationship, driving cycle rigorousness versus emission rate and fuel consumption, was certainly followed by the vehicles in this study. Concerning individual bag NO_x emissions, there was little variation among the four individual bag results, although Bag 3 emission rates were slightly greater than either Bag 1, 2, or 4 emission rates. With regard to individual bag fuel economy, there was moderate variation among the four individual bag results, with fuel economy reaching its maximum during Bag 3 operation and its minimum during either Bag 1 or Bag 4 operation. Generally, for fuel economy, Bag 3 > Bag 2 > Bag 4 $\geq$ Bag 1.

Concerning cold-start versus hot-start emissions sensitivity, cold-start HC and CO emissions were significantly greater than hot-start HC and CO emissions; cold-start and hot-start NO_x emissions were approximately equal; cold-start fuel economies were slightly less than hot-start fuel economies.

It should be recognized that the cold-start portion of the HDTC has only a 1/7 weighting, so its contribution to the overall weighted emission rate is relatively small, as indicated in Figures 8 and 9. The hot-start portion, with its 6/7 weighting, is, therefore, the major contributor to the overall weighted rate.

INDIVIDUAL BAG/CYCLE RESULTS FROM DIESEL TRUCKS--The individual bag/cycle HDTC gaseous and particulate emissions results are listed in Appendices B and C. Two vehicles, a class 2B Ford pickup, FDP387, and a class 6 Chevrolet stake-bed, CDW780, will be used in this section as representative examples of the diesel truck fleet. HDTC gaseous emissions from FDP387 and CDW780 are depicted in Figures 9 and 10, respectively, and HDTC particulate emissions are depicted in Figures 11 and 12, respectively. Cold-start portions of the HDTC are depicted by the solid bars and hot-start portions by the crosshatched bars for these four figures. Gaseous and particulate emissions sensitivity to individual bag/cycle and either cold-start or hot-start shall be discussed.

With regard to individual bag HC, CO, and NO_x emissions, there was moderate variation among the four individual bag results, with the emission rate reaching its maximum during Bag 1 or Bag 4 operation and its minimum during Bag 3 operation. Generally, for HC, CO, and NO_x, Bag 1 $\sim$ Bag 4 > Bag 2 > Bag 3. With regard to individual bag fuel economy, there was moderate variation among the four individual bag results, with fuel economy reaching its maximum during Bag 2 or Bag 3 operation and its minimum during Bag 1 operation. Generally for fuel economy, Bag 2 > Bag 3 > Bag 4 > Bag 1. Concerning cold-start versus hot-start emissions sensitivity, cold-start HC and CO emissions were somewhat greater than hot-start HC and CO emissions; cold-start and hot-start NO_x emissions were approximately equal; cold-start fuel economies were slightly less than hot-start fuel economies.

