

APPENDIX E-1

**REVISED EMISSION REDUCTIONS
CALCULATION METHODOLOGIES**

INTRODUCTION

The SCAQMD received a number of comments on the Draft PEA requesting that the emission reductions be estimated individually for each of the proposed fleet vehicle rules. Additionally, comments were received that recommended that the SCAQMD apply different methodologies than were presented in the Draft PEA for some categories of vehicles. In particular, it was suggested that emission reduction estimates for refuse collection vehicles and street sweepers should be based on estimated fuel use, rather than on vehicle miles traveled (VMT), because much of the fuel consumption (and, thereby, emissions) occurs in activities that produce substantially more emissions compared to an average heavy-duty vehicle, such as in the loading of curbside trash into the refuse truck.

In response to those comments, the SCAQMD estimated the emission reductions from each of the proposed fleet vehicle rules separately and revised some of the methodologies that were used. This appendix summarizes these methodologies.

PROPOSED RULE 1191: CLEAN ON-ROAD LIGHT- AND MEDIUM-DUTY PUBLIC FLEET VEHICLES

The proposed fleet rule is specifically based on achieving emission reductions beyond the ARB Low Emission Vehicle regulation. For light- and medium-duty vehicles, ARB Low Emission Vehicle (LEV I/II) regulations basically require manufacturers to sell vehicles certified to various emission-based categories, with a specific set of NMOG (basically hydrocarbon), carbon monoxide (CO), and oxides of nitrogen (NOx) emission standards assigned to each category. These categories, in descending order of emissions, are Tier 1, transitional low-emission, low-emission (LEV), ultra-low-emission (ULEV), super-ultra-low-emission (SULEV), and zero-emission vehicles (ZEV). The ARB LEV I/II regulations achieve emission reductions by requiring manufacturers to sell progressively cleaner mixes of vehicles over time.

For passenger cars and light-duty trucks, manufacturers sell a specific mix of vehicles certified to the various categories of low-emission vehicles to ensure compliance with a fleet-average NMOG emission level. Emission reductions are achieved over time by the gradual reduction of this fleet average NMOG standard. The fleet-average NMOG emission level for passenger cars, for example, is specified at 0.07 g/mi for the 2001 model year. This level is reduced annually, lowering to 0.035 g/mi for the 2010 model year. In the medium-duty vehicle category, the ARB LEV regulation achieves emission reductions by requiring all vehicles to be certified to more stringent emission categories in specified model years (i.e., LEV in 2002 and ULEV in 2004). Notwithstanding the requirement schedule, medium-duty vehicle manufacturers also have the flexibility, similar to that of light-duty vehicles, to balance the sale of higher emitting vehicle models (e.g., vehicles certified to Tier-1) with vehicles certified to more stringent emission standards (e.g., vehicles certified to ULEV).

Emission reductions of the proposed fleet rule will be the result of affected vehicle fleets purchasing a cleaner mix of vehicles than they would have otherwise purchased. Specifically, fleets are required to purchase vehicles certified to the LEV category or cleaner. Using ARB manufacturer sales projections and staff projections of low-emission vehicles to be purchased by fleets as a result of the proposed fleet rule, corresponding fleet average emission rates by pollutant can be calculated and combined with vehicle population data to estimate overall emission benefits. It should be noted that at some point in the future, which is assumed to be 2004 for emission benefit quantification purposes, the proposed rule would restrict vehicle fleet purchases to ULEV or cleaner. This more stringent requirement is triggered when the percentage of manufacturer sales of ULEV or cleaner vehicles will be 50 percent or greater. The year 2004 was chosen based on ARB manufacturer sales projections.

Emission reductions from implementation of PR 1191 were calculated by first estimating emission reductions from fleet vehicles purchased each year. The total reductions during each year were then estimated by summing the reductions from vehicles purchased during that year and all earlier years. Because exhaust emission standards vary by vehicle category (passenger cars, light-duty trucks 1, light-duty trucks 2, medium-duty vehicles 2, medium-duty vehicles 3, medium-duty vehicles 4, and medium-duty vehicles 5), emission reductions from fleet vehicles purchased each year were estimated by vehicle category, utilizing Equation 1, and then added together to estimate the total reductions from all new fleet vehicle purchases during the year.

$$B_C \frac{\text{tons}}{\text{year}} = \left(E_1 \frac{\text{grams}}{\text{mile}} - E_2 \frac{\text{grams}}{\text{mile}} \right) \times \text{VMT} \frac{\text{miles}}{\text{year}} \times P \times C \frac{\text{tons}}{\text{gram}} \times F \quad (1)$$

Where :

B_C = Emissions benefit per pollutant for vehicle category C.

E_1 = Composite fleet average emission factor for vehicle category C by pollutant based on CARB LEV I/II standards.

E_2 = Composite fleet average emission factor by pollutant for vehicle category C based on PR 1191 projection of fleet vehicle purchases.

VMT = Annual average mile accumulation per year for each vehicle, which is assumed to be 10,000 miles for passenger cars through medium - duty vehicles.

P = Average annual vehicles purchased by fleet operators, which is estimated for each vehicle category by dividing the vehicle population in Table E - 1 - 1 by the estimated average vehicle life of seven years (e.g., number of years vehicle is owned/operated by fleet operator).

C = Conversion factors of 454 grams per pound and 2000 pounds per ton

F = Adjustment factor of 0.6 to account for the consumption of CARB LEV I/II statewide emission credits in the SCAQMD's jurisdiction, generated by vehicle manufacturers through the sale of additional lower emitting vehicles from compliance with the PRs 1191 and 1194. The adjustment factor F is based on an estimated 40 percent of those statewide credits being consumed in the SCAQMD's jurisdiction, using the ratio of vehicle population between the SCAQMD and the entire state.

