LPG Forklift 2006 Emissions Inventory for the CAPCOG Program Area

FINAL REPORT, Task 3.4c, Phase II Rider 8 Work Plan

Prepared by: the Capital Area Council of Governments

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Introduction

Liquefied Petroleum Gas (LPG) forklifts are estimated to be a significant source of nitrogen oxides (NO_X) emissions in Central Texas. Based on default 2006 emissions estimates from the Texas NONROAD (TexN) model, LPG forklifts make up 8% of NO_X emissions from non-road categories in the region and 79% of all NO_X emissions from LPG NONROAD categories. The Texas Commission on Environmental Quality (TCEQ) commissioned a study conducted by Eastern Research Group, Inc. (ERG) in 2005 to improve the estimates of emissions from LPG forklifts and other commercial and industrial non-road equipment in the Dallas-Fort Worth (DFW) and Houston-Galveston-Brazoria (HGB) eight-hour ozone nonattainment areas (Eastern Research Group, Inc., August 2005). ERG's study found significant differences in both activity and equipment populations for LPG forklifts in these areas, resulting in a 31% increase in NO_X emissions from this source category in the DFW area and a 114% increase in the HGB area. The Capital Area Council of Governments (CAPCOG) used the ERG study in conjunction with national forklift shipment data available on the Industrial Truck Association (ITA) website (World Industrial Trucks Statistics, 2012) and employment data on various North American Industrial Classification System (NAICS) codes from the U.S. Census Bureau's County Business Patterns (CBP) website to refine the emissions estimates from this category in CAPCOG's program area.

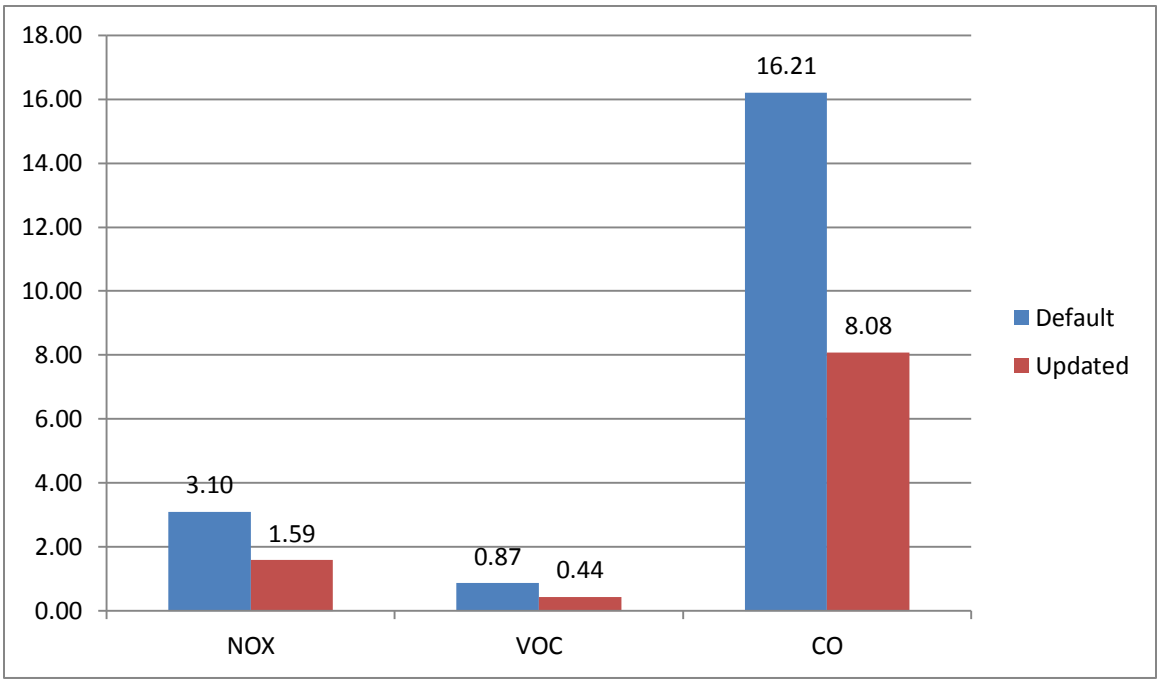
CAPCOG developed an inventory of typical ozone season weekday emissions of NO_X, volatile organic compounds (VOC), and carbon monoxide (CO) for 2006. CAPCOG chose 2006 as the year for this inventory because the June 2006 ozone episode is used by CAPCOG for photochemical modeling. CAPCOG updated the inventory for CAPCOG's entire Rider 8 program area, which consists of Bastrop, Blanco, Burnet, Caldwell, Fayette, Hays, Lee, Llano, Milam, Travis, and Williamson Counties. The table below summarizes CAPCOG's updated to the LPG forklift inventory.