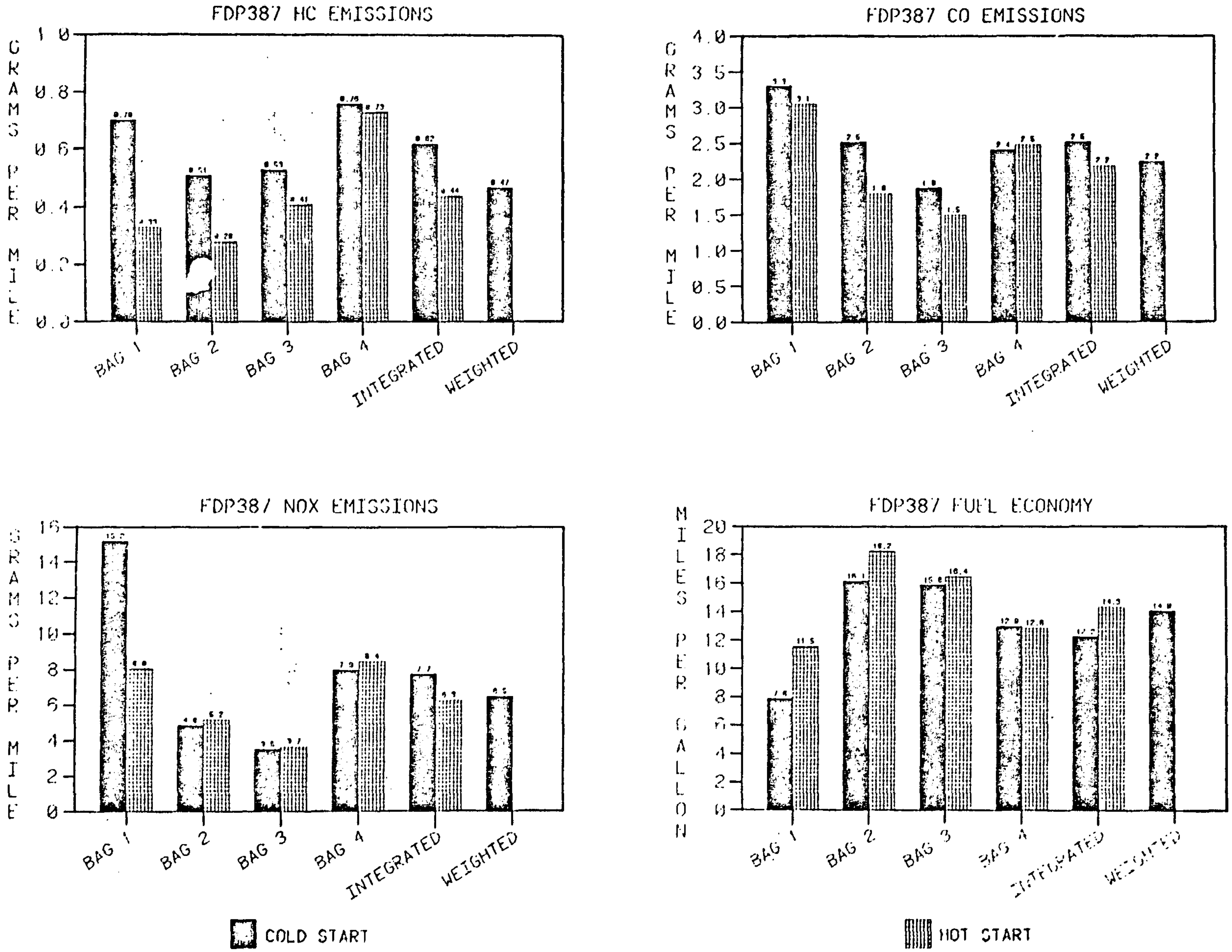


Figure 10. FDP387 - Class 2B Diesel - HDTC Individual Bag Gaseous Emission Rates

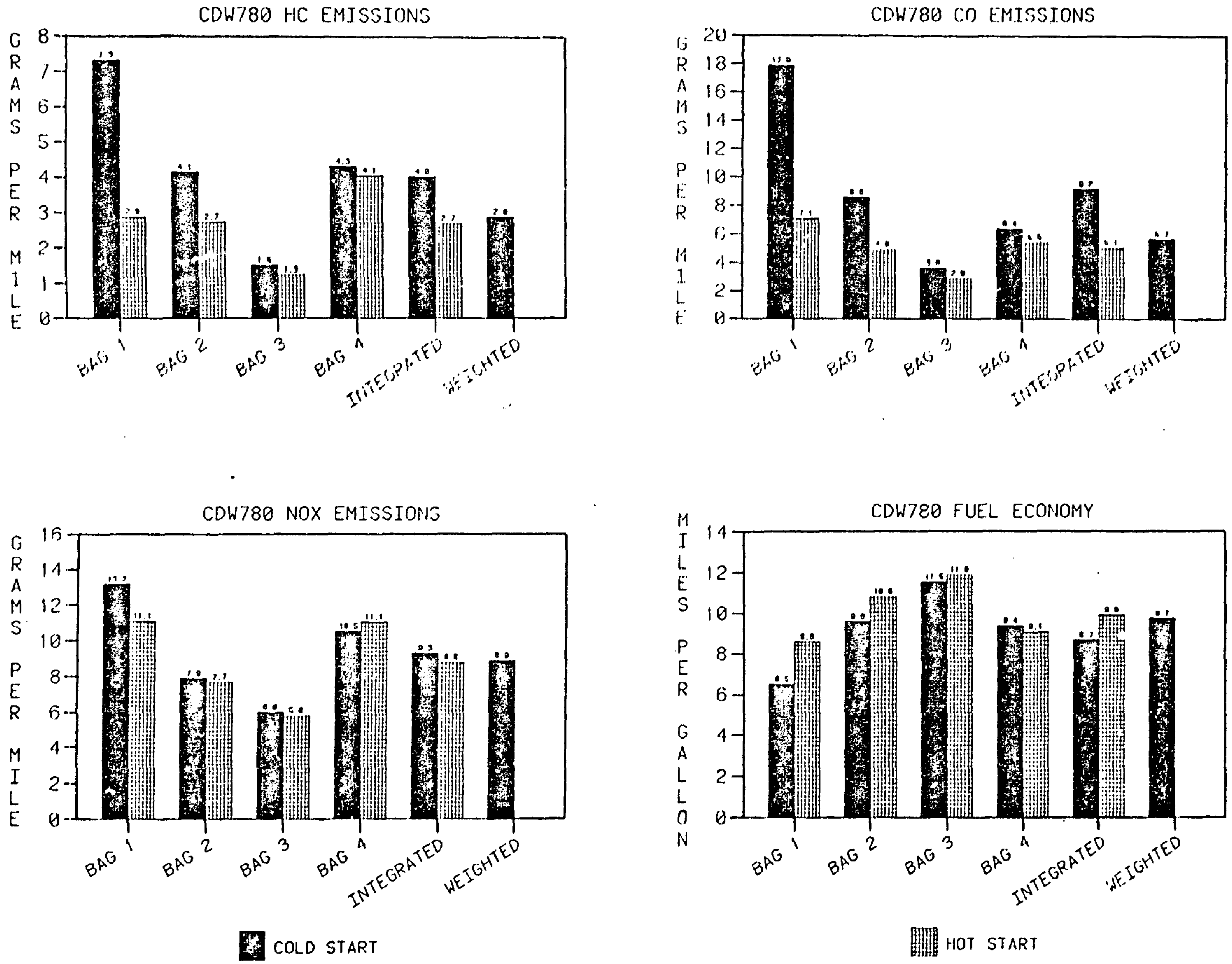


Figure 11. CDW780 - Class 6 Diesel - HDTC Individual Bag Gaseous Emission Rates

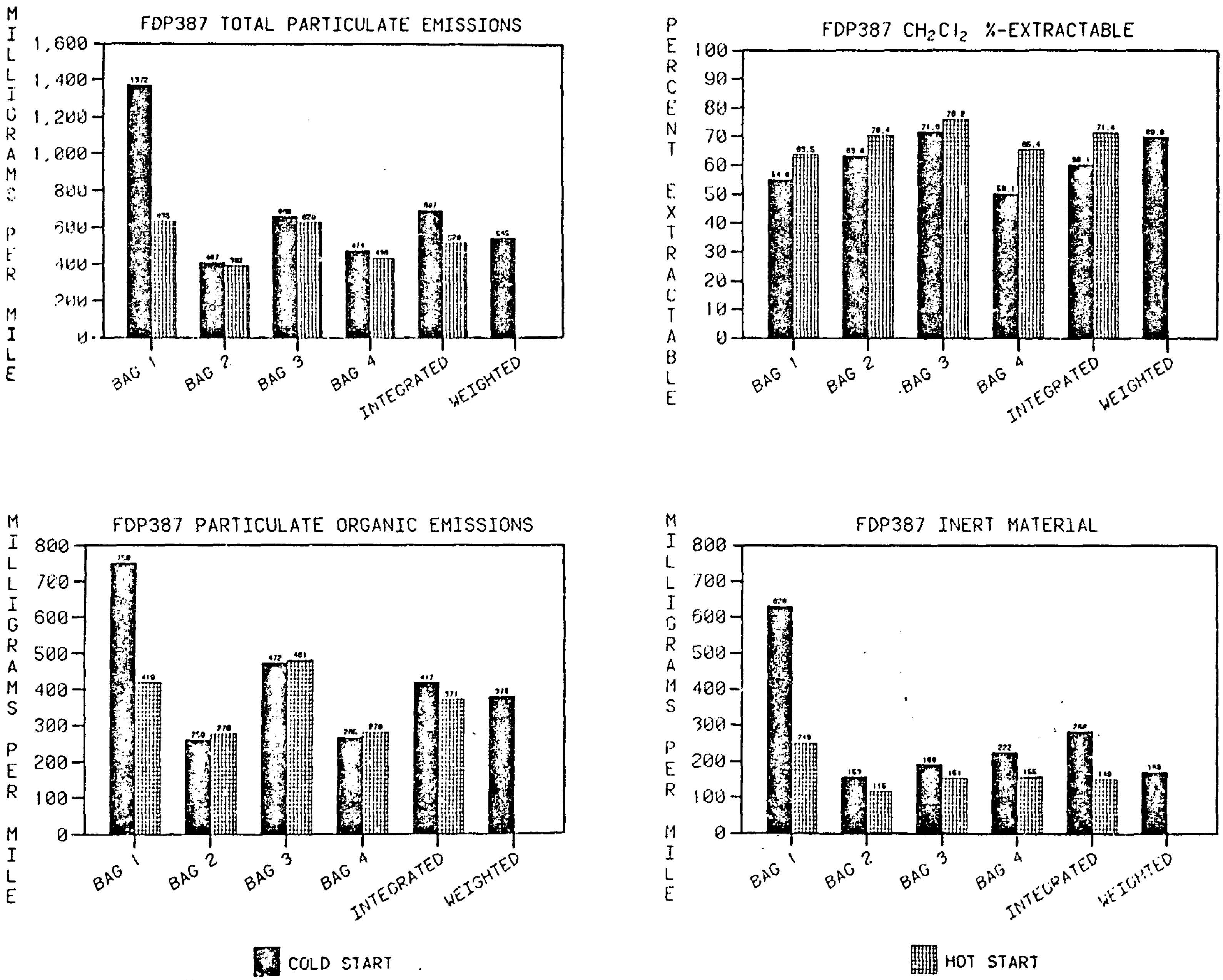
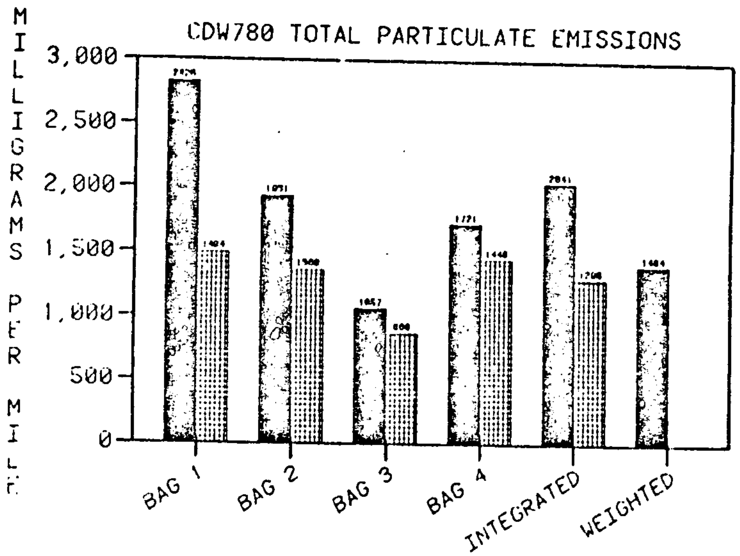
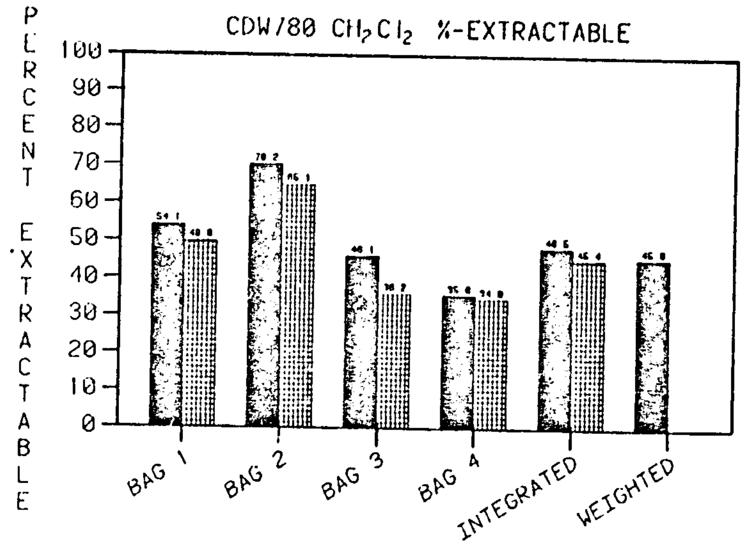
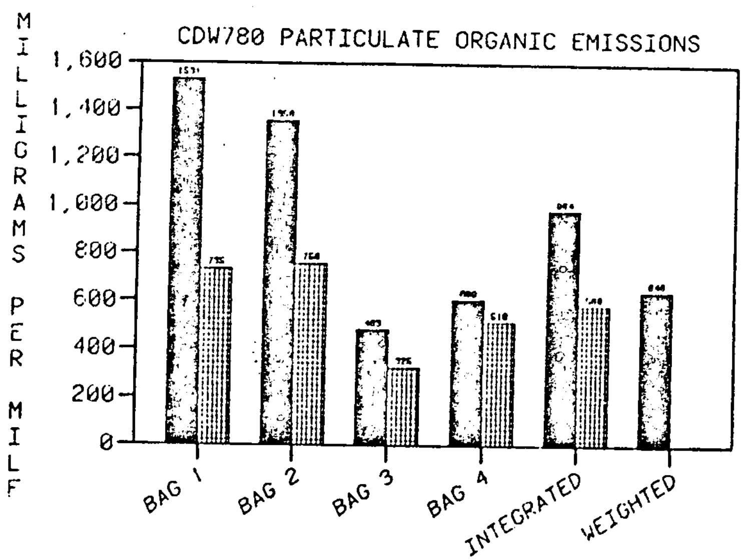
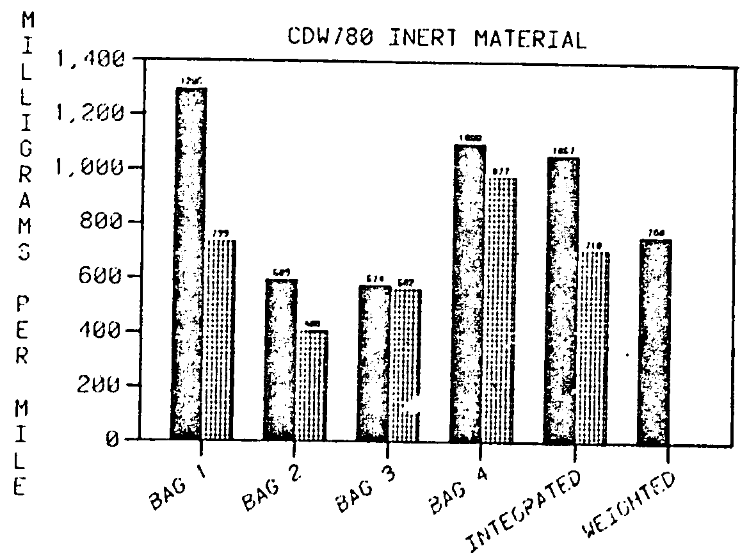


Figure 12. FDP387 Class 2B Diesel ...









COLD START

HOT START

With regard to individual bag total particulate emissions, there was moderate variation among the four individual bag results, with the particulate emission rate reaching its maximum during Bag 1 or Bag 4 operation and its minimum during Bag 2 operation. Generally, total particulate emissions were directly related to fuel consumption, with Bag 1 ∿ Bag 4 > Bag 3 > Bag 2. Cold-start total particulate emissions were significantly greater than hot-start particulate emissions. Concerning individual bag %-extractable results, there was moderate variation among the four individual bag results, with the %-extractable rate reaching its maximum during Bag 2 or Bag 3 operation and its minimum during Bag 4 operation. Generally, for %-extractables, Bag 2 ∿ Bag 3 > Bag 1 > Bag 4. Cold-start and hot-start %-extractable rates were approximately equal. Particulate organic emissions displayed no consistent emissions pattern, there was moderate variation among the individual bags, with particulate organics reaching their maximum during Bag 3 operation (class 2B trucks only) and during Bag 2 or Bag 1 operation (class 6 trucks only). Cold-start particulate organic emissions were usually greater than hot-start particulate organics. Inert material emissions displayed a more consistent emissions pattern; there was moderate variation among the individual bags, with inert material emissions reaching their maximum during Bag 1 or Bag 4 operation and their minimum during Bag 2 or Bag 3 operations. Generally, for inert material emissions, Bag 4 > Bag 1 > Bag 3 > Bag 2.

SUMMARY AND CONCLUSIONS

The main objective of this study was to determine the gaseous and particulate emission rates from heavy-duty gasoline- and diesel-powered trucks using transient chassis dynamometer test procedures. Both the gasoline- and diesel-powered trucks are used in similar types of general delivery service and were tested over the same driving cycles, the HDTC and DRR, at similar chassis dynamometer road-load horsepower settings. How, then, do the emission rates compare by truck type (i.e., gasoline versus diesel)? Table 13 provides a comparison of gasoline and diesel truck HDTC emission rates, listing both the range of emission rates and the average (the mean with its associated standard deviation) emission rate in the various emittant categories. The gasoline trucks are classified by two truck categories, class 2B (four vehicles) and class 5 or 6 (two vehicles); the diesel trucks are classified by class 2B (three vehicles) and class 6 (five vehicles) truck categories. The spread of emission rates listed in Table 13 represents the range of emission rates in each truck class (i.e., minimum-to-maximum emission rate). From observation of the data in Table 13, it can be concluded:

1. All class 2B truck emission rates were less than class 5 or 6 truck emission rates. Class 2B fuel economies were greater than class 5 or 6 fuel economies.

2. HC and CO emission rates were significantly higher from the gasoline trucks. Gasoline truck HC emissions ranged from 4 to 13 times greater than diesel truck HC emissions and gasoline truck CO emissions ranged from 10 to 40 times greater than diesel truck CO emissions.

Table 13. Comparison of Gasoline and Diesel Truck HDTC Emission Rates

Emittant	Class 2B Gasoline		Class 5 or 6 Gasoline		Class 2B Diesel		Class 6 Diesel	
	Range	Average	Range	Average	Range	Average	Range	Average
HC, g/mi	4.11 - 22.54	10.95 ± 8.74	31.93 - 33.99	32.96 ± 1.46	0.47 - 4.11	1.68 ± 2.11	2.24 - 6.24	3.90 ± 1.53
CO, g/mi	44.09 - 82.70	69.15 ± 17.66	220.52 - 370.75	295.64 ± 106.23	1.88 - 7.34	3.89 ± 3.17	5.64 - 9.87	7.80 ± 2.07
NO_x, g/mi	3.67 - 10.90	6.56 ± 3.14	5.91 - 9.44	7.68 ± 2.50	3.30 - 6.46	4.64 ± 1.64	8.86 - 13.36	10.37 ± 1.83
MPG, miles/gallon	8.77 - 9.66	9.30 ± 0.39	5.15 - 5.35	5.25 ± 0.14	12.65 - 15.80	14.15 ± 1.58	8.83 - 10.89	9.82 ± 0.77
Total Particulate, g/mi	0.092 - 0.133	0.113 ± 0.017	0.405 - 0.516	0.461 ± 0.078	0.422 - 1.202	0.722 ± 0.419	0.762 - 2.218	1.602 ± 0.555
CH_2Cl_2 %-Extractable (%)	25.1 - 53.1	39.4 ± 14.3	25.8 - 43.4	34.6 ± 12.4	39.4 - 85.2	64.8 ± 23.3	45.8 - 78.8	53.7 ± 14.1
Particulate Organics, g/mi	0.023 - 0.074	0.048 ± 0.024	0.104 - 0.228	0.166 ± 0.088	0.189 - 1.029	0.532 ± 0.441	0.360 - 1.702	0.891 ± 0.501
Inert Material, g/mi	0.057 - 0.078	0.066 ± 0.010	0.291 - 0.299	0.295 ± 0.006	0.168 - 0.286	0.209 ± 0.067	0.401 - 0.993	0.711 ± 0.248
Leaded Fraction, (%)	2[illegible].5 - 53.2	39.2 ± 13.7	31.5 - 44.8	38.2 ± 9.4	---	---	---	---
Size Fraction <2μ, (%)	80.9 - 86.8	83.9 ± 3.0	77.2 - 96.0	86.6 ± 13.3	68.4 - 101.4	83.2 ± 16.8	65.6 - 103.6	81.1 ± 14.6

3. NO_x emission rates were slightly higher (0 to 50%) from the class 6 diesel trucks compared to the class 5 or 6 gasoline trucks.

4. Fuel economy was approximately 60 to 100% greater with the diesel trucks for comparable truck categories

5. Total particulate matter, CH_2Cl_2 %-extractables, particulate organics, and inert material emissions were significantly greater from the diesel trucks. With the diesel trucks, total particulate matter ranged from 2 to 9 times greater, CH_2Cl_2 %-extractables ranged from 60% to 80% greater, particulate organics ranged from 3 to 14 times greater, and inert material emissions ranged from 1 to 4 times greater than the respective gasoline truck emission counterparts.

6. The particle size fraction less than 2μ averaged over 80% for both gasoline and diesel trucks.

The current data base for heavy-duty mobile sources is quite limited, due primarily to the heavy-duty vehicle certification procedure that develops work-specific gram per hp-hr emission rates, rather than the grams per mile emission rates normally required by air quality modelers (1). The few studies in the heavy-duty mobile sources data base that report data in terms of grams per mile (1-4), indicate emission rates that are comparable to those found in this study. Other conclusions and/or observations of note are:

7. HC, CO, total particulate emissions and fuel consumption were especially sensitive to the characteristics (i.e., average speed, acceleration rates, and cold or hot start) of the transient driving

cycle. The more rigorous the driving cycle, the greater the above-mentioned emission rates. HDTC (18.9 mph average speed) emissions were greater than DRR (24.7 mph average speed) emissions; cold-start Bag 1 (NYNF, 7.6 mph average speed) emissions were the greatest of the composite HDTC.

