APPENDIX B

ENGINE AND EMISSIONS INVENTORY

I. CHARACTERIZATION OF THE SCAQMD ENGINE INVENTORY

A. Methodology

ARB staff estimated the total number of affected vehicles and companies in the SCAQMD based on a combination of information, including ARB's Diesel Retrofit Implementation and Evaluation Database (DRIED), supplemental data provided by the SCAQMDM, and surveys of companies. Using a list generated from these data, staff sent a letter to approximately 128 entities identified as being possibly affected by the rulemaking activity. Staff requested that owners send us records as required in title 13, CCR, Section 2021.2 (f), along with additional information on contract and rate status.

The recording keeping requirement in Section 2021.2(f) specifies that fleet owners shall maintain a list by vehicle identification number of collection vehicles identifying each vehicle type; engine manufacturer, model year, family, and series; and status as active fleet or back-up vehicle. Correlated to each vehicle, they must also provide information on any diesel emission control strategy, including its serial number, manufacturer, model level, installation date, and if using a Level 1 or 2 verified diesel emission control strategy, the reason supporting this choice. In addition, for all diesel emission control strategies, owners must maintain records of maintenance, and if employing a fuel or fuel additive as a diesel emission control strategy, they must provide the most recent two years worth of records of purchased that demonstrate usage.

For a vehicle designated as a backup, the mileage as of January 1 of each year must be provided, and if an owner is claiming an exemption for an engine near retirement, the retirement date of the vehicle is required. For any vehicles participating in a demonstration or experimental program, the owner must provide test plan records, including the start and end dates of the experiment; device manufacturer name and contact information (representative, address, and phone number); name and type of experimental diesel particulate matter emission strategy; and targeted data to be generated by the experiment.

Lastly, all owners are required to provide a signed statement of compliance prepared beginning January 1, 2005, and renewed each January 1 thereafter until January 1, 2013, certifying that the owner's engines are in compliance as required, including required language specified in the regulation as well as the owner's name, business address, and business telephone number. All aforementioned information must be provided to the ARB upon request.

The ARB request letter resulted in very few responses, so staff followed up on the mailed letter with telephone calls, e-mails and site visits. A second survey requesting additional information on in-use experiences was conducted in conjunction to on-site visits. Thirty-one fleet reports were returned in time to be incorporated into this staff report. Site visits, telephone surveys, and data from

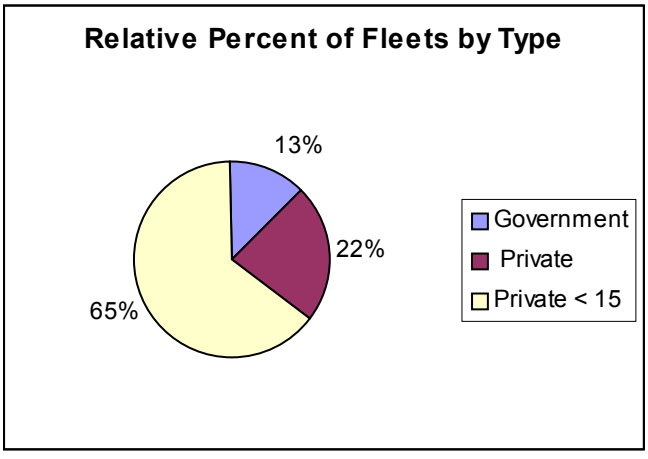
the SCAQMD resulted in 20 additional fleets, for a total of 51 companies. Based on ARB's estimate of the actual number of collection fleets in the SCAQMD, we collected detailed information for about 78 percent of the estimated vehicle total for 2005. However, for some of the summary information, survey results were used in lieu of the fleet return numbers if there was a discrepancy between the fleet information and other information, and/or if the returns appeared to be potentially inaccurate or incorrect. In addition, multiterminal operations having the same owner were only counted as a single entry.

B. Results

Based on all these data, the staff estimates the 2005 population of collection vehicles operating in the SCAQMD covered by this rule to be approximately 5,000. From 2006 though 2009, staff expects that approximately 1,035 new collection vehicle will be purchased. In 2010, all engines, including those engines (or engine plus retrofit combinations) used to comply with BEST requirements must be certified to 0.2 g/bhp-hr NOx and therefore it is not appropriate to include post-2009 engine purchases.