Table 1: Updated Ozone Season Day Emissions from LPG Forklifts in 2006 (tons per day)

County	NO_X	VOC	CO
Bastrop County	0.0184	0.0051	0.0932
Blanco County	0.0110	0.0031	0.0559
Burnet County	0.0171	0.0047	0.0867
Caldwell County	0.0201	0.0056	0.1021
Fayette County	0.0167	0.0046	0.0846
Hays County	0.1353	0.0376	0.6861
Lee County	0.0207	0.0057	0.1049
Llano County	0.0031	0.0009	0.0157
Milam County	0.0057	0.0016	0.0290
Travis County	1.1224	0.3117	5.6915
Williamson County	0.2236	0.0621	1.1337
TOTAL	1.5942	0.4427	8.0835

CAPCOG's inventory has significantly lower estimates of NO_X, VOC, and CO than the existing estimates, as can be seen in the chart below.

Figure 1: Updated v. Default Ozone Season Day Emissions from LPG forklifts - 2006 (tons per day)



In preparing this inventory, CAPCOG made the following updates to the TexN model:

- Updated annual activity (hours/year) from 1,800 to 1,270 based on the ERG study,
- Updated median life from 4,800 to 3,600 based on the ERG study,
- Updated the weekday/weekend allocation of activity from 83% weekday allocation to 95% weekday allocation based on the ERG study, and
- Updated equipment populations using an equipment ratio for employees in the transportation and warehousing sector (NAICS Code 48-49) developed by CAPCOG using national shipment data available on ITA's website and national employment data available on the CBP website.

Activity and Median Life

CAPCOG updated the annual hours of use, median life, and weekday/weekend allocation of LPG forklift equipment directly based on the numbers ERG used for the DFW and HGB areas. These parameters were:

- 1,270 hours per year of use,
- 3,600 hours median life at full load, and
- 95% use on weekdays.

ERG's estimates for hours per year and weekday/weekend allocations were calculated using surveys of 30 establishments in the HGB and DFW areas that owned and operated 129 LPG forklifts. ERG collected data on the establishments' Standard Industrial Classification (SIC) codes, the number of propane-powered class IV and V forklifts, forklift size, method of fuel acquisition, hours of use during weekdays, and hours of use on the weekend.

ERG's survey did show some differences in the annual usage depending on the establishment type, as the table below shows.

Table 2: Hours Per Year of Use by SIC Code from ERG Survey

SIC Group	SIC Code	Hours/Year	% Responses	Sample
Manufacturing	20-39	2,025	25.0%	8.9%
Transportation/Utilities	40	977	35.7%	31.6%
Wholesale/Retail	50	1,238	35.7%	48.1%
Services	70	345	3.6%	11.3%

ERG calculated an adjusted annual usage rate if the industry-specific responses were weighted within the sample frame they used. This produced a somewhat lower usage rate of 1,120 hours per year. However, ERG reported that it learned from ITA that over 1,000 individual SIC codes reported receiving at least one forklift during 2004, and the top 10 SIC groupings for the State of Texas, from which ERG pulled its survey sample, made up only 40% of the shipments in Texas in 2004. Given these challenges to characterizing the activity based on these surveys, and the small difference in usage that this change would produce (12%), ERG decided not to use the weighted average.

In order to evaluate whether or not the average developed from the sample ERG used would be representative of use in the Austin area, CAPCOG used the usage rates presented in the table above and weighted them by the number of establishments in NAICS codes corresponding to the SIC codes used in ERG's study: codes 31-33 (manufacturing), 42 (Wholesale Trade), 48 (Transportation and Warehousing), and 532490 (Other Commercial and Industrial Machinery and Equipment Rental and Leasing). The table below shows the number of establishments in each NAICS code within CAPCOG's program area and the percentage of the subtotal of the four NAICS codes.

Table 3: Number of Establishments in Selected NAICS Codes in CAPCOG Program Area in 2006

NAICS Code	Description	# Establishments	% of Subtotal
31-33	Manufacturing	1,360	34%
42	Wholesale Trade	1,930	48%
48	Transportation and Warehousing	704	17%
532490	Other Commercial and Industrial Machinery and Equipment Rental and Leasing	44	1%

When the annual activity is weighted using the percentages presented in the table above, it produces an annual use of 1,369 hours per year, 8% higher than ERG's estimate. Given that this is less than the variation ERG found when it weighted the responses by SIC code and given the other challenges to knowing whether the data from these SIC codes would be representative of usage in other SIC codes, CAPCOG decided not to use the weighted average and instead just use ERG's 1,270 hours per year estimate. Similarly, CAPCOG directly used ERG's estimate of 95% use on weekdays based on the reported weekday/weekday use in the surveys.

ERG also updated the average median life for forklifts from 4,800 hours to 3,600 hours at full load. This was based on expert input indicating that typically forklifts last at least ten years and all of them would

be scrapped after 20 years. Using the 1,270 hours/year estimate, the TexN default load factor of 30% for LPG forklifts, and NONROAD's default scrappage function, ERG concluded that a median life of 3,600 better matched the information it collected from experts.