8. Newer vehicles (in the same truck class) had lower emission rates.

9. The %-extractables rate seemed related to engine design; engines in the same engine family gave similar %-extractable rates.

10. The leaded particulate fraction emission rate from the gasoline trucks seemed related to engine design; engines in the same engine family emitted similar leaded particulate fractions.

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APPENDIX A

Integrated/Weighted Gaseous and Particulate Emission Rates for Gasoline and Diesel-Powered Trucks over the Heavy-Duty Transient Cycle and the Durham Road Route

(Tables A1 - A14)

Table A1. FUH413 - Class 2B - Gasoline Integrated/Weighted Gaseous and Particulate Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
Heavy-Duty Transient Cycle					
HC	17.81 ± 2.74	4	12.03 ± 0.50	7	12.86 ± 0.89
CO	100.71 ± 2.19	3	76.90 ± 4.70	7	80.30 ± 4.34
NO_x	6.73 ± 0.53	3	6.65 ± 0.24	6	6.66 ± 0.28
MPG	8.79 ± 0.71	3	9.80 ± 0.37	7	9.66 ± 0.42
Total Particulate	0.118 ± 0.014	4	0.088 ± 0.008	7	0.092 ± 0.009
% Extractable	25.0 ± 1.4	4	25.1 ± 2.8	7	25.1 ± 2.6
Part. Organics	0.030 ± 0.003	4	0.022 ± 0.004	7	0.023 ± 0.004
Inert Material	0.088 ± 0.011	4	0.066 ± 0.005	7	0.069 ± 0.006
Size Fraction <2μ	84.3 ± 4.1	4	87.2 ± 2.8	7	86.8 ± 3.0
Durham Road Route					
HC	10.40 ± 2.50	4	6.60 ± 0.76	8	7.14 ± 1.01
CO	58.87 ± 9.81	3	42.80 ± 2.25	8	45.10 ± 3.33
NO_x	8.37 ± 0.55	3	8.81 ± 0.79	6	8.75 ± 0.76
MPG	10.38 ± 0.51	4	11.14 ± 0.35	8	11.03 ± 0.37
Total Particulate	0.115 ± 0.020	4	0.087 ± 0.006	8	0.091 ± 0.008
% Extractable	26.6 ± 2.7	4	28.7 ± 2.3	7	28.4 ± 2.4
Part. Organics	0.031 ± 0.007	4	0.025 ± 0.003	7	0.026 ± 0.004
Inert Material	0.084 ± 0.014	4	0.063 ± 0.004	7	0.066 ± 0.005
Size Fraction <2μ	83.3 ± 2.9	4	84.4 ± 4.1	7	84.2 ± 3.9

[a] Emittant results are expressed in terms of grams/mile except MPG (expressed in miles per gallon), and %-Extractable and Size Fraction <2μ (both expressed in percents).

[b] N = Number of valid runs.

Table A2. F2H411 - Class 2B - Gasoline Integrated/Weighted Gaseous and Particulate Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
Heavy-Duty Transient Cycle					
HC	26.83 ± 1.71	3	21.83 ± 0.18	6	22.54 ± 0.40
CO	88.61 ± 6.01	3	66.34 ± 1.70	6	69.52 ± 2.32
NO_x	11.46 ± 0.91	3	10.81 ± 0.75	6	10.90 ± 0.77
MPG	7.68 ± 0.53	3	8.95 ± 0.29	6	8.77 ± 0.32
Total Particulate	0.170 ± 0.004	2	0.100 ± 0.002	6	0.110 ± 0.002
% Extractable	26.4 ± 0.4	2	29.7 ± 4.1	2	29.2 ± 3.6
Part. Organics	0.045 ± 0.001	2	0.029 ± 0.070	6	0.031 ± 0.060
Inert Material	0.125 ± 0.004	2	0.070 ± 0.005	6	0.078 ± 0.005
Size Fraction <2μ	66.2 ± 2.2	2	84.2 ± 12.9	6	81.6 ± 11.4
Durham Road Route					
HC	11.27 ± 0.83	3	9.32 ± 0.03	5	9.60 ± 0.19
CO	60.44 ± 2.44	3	45.70 ± 0.59	5	47.81 ± 0.85
NO_x	12.57 ± 0.42	3	12.38 ± 0.53	6	12.41 ± 0.51
MPG	9.34 ± 0.14	3	10.44 ± 0.15	5	10.28 ± 0.15
Total Particulate	0.122 ± 0.013	2	0.097 ± 0.004	6	0.101 ± 0.005
% Extractable	29.3 ± 3.7	2	27.8 ± 3.1	6	28.0 ± 3.2
Part. Organics	0.036 ± 0.008	2	0.027 ± 0.002	6	0.028 ± 0.003
Inert Material	0.086 ± 0.004	2	0.070 ± 0.005	6	0.072 ± 0.005
Size Fraction <2μ	78.8 ± 1.3	2	76.8 ± 3.7	5	77.1 ± 3.4

[a] Emittant results are expressed in terms of grams/mile except MPG (expressed in miles per gallon), and %-Extractable and Size Fraction <2μ (both expressed in percents).

[b] N = Number of valid runs.

Table A3. VOY285 - Class 2B - Gasoline Integrated/Weighted Gaseous and Particulate Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
Heavy-Duty Transient Cycle					
HC	6.87 ± 0.80	3	3.86 ± 0.30	6	4.29 ± 0.40
CO	116.15 ± 10.37	3	77.13 ± 5.19	6	82.70 ± 5.93
NO_x	3.47 ± 0.07	3	3.70 ± 0.13	6	3.67 ± 0.12
MPG	8.35 ± 0.26	3	9.68 ± 0.26	6	9.49 ± 0.26
Total Particulate	0.219 ± 0.012	3	0.119 ± 0.010	5	0.133 ± 0.010
% Extractable	58.0 ± 8.4	3	52.3 ± 5.1	6	53.1 ± 5.6
Part. Organics	0.128 ± 0.025	3	0.065 ± 0.006	5	0.074 ± 0.009
Inert Material	0.091 ± 0.013	3	0.054 ± 0.005	5	0.059 ± 0.006
Size Fraction <2μ	67.1 ± 2.0	3	83.2 ± 10.4	6	80.9 ± 9.2
Durham Road Route					
HC	2.96 ± 0.22	3	1.72 ± 0.12	6	1.90 ± 0.13
CO	59.04 ± 8.97	3	39.93 ± 4.64	5	42.66 ± 5.26
NO_x	4.08 ± 0.22	3	4.34 ± 0.14	5	4.30 ± 0.15
MPG	10.94 ± 0.66	3	12.16 ± 0.19	6	11.99 ± 0.26
Total Particulate	0.213 ± 0.018	3	0.103 ± 0.005	6	0.119 ± 0.007
% Extractable	63.3 ± 5.0	3	50.8 ± 1.8	6	52.6 ± 2.3
Part. Organics	0.135 ± 0.008	3	0.052 ± 0.004	6	0.064 ± 0.005
Inert Material	0.079 ± 0.017	3	0.051 ± 0.002	6	0.055 ± 0.004
Size Fraction <2μ	87.9 ± 3.4	3	86.2 ± 3.3	5	86.4 ± 3.3

[a] Emittant results are expressed in terms of grams/mile except MPG (expressed in miles per gallon), and %-Extractable and Size Fraction <2μ (both expressed in percents).

[b] N = Number of valid runs.

Table A4. VOY338 - Class 2B - Gasoline Integrated/Weighted Gaseous and Particulate Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
Heavy-Duty Transient Cycle					
HC	9.38 ± 0.45	3	3.23 ± 0.25	6	4.11 ± 0.28
CO	140.95 ± 12.12	3	27.95 ± 4.20	6	44.09 ± 5.33
NO_x	4.06 ± 0.30	3	5.15 ± 0.21	6	4.99 ± 0.22
MPG	7.48 ± 0.09	3	9.59 ± 0.21	6	9.29 ± 0.19
Total Particulate	0.250 ± 0.052	3	0.096 ± 0.016	6	0.118 ± 0.021
% Extractable	56.0 ± 10.6	3	49.2 ± 7.8	6	50.17 ± 8.2
Part. Organics	0.143 ± 0.056	3	0.048 ± 0.015	6	0.062 ± 0.021
Inert Material	0.106 ± 0.008	3	0.049 ± 0.007	6	0.057 ± 0.007
Size Fraction <2μ	78.8 ± 3.3	3	87.3 ± 14.2	6	86.1 ± 12.6
Durham Road Route					
HC	2.80 ± 0.30	3	1.71 ± 0.05	6	1.87 ± 0.09
CO	56.18 ± 5.61	3	18.37 ± 2.38	6	23.77 ± 2.84
NO_x	4.64 ± 0.42	3	5.35 ± 0.31	6	5.25 ± 0.33
MPG	10.74 ± 0.10	3	12.26 ± 0.10	6	12.04 ± 0.10
Total Particulate	0.145 ± 0.026	3	0.079 ± 0.010	6	0.088 ± 0.012
% Extractable	49.8 ± 5.0	3	47.9 ± 5.1	5	48.2 ± 5.1
Part. Organics	0.073 ± 0.020	3	0.038 ± 0.010	5	0.043 ± 0.010
Inert Material	0.072 ± 0.007	3	0.041 ± 0.003	5	0.045 ± 0.004
Size Fraction <2μ	81.3 ± 10.6	3	81.5 ± 3.5	5	81.4 ± 4.5

[a] Emittant results are expressed in terms of grams/mile except MPG (expressed in miles per gallon), and %-Extractable and Size Fraction <2μ (both expressed in percents).

[b] N = Number of valid runs.

Table A5. F3H633 - Class 5 - Gasoline Integrated/Weighted Gaseous and Particulate Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
Heavy-Duty Transient Cycle					
HC	45.74 ± 3.05	4	32.03 ± 2.16	4	33.99 ± 2.29
CO	405.16 ± 29.09	4	365.01 ± 21.78	4	370.75 ± 22.84
NO_x	5.07 ± 0.70	4	5.05 ± 0.13	4	5.91 ± 0.21
MPG	4.95 ± 0.19	4	5.42 ± 0.27	4	5.35 ± 0.26
Total Particulate	0.512 ± 0.042	2	0.387 ± 0.080	3	0.405 ± 0.074
% Extractable	28.4 ± 0.4	2	25.4 ± 4.9	3	25.8 ± 4.3
Part. Organics	0.145 ± 0.010	2	0.098 ± 0.026	3	0.104 ± 0.024
Inert Material	0.367 ± 0.032	2	0.288 ± 0.063	3	0.299 ± 0.059
Size Fraction <2μ	90.7 ± 0.4	2	75.0 ± 11.6	3	77.2 ± 10.0
Durham Road Route					
HC	23.38 ± 0.79	4	18.92 ± 1.53	8	19.56 ± 1.42
CO	366.28 ± 7.02	4	340.85 ± 17.80	8	344.48 ± 16.26
NO_x	5.65 ± 0.29	4	6.26 ± 0.62	8	6.17 ± 0.57
MPG	5.59 ± 0.10	4	5.77 ± 0.27	8	5.74 ± 0.25
Total Particulate	0.481 ± 0.034	3	0.317 ± 0.024	8	0.340 ± 0.025
% Extractable	27.8 ± 1.5	3	28.5 ± 2.4	4	28.4 ± 2.2
Part. Organics	0.141 ± 0.015	2	0.088 ± 0.004	4	0.096 ± 0.006
Inert Material	0.359 ± 0.000	2	0.221 ± 0.024	4	0.241 ± 0.021
Size Fraction <2μ	93.1 ± 8.0	3	96.7 ± 4.5	4	96.2 ± 5.0

[a] Emittant results are expressed in terms of grams/mile except MPG (expressed in miles per gallon), and %-Extractable and Size Fraction <2μ (both expressed in percents).

[b] N = Number of valid runs.