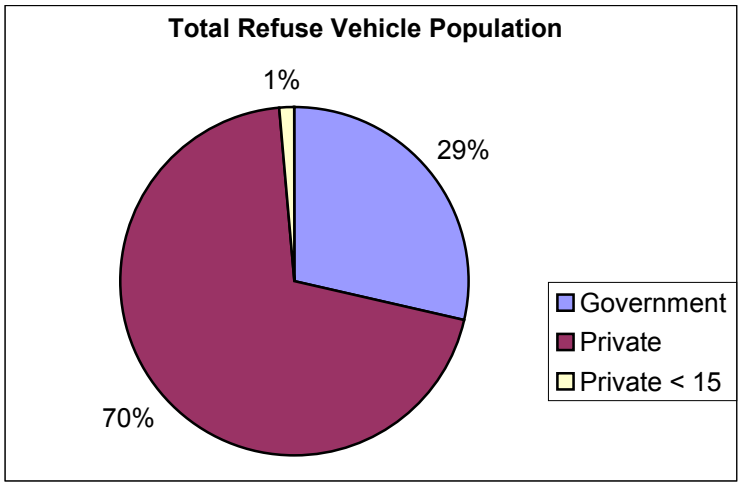
Government, small private (less than 15 vehicles), and large private operators are represented by their relative percent contribution to the total composition of South Coast companies (Figure 1). These estimates are primarily derived from the DRIED database supported by information from the other data sources. DRIED data was used in this case as it represented the most comprehensive listing of companies. Although some companies may no longer exist and/or have been bought out by larger entities, this approach provides the best opportunity to capture the small fleets. We estimate that government entities represent 13 percent of the total fleets estimated as operating in the SCAQMD. Small private (less than 15 vehicles) and large private companies account for 65 and 22 percent of the companies.

Figure 1. Solid Waste Collection Vehicle Owner Distribution



Using the actual fleet information we have from the 51 entities, the number of vehicles housed in small private companies accounts for only about 1 percent of the total. Government held vehicles represent about 29 percent of the total vehicle inventory, with the bulk (70 percent) of the contribution coming from the large private operators (Figure 2). As previously mentioned, it is possible that small private fleets are underrepresented.

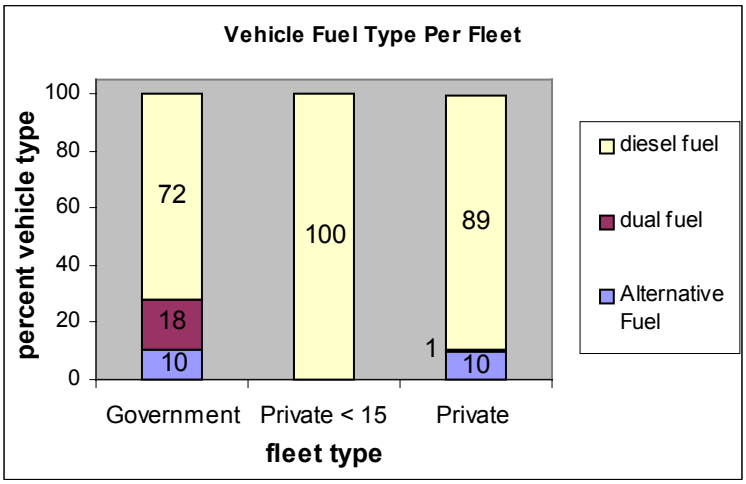
Figure 2. Solid Waste Collection Vehicle Population by Ownership



To estimate the proportion of the operators and vehicles using diesel versus alternative fuels, the ARB used information from all data sources. Because some sources only reported alternative fuel, and not the type of alternative fuel, the data are represented as simply the total number of alternative-fueled vehicles per fleet type. Therefore, alternative-fueled vehicles include LNG and CNG, while dual-fueled vehicles are counted separately.

The percent of government, private and small private operators having alternative-fueled trucks is shown in Figure 3. Alternative-fueled vehicles comprise about 10 percent of the government held vehicles, with another 18 percent of the fleet inventory being dual-fuel vehicles. Large private fleets include about 10 percent alternative-fueled vehicles with only 1 percent coming of their total inventory being dual-fueled vehicles. However, no small private operators, for which we have data, own alternative or dual-fueled vehicles.

Figure 3. Percent of vehicles per fuel type for government, small private and private fleets



When looking at the number of companies, rather than the individual vehicles in those companies, the data indicate that 100 percent of all the companies have diesel vehicles, in other words, there are no fleets that are solely alternative or dual-fueled vehicles.