In the absence of any data or information that would suggest that forklifts in Central Texas are operated substantially differently than forklifts operated in the HGB and DFW areas, CAPCOG believes that ERG's activity estimates are appropriate for Central Texas.

CAPCOG had initially planned to use a survey of LPG operators in the region, and had made some contacts with facilities to see if they would participate, but received very low interest – only 2 establishments returned surveys. This was one of the reasons CAPCOG decided to instead use ERG's survey data.

Equipment Population

CAPCOG updated equipment populations for each county in the region by calculating a new national equipment population using shipment data from ITA and CBP data on employment in the Transportation and Warehousing Sector (NAICS Code 48-49) in 2006. The table below shows the updated equipment populations, which use a ratio of 0.14274 LPG forklifts per employee in NAICS codes 48-49.

Table 4: LPG Forklift Population by County, 2006

County	Employees in NAICS 48-49	Updated Population	Default Population
Bastrop	134	19	40
Blanco	80	11	4
Burnet	124	18	33
Caldwell	146	21	14
Fayette	121	17	38
Hays	981	140	113
Lee	150	21	16
Llano	23	3	4
Milam	42	6	71
Travis	8,138	1,162	1,629
Williamson	1,621	231	288
TOTAL	11,560	1,649	2,250

CAPCOG developed this ratio based on data on national shipments of Class IV and V forklifts from 1988 - 2010 provided on ITA's website, ERG's equipment usage and median life estimates, and national employment in NAICS Code 48-49 from 1998 – 2010.

CAPCOG decided to use the transportation and warehousing sector's employment as the surrogate for LPG equipment populations after analyzing existing datasets for the significance of the relationship between various industries and determining that the transportation and warehousing sector appears to

be the most robust surrogate. CAPCOG analyzed the suitability of a variety of surrogates for estimating equipment populations and found that employment in the NAICS Code 48-49 was the most robust surrogate available. Specifically, CAPCOG conducted an initial analysis of the ownership rates for the respondents to ERG's survey, a comparison of national forklift shipment data with national employment data, and statistical analysis of the county-specific forklift shipments in the HGB and DFW area used in ERG's 2005 study.

The NONROAD default basis for the equipment populations is to allocate national equipment populations to each county based on the number of employees in NAICS codes 31-33 (manufacturing) and 5111 (newspaper, periodical, book, and directory publishers) (U.S. EPA, December 2005). ERG's 2005 study found that equipment populations were quite different than NONROAD defaults. ERG's equipment populations were 49% higher for the DFW area and 144% higher in the HGB area. These data suggested that the NONROAD default allocation methodology needed refinement for this category. One of the challenges of using any industrial classification code as a surrogate for forklift equipment is the wide variety of establishment types that own forklifts; ITA indicated to ERG that over 1,000 individual SIC codes received shipments of at least one forklift in 2004. As part of its 2005 study, ERG obtained a listing of the top ten SIC codes receiving shipments in Texas of class IV and class V lift trucks (which make up the source classification code 22XX003020 and are distinct from rough terrain forklifts). The table below shows the SIC code listing. SIC codes that are in the top ten for both Class IV and Class V are indicated with an asterisk.

Table 5: Top Ten SIC Codes Receiving Shipments of Internal Combustion Forklifts in Texas, 2004

Class IV	Class V
General Warehousing (4225)*	Lumber & Other Building Materials (5211)*
General Production (3999)*	Equipment Rental & Leasing, NEC (7359)*
Lumber and Other Building Materials (5211)*	Industrial Machinery and Equipment (5084)
Corrugated & Solid Fiber Boxes (2653)	General Warehousing (4225)*
Trucking Services, except Local (4213)	Wood Pallets Skids (2448)
Transportation Services, NEC (4789)	General Production (3999)*
Arrangement of Transportation of Freight & Cargo (4731)	Miscellaneous General Merchandise Stores (5399)
Plastics Products, NEC (3089)	Scrap and Waste Materials (5093)
Fabricated Metal Products, NEC (3499)	Lumber, Plywood, and Millwork (5031)
Equipment Rental & Leasing, NEC (7359)*	Construction Materials (5039)

This list indicates that manufacturing establishments (SIC codes 20-39) were the most prevalent type of SIC code in this list, followed by transportation (40), wholesale trade (42), retail trade (52), and equipment rental & leasing, NEC (7359).

Table 6: Prevalence of SIC Groups in List of Ten Receivers of LPG Forklift Shipments

SIC Group	SIC Description	Class IV	Class V	Total
20-39	Manufacturing	4	2	6
40	Transportation	4	1	5
50-51	Wholesale Trade	0	4	4
52	Retail Trade	1	2	3
7359	Equipment Rental & Leasing, NEC	1	1	2
TOTAL	N/A	10	10	20

This list is useful primarily as a screening tool, since CAPCOG does not have the actual number of shipments to any of these SIC codes, and in any case, they only accounted for 40% of all shipments in Texas.