The composite fleet average emission factors, E_1 and E_2 , were calculated by:

$$E = E_{LEV} f_{LEV} + E_{ULEV} f_{ULEV} + E_{SULEV} f_{SULEV} \quad (2)$$

Where :

E_{LEV} , E_{ULEV} , and E_{SULEV} are the LEV, ULEV and SULEV emission standards listed in Table E - 1 - 2

f_{LEV} , f_{ULEV} , and f_{SULEV} are the fractions of the purchased vehicles in the vehicle categories, listed in Tables E - 1 - 3 through E - 1 - 5, that meet the LEV, ULEV and SULEV emission standards.

Table E-1-6 shows the SCAQMD's estimated air quality benefits for PR 1191 and the project alternatives.

**TABLE E-1-1
PR 1191 Unscaled Fleet Vehicle Population**

Estimated Vehicle Population Profile	
Vehicle Category	Vehicles
Passenger Car	35,019
LDT(1)	5,178
LDT(2)	6,030
MDV(2)	7,126
MDV(3)	7,126
MDV(4)	324
MDV(5)	(negligible)
Total	60,802

**TABLE E-1-2
CARB 50,000 Mile Emission Standards**

EXHAUST MASS EMISSION STANDARDS (grams/mile)							
Vehicle Type	Emission Category	LEV-I (current)			LEV-II⁶ (starting 2004)		
		NMOG	CO	NO_x	NMOG	CO	NO_x
All PC & LDT(1)	LEV	0.075	3.4	0.2	0.075	3.4	0.05
	ULEV	0.040	1.7	0.2	0.04	1.7	0.05
	SULEV ¹	0.010	1.0	0.02	0.01	1.0	0.02
LDT(2) ²	LEV	0.100	4.4	0.4	0.075	3.4	0.05
	ULEV	0.050	2.2	0.4	0.04	1.7	0.05
	SULEV ¹	0.010	1.0	0.02	0.01	1.0	0.02
MDV(2) ²	LEV	0.160	4.4	0.4	0.075	3.4	0.05
	ULEV	0.100	4.4	0.4	0.04	1.7	0.05
	SULEV ¹	0.050	2.2	0.2	0.01	1.0	0.02
MDV(3) ²	LEV	0.195	5.0	0.6	0.075	3.4	0.05
	ULEV	0.117	5.0	0.6	0.04	1.7	0.05
	SULEV ¹	0.059	2.5	0.3	0.01	1.0	0.02

TABLE E-1-2 (Continued)
CARB 50,000 Mile Emission Standards

EXHAUST MASS EMISSION STANDARDS (grams/mile)							
Vehicle Type	Emission Category	LEV-I (current)			LEV-II⁶ (starting 2004)		
		NMOG	CO	NOx	NMOG	CO	NOx
MDV(4) ^{3,5}	LEV	0.230	5.5	0.7	0.163	5.2	0.14
	ULEV	0.138	5.5	0.7	0.104	5.2	0.14
	SULEV	0.069	2.8	0.35	0.069	2.6	0.07
MDV(5) ^{3,5}	LEV	0.300	7.0	1.0	0.163	5.9	0.29
	ULEV	0.180	7.0	1.0	0.104	5.9	0.29
	SULEV	0.09	3.5	0.5	0.085	3.0	0.14

¹ SULEV emission standards for PC, LDT(1), MDV(2), & MDV(3) are for 120,000 miles.

² The LEV-I emission standards for LDV(2), MDV(2), and MDV(2) are assumed to correspond to LEV-II standards for PC and LDT (<8,500 lbs GVW).

³ The LEV-I emission standards for MDV(4) are assumed to correspond to LEV-II standards for MDV (8,500 to 10,000 lbs GVW).

⁴ The LEV-I emission standards for MDV(5) are assumed to correspond to LEV-II standards for MDV (10,000 to 14,000lbs GVW).

⁵ Estimated equivalent 50,000 emission standards based on ratios of 50,000 to 120,000 standards by pollutant for PC & LDT(1) LEV-II emission standards.

⁶ LEV II emission standards are phased in according to the following schedule: 25% in 2004; 50% in 2005; 75% in 2006; and 100% in 2007.

**TABLE E-1-3
PR 1191 Projected PC / LDT(1) Purchase Distribution**

Year	Percentage of PC & LDT(1) Purchases by Emission Categories									
	CARB Sales Distribution Projection				PRs 1191 and 1194 Purchase Requirement		PRs 1191 and 1194 Purchase Distribution Projection			
	LEV	ULEV	SULEV	ZEV ¹	LEV or cleaner	ULEV or cleaner	LEV ²	ULEV	SULEV	ZEV ³
2001	86	14	0	0	100	0	86	14	0	0
2002	80	20	0	0	100	0	80	20	0	0
2003	75	15	0	10	100	0	75	15	0	10
2004	52	33	5	10	0	100	0	78	12	10
2005	46	34	10	10	0	100	0	71	19	10
2006	36	44	10	10	0	100	0	70	20	10
2007	31	45	14	10	0	100	0	67	23	10
2008	28	42	20	10	0	100	0	62	28	10
2009	22	48	20	10	0	100	0	64	26	10
2010	18	47	25	10	0	100	0	60	30	10

¹ Years 2001 and 2002 were adjusted based on CARB's elimination of mandatory ZEV sales requirements.

² For 2004 and subsequent years, the percentage of LEVs from the CARB implementation schedule are prorated between the ULEV and SULEV categories, for compliance with proposed fleet vehicle rules purchase requirements.

³ Assumes that ZEV purchases by fleets is the same as the CARB overall vehicle manufacturer sales percentage.