II. EMISSIONS INVENTORY METHODOLOGY

The EMFAC model used by Air Resources Board (ARB) staff to estimate emissions benefits from the proposed amendments used the same parameters and assumptions as in the supplemental staff report for the original Solid Waste Collection Vehicle rulemaking (ARB 2003). These include emissions factors, the mileage accrual rate, the model year age distribution, and future populations. A review of the emissions model development is included below. For the present analysis, statewide emissions generated by the model were scaled down to reflect the current South Coast Air District population.

A. Review of SWCV Emissions Model Development

At the time the rule was under development, the EMFAC model used by ARB did not specifically address emissions from collection vehicles, and instead included them in the generic category of on-road heavy-duty diesel vehicles. Because the rule dealt only with collection vehicles, a more accurate model had to be developed. Towards that end, ARB staff gathered information on collection vehicle activity and emissions data.

1. Collection Vehicle Activity Data

The following collection vehicle activity data were gathered from different sources and analyzed:

- Accrual rate and cumulative mileage;
- Population and age distribution; and
- Vehicle mile traveled (VMT).

The accrual rate for collection vehicles, estimated to be 15,635 miles per year, is based on the annual mileage data gathered from three solid waste collection companies. Staff assumes that this average annual mileage would apply to collection vehicles of all model years.

A statewide collection vehicle population of 11,778 vehicles in year 2000 was obtained from the Department of Motor Vehicle (DMV) annual vehicle registration database. The age distribution for collection vehicles was also determined from the year 2000 DMV registration data.

Collection vehicle populations for future years were projected using statewide annual solid waste generation data from 1989 to 2000, which were provided by the California Integrated Waste Management Board. The projected future populations were adjusted for fleet attrition using survival rates that reflect the current age distribution of collection vehicles. Another adjustment was made to reflect the SCAQMD Rule 1193, which effectively prevented the purchase of new diesel-powered collection vehicles in the SCAQMD[1].

The collection vehicle daily VMT for a given year was estimated from the collection vehicle population and accrual rate using the following equation:

$$VMT = \Sigma\ (POP_i \times \text{Accrual Rate}_i),\ i = 1 \text{ to } 45$$

The collection vehicle accrual rate, cumulative mileage, and age distribution are shown in Table 1.

[1] The Rule 1193 adjustment for future diesel populations may at first appear to be inappropriate for use in the present analysis. However, the annual vehicle purchase rate that results from all the adjustments is about 5 percent of the total population per year. That purchase rate is reasonable to use, based on communications with California Refuse Removal Council staff.

Table 1. Accrual Rate, Cumulative Mileage, and Population Distribution

Age	Accrual Rate (mi/year)	Cumulative Mileage	Statewide Population*
0	15,635	15,635	306
1	15,635	31,270	586
2	15,635	46,905	361
3	15,635	62,540	287
4	15,635	78,175	728
5	15,635	93,810	707
6	15,635	109,445	592
7	15,635	125,080	632
8	15,635	140,715	355
9	15,635	156,350	977
10	15,635	171,985	686
11	15,635	187,620	987
12	15,635	203,255	503
13	15,635	218,890	455
14	15,635	234,525	460
15	15,635	250,160	431
16	15,635	265,795	522
17	15,635	281,430	186
18	15,635	297,065	344
19	15,635	312,700	290
20	15,635	328,335	297
21	15,635	343,970	420
22	15,635	359,605	212
23	15,635	375,240	147
24	15,635	390,875	80
25	15,635	406,510	56
26	15,635	422,145	42
27	15,635	437,780	36
28	15,635	453,415	32
29	15,635	469,050	15
30	15,635	484,685	12
31	15,635	500,320	12
32	15,635	515,955	5
33	15,635	531,590	4
34	15,635	547,225	3
35	15,635	562,860	1
36	15,635	578,495	3
37	15,635	594,130	3
38	15,635	609,765	3

*Year 2000 population in California.

2. Collection Vehicle Emission Rates

To estimate the emissions inventory for collection vehicles, staff used both the heavy heavy-duty (HHD) truck emission rates and emission rates derived from collection vehicle testing cycle (Table 2). HHD truck emission rates, which were based on test data collected over the Urban Dynamometer Driving Schedule (UDDS), were taken directly from EMFAC2000. In EMFAC2000, all HHD trucks were grouped into different model year (MY) groups based on emission characteristics and emission standards. Vehicles within the same MY group were assumed to have the same emission rates.

