

SHORT HAUL HEAVY DUTY VEHICLES — EXAMINATION OF FLEET ACTIVITY AND EMISSIONS IN THE EL PASO REGION

Project performed by

Center for International Intelligent Transportation Research

Project Number: 186068-00005

Project Title: Short Haul Heavy Duty Vehicle Activity Estimation

August 2009

Report prepared by

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DISCLAIMER AND ACKNOWLEDGMENTS

This research was performed by the Center for International Intelligent Transportation Research, a part of the Texas Transportation Institute. The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein.

This report was authored by Les Olson, David Bierling, Mohamadreza Farzaneh, Joe Zietsman, and Tara Ramani. The authors wish to thank Dennis Perkinson and Todd Carlson for their expertise and assistance in the performance of project activities.

EXECUTIVE SUMMARY

The high engine horsepower and large loads pulled by heavy duty truck engines make them significant contributors to pollutant emissions and fuel consumption. Since engine emissions are highly dependent on the type of fuel used, alternative fuels could reduce their emissions.

This study examined short haul heavy duty vehicles, which do not leave the metropolitan areas that they operate in. Examples include transit buses, school buses, refuse trucks, and dump trucks. These vehicles cover the same general area of operation on a daily basis, allowing them to be fueled at centralized locations. Centralized fueling stations can reduce the capital and outlay for infrastructure, making use of alternative fuels cost-effective.

The aim of this study is to identify short haul heavy duty fleets in the El Paso, Texas, region that could benefit from alternative fuels and to gather information about them. Researchers performed a literature review, developed a database of short haul heavy duty fleets, conducted interviews, and analyzed these vehicles' impact on emissions (mobile source emissions for the entire El Paso County and business-specific emissions for the interviewed companies and organizations).

Though this investigation examined only a small portion of the short haul heavy duty fleets, researchers can estimate that short haul fleet vehicles (less cross-border drayage movements) account for approximately 16 percent of the estimated oxides of nitrogen emissions attributable to the entire heavy duty fleet, 18 percent of the carbon monoxide emissions, and 14 percent of the total hydrocarbons emissions.

Research findings indicate that the heavy duty diesel fleets in general, and the short haul fleets in particular, contribute a significant amount of emissions in the El Paso region. Thus, developing strategies to operate short haul fleets on alternative fuels can be an important step toward improving the region's air quality. The findings from this research can form the basis for developing deployment plans for alternative-fueled heavy duty fleets in the El Paso area.

INTRODUCTION

BACKGROUND

The high engine horsepower and large loads pulled by heavy duty truck engines make them significant contributors to pollutant emissions and fuel consumption. Since engine emissions are highly dependent on the type of fuel used, alternative fuels are being proposed as a potential means of reducing harmful tailpipe emissions from heavy duty truck engines¹.

Short haul heavy duty vehicles are defined as heavy duty vehicles that do not leave the metropolitan areas that they operate in. Examples of such vehicles include transit buses, school buses, refuse trucks, and dump trucks. These vehicles cover the same general area of operation on a daily basis, allowing them to be fueled at centralized locations in the metropolitan area. This makes it possible to operate these vehicles on alternative fuels since conducting the fueling at a single centralized location can reduce the capital and outlay required for the necessary infrastructure.

However, there have been concerns raised about the viability of using alternative fuels for heavy duty trucks, especially because of the additional load from extra fuel tanks, which can lower vehicle performance². Again, in the case of short haul fleets, the availability of a central fueling location would eliminate the need for extra fuel tanks and the other problems associated with it.

The El Paso, Texas, region can benefit from such an arrangement. El Paso County is in nonattainment of national air quality standards for particulate matter and is classified as being in maintenance (previously in nonattainment) for carbon monoxide. Thus the use of alternative fuels can help reduce emissions and improve air quality in the region. The region has several fleets that could be categorized as short haul heavy duty vehicles, and the aim of this study is to identify these fleets and gather relevant information about them.

OBJECTIVES AND RESEARCH APPROACH

The main tasks for this research were to:

- determine the major short haul heavy duty fleets operating in the El Paso area,
- obtain information on the fleet composition, and
- develop conclusions related to the fleet profiles and drive cycles of short haul heavy duty fleets operating in the El Paso area and estimate the emissions impact of these fleets.