Since 1998, CBP started reporting employment classified by NAICS code rather than SIC code, so CAPCOG identified the NAICS codes most closely matching the SIC code groupings listed in the table above. CAPCOG identified four potential surrogates to analyze:

- Manufacturing (NAICS Code 31-33),
- Wholesale Trade (NAICS Code 42),
- Building Material and Supplies Dealers (NAICS Code 4441), and
- Transportation and Warehousing (NAICS Code 48-49).

CAPCOG chose not to include equipment rental and leasing or general merchandising in this analysis. SIC code 5211, which is a retail sector – was among the top three receivers of forklift shipments for both classes of forklifts, whereas general merchandising only appeared on one of the lists. Furthermore, the precise employment numbers for the corresponding NAICS Codes (452910 and 452990) are not disclosed for most of the counties in the region, including Travis County, due to the U.S. Census Bureau's rules for disclosing data due to market concentration or the number of establishments reporting. The equipment rental and leasing was not considered because these establishments do not actually operate or use the equipment, and since there are so few of these establishments, the employment estimates for this business type are often not disclosed.

CAPCOG analyzed three sets of data to determine which sector's employment data was the best predictor of equipment populations: ERG's survey data, national forklift shipment data, and the forklift shipment data ERG used for its 2005 project. The rest of this section describes and presents these analyses.

ERG Survey Results

While ERG's survey did not provide enough information directly to produce estimates for the number of forklifts per establishment or per employee, it did provide some breakdown of the survey responses by SIC group. CAPCOG calculated the equipment ratio – the number of forklifts per survey respondent – in each of the SIC codes for which ERG received a response.

Table 7: LPG Forklifts per ERG Survey Respondent by SIC Code

SIC Code	SIC Description	# Surveyed	# Forklifts	Ratio
2448	Wood Pallets and Skids	3	11	3.7
2653	Corrugated & Solid Fiber Boxes	3	19	6.3
3499	Fabricated Metal Products, NEC	1	2	2.0
4213	Trucking Services, Except Local	2	20	10.0
4225	General Warehousing	4	26	6.5
4731	Arrangement of Transportation of Freight and Cargo	3	21	7.0
5031	Lumber, Plywood, and Millwork	2	14	7.0
5039	Construction Materials	1	1	1.0
5084	Industrial Machinery and Equipment	2	2	1.0
5093	Scrap and Waste Materials	3	6	2.0
5211	Lumber and Other Building Materials	2	3	1.5
7359	Equipment Rental & Leasing, NEC	1	4	4.0

ERG's survey data suggest a much higher ownership rate in the transportation and warehousing sector (7.4 forklifts per establishment) than manufacturing (4.6 forklifts per establishment), wholesale trade (2.9 forklifts per establishment), and building and material suppliers (1.5 per establishment). Due to the limited number of responses in this survey, it would not necessarily be appropriate to directly use these equipment ratios to calculate equipment populations in CAPCOG's program area. However, it does suggest that transportation and warehousing may be a better surrogate for equipment populations than manufacturing or the other two sectors considered.

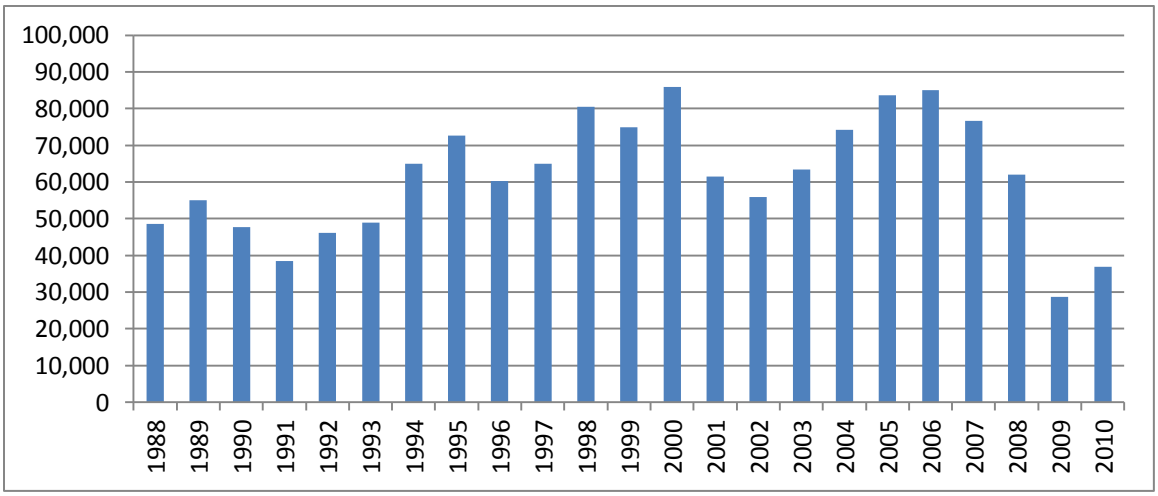
Analysis of Nationwide Forklift Shipments