Table A6. G63333 - Class 6 - Gasoline Integrated/Weighted Gaseous and Particulate Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
Heavy-Duty Transient Cycle					
HC	44.28 ± 2.14	3	29.87 ± 1.69	5	31.93 1 1.75
CO	246.35 ± 25.90	3	216.22 ± 13.09	5	220.52 ± 14.92
NO_x	8.38 ± 0.66	4	9.62 ± 0.86	5	9.44 ± 0.83
MPG	4.93 ± 0.23	3	5.19 ± 0.11	5	5.15 ± 0.13
Total Particulate	0.712 ± 0.041	4	0.483 ± 0.067	7	0.516 ± 0.063
% Extractable	38.9 ± 6.6	5	44.1 ± 3.0	6	43.4 ± 3.5
Part. Organics	0.297 ± 0.017	3	0.217 ± 0.031	6	0.228 ± 0.029
Inert Material	0.415 ± 0.030	3	0.270 ± 0.047	6	0.291 ± 0.045
Size Fraction <2μ	92.8 ± 7.4	2	96.5 ± 3.1	5	96.0 ± 3.7
Durham Road Route					
HC	23.71 ± 3.93	3	15.87 ± 1.05	8	16.99 ± 1.46
CO	221.20 ± 13.17	3	195.29 ± 14.89	8	198.99 ± 14.64
NO_x	10.03 ± 1.06	3	10.77 ± 1.04	7	10.66 ± 1.04
MPG	5.35 ± 0.22	3	5.71 ± 0.21	8	5.66 ± 0.21
Total Particulate	0.637 ± 0.118	3	0.430 ± 0.054	6	0.460 ± 0.063
% Extractable	39.5 ± 3.2	3	38.1 ± 2.2	5	38.3 ± 2.3
Part. Organics	0.249 ± 0.028	3	0.169 ± 0.012	5	0.180 ± 0.014
Inert Material	0.388 ± 0.092	3	0.277 ± 0.034	5	0.293 ± 0.042
Size Fraction <2μ	97.6 ± 0.3	2	93.0 ± 4.2	5	93.7 ± 3.6

[a] Emittant results are expressed in terms of grams/mile except MPG (expressed in miles per gallon), and %-Extractable and Size Fraction <2μ (both expressed in percents).

[b] N = Number of valid runs.

Table A7. FDW112 - Class 2B Diesel Integrated/Weighted Gaseous and Particulate Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
Heavy-Duty Transient Cycle					
HC	4.34 ± 0.36	4	4.07 ± 0.41	9	4.11 ± 0.40
CO	8.56 ± 0.79	4	7.37 ± 0.59	11	7.54 ± 0.62
NO_x	4.09 ± 0.39	4	3.17 ± 0.55	11	3.30 ± 0.53
MPG	11.31 ± 0.68	4	12.87 ± 0.42	13	12.65 ± 0.46
Total Particulate	1.191 ± 0.163	4	1.204 ± 0.190	12	1.202 ± 0.186
% Extractable	76.8 ± 8.9	4	86.6 ± 7.4	12	85.2 ± 7.6
Part. Organics	0.907 ± 0.198	4	1.049 ± 0.224	12	1.029 ± 0.220
Inert Material	0.284 ± 0.079	3	0.155 ± 0.077	12	0.173 ± 0.077
Size Fraction <2μ	103.8 ± 1.1	4	101.0 ± 3.8	11	101.4 ± 3.4
Durham Road Route					
HC	3.09 ± 0.64	3	2.63 ± 0.41	10	2.70 ± 0.44
CO	4.79 ± 0.29	4	4.30 ± 0.08	11	4.37 ± 0.11
NO_x	3.02 ± 0.23	4	2.65 ± 0.14	13	2.70 ± 0.15
MPG	14.26 ± 0.21	4	15.44 ± 0.44	13	15.27 ± 0.41
Total Particulate	0.985 ± 0.039	3	0.871 ± 0.083	11	0.887 ± 0.077
% Extractable	90.8 ± 1.0	4	91.1 ± 0.8	11	91.1 ± 0.8
Part. Organics	0.899 ± 0.040	3	0.794 ± 0.080	11	0.809 ± 0.074
Inert Material	0.086 ± 0.004	3	0.077 ± 0.006	11	0.078 ± 0.006
Size Fraction <2μ	101.1 ± 2.1	4	100.0 ± 1.7	11	100.0 ± 2.6

[a] Emittant results are expressed in terms of grams/mile except MPG (expressed in miles per gallon), and %-Extractable and Size Fraction <2μ (both expressed in percents).

[b] N = Number of valid runs.

Table A8. CDR734 - Class 2B - Diesel Integrated/Weighted Gaseous and Particulate Emission Rates

Emittant[a]	Cold Start			N[b]	Hot Start			N[b]	Weighted		
Heavy-Duty Transient Cycle											
HC	0.67	±	0.05	3	0.42	±	0.03	3	0.45	±	0.03
CO	2.21	±	0.10	8	1.83	±	0.09	15	1.88	±	0.09
NO_x	4.00	±	0.29	7	4.17	±	0.29	14	4.15	±	0.29
MPG	14.38	±	0.67	8	16.04	±	0.57	14	15.80	±	0.58
Total Particulate	0.709	±	0.101	4	0.432	±	0.046	7	0.472	±	0.054
% Extractable	39.1	±	4.2	4	39.4	±	5.0	7	39.4	±	4.9
Part. Organics	0.278	±	0.058	4	0.174	±	0.035	7	0.189	±	0.038
Inert Material	0.431	±	0.057	4	0.262	±	0.034	7	0.286	±	0.037
Size Fraction <2μ	54.5	±	7.0	4	70.7	±	4.6	7	68.4	±	4.9
Durham Road Route											
HC	0.44	±	0.02	3	0.25	±	0.01	3	0.28	±	0.01
CO	1.33	±	0.07	3	1.14	±	0.05	11	1.17	±	0.05
NO_x	4.20	±	0.06	3	4.26	±	0.22	11	4.25	±	0.20
MPG	15.59	±	0.28	3	17.09	±	0.43	12	16.88	±	0.41
Total Particulate	0.316	±	0.026	3	0.282	±	0.028	8	0.287	±	0.028
% Extractable	45.0	±	2.5	3	45.3	±	2.0	8	45.3	±	2.1
Part. Organics	0.142	±	0.005	3	0.127	±	0.008	8	0.129	±	0.008
Inert Material	0.174	±	0.022	3	0.155	±	0.020	8	0.158	±	0.020
Size Fraction <2μ	67.2	±	4.5	3	76.3	±	5.0	8	75.0	±	4.9

[a] Emittant results are expressed in terms of grams/mile except MPG (expressed in miles per gallon), and %-Extractable and Size Fraction <2μ (both expressed in percents).

[b] N = Number of valid runs.

Table A9. FDP387 - Class 2B - Diesel Integrated/Weighted Gaseous and Particulate Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
Heavy-Duty Transient Cycle					
HC	0.62 ± 0.05	3	0.44 ± 0.04	7	0.47 ± 0.04
CO	2.51 ± 0.11	4	2.19 ± 0.12	7	2.24 ± 0.12
NO_x	7.71 ± 0.19	4	6.25 ± 0.09	7	6.46 ± 0.10
MPG	12.2 ± 0.16	4	14.3 ± 0.32	7	14.0 ± 0.28
Total Particulate	0.697 ± 0.053	4	0.520 ± 0.012	7	0.545 ± 0.018
% Extractable	60.1 ± 5.7	4	71.4 ± 5.4	7	69.8 ± 5.4
Part. Organics	0.417 ± 0.026	4	0.371 ± 0.027	7	0.378 ± 0.027
Inert Material	0.280 ± 0.057	4	0.149 ± 0.029	7	0.168 ± 0.033
Size Fraction <2µ	64.4 ± 4.8	4	79.0 ± 3.2	6	76.9 ± 3.4
Durham Road Route					
HC	0.51 ± 0.07	7	0.40 ± 0.01	3	0.42 ± 0.02
CO	1.91 ± 0.05	7	1.55 ± 0.05	11	1.60 ± 0.05
NO_x	4.54 ± 0.12	7	4.47 ± 0.20	11	4.48 ± 0.19
MPG	14.8 ± 0.31	7	16.4 ± 0.20	11	16.2 ± 0.21
Total Particulate	0.607 ± 0.029	4	0.476 ± 0.014	8	0.495 ± 0.016
% Extractable	58.2 ± 4.8	4	71.4 ± 2.7	8	69.5 ± 3.0
Part. Organics	0.353 ± 0.032	4	0.340 ± 0.012	8	0.342 ± 0.015
Inert Material	0.254 ± 0.034	4	0.137 ± 0.016	8	0.154 ± 0.019
Size Fraction <2µ	59.7 ± 7.3	3	79.6 ± 7.5	7	76.8 ± 7.5

[a] Emittant results are expressed in terms of grams/mile except MPG (expressed in miles per gallon), and %-Extractable and Size Fraction <2µ (both expressed in percents).

[b] N = Number of valid runs.

Table A10. CDW786A - Class 6 - Diesel Integrated/Weighted Gaseous and Particulate Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
Heavy-Duty Transient Cycle					
HC	4.88 ± 0.07	3	4.06 ± 0.15	7	4.18 ± 0.14
CO	13.09 ± 0.49	3	9.14 ± 0.38	7	9.70 ± 0.40
NO_x	9.50 ± 0.11	3	9.27 ± 0.19	7	9.30 ± 0.18
MPG	8.28 ± 0.10	3	8.92 ± 0.04	7	8.83 ± 0.05
Total Particulate	2.191 ± 0.287	3	1.627 ± 0.343	4	1.708 ± 0.335
% Extractable	54.8 ± 9.7	3	49.6 ± 8.9	5	50.3 ± 9.0
Part. Organics	1.212 ± 0.336	3	0.758 ± 0.122	4	0.823 ± 0.153
Inert Material	0.979 ± 0.178	3	0.869 ± 0.221	4	0.883 ± 0.215
Size Fraction <2μ	100.9 ± 4.7	3	104.0 ± 3.7	5	103.6 ± 3.8
Durham Road Route					
HC	3.19 ± 0.08	3	2.78 ± 0.13	6	2.84 ± 0.12
CO	8.60 ± 0.31	3	6.84 ± 0.30	6	7.09 ± 0.30
NO_x	7.23 ± 0.49	3	7.34 ± 0.44	6	7.32 ± 0.45
MPG	10.12 ± 0.27	3	10.76 ± 0.41	6	10.67 ± 0.39
Total Particulate	1.795 ± 0.061	2	1.447 ± 0.094	6	1.497 ± 0.089
% Extractable	34.5 ± 4.8	2	34.0 ± 3.8	5	34.07 ± 3.9
Part. Organics	0.618 ± 0.065	2	0.492 ± 0.034	5	0.510 ± 0.038
Inert Material	1.177 ± 0.126	2	0.963 ± 0.118	5	0.994 ± 0.119
Size Fraction <2μ	82.7 ± 15.7	2	88.3 ± 14.7	6	87.5 ± 14.8

[a] Emittant results are expressed in terms of grams/mile except MPG (expressed in miles per gallon), and %-Extractable and Size Fraction <2μ (both expressed in percents).

[b] N = Number of valid runs.

Table A11. CDW780 - Class 6 - Diesel Integrated/Weighted Gaseous and Particulate Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
Heavy-Duty Transient Cycle					
HC	4.03 ± 0.45	3	2.71 ± 0.21	7	2.90 ± 0.24
CO	9.21 ± 0.19	3	5.10 ± 0.30	10	5.69 ± 0.28
NO_x	9.29 ± 0.28	3	8.79 ± 0.33	8	8.86 ± 0.32
MPG	8.67 ± 0.50	3	9.90 ± 0.22	9	9.72 ± 0.26
Total Particulate	2.041 ± 0.263	4	1.298 ± 0.122	7	1.404 ± 0.142
% Extractable	48.5 ± 4.1	4	45.4 ± 3.6	7	45.8 ± 3.7
Part. Organics	0.984 ± 0.092	4	0.588 ± 0.058	7	0.646 ± 0.063
Inert Material	1.057 ± 0.206	4	0.710 ± 0.094	7	0.760 ± 0.110
Size Fraction <2μ	66.5 ± 8.2	4	74.5 ± 2.8	7	73.4 ± 3.6
Durham Road Route					
HC	2.21 ± 0.28	4	1.84 ± 0.13	8	1.91 ± 0.15
CO	7.11 ± 0.21	4	5.20 ± 0.35	8	5.47 ± 0.33
NO_x	8.97 ± 0.32	4	9.30 ± 0.26	7	9.25 ± 0.27
MPG	9.16 ± 0.34	4	9.91 ± 0.13	7	9.81 ± 0.15
Total Particulate	1.435 ± 0.213	4	1.142 ± 0.074	8	1.184 ± 0.094
% Extractable	37.4 ± 4.4	4	27.7 ± 2.5	8	29.1 ± 2.8
Part. Organics	0.531 ± 0.041	4	0.366 ± 0.161	8	0.390 ± 0.144
Inert Material	0.904 ± 0.190	4	0.765 ± 0.202	8	0.785 ± 0.200
Size Fraction <2μ	71.9 ± 3.7	4	73.2 ± 2.9	8	73.0 ± 3.0

[a] Emittant results are expressed in terms of grams/mile except MPG (expressed in miles per gallon), and %-Extractable and Size Fraction <2μ (both expressed in percents).

[b] N = Number of valid runs.