The findings from this research can form the basis for developing deployment plans for alternative-fueled heavy duty fleets in the El Paso area. A database of basic fleet information was compiled to describe vehicle ownership, makes and models, and drive cycles. This information was used to develop an estimated emissions inventory for the local heavy duty vehicle fleets.

The following sections of this report include a literature review, discussion of methodology for fleet identification, and the analysis of emissions due to the short haul heavy duty fleet. The final section is a discussion of results and conclusions.

DEVELOPING A DATABASE FOR EL PASO'S SHORT HAUL HEAVY DUTY FLEET

Developing a database of the short haul heavy duty fleet can help determine the potential for emissions reduction in El Paso by implementing the use of natural gas as an alternative fuel for local heavy duty delivery vehicles. In order to economically convert diesel- or gasoline-fueled truck engines to use natural gas, the vehicle operator must have a minimum fleet size that uses enough fuel to support the basic ancillary equipment needed to maintain the vehicles. The researchers' previous experience indicated that truck engine kits for conversion from gasoline/diesel to natural gas fuel sources required a minimum fleet size of eight vehicles to economically justify investment. This fleet size allowed for repayment of the conversion equipment (through savings in fuel costs) within a four-year period. Based on this information, a fleet size of at least eight vehicles was selected as the criterion for inclusion in the database.

The vehicle registration database for El Paso County did not provide any information regarding vehicle service. However, Texas Transportation Institute (TTI) road surveys have indicated that approximately 16 percent of the actual heavy duty trucks operating on the roads during the survey count were registered in the county where the survey is conducted³. Also, large corporate businesses such as package/parcel delivery and beverage/food distributors that have local freight delivery operations may have a substantial portion of their local fleet vehicles that are not registered in the county. Thus vehicle registration data were not considered as a reliable source for fleet identification, and surveys and interviews were instead conducted to inventory the fleet.

IDENTIFICATION OF SHORT HAUL HEAVY DUTY FLEETS

Internet searches and local contacts were used to identify specific fleet operators. A survey questionnaire was prepared for those fleet operators willing to assist the research team. The survey was designed to obtain data about fleet characteristics and operations; the sample questionnaire is included in Appendix A.

A final list of potential fleets was developed that included the following:

1. Distributors
 - a. Grocers
 - b. Bottling companies
2. Freight delivery
3. Local government
 - a. Environmental
 - i. Garbage haulers
 - ii. Parks
 - b. Streets
 - i. Maintenance
 - ii. Construction
 - c. Engineering

- d. Sun Metro Transit
- e. School districts with buses

Grocery distributors were assumed to be long haul fleets, and furniture delivery and oil field service vehicles were assumed to have too small a fleet size. Multiple attempts were made to contact the selected companies and organizations to establish their principal business (over the road long haul or local pick-up and delivery) and fleet size. Table 1 includes all the companies and government agencies contacted that operate local fleets that meet the criterion of interest to this investigation (a local fleet with more than eight diesel trucks). Interviews were scheduled with agencies willing to discuss further data requests and were organized by TTI's El Paso office. Meetings were arranged for two independent school districts (ISDs), two local delivery trucking companies, the City of El Paso General Services Department and Environmental Department, and Sun Metro Transit. A selection of five of these interviews are synopsized and included in Appendix B. The agencies included in Table 1 represent only a small proportion of the entire list of companies initially identified and contacted, many of which did not have sufficient fleet size or could not be contacted for other reasons. Information was also collected from a few other agencies, including an additional ISD, where extensive interviews could not be conducted. This information, while not shown in Table 1, is used for further calculations in the next section.

VEHICLE CLASSIFICATION

This report uses specific terminology to describe the different vehicle types. Since the vehicle fleets were being identified and classified with a view to estimating emissions, the vehicle types were referred to using the classifications from the Environmental Protection Agency's (EPA's) MOBILE6 emissions model. Heavy duty diesel vehicles are referred to as "HDDV," followed by a number signifying the subclass. For example, most large heavy duty diesel tractors are classified as HDDV8b, while some are categorized as HDDV8a. The categories of smaller heavy-duty diesel trucks in this study range from HDDV2 to HDDV7 vehicles. The categorization of a vehicle depends upon the truck's Gross Vehicle Weight Rating (GWVR). Additionally, the HDDBT and HDDBS classifications refer to heavy duty diesel transit buses and heavy duty diesel school buses, respectively.