ITA provides data on nationwide shipments of industrial trucks (Industrial Truck Association, 2012) from 1988 – 2012 on its website. ITA describes this data as follows:

> *Based on actual information supplied by ITA members, the U.S. Shipments Table & Graph reveals shipments in the United States for electric rider trucks (Class 1 and Class 2 combined), motorized hand trucks (Class 3) and internal combustion powered trucks (Class 4 and 5 combined) since 1983. Although annual numbers are not comparable considering member fluctuation, these figures provide an accurate description of market activity each year.*

The following chart shows the shipments by year.

Figure 2: U.S. Shipments of Internal Combustion Forklifts 1988 – 2010



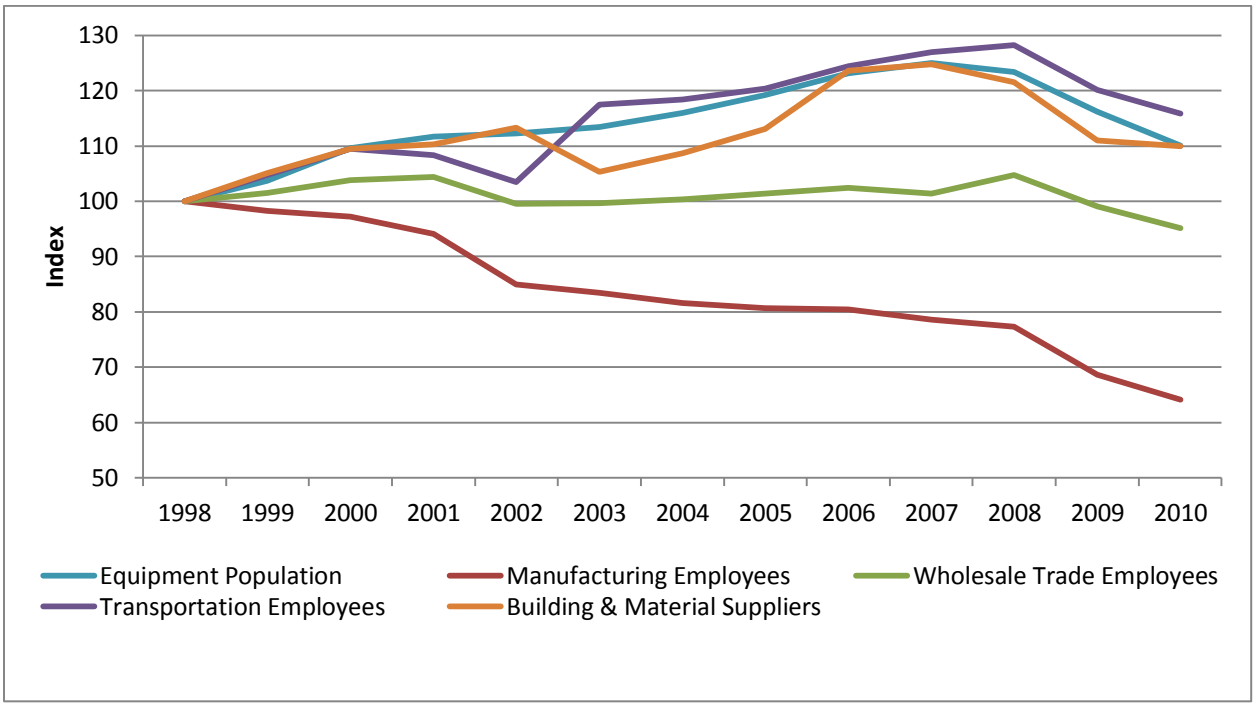
CAPCOG believes that these data are the best available representation of the nationwide market activity for this sector. The other types of data available for LPG forklifts tend to rely on Universal Commercial Code filings, which are only used when financing the acquisition of a piece of equipment, and may not provide as robust of a picture of the equipment population as these ITA data suggest. Moreover, due to the variety of settings in which LPG forklifts may be used – everything ranging from warehouses and factories to hardware stores and hotels – it would be very difficult to obtain a robust equipment population using a local survey. Since ITA represents over 90% of manufacturers of forklifts, which in turn are responsible for well over 90% of the actual forklift shipments in the U.S., CAPCOG believes that it is reasonable to rely on these shipment data as the basis for an equipment population. CAPCOG had made some initial inquiries to the ITA about obtaining shipment data for the Austin area, but the cost of obtaining the data (approximately $18,000) made this option cost-prohibitive.