Table A12. FDW161 - Class 6 - Diesel Integrated/Weighted Gaseous and Particulate Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
Heavy-Duty Transient Cycle					
HC	2.87 ± 0.06	4	2.12 ± 0.14	8	2.24 ± 0.13
CO	8.75 ± 0.51	4	5.12 ± 0.46	8	5.64 ± 0.47
NO_x	10.97 ± 0.54	4	10.85 ± 0.22	7	10.87 ± 0.27
MPG	9.77 ± 0.30	4	11.08 ± 0.25	8	10.89 ± 0.26
Total Particulate	1.253 ± 0.029	4	0.680 ± 0.072	7	0.762 ± 0.066
% Extractable	54.8 ± 6.7	4	44.5 ± 5.5	8	46.0 ± 5.7
Part. Organics	0.687 ± 0.087	4	0.306 ± 0.055	7	0.360 ± 0.059
Inert Material	0.566 ± 0.085	4	0.374 ± 0.053	7	0.401 ± 0.053
Size Fraction <2μ	70.4 ± 3.2	4	77.5 ± 4.1	7	76.5 ± 4.0
Durham Road Route					
HC	1.55 ± 0.04	3	1.15 ± 0.04	6	1.21 ± 0.04
CO	6.24 ± 0.31	3	4.05 ± 0.16	6	4.36 ± 0.18
NO_x	9.54 ± 0.12	3	9.74 ± 0.23	6	9.71 ± 0.21
MPG	10.25 ± 0.26	3	11.19 ± 0.23	6	11.06 ± 0.23
Total Particulate	0.995 ± 0.087	3	0.611 ± 0.037	6	0.666 ± 0.044
% Extractable	49.4 ± 2.5	3	34.7 ± 2.7	6	36.8 ± 2.7
Part. Organics	0.490 ± 0.022	3	0.211 ± 0.011	6	0.251 ± 0.013
Inert Material	0.505 ± 0.068	3	0.400 ± 0.038	6	0.415 ± 0.042
Size Fraction <2μ	74.7 ± 6.7	3	73.2 ± 4.0	6	73.4 ± 4.4

[a] Emittant results are expressed in terms of grams/mile except MPG (expressed in miles per gallon), and %-Extractable and Size Fraction <2u (both expressed in percents).

[b] N = Number of valid runs.

Table A13. FDB420 - Class 6 - Diesel Integrated/Weighted Gaseous and Particulate Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
Heavy-Duty Transient Cycle					
HC	7.71 ± 0.87	4	5.99 ± 0.26	6	6.24 ± 0.35
CO	12.01 ± 1.08	4	7.45 ± 0.46	8	8.10 ± 0.55
NO_x	14.07 ± 0.32	3	13.24 ± 0.72	6	13.36 ± 0.66
MPG	9.11 ± 0.16	4	10.33 ± 0.44	8	10.16 ± 0.40
Total Particulate	3.105 ± 0.423	4	2.070 ± 0.071	8	2.218 ± 0.121
% Extractable	77.1 ± 5.8	4	79.1 ± 3.0	8	78.8 ± 3.4
Part. Organics	2.388 ± 0.339	4	1.588 ± 0.191	8	1.702 ± 0.212
Inert Material	0.718 ± 0.239	4	0.482 ± 0.142	8	0.516 ± 0.156
Size Fraction <2µ	79.6 ± 6.7	3	87.3 ± 5.4	8	86.2 ± 5.6
Durham Road Route					
HC	5.15 ± 0.08	3	4.61 ± 0.16	6	4.69 ± 0.15
CO	8.42 ± 0.26	3	6.26 ± 0.31	6	6.57 ± 0.30
NO_x	11.64 ± 0.20	3	11.37 ± 0.70	6	11.41 ± 0.63
MPG	9.83 ± 0.11	3	10.60 ± 0.11	6	10.49 ± 0.11
Total Particulate	2.411 ± 0.210	3	1.863 ± 0.038	6	1.941 ± 0.060
% Extractable	84.4 ± 4.2	3	85.0 ± 3.6	6	84.9 ± 3.7
Part. Organics	2.029 ± 0.070	3	1.583 ± 0.048	6	1.647 ± 0.051
Inert Material	0.371 ± 0.212	3	0.281 ± 0.072	6	0.294 ± 0.092
Size Fraction <2µ	87.3 ± 7.5	3	90.6 ± 3.1	6	90.1 ± 3.7

[a] Emittant results are expressed in terms of grams/mile except MPG (expressed in miles per gallon), and %-Extractable and Size Fraction <2µ (both expressed in percents).

[b] N = Number of valid runs.

Table A14. CDW786B - Class 6 - Diesel Integrated/Weighted Gaseous and Particulate Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
Heavy-Duty Transient Cycle					
HC	6.45 ± 0.39	3	3.55 ± 0.24	7	3.96 ± 0.26
CO	15.28 ± 1.17	4	8.97 ± 0.70	8	9.87 ± 0.76
NO_x	9.43 ± 0.64	4	9.47 ± 0.15	6	9.46 ± 0.22
MPG	8.72 ± 0.21	4	9.61 ± 0.13	8	9.48 ± 0.14
Total Particulate	3.029 ± 0.226	4	1.730 ± 0.192	4	1.916 ± 0.197
% Extractable	54.3 ± 4.6	4	46.5 ± 7.6	4	47.6 ± 7.2
Part. Organics	1.647 ± 0.220	4	0.802 ± 0.134	4	0.923 ± 0.146
Inert Material	1.382 ± 0.142	4	0.928 ± 0.195	4	0.993 ± 0.187
Size Fraction <2μ	61.4 ± 9.4	4	66.3 ± 5.1	4	65.6 ± 5.7
Durham Road Route					
HC			1.99 ± 0.27	7	
CO			6.94 ± 0.50	7	
NO_x			8.72 ± 0.54	7	
MPG			9.66 ± 0.24	7	
Total Particulate			1.547 ± 0.239	8	
% Extractable			30.0 ± 5.0	8	
Part. Organics			0.456 ± 0.052	8	
Inert Material			1.091 ± 0.240	8	
Size Fraction <2μ			63.0 ± 6.1	8	

[a] Emittant results are expressed in terms of grams/mile except MPG (expressed in miles per gallon), and %-Extractable and Size Fraction <2μ (both expressed in percents).

[b] N = Number of valid runs.

APPENDIX B

Heavy-Duty Transient Cycle Individual Bag Gaseous Emission Rates for Gasoline and Diesel-Powered Trucks

(Tables B1 - B14)

Table B1. FUH413 - Class 2B - Gasoline HDTC Individual Bag Gaseous Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
HC Bag-1	32.36 ± 6.25	3	16.23 ± 0.53	4	
HC Bag-2	20.29 ± 2.02	3	11.95 ± 1.103	8	
HC Bag-3	3.12 ± 0.31	3	2.33 ± 0.18	6	
HC Bag-4	18.26 ± 1.79	3	18.21 ± 0.94	5	
Integrated HC	17.81 ± 2.74	4	12.03 ± 0.50	7	12.86 ± 0.89
CO Bag-1	170.69 ± 15.83	3	105.76 ± 2.20	5	
CO Bag-2	86.91 ± 3.32	3	68.57 ± 6.36	8	
CO Bag-3	23.45 ± 2.10	3	16.95 ± 1.33	5	
CO Bag-4	118.27 ± 1.50	3	123.32 ± 2.52	4	
Integrated CO	100.71 ± 2.19	3	76.90 ± 4.70	7	80.30 ± 4.34
NOx Bag-1	6.02 ± 0.91	4	5.67 ± 0.19	4	
NOx Bag-2	5.06 ± 0.49	3	5.57 ± 0.28	8	
NOx Bag-3	10.68 ± 0.73	4	10.72 ± 0.28	6	
NOx Bag-4	5.33 ± 0.60	3	4.57 ± 0.25	5	
Integrated NOx	6.73 ± 0.53	3	6.65 ± 0.24	6	6.66 ± 0.28
MPG Bag-1	5.75 ± 0.14	3	8.17 ± 0.19	6	
MPG Bag-2	9.73 ± 0.69	3	11.30 ± 0.20	5	
MPG Bag-3	11.35 ± 0.08	4	11.66 ± 0.14	7	
MPG Bag-4	9.01 ± 0.44	3	9.15 ± 0.50	7	
Integrated MPG	8.79 ± 0.71	3	9.80 ± 0.37	7	9.66 ± 0.42

[a] Emittant results are expressed in terms of grams/mile except MPG, which is expressed in miles per gallon.

[b] N = Number of valid runs.

Table B2. F2H411 - Class 2B - Gasoline HDTC Individual Bag Gaseous Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
HC Bag-1	49.27 ± 4.51	3	34.08 ± 0.74	6	
HC Bag-2	23.20 ± 1.56	3	19.23 ± 0.95	6	
HC Bag-3	4.49 ± 0.22	3	3.95 ± 0.24	6	
HC Bag-4	31.92 ± 3.60	3	31.30 ± 0.50	6	
Integrated HC	26.83 ± 1.71	3	21.83 ± 0.18	6	22.54 ± 0.40
CO Bag-1	137.90 ± 13.264	3	86.46 ± 8.89	6	
CO Bag-2	82.28 ± 6.26	3	54.42 ± 4.02	5	
CO Bag-3	37.17 ± 1.29	3	28.33 ± 0.91	6	
CO Bag-4	100.46 ± 11.77	3	97.45 ± 9.64	6	
Integrated CO	88.61 ± 6.01	3	66.34 ± 1.70	6	69.52 ± 2.32
NOx Bag-1	12.08 ± 1.90	3	9.38 ± 0.77	4	
NOx Bag-2	8.71 ± 0.82	3	8.74 ± 0.41	5	
NOx Bag-3	15.86 ± 0.93	3	16.05 ± 0.81	6	
NOx Bag-4	9.30 ± 0.40	3	8.61 ± 0.93	5	
Integrated NOx	11.46 ± 0.91	3	10.81 ± 0.75	6	10.90 ± 0.77
MPG Bag-1	5.37 ± 0.77	3	7.49 ± 0.21	4	
MPG Bag-2	9.26 ± 0.49	3	10.60 ± 0.28	6	
MPG Bag-3	10.75 ± 0.02	3	11.29 ± 0.10	6	
MPG Bag-4	7.31 ± 0.17	3	7.59 ± 0.34	6	
Integrated MPG	7.68 ± 0.53	3	8.95 ± 0.29	6	8.77 ± 0.32

[a] Emittant results are expressed in terms of grams/mile except MPG, which is expressed in miles per gallon.

[b] N = Number of valid runs.

Table B3. VOY285 - Class 2B - Gasoline HDTC Individual Bag Gaseous Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
HC Bag-1	13.06 ± 2.57	3	6.10 ± 0.43	5	
HC Bag-2	7.93 ± 0.74	3	3.74 ± 0.41	5	
HC Bag-3	1.45 ± 0.21	3	1.09 ± 0.06	6	
HC Bag-4	5.18 ± 0.61	3	4.05 ± 0.38	6	
Integrated HC	6.87 ± 0.80	3	3.86 ± 0.30	6	4.29 ± 0.40
CO Bag-1	197.96 ± 43.72	3	99.03 ± 10.24	5	
CO Bag-2	110.62 ± 8.38	3	72.33 ± 3.00	5	
CO Bag-3	24.90 ± 0.85	3	17.16 ± 1.20	5	
CO Bag-4	136.47 ± 9.12	3	115.72 ± 6.91	6	
Integrated CO	116.15 ± 10.37	3	77.13 ± 5.19	6	82.70 ± 5.93
NOx Bag-1	3.18 ± 0.43	3	3.01 ± 0.31	6	
NOx Bag-2	3.09 ± 0.13	3	3.39 ± 0.13	6	
NOx Bag-3	4.49 ± 0.64	3	5.00 ± 0.21	6	
NOx Bag-4	3.09 ± 0.11	3	3.38 ± 0.22	6	
Integrated NOx	3.47 ± 0.07	3	3.70 ± 0.13	6	3.67 ± 0.12
MPG Bag-1	6.37 ± 0.63	3	8.45 ± 0.56	6	
MPG Bag-2	9.12 ± 0.20	3	10.78 ± 0.38	6	
MPG Bag-3	12.22 ± 0.04	3	13.01 ± 0.14	6	
MPG Bag-4	7.52 ± 0.29	3	7.83 ± 0.27	6	
Integrated MPG	8.35 ± 0.26	3	9.68 ± 0.26	6	9.49 ± 0.26

[a] Emittant results are expressed in terms of grams/mile except MPG, which is expressed in miles per gallon.

[b] N = Number of valid runs.

Table B4. VOY338 - Class 2B - Gasoline HDTC Individual Bag Gaseous Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
HC Bag-1	27.32 ± 3.40	3	5.67 ± 0.57	5	
HC Bag-2	5.59 ± 1.33	3	2.64 ± 0.16	6	
HC Bag-3	1.54 ± 0.14	3	1.27 ± 0.04	6	
HC Bag-4	3.96 ± 0.19	3	3.36 ± 0.10	5	
Integrated HC	9.38 ± 0.45	3	3.23 ± 0.25	6	4.11 ± 0.28
CO Bag-1	424.36 ± 29.90	2	41.87 ± 4.71	4	
CO Bag-2	62.26 ± 8.98	3	24.26 ± 3.35	5	
CO Bag-3	20.64 ± 0.01	2	12.74 ± 0.47	5	
CO Bag-4	43.01 ± 0.06	2	31.63 ± 2.17	4	
Integrated CO	140.95 ± 12.12	3	27.95 ± 4.20	6	44.09 ± 5.33
NOx Bag-1	1.76 ± 0.21	2	5.31 ± 0.39	5	
NOx Bag-2	4.18 ± 0.15	3	4.69 ± 0.24	6	
NOx Bag-3	5.57 ± 0.36	3	6.40 ± 0.30	6	
NOx Bag-4	4.04 ± 0.35	3	4.13 ± 0.23	5	
Integrated NOx	4.06 ± 0.30	3	5.15 ± 0.21	6	4.99 ± 0.22
MPG Bag-1	4.15 ± 0.18	3	7.06 ± 0.18	6	
MPG Bag-2	10.20 ± 0.35	3	11.71 ± 0.37	6	
MPG Bag-3	12.75 ± 0.16	3	13.39 ± 0.17	6	
MPG Bag-4	8.04 ± 0.20	3	8.38 ± 0.30	6	
Integrated MPG	7.48 ± 0.09	3	9.59 ± 0.21	6	9.29 ± 0.19

[a] Emittant results are expressed in terms of grams/mile except MPG, which is expressed in miles per gallon.