Table 1. Local Fleet Size and Interview Status.

Company	Local Fleet	Interview Scheduled
Southwestern Motor Transport	15	
Southeastern Freight Lines	30 HDDV8a	
Fly International	12	
FedEx	68	
Stagecoach Cartage and Distributors	45 HDDV8a 5 Bobtail	Yes
Land Air Express, Inc.	15	
Yellow Transportation, Inc.	17	
Con-Way Freight-Southern	8+	
Central Freight Lines, Inc.	Unknown	Yes
West Texas Express	15 HDDV8a	
R & L Carriers, Inc.	15 HDDV8a	
Averitt Express, Inc.	8	
BKT	15	
City of El Paso General Services	677	Yes
City of El Paso Environmental Department	159	Yes
Sun Metro Transit	9	Yes
Socorro Independent School District	10	Yes
Canutillo Independent School District	36	Yes
Desert Eagle Distributing	-	Yes
Frito-Lay	44	Yes

ANALYSIS OF SHORT HAUL HEAVY DUTY VEHICLE EMISSIONS

Two estimates of emissions were performed for this investigation: mobile source emissions for the entire El Paso County, and business-specific emissions for the interviewed companies and organizations. Both estimations included the emissions of carbon monoxide (CO), oxides of nitrogen (NO_x), and total hydrocarbons (THC).

EMISSIONS ESTIMATION FOR INTERVIEWED BUSINESSES

From the interviews with businesses and organizations with diesel-powered vehicles, data used in the emissions estimation process were collected. These included the number of diesel-powered vehicles, vehicle class, total vehicle miles traveled (VMT) by vehicle class, and proportion of operational miles on highways and arterials for the fleet. In addition to these data sources, the research team used the results of two past TTI studies for the special cases of refuse trucks⁴ and drayage trucks (cross-border short haul freight trucks)⁵ — additional short haul fleets operating in the El Paso area. The analysis of emissions data included a number of assumptions, depending on the availability of fleet data, which varied for different fleet owners. The principal amount of data was supplied by the two school districts, the City of El Paso General Services Department, and Sun Metro Transit. Annual vehicle miles traveled were estimated on a generalization based on similar industry practices in other venues. Actual diesel vehicle classes were used for correct emission profiles when known, while conservative estimates were used in all cases when data were not clear. The emissions estimation process consisted of the following two steps for each organization/company:

1. The total vehicle-class-specific VMT was distributed according to highway/arterial proportions obtained in the interviews. If the proportions were not provided, the default VMT proportions of TTI's emission inventories for El Paso were used³. For the case of refuse trucks, the VMT proportions from TTI's refuse truck study were used.
2. The VMT mix data from step 1 above were combined with corresponding emissions factors from TTI's emissions inventories. The selection of the appropriate emissions factors were based on road type and average speed for each vehicle class.

The results of the emissions calculations for the interviewed businesses are shown in Table 2. The combined annual emissions estimated for all the surveyed agencies (and including the drayage and refuse truck fleets) are approximately 680 tons of NO_x, 125 tons of CO, and 20 tons of THC.

Table 2. Estimated Annual Emissions for Short Haul Fleets of Interviewed Businesses.