CAPCOG used the national shipment data in conjunction with ERG's scrappage assumptions to estimate the in-use nation-wide population. CAPCOG calculated the in-use equipment population for all years from 1998 through 2010. While data were available directly from the shipments for 2006 through 2010, and it would have required data back to 1979 to directly calculate the equipment population as far back as 1998, the oldest nine years of forklifts in the fleet for 2006 through 2010 only made up 7.8% to 11.0% of all of the forklifts in use. CAPCOG assumed that the average portion of the fleet in those years for which data were not available was similar to those for which data were available. For instance, using the shipment data from 1988 – 1998 and ERG's scrappage assumptions, CAPCOG estimated that there were 538,272 LPG forklifts in-use in 1988 that had been shipped between 1988 and 1998. CAPCOG used the average of the "remaining fraction" for the last nine years of shipments still in the fleet from 2006 – 2010 to estimate that another 56,039 being used in 1998, for a total of 642,534 internal combustion forklifts. The accompanying spreadsheet includes the calculations used for these assumptions.

CAPCOG compared the equipment population to national employment data in the key sectors of interest to discern the relationships. The chart below shows the year-by-year change in the number of shipments of forklifts, the estimated in-use equipment population, and number of employees in manufacturing, wholesale trade, transportation and warehousing, and building material suppliers, using

1998 as a base year (employment and equipment population in 1998 equals 100). The number of shipments in any given year does not look like it can be accurately predicted by any one of these variables, but the in-use equipment population very closely tracks the employment in the transportation and warehousing sector (NAICS Code 48-49) and the Building Materials Suppliers sector (NAICS Code 4441).

Figure 3: National Equipment and Shipments Versus Employment Compared to 1998 Base



These data seem to indicate that the equipment population was much more strongly correlated to employment in the transportation and warehousing sectors and the building and material suppliers sector than it was to employment in manufacturing or wholesale trade. While manufacturing employment in 2006 was 20% less than it was in 1998, the estimated LPG equipment population was 23% higher and employment in wholesale trade remained almost unchanged.

CAPCOG calculated the equipment ratio per employee for all four sectors for every year from 1998 to 2010. The table below shows the average of these ratios, the standard deviation (SD), and SD's percent of the average.

Table 8: Equipment Ratios (Number of Internal Combustion Forklifts Per Employee)

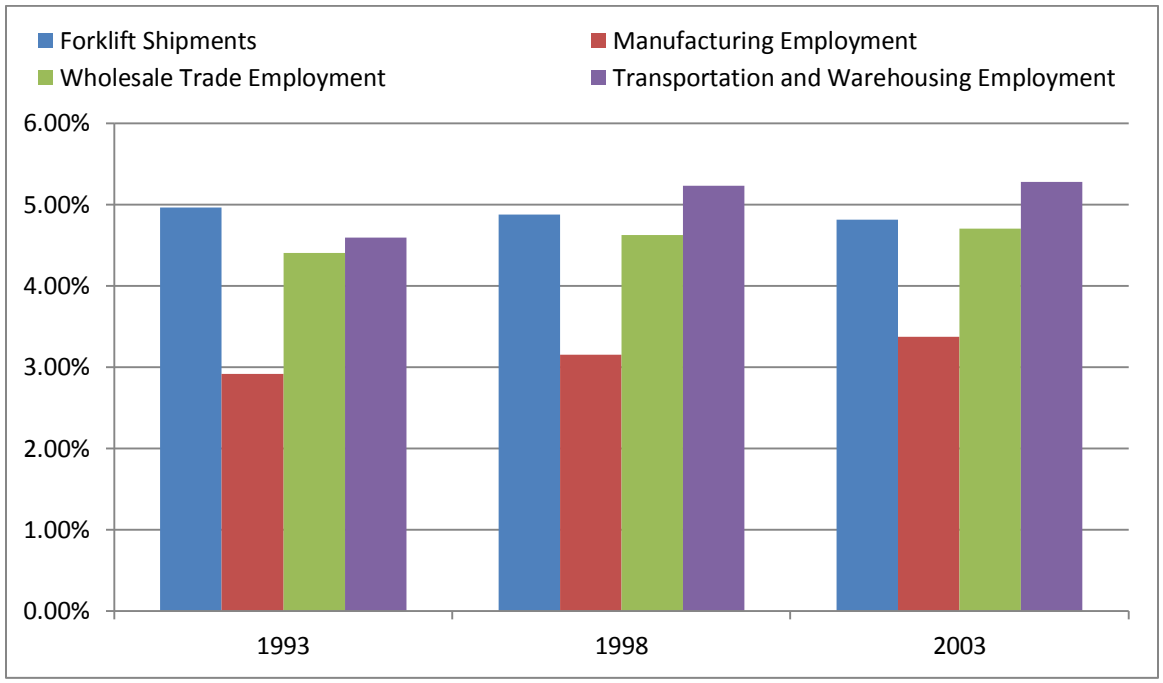
NAICS Code	Ratio	SD	SD % of Avg.
31-33	0.048119	0.008301	17.25%
42	0.112569	0.007128	6.33%
48	0.168017	0.005893	3.51%
4441	0.620366	0.018888	3.04%

The equipment ratio for NAICS Code 48 was the basis for CAPCOG's equipment ratio. CAPCOG multiplied it by 85% to yield the number of LPG forklifts, since ERG and the NONROAD model both found that LPG forklifts make up 85% of the forklift equipment population.