**TABLE E-1-4
PR 1191 Projected LDT(2) Purchase Distribution**

Year	Percentage of LDT(2) Purchases by Emission Categories							
	CARB Sales Distribution Projection			PRs 1191 and 1194 Purchase Requirement		PRs 1191 and 1194 Fleet Purchase Distribution		
	LEV	ULEV	SULEV	LEV or cleaner	ULEV or cleaner	LEV ¹	ULEV	SULEV
2001	95	5	0	100	0	95	5	0
2002	90	10	0	100	0	90	10	0
2003	85	15	0	100	0	85	15	0
2004	91	19	0	0	100	0	100	0
2005	74	26	0	0	100	0	100	0
2006	54	42	4	0	100	0	91	9
2007	47	48	5	0	100	0	91	9
2008	36	54	10	0	100	0	84	16
2009	28	62	10	0	100	0	86	14
2010	21	64	15	0	100	0	81	19

¹ For 2004 and subsequent years, the percentage of LEVs from the CARB implementation schedule are prorated between the ULEV and SULEV categories, for compliance with proposed fleet vehicle rules purchase requirements.

**TABLE E-1-5
PR 1191 Projected MDV Purchase Distribution**

Year	Percentage of MDV ¹ Purchases by Emission Categories					
	CARB Sales Requirement		PRs 1191 and 1194 Purchase Requirement		PRs 1191 and 1194 Fleet Purchase Distribution	
	LEV	ULEV	LEV or cleaner	ULEV or cleaner	LEV	ULEV
2001	80	20	100	0	80	20
2002	70	30	100	0	70	30
2003	60	40	100	0	60	40
2004	40	60	0	100	0	100
2005	40	60	0	100	0	100
2006	40	60	0	100	0	100
2007	40	60	0	100	0	100
2008	40	60	0	100	0	100
2009	40	60	0	100	0	100
2010	40	60	0	100	0	100

¹ Covers MDV(2), MDV(3), MDV(4), and MDV(5).

**TABLE E-1-6
PR 1191 And Project Alternatives
Vehicle Emission Benefits (tons/yr)**

PR 1191			
Year	HC¹	CO	NO_x
2001	~ ²	~	~
2002	~	~	~
2003	~	~	~
2004	1	47	0
2005	3	92	1
2006	3	131	1
2007	4	167	1
2008	5	200	1
2009	6	228	1
2010	6	252	1
Alternative B			
Year	HC	CO	NO_x
2001	~	~	~
2002	~	~	~
2003	~	~	~
2004	1	47	0
2005	3	92	1
2006	3	131	1
2007	4	167	1
2008	5	200	1
2009	6	228	1
2010	6	252	1
Alternative C			
Year	HC	CO	NO_x
2001	0	0	0
2002	~	~	~
2003	~	~	~
2004	1	47	0
2005	3	92	1
2006	3	131	1
2007	4	167	1
2008	5	200	1
2009	6	228	1
2010	6	252	1

TABLE E-1-6 (Continued)
PR 1191 And Project Alternatives
Vehicle Emission Benefits (tons/yr)

Alternative D			
Year	HC	CO	NO_x
2001	~	~	~
2002	~	~	~
2003	~	~	~
2004	1	43	0
2005	2	83	1
2006	3	118	1
2007	4	151	1
2008	5	181	1
2009	5	206	1
2010	6	228	1
Alternative E			
Year	HC	CO	NO_x
2001	~	~	~
2002	~	~	~
2003	~	~	~
2004	1	47	0
2005	3	92	1
2006	3	131	1
2007	4	167	1
2008	5	200	1
2009	6	228	1
2010	6	252	1
Alternative F			
Year	HC	CO	NO_x
2001	~	~	~
2002	~	~	~
2003	~	~	~
2004	1	47	0
2005	3	92	1
2006	3	131	1
2007	4	167	1
2008	5	200	1
2009	6	228	1
2010	6	252	1

¹ HC = Hydrocarbon

² ~ = Small unquantified emission benefit due to restriction on the purchase of Tier I vehicles and TLEVs by fleets in years 2001 through 2003.

PROPOSED RULE 1192: CLEAN ON-ROAD TRANSIT BUSES

With regard to quantifying surplus emission reductions, the specific rule that affects this quantification procedure to the greatest degree is ARB's Public Transit Bus Fleet Rule and Emission Standards for New Urban Buses (Urban Bus Fleet Rule), adopted February 24, 2000. At the time the emission benefits were first estimated for transit buses for the Draft PEA, there were some uncertainties regarding the specific requirements that would ultimately be adopted by ARB as part of their Urban Bus Fleet Rule, as evidenced by significant changes made to the rule at their public hearing. PR 1192's baseline emission benefit calculation methodology has been revised to reflect the requirements in the adopted version of ARB's Urban Bus Fleet Rule. In addition, AQMD staff has requested and received specific emission factors and other relevant input that was used by ARB staff to quantify the benefits from the ARB Urban Bus Fleet Rule. Based on comments received by potentially affected parties regarding the overall consistency in the emissions quantification methodology, AQMD staff utilized these emission factors and other relevant input as part of PR 1192's emission benefit quantification methodology. These assumptions and corresponding explanations are listed below along with other relevant assumptions that AQMD staff has developed based on AQMD staff's current state of knowledge and feedback received from organizations reviewing AQMD calculation methodologies.