Company/Organization/Service	No. Diesel Vehicles	Vehicle Class	Annual Diesel VMT	NOx (Ton)	CO (Ton)	THC (Ton)
FedEx	130*	HDDV2b	4,461,600	15.1	4.8	0.9
HDDV2b Summary:			4,461,600	15.1	4.8	0.9
City of El Paso — Ambulances	34	HDDV3	1,700,000	8.2	1.7	0.4
Frito-Lay	12	HDDV3	214,286	1.0	0.2	0.1
HDDV3 Summary:			1,914,286	9.2	1.9	0.5
Frito-Lay	32	HDDV4	571,429	3.5	0.8	0.2
HDDV4 Summary:			571,429	3.5	0.8	0.2
Sun Metro Transit	9	HDDBT	344,000	17.0	3.6	0.5
HDDBT Summary:			344,000	17.0	3.6	0.5
Canutillo ISD	36	HDDBS	300,000	3.7	0.7	0.2
Ysleta ISD	20	HDDBS	186,120	2.3	0.4	0.1
Socorro ISD	10	HDDBS	110,000	1.4	0.2	0.1
HDDBS Summary:			596,120	7.4	1.4	0.4
Drayage Trucks	744,951**	HDDV8b	22,348,530	471.6	81.3	12.6
HDDV8b Summary:			22,348,530	471.6	81.3	12.6
City of El Paso — Refuse Trucks	122	HDDV8a	1,590,000	57.7	11.1	1.3
City of El Paso — Dump Trucks	37	HDDV8a	350,000	7.9	1.4	0.2
Southwestern Motor Transport	15	HDDV8a	344,250	6.4	1.4	0.2
Fly Intermodal (Intermodal Only)	12	HDDV8a	336,600	6.2	1.3	0.2
Stagecoach Cartage and Distributing	40	HDDV8a	1,382,400	25.7	5.8	0.9
Stagecoach Cartage and Distributing	5	HDDV8a	96,000	1.8	0.4	0.1
Land Air Express, Inc.	15	HDDV8a	624,000	11.6	2.7	0.4
Yellow Transportation, Inc.	17	HDDV8a	520,200	9.7	1.2	0.3
West Texas Express	15	HDDV8a	306,000	5.7	1.2	0.2
R & L Carriers, Inc.	15	HDDV8a	468,750	8.7	1.9	0.3
Averitt Express, Inc.	8	HDDV8a	204,000	3.8	0.8	0.1
BKT	15	HDDV8a	420,750	7.8	1.7	0.2
HDDV8a Summary:			6,642,950	152.9	31.1	4.5
Grand Total:			36,878,914	676.6	124.8	19.5

* This number is the total for both FedEx locations in El Paso. The number shown in Table 1 is only for the interviewed location; hence, the numbers do not match.

** This is the number of annual vehicle crossings to the United States obtained from border crossing information.

EMISSIONS ESTIMATION FOR ENTIRE EL PASO COUNTY

To compile the emissions estimations, emissions inventories for El Paso County by TTI were used to obtain data on VMT and emissions rates by road type and vehicle class.³ Two major tasks were performed to refine the initial estimation from TTI's emission inventory for El Paso. The first task consisted of identifying the alternative-fueled vehicles (mainly natural gas or petroleum gas) and adjusting the estimated emissions for their impact. The second task involved identifying and eliminating the long haul operation of class 8b heavy duty diesel trucks and updating the emissions inventory estimates.

During the interviews with companies and organizations, it was found that some of them are using alternative-fueled vehicles. Sun Metro, El Paso's main transit operator employs only nine diesel-powered buses (out of 146 vehicles). The El Paso Independent School District has an entirely liquefied petroleum gas (LPG)-powered fleet. The total VMT data of El Paso's emissions inventory were updated, and emissions were recalculated to include the impact of these non-diesel heavy duty vehicles.

Class 8b heavy duty vehicles make a substantial portion of VMT and emissions for El Paso County. Class 8b vehicles are mainly used in two major tasks: long haul operations (inter-city and inter-state freight movement) and drayage operations (short haul cross-border operations). Since the focus of this investigation is the short haul operations, it is crucial to only include the drayage part and eliminate the long haul operations from the emissions inventory. For this purpose, the VMT for drayage traffic was estimated based on the results of TTI's drayage truck study⁵. The emissions inventory was updated based on this drayage-only VMT data. The results of the emissions estimation are summarized in Table 3.

Table 3. Estimated Annual Emissions for All Short Haul Fleets in El Paso.