Analysis of ITA County-Level Shipment Data for 2005 ERG Study

ERG's 2005 study included county-level shipments to the DFW and HGB area for 1993, 1998, and 2003. The shipment data for the DFW and HGB areas across these three years closely resemble the national shipment data, with shipments sharply rising from 1993 to 1998, and then decreasing somewhat from 1998 to 2003. This suggests that national-scale analyses of the relationship between employment in these sectors and shipments may also work at a local scale. The county-specific shipment data can be used in conjunction with the national shipment data and county-level employment data to further analyze the relationship between each NAICS code and forklift shipments. The chart below shows the first analysis CAPCOG performed using these data – a comparison of the portion of the national shipments that went to the 17 counties included in ERG's study in the DFW and Houston area compared to the portion of national employment in each sector. The 1993 data used the corresponding SIC codes, which do not match 1:1 to the NAICS codes.

Table 9: Portion of Class IV and V Forklift Shipments and Employment in NAICS Codes 31-33, 42, and 48 in HGB and DFW



This shows that despite the large fluctuations in the actual number of shipments each area received across the three years, the actual portion of the national shipments remained fairly constant, as did the portion of national employment in these sectors. It also shows a clear discrepancy between the portion of national forklift shipments the HGB and DFW areas received compared to their share of manufacturing employment. The employment in transportation and warehousing and wholesale trade appear to more closely match the shipment data in these three years. Note that the 1993 data used the

SIC classifications, which accounts for some of the discrepancy between the portions of employment between 1993 and the 1998 and 2003 analysis years.

CAPCOG also decided to perform a series of regression analyses on the county-level data in order to assess the statistical significance of each of the variables CAPCOG was testing. Rather than modeling the impact of employment and population on shipments directly, CAPCOG instead divided each county's shipments, employment, and population by the national shipments, employment, and population for a given year. This helped control for another variable – the fact that shipments can vary significantly by year, even if the actual level of employment varies much less significantly, as the chart above shows. Since there is a difference in business classifications between 1993 and 1998 (the change from SIC to NAICS), CAPCOG also used a control variable for 1993 data. The table below summarizes the results of these regression analyses.

CAPCOG modeled four sets of this data:

- Model 1: All counties, all three years (1993, 1998, 2003)
- Model 2: All counties, all three years, w/o population as independent variable
- Model 3: All counties, only years with NAICS codes (1998, 2003)
- Model 4: Smaller counties (minus Dallas, Harris, and Tarrant counties), all three years
- Model 5: Smaller counties, all three years, w/o population as independent variable
- Model 6: Smaller counties, only years with NAICS codes

The table below shows the results of this analysis.

Table 10: Regression Modeling Statistics using ITA Shipments to DFW and HGB

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Population (p-val.)	**<0.0001**	N/A	**<0.0001**	0.7960	N/A	0.9212
NAICS 31-33 (p-val.)	**0.0119**	0.1549	0.5710	**0.0001**	**<0.0000**	**0.0045**
NAICS 42 (p-val.)	0.9816	0.1877	0.0373	0.7836	0.6219	0.6972
NAICS 4441 (p-val.)	0.0742	**<0.0001**	0.0916	0.4526	0.1656	0.4779
NAICS 48-49 (p-val.)	**0.0037**	0.1417	**<0.0001**	**0.0221**	**0.0070**	**0.0307**
1993 (p-val.)	0.3327	**0.0447**	N/A	0.3644	0.3167	N/A
Adjusted R2 statistic	0.9785	0.9549	0.9846	0.5818	0.5926	0.5717
Model F statistic	381.1057	212.9227	423.0324	10.5051	12.9273	8.20787

The table above shows a somewhat mixed picture. When larger counties are included, population quite clearly has a significant impact on forklift shipments, while it is not clear that manufacturing has an independent impact. For smaller counties, however, the reverse is true – manufacturing has a clear impact, but population does not. This suggests that the impact of population on the amount of forklifts shipped to a particular county grows with the size of the county. The presence of a particularly large manufacturing facility using lots of forklifts in a county adjacent to one of these "core" counties would not be accounted for if population alone were used. However, the presence of significantly more forklifts used in retail or other uses more tied to population in the "core" counties would not be accounted for if only using manufacturing. Building and material suppliers only have a significant impact

when population is not included as a variable, suggesting a strong correlation between these two variables. Its significance with the smaller county model is consistent with an assumption that the actual location of an establishment becomes more important to the number of shipments when populations are smaller in a county. Wholesale Trade, meanwhile, seems to be significant in only one of these models. The most robust variable in terms of significance is transportation and warehousing employees. This variable is significant in five of the six models, and in the one model in which it is not significant, the "1993" variable is significant – meaning that the actual classification change from SIC to NAICS could account for this discrepancy.