1. Emission benefits accrue beginning 2002, which is based on a June 2000 implementation date plus an 18-months lead time for the ordering and delivery of buses.
2. Based on input from ARB staff, the ARB Urban Bus Fleet Rule emission benefit methodology is based on 100 percent of the fleet choosing the diesel path. The effect of PR 1192, therefore, will be to basically require affected fleet operators to choose the alternative fuel path. Based on the most up-to-date data that AQMD staff has received from fleet operators, it is estimated that there are approximately 3,400 diesel powered urban buses and another 800 powered by natural gas. For consistency with ARB's calculation, as well as to recognize the alternative-fuel buses that are currently in place, PR 1192's emission benefit methodology will be based on the eventual replacement of 3,400 diesel buses with alternative-fuel buses (specifically, natural gas).
3. Only adopted ARB and U.S. EPA emission regulations are considered in PR 1192's emission benefit calculation methodology.
4. Standard assumptions for urban buses are used for annual average vehicle miles traveled per bus and bus life, which are 40,000 miles per year and 12 years, respectively.

5. The following NOx emission rates are used for diesel powered urban buses:

<u>Timeframe</u>	<u>Rate</u>	<u>Explanation</u>
2002 - 9/2002	4.0 g/bhp-hr	Mandatory ARB/U.S. EPA Emission Std.
10/2002 - 2003	2.0 g/bhp-hr	Nominal NOx emission level assumed by ARB as the NOx portion of the mandatory 2.5 g/bhp-hr NMHC+NOx emission standard, specified in Urban Bus Fleet Rule.
2004 - 2006	2.0 g/bhp-hr	Based on mandatory ARB combined NMHC+NOx standard of 2.5 g/bhp-hr for diesel urban bus engines.
2007 - 2010	0.2 g/bhp-hr	Mandatory ARB emission standard in specified in Urban Bus Fleet Rule

6. The following NOx emission rates are used for alternative-fuel powered urban buses:

<u>Timeframe</u>	<u>Rate</u>	<u>Explanation</u>
2002 - 9/2002	2.5 g/bhp-hr	Optional NOx emission standard, consistent with ARB's Urban Bus Fleet Rule documentation.
10/2002 - 2006	1.4 g/bhp-hr	Based on discussions and concurrence with ARB technical staff regarding the appropriate nominal NOx emission level that corresponds with the expected certification level of 1.8 g/bhp-hr NMHC+NOx for alternative-fuel urban buses, as indicated in their Urban Bus Fleet Rule documentation.
2007 - 2010	0.2 g/bhp-hr	Mandatory ARB emission standard in specified in Urban Bus Fleet Rule.

7. For the NOx emission benefit calculation, the standard conversion factor ARB has specified for urban bus applications, 4.3 bhp-hr/mi, was utilized.

8. The following PM emission rates are used for diesel powered urban buses:

<u>Timeframe</u>	<u>Rate</u>	<u>Explanation</u>
2002 - 9/2002	0.44 g/mi	Utilized in ARB Urban Bus Fleet Rule, based on National Renewal Energy Laboratory (NREL) data for chassis-based emission testing of diesel urban transit buses, based on input from ARB technical staff.
10/2002 - 2010	0.09 g/mi	Based on input from ARB technical staff, assuming 80 percent reduction in the applicable engine-based PM emission standard will result in corresponding gram per mile emission reductions.

9. Zero to 100 percent of emission reductions associated with ARB's optional 0.5 g/bhp-hr NOx standard for 2004 through 2006 will occur. Based on input from ARB staff, urban bus engine manufacturers are not required to and are not anticipated to certify engines meeting this emission standard. This situation would force affected urban bus fleets to implement alternative strategies to generate these emission reductions, which are uncertain since affected fleets are already constrained relative to actions they could implement to achieve these emission reductions, such as early bus retirement. Based on input from ARB technical staff, these constraints include, for example, the mandatory 4.8 g/bhp-hr NOx fleet average standard that transit fleets already must meet, as well as certain federal rules that transit fleets must comply with in terms of the time period fleet operators must keep their buses in operation. It should be noted that because of these uncertainties, ARB Governing Board, rather than its staff, will consider for approval the first alternative strategy to be proposed by a transit fleet for compliance with this provision of ARBs Urban Bus Rule.

The PM emission rate for alternative fuel transit buses, as utilized in ARB's Urban Bus Fleet rule is 0.02g/mi, which is based on NREL chassis dynamometer emission testing of natural gas powered urban buses, based on input from ARB staff.

The number of buses weighing 14,000 to 33,000 lbs. GVW operated by fleets potentially affected by PR 1192 has not been included, since many of these fleets have not provided requested data to AQMD staff. However, it appears the number of these vehicles is small, possibly adding only a small percentage to the transit bus fleet population.

Table E-1-7 shows the SCAQMD's estimated air quality benefits for the urban bus portion of the transit bus fleet, using the above assumptions, for PR 1192 and the project alternatives. The year 2010 PM and NOx emission reductions are 11 tons PM per year and zero to 197 tons NOx per year. The lower limit of zero tons per year for the NOx emission reduction is based on a determination by ARB staff that the diesel and alternative-fuel paths provide equivalent NOx emission reductions. The upper limit of 197 tons per year of NOx emission

reduction is based on ARB staff input regarding the anticipated unavailability of urban buses equipped with 0.5 g/bhp-hr NOx certified engines in the 2004 through 2006 time frame, as well as the uncertain nature of alternative emission control strategies as discussed in assumption 9, above to be implemented by transit bus fleets. Overall staff believes that the 197 tons per year provides the best estimate for NOx emission reductions for PR 1192, surplus to ARB's Urban Bus Fleet Rule. PR 1192 will also ensure that there are no unnecessary delays in achieving the emissions reductions attributed to parts of ARB's efforts.