Vehicle Type	NOx Emissions		CO Emissions		THC Emissions	
	Total (Ton)	Total (%)	Total (Ton)	Total (%)	Total (Ton)	Total (%)
HDDV2b	171.4	13.25	39.95	16.11	7.75	15.91
HDDV3	45.29	3.5	9.09	3.67	2.08	4.27
HDDV4	32.52	2.51	6.51	2.62	1.53	3.14
HDDV5	24.16	1.87	5.35	2.16	1.26	2.59
HDDV6	148.15	11.45	25.35	10.23	7.01	14.39
HDDV7	93.31	7.21	16.8	6.78	4.53	9.3
HDDV8a	229.51	17.74	48.86	19.71	8.1	16.63
HDDV8b	471.59	36.46	81.27	32.79	12.62	25.92
HDDBT	17.04	1.32	3.6	1.45	0.48	0.99
HDDBS	60.64	4.69	11.11	4.48	3.34	6.85
Total	1293.6	100	247.88	100	48.68	100

CONCLUSIONS AND RECOMMENDATIONS

The short haul heavy duty diesel fleet information captured during this investigation appears to be a very small portion of the possible fleet data when examined against the estimated entire short haul diesel VMT for El Paso. The entire VMT is estimated to be more than 130 million miles annually, and the estimated VMT of the short haul vehicles obtained in this investigation is approximately 15.5 million miles annually, excluding cross-border drayage movements.

Short haul fleet vehicles (less cross-border drayage movements) account for approximately 16 percent of the estimated NO_x emissions attributable to the entire heavy duty fleet, 18 percent of the CO emissions, and only 14 percent of the THC emissions.

Because there is only a small representation of the private company heavy duty diesel fleet in this investigation, a more robust estimate could be developed given a greater participation from the private company fleets in the El Paso area. Given more time to work with private companies to develop more accurate data on additional fleet vehicles, researchers could substantially improve the estimate.

However, the research findings do indicate that the heavy duty diesel fleets in general, and the short haul fleets in particular, contribute a significant amount of emissions in the El Paso region. Thus, developing strategies to operate short haul fleets on alternative fuels can be an important step toward improving the region's air quality.

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APPENDIX A

Interview Survey Questionnaire

Questions about heavy duty fleet vehicle operations:

1. How many diesel vehicles are in the local delivery fleet? How many gasoline vehicles are in the local delivery fleet?
2. Who owns these vehicles?
 - a. Company
 - b. Owner/operators
 - c. Leased
3. What are the major engine makes/models/horsepower in the local fleet (and around how many of each are there)?
4. What is the approximate percent of the local fleet's diesel engines that are new within the last four years? Within the last six years?
5. How much diesel fuel is typically consumed by the local fleet per year? How much gasoline is typically consumed by the local fleet per year?
6. How many hours per day on average do the local fleet vehicles operate?
7. How many days per week on average do the local fleet vehicles operate?
8. Approximately what percent of the local fleet is operating on a given day (on average)?
9. What is the typical daily mileage of each local fleet vehicle? Or, what is the average annual mileage per vehicle?
10. Do vehicles in the local fleet have specific routes they are assigned to on a long term (e.g., annual) basis, or are vehicle routes rotated to balance mileage, wear and tear, etc.?
11. Are the local routes of travel approximately equivalent with regard to city streets and highways, or is one much greater than the other (if so, which, and by how much)?
12. Is your local fleet maintenance performed "in house" or external to your organization?

APPENDIX B

Results of Interviews during the Week of July 7, 2008

Interview Summary: Socorro Independent School District (SISD), July 8, 2008

SISD currently owns and operates 195 vehicles in the bus fleet; 92 have diesel-fueled engines, and the remaining 103 have gasoline-fueled engines.

The bus operations are restricted to the school district boundaries and specified routes except for extracurricular activities, when they go to other districts, El Paso activities, etc.

Normal daily operations begin at approximately 5:15 a.m., with limited traffic in designated special needs buses. The early departure amounts to four or five buses. The majority (95 percent) of the operating buses (85 percent of the fleet) operates between the hours of 6:30 a.m. and 8:30 a.m., and then begins again at 2:30 p.m. and operates until approximately 5:00 p.m. Approximately 25 percent of the returning buses will again depart between 10:30 a.m. and 12:00 noon for extracurricular activities. SISD provided a spreadsheet that indicates 27 midday buses, which may be either diesel or gasoline fueled.