[b] N = Number of valid runs.

Table B5. F3H633 - Class 5 - Gasoline HDTC Individual Bag Gaseous Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
HC Bag-1	70.36 ± 8.99	3	35.71 ± 3.74	4	
HC Bag-2	43.65 ± 1.89	3	33.82 ± 1.92	4	
HC Bag-3	11.67 ± 0.56	3	11.25 ± 0.36	4	
HC Bag-4	50.90 ± 2.92	3	48.18 ± 8.46	4	
Integrated HC	45.74 ± 3.05	4	32.03 ± 2.16	4	33.99 ± 2.29
CO Bag-1	434.02 ± 73.84	3	364.49 ± 34.51	5	
CO Bag-2	332.16 ± 17.60	3	294.33 ± 0.34	6	
CO Bag-3	395.04 ± 6.59	3	394.13 ± 20.84	6	
CO Bag-4	410.24 ± 48.52	3	422.67 ± 22.32	4	
Integrated CO	405.16 ± 29.09	4	365.01 ± 21.78	4	370.75 ± 22.84
NOx Bag-1	5.55 ± 0.73	3	5.35 ± 0.39	4	
NOx Bag-2	6.46 ± 0.32	3	6.49 ± 0.34	4	
NOx Bag-3	6.88 ± 0.69	3	6.52 ± 0.52	5	
NOx Bag-4	4.53 ± 0.31	4	5.21 ± 0.70	4	
Integrated NOx	5.07 ± 0.70	4	6.05 ± 0.13	4	5.91 ± 0.21
MPG Bag-1	4.48 ± 0.57	3	5.16 ± 0.24	4	
MPG Bag-2	5.76 ± 0.14	4	6.04 ± 0.38	6	
MPG Bag-3	5.35 ± 0.10	3	5.45 ± 0.16	6	
MPG Bag-4	4.56 ± 0.32	3	4.80 ± 0.41	5	
Integrated MPG	4.95 ± 0.19	4	5.42 ± 0.27	4	5.35 ± 0.26

[a] Emittant results are expressed in terms of grams/mile except MPG, which is expressed in miles per gallon.

[b] N = Number of valid runs.

Table B6. G63333 - Class 6 - Gasoline HDTC Individual Bag Gaseous Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
HC Bag-1	89.50 ± 14.71	3	45.76 ± 3.73	8	
HC Bag-2	40.82 ± 3.95	3	30.15 ± 3.42	7	
HC Bag-3	10.03 ± 1.13	4	8.32 ± 0.87	8	
HC Bag-4	39.94 ± 3.21	4	34.82 ± 2.77	8	
Integrated HC	44.28 ± 2.14	3	29.87 ± 1.69	5	31.93 ± 1.75
CO Bag-1	417.09 ± 88.37	3	285.25 ± 38.39	8	
CO Bag-2	179.09 ± 9.92	2	194.19 ± 26.44	6	
CO Bag-3	163.49 ± 20.10	4	155.00 ± 17.71	6	
CO Bag-4	311.35 ± 30.22	4	297.78 ± 24.51	6	
Integrated CO	246.35 ± 25.90	3	216.22 ± 13.09	5	220.52 ± 14.92
NOx Bag-1	7.05 ± 0.63	3	11.04 ± 1.02	6	
NOx Bag-2	8.55 ± 0.42	3	9.88 ± 0.96	6	
NOx Bag-3	9.42 ± 1.76	4	10.50 ± 0.88	6	
NOx Bag-4	9.04 ± 1.14	4	9.82 ± 0.84	6	
Integrated NOx	8.38 ± 0.66	4	9.62 ± 0.86	5	9.44 ± 0.83
MPG Bag-1	3.67 ± 0.48	3	4.30 ± 0.13	8	
MPG Bag-2	5.48 ± 0.48	3	5.49 ± 0.19	7	
MPG Bag-3	6.68 ± 0.39	4	6.74 ± 0.17	8	
MPG Bag-4	4.61 ± 0.36	4	4.53 ± 0.16	7	
Integrated MPG	4.93 ± 0.23	3	5.19 ± 0.11	5	5.15 ± 0.13

[a] Emittant results are expressed in terms of grams/mile except MPG, which is expressed in miles per gallon.

[b] N = Number of valid runs.

Table B7. FDW112 - Class 2B - Diesel HDTC Individual Bag Gaseous Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
HC Bag-1	3.83 ± 0.63	3	4.86 ± 0.41	8	
HC Bag-2	3.93 ± 0.39	4	2.97 ± 0.21	8	
HC Bag-3	3.75 ± 0.02	3	3.47 ± 0.13	8	
HC Bag-4	5.46 ± 0.77	4	5.47 ± 0.76	8	
Integrated HC	4.34 ± 0.36	4	4.07 ± 0.41	9	4.11 ± 0.40
CO Bag-1	12.86 ± 1.14	3	12.48 ± 0.82	8	
CO Bag-2	8.92 ± 0.19	3	5.83 ± 0.23	8	
CO Bag-3	4.39 ± 0.94	5	4.42 ± 0.16	8	
CO Bag-4	8.98 ± 0.50	5	9.20 ± 0.45	7	
Integrated CO	8.56 ± 0.79	4	7.37 ± 0.59	11	7.54 ± 0.62
NOx Bag-1	6.12 ± 0.46	3	3.63 ± 0.66	7	
NOx Bag-2	3.00 ± 0.25	4	2.07 ± 0.06	4	
NOx Bag-3	2.67 ± 0.23	4	2.18 ± 0.38	7	
NOx Bag-4	4.33 ± 0.32	4	2.97 ± 0.25	4	
Integrated NOx	4.09 ± 0.39	4	3.17 ± 0.55	11	3.30 ± 0.53
MPG Bag-1	7.45 ± 0.37	3	10.41 ± 0.31	8	
MPG Bag-2	15.16 ± 0.59	3	16.61 ± 0.30	7	
MPG Bag-3	14.88 ± 0.10	3	15.49 ± 0.12	8	
MPG Bag-4	10.85 ± 0.54	5	11.55 ± 0.43	8	
Integrated MPG	11.31 ± 0.68	4	12.87 ± 0.42	13	12.65 ± 0.46

[a] Emittant results are expressed in terms of grams/mile except MPG, which is expressed in miles per gallon.

[b] N = Number of valid runs.

Table B8. CDR734 - Class 2B - Diesel HDTC Individual Bag Gaseous Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
HC Bag-1	1.00 ± 0.14	3	0.53 ± 0.06	4	
HC Bag-2	0.62 ± 0.05	7	0.35 ± 0.04	4	
HC Bag-3	0.30 ± 0.03	7	0.22 ± 0.01	5	
HC Bag-4	0.78 ± 0.06	3	0.62 ± 0.07	3	
Integrated HC	0.67 ± 0.05	3	0.42 ± 0.03	3	0.45 ± 0.03
CO Bag-1	3.65 ± 0.30	8	2.87 ± 0.15	14	
CO Bag-2	2.34 ± 0.11	8	1.62 ± 0.09	15	
CO Bag-3	0.95 ± 0.03	8	0.88 ± 0.03	14	
CO Bag-4	1.97 ± 0.12	8	1.99 ± 0.17	15	
Integrated CO	2.21 ± 0.10	8	1.83 ± 0.09	15	1.88 ± 0.09
NOx Bag-1	5.48 ± 0.58	7	4.91 ± 0.46	14	
NOx Bag-2	2.85 ± 0.28	7	3.14 ± 0.32	14	
NOx Bag-3	3.37 ± 0.28	7	3.84 ± 0.26	14	
NOx Bag-4	4.49 ± 0.31	7	4.93 ± 0.51	14	
Integrated NOx	4.00 ± 0.29	7	4.17 ± 0.29	14	4.15 ± 0.29
MPG Bag-1	10.17 ± 0.63	6	13.71 ± 0.67	14	
MPG Bag-2	17.43 ± 0.40	6	20.33 ± 1.00	15	
MPG Bag-3	16.19 ± 0.20	8	16.88 ± 0.34	15	
MPG Bag-4	14.59 ± 0.87	8	14.44 ± 0.78	14	
Integrated MPG	14.38 ± 0.67	8	16.04 ± 0.57	14	15.80 ± 0.58

[a] Emittant results are expressed in terms of grams/mile except MPG, which is expressed in miles per gallon.

[b] N = Number of valid runs.

Table B9. FDP387 - Class 2B - Diesel HDTC Individual Bag Gaseous Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
HC Bag-1	0.70 ± 0.12	3	0.33 ± 0.04	5	
HC Bag-2	0.51 ± 0.03	3	0.28 ± 0.03	7	
HC Bag-3	0.53 ± 0.04	[illegible]	0.41 ± 0.02	7	
HC Bag-4	0.76 ± 0.06	3	0.73 ± 0.07	7	
Integrated HC	0.62 ± 0.05	3	0.44 ± 0.04	7	0.47 ± 0.04
CO Bag-1	3.30 ± 0.15	4	3.05 ± 0.17	7	
CO Bag-2	2.51 ± 0.13	4	1.80 ± 0.12	7	
CO Bag-3	1.87 ± 0.06	4	1.50 ± 0.07	7	
CO Bag-4	2.40 ± 0.15	4	2.48 ± 0.26	7	
Integrated CO	2.51 ± 0.11	4	2.19 ± 0.12	7	2.24 ± 0.12
NOx Bag-1	15.17 ± 0.67	4	8.04 ± 0.30	7	
NOx Bag-2	4.81 ± 0.16	4	5.15 ± 0.14	7	
NOx Bag-3	3.48 ± 0.21	4	3.65 ± 0.07	7	
NOx Bag-4	7.94 ± 0.53	4	8.44 ± 0.26	7	
Integrated NOx	7.71 ± 0.19	4	6.25 ± 0.09	7	6.46 ± 0.10
MPG Bag-1	7.84 ± 0.26	4	11.52 ± 0.56	7	
MPG Bag-2	16.10 ± 0.07	4	18.23 ± 0.53	6	
MPG Bag-3	15.83 ± 0.24	4	16.44 ± 0.13	6	
MPG Bag-4	12.93 ± 0.31	4	12.83 ± 0.64	6	
Integrated MPG	12.23 ± 0.16	4	14.30 ± 0.32	7	14.00 ± 0.28

[a] Emittant results are expressed in terms of grams/mile except MPG, which is expressed in miles per gallon.

[b] N = Number of valid runs.

Table B10. CDW786 - Class 6 - Diesel HDTC Individual Bag Gaseous Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
HC Bag-1	7.51 ± 0.38	3	4.65 ± 0.17	7	
HC Bag-2	4.45 ± 0.03	3	3.98 ± 0.17	7	
HC Bag-3	1.66 ± 0.05	3	1.59 ± 0.04	7	
HC Bag-4	6.12 ± 0.46	3	6.18 ± 0.33	7	
Integrated HC	4.88 ± 0.07	3	4.06 ± 0.15	7	4.18 ± 0.14
CO Bag-1	27.17 ± 2.08	3	13.95 ± 0.69	7	
CO Bag-2	10.63 ± 0.33	3	8.12 ± 0.43	7	
CO Bag-3	4.61 ± 0.43	3	4.34 ± 0.29	7	
CO Bag-4	10.68 ± 0.13	3	10.52 ± 0.88	7	
Integrated CO	13.09 ± 0.49	3	9.14 ± 0.38	7	9.70 ± 0.40
NOx Bag-1	12.33 ± 0.88	3	11.14 ± 0.55	6	
NOx Bag-2	8.03 ± 0.37	3	7.88 ± 1.51	6	
NOx Bag-3	6.67 ± 0.03	3	6.58 ± 0.15	6	
NOx Bag-4	11.31 ± 0.86	3	12.09 ± 1.02	7	
Integrated NOx	9.50 ± 0.11	3	9.27 ± 0.19	7	9.30 ± 0.18
MPG Bag-1	6.09 ± 0.20	3	7.38 ± 0.11	6	
MPG Bag-2	9.45 ± 0.17	3	9.87 ± 0.25	7	
MPG Bag-3	10.57 ± 0.17	3	10.83 ± 0.15	7	
MPG Bag-4	8.27 ± 0.38	3	8.24 ± 0.12	7	
Integrated MPG	8.28 ± 0.10	3	8.92 ± 0.04	7	8.83 ± 0.05

[a] Emittant results are expressed in terms of grams/mile except MPG, which is expressed in miles per gallon.