**TABLE E-1-7
PR 1192 And Project Alternatives
Vehicle Emission Benefits (tons/yr)**

PR 1192		
Year	NOx	PM10
2001	0	0
2002	68	4
2003	101	5
2004	133	6
2005	165	7
2006	197	8
2007	197	9
2008	197	9
2009	197	10
2010	197	11
Alternative B		
Year	NOx	PM10
2001	0	0
2002	68	4
2003	101	5
2004	133	6
2005	165	7
2006	197	8
2007	197	9
2008	197	9
2009	197	10
2010	197	11

TABLE E-1-7 (Continued)
PR 1192 And Project Alternatives
Vehicle Emission Benefits (tons/yr)

Alternative C		
Year	NO_x	PM₁₀
2001	0	0
2002	0	0
2003	32	1
2004	64	2
2005	97	3
2006	129	3
2007	129	4
2008	129	5
2009	129	6
2010	129	7
Alternative D		
Year	NO_x	PM₁₀
2001	0	0
2002	68	4
2003	101	5
2004	133	6
2005	165	7
2006	197	8
2007	197	9
2008	197	9
2009	197	10
2010	197	11
Alternative E		
Year	NO_x	PM₁₀
2001	0	0
2002	34	2
2003	50	3
2004	83	3
2005	115	4
2006	147	5
2007	147	6
2008	147	7
2009	147	8
2010	147	9

TABLE E-1-7 (Continued)
PR 1192 And Project Alternatives
Vehicle Emission Benefits (tons/yr)

Alternative F		
Year	NO _x	PM ₁₀
2001	0	0
2002	68	4
2003	101	5
2004	133	6
2005	165	7
2006	197	8
2007	197	9
2008	197	9
2009	197	10
2010	197	11

PROPOSED RULE 1193: CLEAN ON-ROAD RESIDENTIAL AND COMMERCIAL REFUSE COLLECTION VEHICLES

Emission reduction estimates were originally developed for the Draft PEA for the entire suite of fleet rules using an approach based on vehicle-miles-traveled (VMT) data from the latest ARB-approved emissions inventory model, EMFAC7G. Based on this approach and on general assumptions that apply to all heavy-duty vehicles in all of the proposed fleet rules, estimates for the year 2010 would be 11 to 16 tons per year of PM and 75 tons per year of NO_x.

However, one of the largest waste hauler fleet operators noted that, for a typical refuse truck operation, much of the fuel consumption (and, thereby, emissions) occurs in activities that produce substantially more emissions compared to an average heavy-duty vehicle – that is, in the loading of curbside trash into the refuse truck, in frequent or prolonged engine idle, and in frequent low-speed stop-and-go driving conditions. Therefore, the emission reduction estimates presented below have been based on total fuel consumption, covering both travel and collection activities. Emission reductions were specifically determined using input provided by the waste hauling industry, and the Carl Moyer Program methodology for quantifying emission reductions for natural gas heavy-duty vehicle projects, including waste hauling projects. In addition, based on input from ARB staff, this methodology should provide an improved estimate of emission reductions from clean fuel fleet operations. The following formula and assumptions are utilized to estimate the emission reductions for PR 1193:

$$\text{Annual ER} = (\text{Number of vehicles}) * (\text{Annual Fuel consumption, gal}) * (18.5 \text{ bhp-hr/gal}) * (\text{Mandatory std} - \text{Optional std}) / \text{Useful life}$$

Assumptions:

1. Incorporate adopted ARB & U.S. EPA emission standards, to ensure surplus emission reductions only.
2. Rule implementation starts July 1, 2001.
3. Rule affects 6000 refuse trucks (based on industry input).
4. Diesel fuel consumption equals 10,000 gallons per vehicle per year (based on industry input).
5. Useful life equals 12 years (industry input is 10 to 15 years).
6. The following NOx emission rates are used for diesel powered refuse trucks:

<u>Timeframe</u>	<u>Rate</u>	<u>Explanation</u>
2001 - 9/2002	4.0 g/bhp-hr	Mandatory ARB/U.S. EPA Emission Std.
10/2002 - 2010	2.0 g/bhp-hr	Nominal NOx emission level assumed by ARB as the NOx portion of the mandatory 2.5 g/bhp-hr NMHC+NOx emission standard, based on ARB staff input.

7. The following NOx emission rates are used for alternative-fuel powered refuse trucks:

<u>Timeframe</u>	<u>Rate</u>	<u>Explanation</u>
2001 - 9/2002	2.5 g/bhp-hr	Based on ARB staff input and certification standards for natural gas heavy-duty engines.
10/2002 - 2010	1.4 g/bhp-hr	Based on discussions and concurrence with ARB technical staff regarding the appropriate nominal NOx emission level that corresponds with the expected certification level of 1.8 g/bhp-hr NMHC+NOx for alternative-fuel heavy-duty engines in this time frame.

8. PM standard for diesel HDEs is based on 0.1 g/bhp-hr emission standard.
9. For alternative fuels (e.g., natural gas), the PM level is 0.03 g/bhp-hr, based on ARB input and certification data for HDEs. Also, this emission level is consistent with the PM standard for the alternative-fuel path in the recently adopted ARB Urban Bus Fleet Rule.

Table E-1-8 shows the SCAQMD’s estimated air quality benefits for PR 1193 and the project alternatives.