Average emission rates for collection vehicles in particular were calculated from test data collected over the New York Garbage Truck Cycle (NYGTC). Test data from six 1992 MY and eight 1994 MY collection vehicles were obtained from the National Renewable Energy Laboratory heavy-duty truck database. Emission rates for other model years were estimated from the rates of 1991 to 1993 and 1994 to 1997 groups using ratios of the emission rates of 1991 to 1993 or 1994 to 1997 HHD truck groups and the rates of other HHD truck groups.

The NYGTC simulates the operation of a collection vehicle on a metropolitan local street; that is, stop-and-go travel at low speed, picking up and emptying trash containers and compacting waste. The NYGTC does not include a collection vehicle's trip from its collection location to its designated dumpsite. Such a trip is typically highway or freeway type of driving and may be similar to the operation of a HHD truck. Operation information from solid waste collection companies shows the typical waste collection trip of a collection vehicle consists of activities on both local streets and driving on highways, although the fractions of the two can vary from location to location.

To reflect this observation, the NYGTC emission rates and EMFAC2000 HHD truck emission rates were combined using fractions of local street versus highway driving. The composite basic emission rate for a given MY group was calculated as follows:

$$BER_X = f\, BER_{NYGTC} + (1-f)\, BER_{HHDD} \quad (3)$$

Where, BER_X is the composite basic emission rate for MY group x; BER_{NYGTC} and BER_{HHDD} are, respectively, the NYGTC and EMFAC2000 HHD truck emission rates for MY group x; and f is the fraction of trip on local streets. Data furnished by three solid waste collection companies showed that about half of a collection vehicle's travel was spent on local street picking up and compacting waste and the other half spent on highway en route to a dumpsite. In particular, an f value of 0.47 was used.

Table 2. NYGTC and EMFAC2000 HHD Truck Emission Rates (g/mi)

Model Year Group	Avg. NYGTC Emission Rates				EMFAC2000 HHD Truck Emission Rates*							
	HC	CO	NOx	PM	HC		CO		NOx		PM	
					ZM	DR	ZM	DR	ZM	DR	ZM	DR
Pre 1975	47.6	104	158	11.66	1.60	0.017	8.36	0.095	28.5	0.013	1.98	0.016
1975-76	43.2	97.0	150	10.89	1.45	0.017	7.81	0.095	27.2	0.013	1.85	0.016
1977-79	43.2	97.0	150	10.89	1.45	0.017	7.81	0.095	27.2	0.013	1.85	0.016
1980-83	43.2	97.0	150	10.89	1.45	0.017	7.81	0.095	27.2	0.013	1.85	0.016
1984-86	22.0	60.5	112	6.947	0.74	0.017	4.87	0.095	20.2	0.013	1.18	0.016
1987-90	10.1	30.8	92.9	4.945	0.34	0.009	2.48	0.065	16.8	0.015	0.84	0.008
1991-93	8.33	21.6	88.4	3.002	0.28	0.009	1.74	0.056	16.0	0.030	0.51	0.009
1994-97	3.21	13.2	92.1	1.050	0.19	0.016	0.84	0.068	19.1	0.042	0.32	0.010
1998	3.05	9.86	111	0.853	0.18	0.014	0.63	0.049	23.0	0.037	0.26	0.007
1999-02	3.05	9.86	64.5	0.853	0.18	0.009	0.63	0.031	13.4	0.013	0.26	0.003
2003-06	2.37	15.8	32.3	0.853	0.14	0.003	1.01	0.023	6.68	0.007	0.26	0.003
2007-09	1.52	10.1	17.8	0.0853	0.09	0.003	0.65	0.023	3.67	0.007	0.026	0.003
2010+	0.663	4.43	3.23	0.0853	0.039	0.003	0.283	0.023	0.668	0.007	0.026	0.003

* ZM = Zero mile emission rate; DR = Deterioration rate per 10,000 miles.

B. Characterization of Baseline Emissions

The baseline of the present analysis incorporates the application of Best Available Control Technology (BACT) to in-use collection vehicles, which was the subject of the original rulemaking. In particular, staff selected the retrofit implementation scenario "Potential 1" to characterize the baseline (Table 3). This scenario is described in detail in the 2003 staff report. Staff selected Potential 1 out of the three scenarios considered in the original rulemaking because it most closely reflects the situation today (i.e., diesel oxidation catalyst technology has been verified for use with 1988 and newer on-road engines).