[b] N = Number of valid runs.

Table B11. CDW780 - Class 6 - Diesel HDTC Individual Bag Gaseous Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
HC Bag-1	7.32 ± 1.29	3	2.88 ± 0.36	6	
HC Bag-2	4.14 ± 0.08	3	2.74 ± 0.14	6	
HC Bag-3	1.52 ± 0.10	3	1.26 ± 0.05	5	
HC Bag-4	4.31 ± 0.73	3	4.06 ± 0.33	5	
Integrated HC	4.03 ± 0.45	3	2.71 ± 0.21	7	2.90 ± 0.24
CO Bag-1	17.87 ± 1.93	4	7.12 ± 0.50	9	
CO Bag-2	8.60 ± 0.15	4	4.93 ± 0.39	10	
CO Bag-3	3.62 ± 0.19	4	2.91 ± 0.16	10	
CO Bag-4	6.40 ± 0.46	4	5.45 ± 0.40	10	
Integrated CO	9.21 ± 0.19	3	5.10 ± 0.30	10	5.69 ± 0.28
NOx Bag-1	13.17 ± 1.14	3	11.12 ± 0.77	8	
NOx Bag-2	7.86 ± 0.56	3	7.67 ± 0.22	8	
NOx Bag-3	5.98 ± 0.39	3	5.79 ± 0.32	8	
NOx Bag-4	10.51 ± 0.95	3	11.06 ± 0.48	5	
Integrated NOx	9.29 ± 0.28	3	8.79 ± 0.33	8	8.86 ± 0.32
MPG Bag-1	6.50 ± 0.93	4	8.60 ± 0.42	10	
MPG Bag-2	9.58 ± 0.30	4	10.81 ± 0.35	10	
MPG Bag-3	11.53 ± 0.62	4	11.90 ± 0.46	10	
MPG Bag-4	9.36 ± 0.09	4	9.08 ± 0.50	10	
Integrated MPG	8.67 ± 0.50	3	9.90 ± 0.22	9	9.72 ± 0.26

[a] Emittant results are expressed in terms of grams/mile except MPG, which is expressed in miles per gallon.

[b] N = Number of valid runs.

Table B12. FDW161 - Class 6 - Diesel HDTC Individual Bag Gaseous Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
HC Bag-1	4.89 ± 0.57	4	2.50 ± 0.29	8	
HC Bag-2	2.71 ± 0.38	4	2.11 ± 0.21	8	
HC Bag-3	1.04 ± 0.12	3	1.11 ± 0.11	8	
HC Bag-4	2.88 ± 0.16	4	2.83 ± 0.17	8	
Integrated HC	2.87 ± 0.06	4	2.12 ± 0.14	8	2.24 ± 0.13
CO Bag-1	18.29 ± 2.15	4	7.61 ± 0.83	7	
CO Bag-2	7.96 ± 0.62	4	4.66 ± 0.37	7	
CO Bag-3	3.48 ± 0.08	4	2.80 ± 0.10	8	
CO Bag-4	5.63 ± 0.31	4	4.99 ± 0.13	7	
Integrated CO	8.75 ± 0.51	4	5.12 ± 0.46	8	5.64 ± 0.47
NOx Bag-1	14.24 ± 1.00	4	13.44 ± 0.67	8	
NOx Bag-2	9.66 ± 0.64	4	9.35 ± 0.33	8	
NOx Bag-3	7.75 ± 0.32	4	8.05 ± 0.09	7	
NOx Bag-4	12.57 ± 0.32	4	13.24 ± 0.46	8	
Integrated NOx	10.97 ± 0.54	4	10.85 ± 0.22	7	10.87 ± 0.27
MPG Bag-1	7.00 ± 0.34	4	9.20 ± 0.47	8	
MPG Bag-2	11.09 ± 0.79	4	12.84 ± 0.57	8	
MPG Bag-3	12.34 ± 0.19	4	12.72 ± 0.11	8	
MPG Bag-4	10.24 ± 0.47	4	10.27 ± 0.38	8	
Integrated MPG	9.77 ± 0.30	4	11.08 ± 0.25	8	10.89 ± 0.26

[a] Emittant results are expressed in terms of grams/mile except MPG, which is expressed in miles per gallon.

[b] N = Number of valid runs.

Table B13. FDB420 - Class 6 - Diesel HDTC Individual Bag Gaseous Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
HC Bag-1	10.47 ± 1.33	3	6.97 ± 0.24	5	
HC Bag-2	6.67 ± 0.80	3	5.96 ± 0.34	5	
HC Bag-3	3.46 ± 0.11	3	3.25 ± 0.18	6	
HC Bag-4	8.03 ± 0.15	3	8.23 ± 0.23	6	
Integrated HC	7.71 ± 0.87	4	5.99 ± 0.26	6	6.24 ± 0.35
CO Bag-1	21.95 ± 0.12	3	10.52 ± 0.40	6	
CO Bag-2	9.52 ± 0.45	3	6.98 ± 0.29	6	
CO Bag-3	5.22 ± 0.20	4	4.43 ± 0.24	6	
CO Bag-4	8.67 ± 0.39	4	7.86 ± 0.38	5	
Integrated CO	12.01 ± 1.08	4	7.45 ± 0.46	8	8.10 ± 0.55
NOx Bag-1	19.17 ± 0.32	3	17.91 ± 0.53	5	
NOx Bag-2	11.77 ± 0.44	3	11.08 ± 0.51	5	
NOx Bag-3	9.62 ± 0.29	3	9.18 ± 0.58	6	
NOx Bag-4	16.24 ± 0.30	3	16.43 ± 0.03	4	
Integrated NOx	14.07 ± 0.32	3	13.24 ± 0.72	6	13.36 ± 0.66
MPG Bag-1	6.71 ± 0.22	3	8.26 ± 0.22	8	
MPG Bag-2	10.35 ± 0.45	3	11.62 ± 0.41	6	
MPG Bag-3	11.58 ± 0.21	3	12.24 ± 0.10	4	
MPG Bag-4	9.28 ± 0.06	3	9.17 ± 0.21	4	
Integrated MPG	9.11 ± 0.16	4	10.33 ± 0.44	8	10.16 ± 0.40

[a] Emittant results are expressed in terms of grams/mile except MPG, which is expressed in miles per gallon.

[b] N = Number of valid runs.

Table B14. CDW786B - Class 6 - Diesel HDTC Individual Bag Gaseous Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
HC Bag-1	13.15 ± 1.20	4	4.18 ± 0.28	8	
HC Bag-2	5.27 ± 0.90	3	3.39 ± 0.33	8	
HC Bag-3	1.55 ± 0.06	3	1.40 ± 0.16	5	
HC Bag-4	5.68 ± 0.05	3	5.40 ± 0.66	7	
Integrated HC	6.45 ± 0.39	3	3.55 ± 0.24	7	3.96 ± 0.26
CO Bag-1	33.87 ± 1.58	4	13.07 ± 1.35	8	
CO Bag-2	11.33 ± 0.13	3	7.20 ± 0.62	7	
CO Bag-3	4.47 ± 0.45	3	3.80 ± 0.41	6	
CO Bag-4	10.52 ± 0.83	3	11.55 ± 0.84	8	
Integrated CO	15.28 ± 1.17	4	8.97 ± 0.70	8	9.87 ± 0.76
NOx Bag-1	12.21 ± 0.40	3	12.01 ± 1.14	8	
NOx Bag-2	8.39 ± 0.62	4	8.14 ± 0.62	8	
NOx Bag-3	7.14 ± 0.31	4	7.39 ± 0.25	6	
NOx Bag-4	10.91 ± 0.80	4	11.99 ± 0.96	8	
Integrated NOx	9.43 ± 0.64	4	9.47 ± 0.15	6	9.46 ± 0.22
MPG Bag-1	6.52 ± 0.63	4	8.13 ± 0.50	8	
MPG Bag-2	9.91 ± 0.52	4	11.46 ± 0.87	8	
MPG Bag-3	10.79 ± 0.28	4	11.09 ± 0.35	8	
MPG Bag-4	8.83 ± 0.51	4	8.31 ± 0.47	8	
Integrated MPG	8.72 ± 0.21	4	9.61 ± 0.13	8	9.48 ± 0.14

[a] Emittant results are expressed in terms of grams/mile except MPG, which is expressed in miles per gallon.

[b] N = Number of valid runs.

APPENDIX C

Heavy-Duty Transient Cycle Individual Bag Particulate Emission Rates for Diesel-Powered Trucks

(Tables C1 - C8)

Table C1. FDW112 - Class 2B - Diesel HDTC Individual Bag Particulate Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
Part. Bag-1	1.270 ± 0.096	4	1.100 ± 0.147	4	
Part. Bag-2	1.137 ± 0.211	4	1.027 ± 0.098	4	
Part. Bag-3	1.392 ± 0.292	4	1.402 ± 0.201	4	
Part. Bag-4	0.756 ± 0.164	3	1.250 ± 0.344	4	
Integrated Total Particulate	1.191 ± 0.163	4	1.204 ± 0.190	12	1.202 ± 0.18
% Extr. Bag-1	64.5 ± 2.6	3	68.5 ± 4.8	4	
% Extr. Bag-2	83.4 ± 2.1	3	81.2 ± 0.9	4	
% Extr. Bag-3	90.9 ± 3.1	3	92.1 ± 2.2	5	
% Extr. Bag-4	78.4 ± 18.8	2	58.6 ± 1.5	3	
Integrated CH_2Cl_2 % Extr.	76.8 ± 8.9	4	86.6 ± 7.4	12	85.2 ± 7.6
Part. Org. Bag-1	0.793 ± 0.024	3	0.758 ± 0.143	4	
Part. Org. Bag-2	1.010 ± 0.185	3	0.835 ± 0.085	4	
Part. Org. Bag-3	1.273 ± 0.371	3	1.304 ± 0.211	4	
Part. Org. Bag-4	0.624 ± 0.013	2	0.511 ± 0.047	2	
Integrated Particulate Organics	0.907 ± 0.193	4	1.049 ± 0.224	12	1.029 ± 0.22
Inert Bag-1	0.438 ± 0.054	3	0.311 ± 0.032	3	
Inert Bag-2	0.198 ± 0.015	3	0.193 ± 0.015	4	
Inert Bag-3	0.118 ± 0.014	3	0.099 ± 0.012	4	
Inert Bag-4	0.193 ± 0.192	2	0.374 ± 0.035	2	
Integrated Inert Material	0.239 ± 0.079	3	0.155 ± 0.077	12	0.173 ± 0.077

[a] Emittant results are expressed in terms of grams/mile except % Extractable, which is expressed in percent.

[b] N = Number of valid runs.

Table C2. CDR734 - Class 2B - Diesel HDTC Individual Bag Particulate Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
Part. Bag-1	0.806 ± 0.148	4	0.531 ± 0.032	8	
Part. Bag-2	0.808 ± 0.517	4	0.319 ± 0.061	7	
Part. Bag-3	0.338 ± 0.292	4	0.319 ± 0.027	7	
Part. Bag-4	0.885 ± 0.189	4	0.513 ± 0.055	7	
Integrated Total Particulate	0.709 ± 0.101	4	0.432 ± 0.046	7	0.472 ± 0.054
% Extr. Bag-1	38.0 ± 20.0	4	33.3 ± 5.3	7	
% Extr. Bag-2	44.2 ± 7.2	4	36.5 ± 2.0	5	
% Extr. Bag-3	33.7 ± 7.4	3	57.1 ± 3.1	7	
% Extr. Bag-4	27.4 ± 4.0	4	32.9 ± 14.3	7	
Integrated CH_2Cl_2 % Extr.	39.1 ± 4.2	4	39.4 ± 5.0	7	39.4 ± 4.9
Part. Org. Bag-1	0.255 ± 0.009	2	0.153 ± 0.013	4	
Part. Org. Bag-2	0.626 ± 0.007	2	0.105 ± 0.006	4	
Part. Org. Bag-3	0.027 ± 0.002	2	0.187 ± 0.005	6	
Part. Org. Bag-4	0.256 ± 0.036	3	0.153 ± 0.022	5	
Integrated Particulate Organics	0.278 ± 0.058	4	0.174 ± 0.035	7	0.189 ± 0.038
Inert Bag-1	0.374 ± 0.031	2	0.353 ± 0.026	5	
Inert Bag-2	0.682 ± 0.036	2	0.182 ± 0.010	5	
Inert Bag-3	0.065 ± 0.001	2	0.127 ± 0.009	5	
Inert Bag-4	0.724 ± 0.043	3	0.361 ± 0.030	4	
Integrated Inert Material	0.431 ± 0.057	4	0.262 ± 0.034	7	0.286 ± 0.037

[a] Emittant results are expressed in terms of grams/mile except % Extractable, which is expressed in percent.

[b] N = Number of valid runs.