**TABLE E-1-8
PR 1193 And Project Alternatives
Vehicle Emission Benefits (tons/yr)**

PR 1193		
Year	NOx	PM10
2001	76	4
2002	206	11
2003	267	18
2004	329	25
2005	390	32
2006	451	39
2007	512	46
2008	573	53
2009	634	61
2010	695	68
Alternative B		
Year	NOx	PM10
2001	76	4
2002	206	11
2003	267	18
2004	329	25
2005	390	32
2006	451	39
2007	466	39
2008	466	39
2009	466	39
2010	466	39

TABLE E-1-8 (Continued)
PR 1193 And Project Alternatives
Vehicle Emission Benefits (tons/yr)

Alternative C		
Year	NO_x	PM₁₀
2001	0	0
2002	53	3.6
2003	115	10.7
2004	176	17.8
2005	237	25
2006	298	32
2007	359	39
2008	420	46
2009	481	53
2010	542	61
Alternative D		
Year	NO_x	PM₁₀
2001	61	3
2002	165	9
2003	214	14
2004	263	20
2005	312	26
2006	361	31
2007	410	37
2008	458	43
2009	507	48
2010	556	54
Alternative E		
Year	NO_x	PM₁₀
2001	38	2
2002	103	5
2003	149	11
2004	210	18
2005	271	25
2006	332	32
2007	393	39
2008	455	46
2009	516	53
2010	577	61

TABLE E-1-8 (Continued)
PR 1193 And Project Alternatives
Vehicle Emission Benefits (tons/yr)

Alternative F		
Year	NO_x	PM₁₀
2001	76	4
2002	206	11
2003	267	18
2004	329	25
2005	390	32
2006	451	39
2007	512	46
2008	573	53
2009	634	61
2010	695	68

PROPOSED RULE 1194: COMMERCIAL AIRPORT GROUND ACCESS

PR 1194 is anticipated to affect light-duty, medium-duty and heavy-duty fleet vehicles providing commercial airport ground access. The SCAQMD applied the approach for estimating emission reductions from the light- and medium-duty vehicle portions of these fleets using the same approach that was applied for PR 1191. The SCAQMD also used the same projected vehicle sales distributions that were used for PR-1191 (see Tables E-1-3 through E-1-5). The SCAQMD's estimate of the distribution of light- and medium-duty vehicles by vehicle category that will be affected by PR 1194 is listed in Table E-1-9.

TABLE E-1-9
PR 1191 Unscaled Light- and Medium Duty Fleet Vehicle Population

Estimated Vehicle Population Profile	
Vehicle Category	Vehicles
Passenger Car	2,216
LDT(1)	328
LDT(2)	382
MDV(2)	227
MDV(3)	227
MDV(4)	10
MDV(5)	(negligible)
Total	3,390

The SCAQMD estimated emission reductions from heavy-duty vehicles affected by PR 1194 based on VMT using the following equation:

$$\text{Annual ER} = (\text{Number of vehicles}) * (\text{Annual VMT}) * (2.6 \text{ bhp-hr/mi}) \\ * (\text{Mandatory std} - \text{Optional std}) / \text{Useful life}$$

Assumptions:

1. Incorporate adopted ARB & U.S. EPA emission standards, to ensure surplus emission reductions only.
2. Rule implementation starts July 1, 2001.
3. Rule affects 318 heavy-duty vehicles, based on SCAQMD survey.
4. Annual VMT equals 10,000 miles per vehicle per year, based on industry input.
5. Useful life equals 10 years, based on industry input.
6. The following NOx emission rates are used for diesel powered heavy-duty vehicles in commercial airport ground access fleets:

<u>Timeframe</u>	<u>Rate</u>	<u>Explanation</u>
2001 - 9/2002	4.0 g/bhp-hr	Mandatory ARB/U.S. EPA Emission Std.
10/2002 - 2010	2.0 g/bhp-hr	Nominal NOx emission level assumed by ARB as the NOx portion of the mandatory 2.5 g/bhp-hr NMHC+NOx emission standard, based on ARB staff input.

7. The following NOx emission rates are used for alternative-fuel powered heavy-duty vehicles in commercial airport ground access fleets:

<u>Timeframe</u>	<u>Rate</u>	<u>Explanation</u>
2001 - 9/2002	2.5 g/bhp-hr	Based on ARB staff input and certification standards for natural gas heavy-duty engines.
10/2002 - 2010	1.4 g/bhp-hr	Based on discussions and concurrence with ARB technical staff regarding the appropriate nominal NOx emission level that corresponds with the expected certification level of 1.8 g/bhp-hr NMHC+NOx for alternative-fuel heavy-duty engines in this time frame.

8. PM standard for diesel HDVs is based on 0.1 g/bhp-hr emission standard.

For alternative fuels (e.g., natural gas), the PM level is 0.03 g/bhp-hr, based on ARB input and certification data for HDEs. Also, this emission level is consistent with the PM standard for the alternative-fuel path in the recently adopted ARB Urban Bus Fleet Rule.

Table E-1-10 shows the SCAQMD’s estimated air quality benefits for PR 1194 and the project alternatives.

**TABLE E-1-10
PR 1194 And Project Alternatives
Vehicle Emission Benefits (tons/yr)**

PR 1194				
Year	HC¹	CO	NOx	PM10
2001	0	0	1	< 1
2002	0	0	3	< 1
2003	0	0	3	< 1
2004	< 1	3	3	< 1
2005	< 1	6	3	< 1
2006	< 1	8	3	< 1
2007	< 1	10	4	1
2008	< 1	12	4	1
2009	< 1	13	4	1
2010	< 1	14	4	1
Alternative B				
Year	HC	CO	NOx	PM10
2001	0	0	1	< 1
2002	0	0	3	< 1
2003	0	0	3	< 1
2004	< 1	3	3	< 1
2005	< 1	6	3	< 1
2006	< 1	8	3	1
2007	< 1	10	3	1
2008	< 1	12	3	1
2009	< 1	13	3	1
2010	< 1	14	3	1

TABLE E-1-10 (Continued)
PR 1194 And Project Alternatives
Vehicle Emission Benefits (tons/yr)