Table 3. BACT Implementation Scenario - Potential 1

Group	Engine MY	%BACT	Implementation Date	Technology Option (By Percent Phase-In)			
				Level 1	Level 2	Level 3	Repower
1	1994-2002	10%	12/31/2004	2%		8%	
		25%	12/31/2005	7%		8%	
		50%	12/31/2006	17%		8%	
		100%	12/31/2007	40%		5%	5%
		25%	12/31/2005	15%			
		50%	12/31/2006	25%			
		100%	12/31/2007	45%			5%
1	1988-1990	10%	12/31/2004	10%			
		25%	12/31/2005	15%			
		50%	12/31/2006	25%			
		100%	12/31/2007	45%			5%
2	1960-1987	25%	12/31/2007	2.5%			22.5%
		50%	12/31/2008	2.5%			22.5%
		75%	12/31/2009	2.5%			22.5%
		100%	12/31/2010	2.5%			22.5%
3	2003-2006	50%	12/31/2009	21.5%		28.5%	
		100%	12/31/2010	21.5%		28.5%	
Percent of California's Collection Vehicle Fleet Total:				66%	0%	21%	14%

C. Characterization of the BEST Purchasing Scenario

The proposed amendments to the SWCV rule would affect new vehicle purchasing in the South Coast Air District. If adopted, staff's proposal would require owners of collection vehicles to purchase vehicles that meet Best Engine Selection/Technology (BEST) requirements. There would be no prescribed way to meet BEST requirements. Two potential routes for compliance would be purchasing alternative-fueled vehicles and retrofitting new diesel vehicles with verified diesel emission control systems.

The present analysis deals primarily with future engines that will rely on new technology to meet stringent future emissions standards. Because these engines are not available today, there are no chassis test data available on which to base emissions factors. Therefore, staff used the emission factors as derived in the original analysis for diesel collection vehicles that were consistent with BEST requirements.

Although BEST purchase requirements span 2005 and subsequent years, the scenario used by staff covered only 2006-2009. If adopted in July 2005, the

proposed rule would not affect a significant amount of 2005 MY purchasing, so that year was excluded. From 2010 onward, the proposed BEST requirements align with 2010 on-road heavy-duty engine standards and so no significant benefits would be gained from new purchases in that timeframe. Emissions benefits from cleaner collection vehicles would therefore come from 2006-2009 purchases.

For each year in the 2006-2009 window, staff modeled the new vehicle purchase rate at about 5 percent of the total population. Both the baseline and BEST purchasing scenarios used the same purchase rate. Staff from the California Refuse Removal Council indicated that 5 to 10 percent was reflective of typical purchasing rates, but that the actual future purchasing rate may be difficult to predict in light of the proposed purchase requirements.

C. Emissions Specific to the South Coast Air District

To estimate emissions specific to the South Coast Air District, staff multiplied the model's statewide results by a factor of 0.39. Data from the ARB survey of fleets in the South Coast combined with additional data from the SCAQMD's survey in 2004 show that there are approximately 5,000 collection vehicles in the South Coast Air District. This is about 39 percent of the estimated 2005 statewide population of 12,975 vehicles.

III. COLLECTION VEHICLE EMISSIONS INVENTORY

Using the above data and assumptions, staff calculated a baseline collection vehicle emissions inventory for calendar years 2000, 2005, 2010, and 2020 (Table 4). It includes implementation of BACT according to the Potential 1 scenario described above. The inventory takes into account the U.S. EPA 2007 heavy-duty diesel engine and 2006 low sulfur diesel fuel regulations. The emissions shown correspond to 39 percent of the total statewide emissions from collection vehicles.

Table 4. SCAQMD Collection Vehicle Emissions Inventory (tons/day)

Pollutant	2000	2005	2010	2020
NOx	11.6	10.5	7.3	3.5
PM	0.48	0.35	0.11	0.05

III. REFERENCES

ARB. 2003. Staff Report: Initial Statement of Reasons, Supplemental Report, Proposed Diesel Particulate Matter Control Measure for On-Road Heavy-Duty Residential and Commercial Solid Waste Collection Vehicles. August 8, 2003.