Table C3. FDP387 - Class 2B - Diesel HDTC Individual Bag Particulate Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
Part. Bag-1	1.372 ± 0.034	3	0.635 ± 0.056	6	
Part. Bag-2	0.407 ± 0.030	4	0.392 ± 0.026	7	
Part. Bag-3	0.660 ± 0.023	4	0.629 ± 0.017	7	
Part. Bag-4	0.474 ± 0.023	3	0.436 ± 0.047	6	
Integrated Total Particulate	0.697 ± 0.053	4	0.520 ± 0.012	7	0.545 ± 0.018
% Extr. Bag-1	54.9 ± 0.6	3	63.5 ± 2.0	4	
% Extr. Bag-2	63.0 ± 3.0	3	70.4 ± 4.9	6	
% Extr. Bag-3	71.6 ± 1.8	4	76.2 ± 2.3	6	
% Extr. Bag-4	50.1 ± 7.7	3	65.4 ± 3.2	5	
Integrated CH_2Cl_2 % Extr.	60.1 ± 5.7	4	71.4 ± 5.4	7	69.8 ± 5.4
Part. Org. Bag-1	0.750 ± 0.020	2	0.419 ± 0.034	3	
Part. Org. Bag-2	0.259 ± 0.014	3	0.276 ± 0.033	6	
Part. Org. Bag-3	0.472 ± 0.020	4	0.481 ± 0.017	6	
Part. Org. Bag-4	0.265 ± 0.023	2	0.279 ± 0.027	4	
Integrated Particulate Organics	0.417 ± 0.026	4	0.371 ± 0.027	7	0.378 ± 0.027
Inert Bag-1	0.628 ± 0.018	2	0.249 ± 0.004	3	
Inert Bag-2	0.153 ± 0.025	3	0.115 ± 0.015	6	
Inert Bag-3	0.188 ± 0.013	±	0.151 ± 0.016	6	
Inert Bag-4	0.222 ± 0.011	2	0.155 ± 0.032	4	
Integrated Inert Material	0.280 ± 0.057	4	0.149 ± 0.029	7	0.168 ± 0.033

[a] Emittant results are expressed in terms of grams/mile except % Extractable, which is expressed in percent.

[b] N = Number of valid runs.

Table C4. CBW786A - Class 6 - Diesel HDTC Individual Bag Particulate Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
Part. Bag-1	3.688 ± 0.511	3	2.008 ± 0.576	4	
Part. Bag-2	2.046 ± 0.241	3	1.933 ± 1.062	4	
Part. Bag-3	1.450 ± 0.429	3	1.226 ± 0.175	3	
Part. Bag-4	1.636 ± 0.241	3	1.571 ± 0.246	4	
Integrated Total Particulate	2.191 ± 0.287	3	1.627 ± 0.343	4	1.708 ± 0.335
% Extr. Bag-1	75.2 ± 24.2	3	53.3 ± 8.8	4	
% Extr. Bag-2	69.0 ± 4.3	3	68.7 ± 3.6	3	
% Extr. Bag-3	35.4 ± 5.9	3	34.0 ± 2.6	4	
% Extr. Bag-4	39.8 ± 6.7	3	40.3 ± 5.9	4	
Integrated CH_2Cl_2 % Extr.	54.8 ± 9.7	3	49.6 ± 8.9	5	50.3 ± 9.0
Part. Org. Bag-1	2.165 ± 0.662	2	0.846 ± 0.071	3	
Part. Org. Bag-2	1.420 ± 0.260	3	0.964 ± 0.109	3	
Part. Org. Bag-3	0.405 ± 0.032	2	0.416 ± 0.051	3	
Part. Org. Bag-4	0.640 ± 0.027	3	0.625 ± 0.083	4	
Integrated Particulate Organics	1.212 ± 0.336	3	0.758 ± 0.122	4	0.823 ± 0.153
Inert Bag-1	1.228 ± 0.674	2	0.903 ± 0.106	4	
Inert Bag-2	0.627 ± 0.020	3	0.443 ± 0.096	3	
Inert Bag-3	0.935 ± 0.263	3	0.810 ± 0.139	3	
Inert Bag-4	0.996 ± 0.263	3	0.945 ± 0.212	4	
Integrated Inert Material	0.979 ± 0.178	3	0.869 ± 0.221	4	0.883 ± 0.215

[a] Emittant results are expressed in terms of grams/mile except % Extractable, which is expressed in percent.

[b] N = Number of valid runs.

Table C5. CDW780 - Class 6 - Diesel HDTC Individual Bag Particulate Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
Part. Bag-1	2.826 ± 0.246	3	1.494 ± 0.121	7	
Part. Bag-2	1.931 ± 0.274	3	1.360 ± 0.261	7	
Part. Bag-3	1.057 ± 0.119	4	0.866 ± 0.043	7	
Part. Bag-4	1.721 ± 0.161	4	1.448 ± 0.227	7	
Integrated Total Particulate	2.041 ± 0.263	4	1.298 ± 0.122	7	1.404 ± 0.142
% Extr. Bag-1	54.1 ± 4.3	3	49.8 ± 4.5	5	
% Extr. Bag-2	70.2 ± 1.1	3	65.1 ± 1.7	4	
% Extr. Bag-3	46.1 ± 4.9	4	36.2 ± 1.5	6	
% Extr. Bag-4	35.8 ± 3.4	3	34.9 ± 2.7	6	
Integrated CH_2Cl_2 % Extr.	48.5 ± 4.1	4	45.4 ± 3.6	7	45.8 ± 3.7
Part. Org. Bag-1	1.531 ± 0.212	3	0.735 ± 0.124	3	
Part. Org. Bag-2	1.355 ± 0.192	3	0.758 ± 0.092	3	
Part. Org. Bag-3	0.483 ± 0.027	4	0.325 ± 0.007	4	
Part. Org. Bag-4	0.609 ± 0.055	3	0.518 ± 0.048	3	
Integrated Particulate Organics	0.984 ± 0.092	4	0.588 ± 0.058	7	0.646 ± 0.063
Inert Bag-1	1.295 ± 0.132	5	0.733 ± 0.013	5	
Inert Bag-2	0.593 ± 0.110	4	0.406 ± 0.032	4	
Inert Bag-3	0.574 ± 0.112	4	0.562 ± 0.025	6	
Inert Bag-4	1.099 ± 0.168	6	0.977 ± 0.171	6	
Integrated Inert Material	1.057 ± 0.206	4	0.710 ± 0.094	7	0.760 ± 0.110

[a] Emittant results are expressed in terms of grams/mile except % Extractable, which is expressed in percent.

[b] N = Number of valid runs.

Table C6. FCW161 - Class 6 - Diesel HDTC Individual Bag Particulate Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
Part. Bag-1	2.262 ± 0.112	4	0.858 ± 0.103	7	
Part. Bag-2	0.919 ± 0.184	4	0.525 ± 0.110	7	
Part. Bag-3	0.849 ± 0.185	4	0.602 ± 0.105	8	
Part. Bag-4	0.994 ± 0.049	4	0.767 ± 0.120	8	
Integrated Total Particulate	1.253 ± 0.029	4	0.680 ± 0.072	8	0.762 ± 0.06[illegible]
% Extr. Bag-1	57.6 ± 13.0	4	48.3 ± 9.4	7	
% Extr. Bag-2	68.5 ± 3.6	4	56.0 ± 4.2	7	
% Extr. Bag-3	60.1 ± 9.0	4	46.4 ± 6.1	7	
% Extr. Bag-4	25.9 ± 3.9	3	31.1 ± 5.3	8	
Integrated CH_2Cl_2 % Extr.	54.8 ± 6.7	4	44.5 ± 5.5	8	46.0 ± 5.7
Part. Org. Bag-1	1.128 ± 0.032	3	0.367 ± 0.028	3	
Part. Org. Bag-2	0.55 ± 0.030	3	0.272 ± 0.036	6	
Part. Org. Bag-3	0.527 ± 0.037	4	0.260 ± 0.030	5	
Part. Org. Bag-4	0.260 ± 0.045	3	0.233 ± 0.036	7	
Integrated Particulate Organics	0.687 ± 0.087	4	0.306 ± 0.055	7	0.360 ± 0.059
Inert Bag-1	1.129 ± 0.125	3	0.473 ± 0.036	5	
Inert Bag-2	0.312 ± 0.026	4	0.236 ± 0.027	5	
Inert Bag-3	0.434 ± 0.063	3	0.289 ± 0.043	6	
Inert Bag-4	0.742 ± 0.037	3	0.563 ± 0.021	5	
Integrated Inert Material	0.566 ± 0.085	3	0.374 ± 0.053	7	0.401 ± 0.058

[a] Emittant results are expressed in terms of grams/mile except % Extractable, which is expressed in percent.

[b] N = Number of valid runs.

Table C7. FDB420 - Class 6 - Diesel HDTC Individual Bag Particulate Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
Part. Bag-1	4.796 ± 0.480	3	2.647 ± 0.177	7	
Part. Bag-2	2.996 ± 0.561	4	2.314 ± 0.141	8	
Part. Bag-3	1.729 ± 0.054	3	1.400 ± 0.115	7	
Part. Bag-4	1.900 ± 0.141	3	1.750 ± 0.138	8	
Integrated Total Particulate	3.105 ± 0.423	4	2.070 ± 0.071	8	2.218 ± 0.121
% Extr. Bag-1	81.8 ± 2.6	3	79.3 ± 1.1	6	
% Extr. Bag-2	88.4 ± 1.5	3	86.9 ± 1.4	7	
% Extr. Bag-3	76.3 ± 2.4	3	79.7 ± 1.6	7	
% Extr. Bag-4	73.1 ± 5.5	3	71.3 ± 3.2	6	
Integrated CH_2Cl_2 % Extr.	77.1 ± 5.8	4	79.1 ± 3.0	8	78.8 ± 3.4
Part. Org. Bag-1	3.735 ± 0.030	2	2.061 ± 0.111	5	
Part. Org. Bag-2	2.432 ± 0.307	3	1.994 ± 0.126	7	
Part. Org. Bag-3	1.321 ± 0.058	3	1.085 ± 0.045	5	
Part. Org. Bag-4	1.394 ± 0.198	3	1.252 ± 0.131	6	
Integrated Particulate Organics	2.388 ± 0.339	4	1.588 ± 0.191	8	1.702 ± 0.212
Inert Bag-1	0.789 ± 0.164	2	0.558 ± 0.024	4	
Inert Bag-2	0.317 ± 0.045	3	0.313 ± 0.018	6	
Inert Bag-3	0.409 ± 0.044	3	0.285 ± 0.046	7	
Inert Bag-4	0.506 ± 0.073	3	0.499 ± 0.046	6	
Integrated Inert Material	0.718 ± 0.239	4	0.482 ± 0.142	8	0.516 ± 0.156

[a] Emittant results are expressed in terms of grams/mile except % Extractable, which is expressed in percent.

[b] N = Number of valid runs.

Table C8. CDW786B - Class 6 - Diesel HDTC Individual Bag Particulate Emission Rates

Emittant[a]	Cold Start	N[b]	Hot Start	N[b]	Weighted
Part. Bag-1	6.315 ± 0.395	4	1.787 ± 0.458	4	
Part. Bag-2	2.205 ± 0.280	4	1.510 ± 0.177	4	
Part. Bag-3	1.431 ± 0.365	4	1.251 ± 0.294	4	
Part. Bag-4	2.340 ± 0.748	4	2.245 ± 0.336	4	
Integrated Total Particulate	3.029 ± 0.226	4	1.730 ± 0.192	4	1.916 ± 0.197
% Extr. Bag-1	70.8 ± 4.0	4	51.0 ± 6.7	4	
% Extr. Bag-2	69.0 ± 9.5	4	66.1 ± 10.1	3	
% Extr. Bag-3	36.6 ± 2.1	4	35.5 ± 5.9	3	
% Extr. Bag-4	40.7 ± 6.8	4	34.7 ± 1.7	3	
Integrated CH_2Cl_2 % Extr.	54.3 ± 4.6	4	46.5 ± 7.6	4	47.6 ± 7.2
Part. Org. Bag-1	4.482 ± 0.520	4	0.889 ± 0.127	3	
Part. Org. Bag-2	1.525 ± 0.322	4	1.053 ± 0.152	3	
Part. Org. Bag-3	0.464 ± 0.065	3	0.390 ± 0.016	3	
Part. Org. Bag-4	1.027 ± 0.124	3	0.817 ± 0.124	3	
Integrated Particulate Organics	1.647 ± 0.220	4	0.802 ± 0.134	4	0.923 ± 0.146
Inert Bag-1	1.834 ± 0.167	4	0.994 ± 0.079	3	
Inert Bag-2	0.579 ± 0.097	3	0.543 ± 0.167	3	
Inert Bag-3	0.789 ± 0.029	3	0.724 ± 0.146	3	
Inert Bag-4	1.627 ± 0.517	3	1.550 ± 0.311	3	
Integrated Inert Material	1.382 ± 0.142	4	0.928 ± 0.195	4	0.993 ± 0.187

[a] Emittant results are expressed in terms of grams/mile except % Extractable, which is expressed in percent.

[b] N = Number of valid runs.