Alternative C				
Year	HC	CO	NOx	PM10
2001	0	0	0	0
2002	0	0	1	< 1
2003	0	0	1	< 1
2004	< 1	3	2	< 1
2005	< 1	6	2	< 1
2006	< 1	8	2	< 1
2007	< 1	10	2	1
2008	< 1	12	2	1
2009	< 1	13	3	1
2010	< 1	14	3	1
Alternative D				
Year	HC	CO	NOx	PM10
2001	0	0	1	< 1
2002	0	0	2	< 1
2003	0	0	3	< 1
2004	< 1	3	3	< 1
2005	< 1	5	3	< 1
2006	< 1	7	3	< 1
2007	< 1	9	3	1
2008	< 1	11	4	1
2009	< 1	12	4	1
2010	< 1	13	4	1
Alternative E				
Year	HC	CO	NOx	PM10
2001	0	0	1	< 1
2002	0	0	1	< 1
2003	0	0	1	< 1
2004	< 1	3	2	< 1
2005	< 1	6	2	< 1
2006	< 1	8	2	< 1
2007	< 1	10	2	1
2008	< 1	12	2	1
2009	< 1	13	3	1
2010	< 1	14	3	1

TABLE E-1-10 (Continued)
PR 1194 And Project Alternatives
Vehicle Emission Benefits (tons/yr)

Alternative F				
Year	HC	CO	NO _x	PM ₁₀
2001	0	0	1	< 1
2002	0	0	3	< 1
2003	0	0	3	< 1
2004	< 1	3	3	< 1
2005	< 1	6	3	< 1
2006	< 1	8	3	< 1
2007	< 1	10	4	1
2008	< 1	12	4	1
2009	< 1	13	4	1
2010	< 1	14	4	1

¹ HC = Hydrocarbon

PROPOSED RULE 1195: CLEAN ON-ROAD SCHOOL BUSES

The SCAQMD estimated emission reductions from school buses affected by PR 1195 based on VMT using the same equation and assumptions regarding emission factors and fuel efficiency (i.e., 2.6 bhp-hr/mi). Because contract and non-contract school buses have different annual expected VMT and useful life, the SCAQMD calculated the emission reductions from these two operations separately, using the following assumptions:

1. PR 1195 will affect 4428 contract school buses, based on SCAQMD survey.
2. Contract school buses accrue an average annual VMT of 10,000 miles, based on industry input.
3. Contract school buses have an average useful life of 10 years, based on industry input.
4. PR 1195 will affect 4428 non-contract school buses, based on SCAQMD survey.
5. Non-contract school buses accrue an average annual VMT of 12,000 miles, based on industry input.
6. Non-contract school buses have an average useful life of 20 years, based on industry input.

Table E-1-11 shows the SCAQMD's estimated air quality benefits for PR 1195 and the project alternatives.

TABLE E-1-11
PR 1195 And Project Alternatives
Vehicle Emission Benefits (tons/yr)

PR 1195		
Year	NO_x	PM10
2001	28	2
2002	51	3
2003	55	5
2004	58	7
2005	62	8
2006	66	10
2007	69	12
2008	73	14
2009	77	15
2010	80	17
Alternative B		
Year	NO_x	PM10
2001	28	2
2002	51	3
2003	55	5
2004	58	7
2005	62	8
2006	66	10
2007	66	10
2008	66	10
2009	66	10
2010	66	10

TABLE E-1-11 (Continued)
PR 1195 And Project Alternatives
Vehicle Emission Benefits (tons/yr)

Alternative C		
Year	NO_x	PM₁₀
2001	0	0
2002	24	2
2003	27	3
2004	31	5
2005	35	7
2006	38	8
2007	42	10
2008	46	12
2009	49	14
2010	53	15
Alternative D		
Year	NO_x	PM₁₀
2001	23	1
2002	43	3
2003	46	4
2004	49	6
2005	52	7
2006	55	8
2007	58	10
2008	61	11
2009	64	13
2010	68	14
Alternative E		
Year	NO_x	PM₁₀
2001	14	1
2002	26	2
2003	29	3
2004	33	5
2005	37	7
2006	40	8
2007	44	10
2008	48	12
2009	51	14
2010	55	15

TABLE E-1-11 (Continued)
PR 1195 And Project Alternatives
Vehicle Emission Benefits (tons/yr)

Alternative F		
Year	NO _x	PM ₁₀
2001	0	0
2002	0	0
2003	0	0
2004	0	0
2005	0	0
2006	0	0
2007	0	0
2008	0	0
2009	0	0
2010	0	0

PROPOSED RULE 1196: CLEAN ON-ROAD HEAVY-DUTY PUBLIC FLEET VEHICLES

The SCAQMD estimated emission reductions from on-road heavy-duty fleet vehicles affected by PR 1196 based on VMT using the same approach as for PRs 1194 and 1195. The SCAQMD that 6293 heavy-duty vehicles would be affected by PR 1196, with an average annual VMT of 10000 mi and an average useful life of 10 years (**BASIS??**). Table E-1-12 shows the SCAQMD's estimated air quality benefits for PR 1196 and the project alternatives.

TABLE E-1-12
PR 1196 And Project Alternatives
Vehicle Emission Benefits (tons/yr)

PR 1196		
Year	NOx	PM10
2001	27	2
2002	50	3
2003	54	5
2004	57	7
2005	61	8
2006	65	10
2007	68	11
2008	72	13
2009	75	15
2010	79	16
Alternative B		
Year	NOx	PM10
2001	27	2
2002	50	3
2003	54	5
2004	57	7
2005	61	8
2006	65	10
2007	65	10
2008	65	10
2009	65	10
2010	65	10

TABLE E-1-12 (Continued)
PR 1196 And Project Alternatives
Vehicle Emission Benefits (tons/yr)

Alternative C		
Year	NO_x	PM₁₀
2001	0	0
2002	23	2
2003	27	3
2004	30	5
2005	34	7
2006	38	8
2007	41	10
2008	45	11
2009	48	13
2010	52	15
Alternative D		
Year	NO_x	PM₁₀
2001	26	2
2002	48	3
2003	52	5
2004	55	6
2005	59	8
2006	62	9
2007	66	11
2008	69	13
2009	72	14
2010	76	16
Alternative E		
Year	NO_x	PM₁₀
2001	14	1
2002	25	2
2003	29	3
2004	32	5
2005	36	7
2006	39	8
2007	43	10
2008	47	11
2009	50	13
2010	54	15