During heavy weekend operations, SISD estimates, every fourth weekend 60-70 buses are used in support of extracurricular activities. Each bus used is sent out for a single round trip during the activity day; there are no multiple trips per bus. During normal weekend operations, 20-30 buses are used, with one round trip for each bus. Other points to note from the interview:

- During vacation operations, 10-15 buses, assume only one departure/return.
- Between June 1, 2007, and June 1, 2008, the fleet consumed:
 - #2 diesel — 150,789 gallons. Average fuel consumption for the diesel fleet is approximately 6 mpg.
 - Gasoline — 246,279 gallons. Average fuel consumption for the gasoline fleet is approximately 4.5 mpg.
- The fuel amounts are consumed by the following engine distribution in the fleet:
 - Diesel bus fleet: all engines are turbocharged equipped
 - 8 Cummins (Model ISC 260)
 - 10 International (T444 Engines)
 - 74 Caterpillar (8.1 liter)
 - D-C7 (7.2-liter 2004 turbo engines)
 - Gasoline engines: all are General Motors (GM) engines
 - 7.4 liter and 6.0 liter, Exact numbers unknown
- With the exception of heavy diesel maintenance (engine rebuilds, etc.) the school district performs all maintenance.

Interview Summary: Canutillo Independent School District (CISD), July 9, 2008

CISD currently has only two or three buses that are diesel powered. The balance is gasoline powered. CISD previously used propane buses but stopped because of offsite fueling

requirements. The district is going to replace the diesel buses with propane buses through a Railroad Commission grant that covers three-fourths of the vehicle costs.

The district currently owns (as do the nine other school districts in El Paso County) 42 buses that service the communities of West Way, Canutillo, Helen of Troy, and Upper Valley. The board generally authorizes the purchase of four new buses per year, but it has not purchased buses in some recent years. The current CISD student population is 6,000, and the total CISD population is 27,000. CISD projects 12,000 CISD students in the next three to five years and a need for around 80 buses.

Average bus travel is 50 miles per day, serving five elementary schools, two middle schools, and one high school (sequenced runs). There are other programs during the day, such as Evenstar, special education, and pre-kindergarten, that use bus services. Previously bus traffic was approximately 125 miles per day before operations revisions were made; this year fuel consumption dropped 50 percent from the previous year.

Current bus operations include a 15-minute warm-up prior to trip routes. During the school week, morning trip routes (bus departure from the facility) start at 7 a.m. and are concluded by 8:30 a.m. Five to seven vehicles are held in reserve. Midday trip routes use approximately 15 percent of the bus fleet. Afternoon bus routes start at 2 p.m., and by 4:30 p.m. 60 percent of the bus fleet has concluded its runs. The balance runs until approximately 6:30 p.m. supporting afterschool activities such as Big Brother/Big Sister, tutoring, and sports.

Weekend bus activities include Friday night sports events. On Saturday approximately 15 percent of the fleet supports Upward Bound. Sunday activities use one or two buses. Downtime operations include Summer I and II vacation, during which 12 buses run. In-service days are once monthly, during which half-day bus schedules are run.

Interview Summary: Frito-Lay, July 9, 2008

Frito-Lay's fleet consists of route trucks (24-foot box) and road (tractor-trailer) trucks. There are 12 route trucks, all equipped with Ford 7.3-liter 365S diesel engines. There are 44 road trucks plus two spares, of which 12 are equipped with Ford 5.4-liter gasoline engines, four of these older than 2002 and the rest newer than 2002. The balance of the fleet is diesel powered. This includes 6.5-liter GM engines, a few 5.7-liter GM engines, some Cummins engines (4BTA model), and a 350-cc engine of unknown make. When replacing fleet vehicles, Frito-Lay's current policy is to purchase gasoline trucks instead of diesel trucks because they meet emission standards. This year they are purchasing four new trucks, but last year they purchased none. New vehicles generally go to Las Cruces because their maintenance capabilities are not as extensive there.

Operations of route trucks start around 3 or 4 a.m. daily, seven days per week. Truck operations are one 10-hour shift per day, during which the trucks are running approximately three hours per day. Shifts conclude between 4 and 7 p.m., and most trucks have returned by 4 p.m. The trucks run 60 miles on average over the entire fleet, or approximately 22,000 miles per year. They do not operate across the U.S.-Mexico border. They have a route engineering service

provider/program to optimize vehicle operations and routes. Ninety-five percent of their truck operations are in El Paso County, and 85 percent are within the El Paso metro area. Frito-Lay has a program to reward innovative employee ideas, called the Idea Network, as well as programs that reward workers for good performance (e.g., safety).