TABLE E-1-12 (Continued)
PR 1196 And Project Alternatives
Vehicle Emission Benefits (tons/yr)

Alternative F		
Year	NO_x	PM₁₀
2001	27	2
2002	50	3
2003	54	5
2004	57	7
2005	61	8
2006	65	10
2007	68	11
2008	72	13
2009	75	15
2010	79	16

PROPOSED RULE 1186.1: ALTERNATIVE FUEL SWEEPERS

The SCAQMD estimated emission reductions from PR 1186.1 based on fuel use, similarly to the approach used for PR 1193. The assumptions regarding emission factors were the same as used for PR 1193. The SCAQMD estimated that 700 sweepers would be affected by PR 1186.1, that they would consume an average of 7,500 gal/year and that the average useful life is 7 years, based on the SCAQMD survey. Table E-1-13 shows the SCAQMD’s estimated air quality benefits for PR 1186.1 and the project alternatives.

TABLE E-1-13
PR 1186.1 And Project Alternatives
Vehicle Emission Benefits (tons/yr)

PR 1186.1		
Year	NOx	PM10
2001	0	0
2002	0	0
2003	9	1
2004	18	2
2005	28	3
2006	37	4
2007	46	5
2008	55	6
2009	64	7
2010	64	7
Alternative B		
Year	NOx	PM10
2001	0	0
2002	0	0
2003	9	1
2004	18	2
2005	28	3
2006	37	4
2007	39	4
2008	39	4
2009	39	4
2010	30	3

TABLE E-1-13 (Continued)
PR 1186.1 And Project Alternatives
Vehicle Emission Benefits (tons/yr)

Alternative C		
Year	NO_x	PM₁₀
2001	0	0
2002	0	0
2003	0	0
2004	9	1
2005	18	2
2006	28	3
2007	37	4
2008	46	5
2009	55	6
2010	64	7
Alternative D		
Year	NO_x	PM₁₀
2001	0	0
2002	0	0
2003	9	1
2004	18	2
2005	28	3
2006	37	4
2007	46	5
2008	55	6
2009	64	7
2010	64	7
Alternative E		
Year	NO_x	PM₁₀
2001	0	0
2002	0	0
2003	5	1
2004	9	1
2005	18	2
2006	28	3
2007	37	4
2008	46	5
2009	55	6
2010	60	7

**TABLE E-1-13 (Continued)
PR 1186.1 And Project Alternatives
Vehicle Emission Benefits (tons/yr)**

Alternative F		
Year	NO _x	PM10
2001	0	0
2002	0	0
2003	9	1
2004	18	2
2005	28	3
2006	37	4
2007	46	5
2008	55	6
2009	64	7
2010	64	7

TOTAL PROPOSED FLEET VEHICLE RULES EMISSION REDUCTIONS

The total emission reductions by year from all of the proposed fleet vehicle rules combined are shown in Table E-1-14.

**TABLE E-1-14
Proposed Fleet Vehicle Rules And Project Alternatives
Vehicle Emission Benefits (tons/yr)**

Proposed Fleet Vehicle Rules				
Year	HC ¹	CO	NO _x	PM10
2001	0	0	132	7
2002	0	0	378	22
2003	0	0	488	34
2004	1	50	599	47
2005	3	98	709	59
2006	4	139	819	72
2007	5	177	897	84
2008	5	212	975	97
2009	6	241	1,053	109
2010	7	266	1,122	121

TABLE E-1-14 (Continued)
Proposed Fleet Vehicle Rules And Project Alternatives
Vehicle Emission Benefits (tons/yr)

Alternative B				
Year	HC	CO	NOx	PM10
2001	0	0	132	7
2002	0	0	378	22
2003	0	0	488	34
2004	1	50	599	47
2005	3	98	709	59
2006	4	139	819	72
2007	5	177	837	72
2008	5	212	837	73
2009	6	241	837	74
2010	7	266	837	74
Alternative C				
Year	HC	CO	NOx	PM10
2001	0	0	0	0
2002	0	0	101	7
2003	0	0	202	18
2004	1	50	312	31
2005	3	98	423	43
2006	4	139	533	56
2007	5	177	611	68
2008	5	212	689	81
2009	6	241	767	93
2010	7	266	844	106
Alternative D				
Year	HC	CO	NOx	PM10
2001	0	0	112	6
2002	0	0	327	19
2003	0	0	424	30
2004	1	46	521	40
2005	2	89	619	51
2006	3	126	716	62
2007	4	160	781	72
2008	5	192	846	83
2009	5	219	911	94
2010	6	242	966	104

TABLE E-1-14 (Continued)
Proposed Fleet Vehicle Rules And Project Alternatives
Vehicle Emission Benefits (tons/yr)

Alternative E				
Year	HC	CO	NOx	PM10
2001	0	0	66	3
2002	0	0	189	11
2003	0	0	263	21
2004	1	50	369	33
2005	3	98	479	45
2006	4	139	590	57
2007	5	177	668	70
2008	5	212	745	82
2009	6	241	823	95
2010	7	266	896	107
Alternative F				
Year	HC	CO	NOx	PM10
2001	0	0	105	5
2002	0	0	327	18
2003	0	0	434	29
2004	1	50	540	40
2005	3	98	647	51
2006	4	139	754	61
2007	5	177	828	72
2008	5	212	902	83
2009	6	241	976	94
2010	7	266	1,041	104

¹ HC = Hydrocarbon