Interview Summary: City of El Paso, July 10, 2008

The City of El Paso's heavy duty fleet is owned by the city and consists of 438 vehicles that are 1 ton or greater. This includes fire trucks, ambulances, pump trucks, ladder trucks, pothole fillers, dump trucks, refuse trucks, utility trucks, etc. The water utility's fleet is not under city jurisdiction but under the Public Services Board, and that fleet consists of around 200 vehicles, mostly automobiles.

The majority of the heavy duty fleet vehicles (approximately 70 percent) has Cummins diesel IMB, ISM, or ISL engines with 200-400 horsepower. The balance is a mix of Caterpillar, International, Ford, and GM engines (the fire services fleet has Detroit Diesel engines). It is estimated that around 10 vehicles meet 2007 emission standards. Replacement of fleet vehicles is not as much scheduled as it is driven by budget availability.

The total annual amount of fuel consumed by the local fleet in 2007 was around 1.5 million gallons of diesel and 1.5 million gallons of unleaded gasoline. The fire services department accounted for 320,000 gallons, 80 percent of which was diesel. The environmental (refuse) department accounted for 1 million gallons, 70 percent of which was diesel.

Typically, the general fleet (excluding fire and environmental) operates eight hours per day and five days per week. Approximately 90 percent of the fleet operates on a given day. The environmental fleet operates 10 hours per day and four days per week. Fire department vehicles operate 24 hours a day and seven days a week but are not running for much of that time.

The city's fire services have 34 ambulances, all of which are diesel, that average around 50,000 miles per year per vehicle. Dump trucks average 25,000-30,000 miles per year per vehicle. Refuse trucks average around 24,000 miles per year per vehicle. The total fleet mileage is around 30 million miles per year. The overall average of medium heavy duty vehicle mileage is around 15,000 miles per year, including ambulances and refuse trucks. Some low mileage vehicles, such as pothole fillers, average 5,000-6,000 miles per year.

Refuse vehicles have specific weekly routes, which — along with fire and ambulance vehicles — travel within specific regions for the most part. The only vehicles that spend a lot of time (75 percent of mileage) on highways are refuse and dump trucks. Other vehicles spend most of their time (75 percent of mileage) on city streets, including main arterials. Vehicle mileage determines usage and location redistribution to balance mileage on an annual basis.

Eighty percent of the city's maintenance is performed in house, and the balance is contracted for body work, glass work, and major overhaul (not regular maintenance). They do share some common contracts with Sun Metro and do transfer employees between the city's fleet maintenance division and Sun Metro's fleet maintenance division, but they maintain separate operations and facilities because it is logistically difficult to maintain shared operations.

Interview Summary: Sun Metro, July 10, 2008

Sun Metro's bus fleet consists of 146 buses, of which nine are diesel, 51 are natural gas-converted Detroit Diesel Series 50 spark ignition engines, 60 are natural gas-converted 8.3-liter Cummins ISG engines, 20 are natural gas-converted 8.9-liter Cummins ISL engines, and nine are Cummins L10 engines from 1993. Sun Metro has had good success with the 8.9-liter Cummins engines with good low end, slow speed torque, and beginning in November 2008 the fleet will order 40 more buses with this power to replace buses equipped with the L10 and Detroit Diesel engines.

Fuel consumption in 2007 was 3,560,000 gallons of standard liquefied natural gas (LNG), with an estimated boil-off of 10 percent and a target boil-off of 6-7 percent. Total vehicle mileage was 12,050,000 miles, which includes paratransit non-fixed route vehicles (25 gasoline-powered E450 vehicles and 40 natural gas-powered E450 vehicles); 7,600,000 of the miles are associated with the fixed-route bus fleet. Vehicles are rotated on a periodic basis to equalize mileage. Seventy-five percent of the roadways traveled by the bus fleet are main arteries but not interstate highways.

During weekly operations, the first bus route begins at 4:45 a.m., and the last bus finishes at 10:50 p.m. There are three peak operating times: around 7:30 a.m., there are around 105 buses in operation; at 1:45 p.m., there are around 112 buses in operation; and at 4:00 p.m., there are around 105 buses in operation. The bus fleet operates at around 90 percent of weekly levels on Saturdays and at around 60 percent of weekly levels on Sundays.