CAPCOG then performed regressions on the shipment data using two single-variable models: employment in manufacturing and employment in transportation and warehousing. Comparing these two results would provide a final check to see which variable would better predict the county-level shipment data in ERG's study. The table below summarizes these results. The coefficient should be interpreted as the portion of shipments divided by the portion of employees. The closer the coefficient is to one, the closer the variable would be to providing an accurate prediction of the number of shipments to a given county.

Table 11: Regression Statistics for Single-Variable Models

Metric	NAICS 31-33	NAICS 48-49
All Counties Coefficient	1.138678	0.926969
All Counties Adj. R^2	0.93876	0.956454
Small Counties Coefficient	0.472113	1.075842
Small Counties Adj. R^2	0.462205	0.371544

This analysis further shows that employment in transportation and warehousing is a better predictor of equipment shipments (and hence populations). The consistency of the importance of this variable in forklift equipment populations provides enough justification to switch from using manufacturing employment as the basis for forklift populations to transportation and warehousing employment.

Conclusion and Recommendations

CAPCOG has refined the emissions inventory for LPG forklifts in Central Texas based on survey data collected in the DFW and HGB areas and on forklift shipment data provided by the industry group representing over 90% of the suppliers of LPG forklifts in the U.S. CAPCOG updated equipment populations, annual hours of use, weekday/weekend allocation of use, and the median life of the equipment on the basis of these data, resulting in a substantial decrease in the emissions inventory for this category. This result is primarily due to the lower annual hours per year of use from the ERG study and the shift from using manufacturing to transportation and warehousing as the basis for equipment populations and Austin's relatively smaller share of transportation and warehousing employment than its share of manufacturing employment.

CAPCOG believes that these are substantial improvements to the existing inventory, but believes that major improvements could still be made to the inventory using data specific to the region. Due to the

variety of businesses that use forklifts, using a survey as the basis for estimating equipment populations would likely prove quite challenging. Actual shipment data from ITA would provide the most defensible basis for an equipment population, but this can be expensive. The next best option would be to use universal commercial code (UCC) filings on the financing of LPG forklift purchases to estimate the equipment population, although these filings would only include forklifts purchased using financing, not forklifts purchased by a company using their own cash. In absence of these data, a targeted survey at a larger scale than a particular city or region could help characterize equipment ownership and usage within various NAICS codes. The data collected by ERG suggest, for instance, that transportation businesses may own more pieces of equipment but use them less than manufacturing establishments. Moreover, there might be some opportunities to analyze the data at lower-level NAICS codes than what was used in this project.

There are also other national data sources that are available that could help prioritize future research efforts. One such data set is the Manufacturing Energy Consumption Survey (MECS), produced by the Energy Information Administration (EIA). This survey includes questions on the quantities and uses of various fuels, including LPG. One of the tables provides the amount of LPG energy consumed by "onsite transportation," which would include forklifts, at various NAICS levels within the manufacturing sector (Energy Information Administration, February 2010). The following table summarizes the data available from the 2006 EIA.

Table 12: LPG Consumed by Manufacturing Sector in Onsite Transportation, 2006

NAICS Code	Description	Consumption (Trillion BTU)	Employees	MMBTU/Employee
31-33	Manufacturing – All	20	13,631,683	1.47
311	Food	1	1,458,738	0.69
321	Wood Products	3	576,506	5.20
322	Paper	3	441,430	6.80
325	Chemicals	1	805,064	1.24
326	Plastics and Rubber Products	2	900,842	2.22
327	Nonmetallic Mineral Products	1	482,459	2.07
331	Primary Metals	1	449,914	2.22
332	Fabricated Metal Products	3	1,563,713	1.92
333	Machinery	1	1,126,671	0.89
335	Electrical Equipment, Appliances, and Components	1	419,691	2.38
336	Transportation Equipment	2	1,622,527	1.23
Other	All Other Manufacturing	1	3,784,128	0.26

These data indicate that LPG forklifts may only be used heavily in certain manufacturing sectors, such as wood product and paper manufacturing, and not in others, such as petroleum product manufacturing and computer and electronics manufacturing. These data can be used to better target future research towards those sectors with high usage of LPG for "onsite transportation."

One thing that is notable about this list is that computer and electronics manufacturing, which is by far the largest source of manufacturing employment in CAPCOG's program area, is not one of the larger manufacturing consumers of LPG forklifts. So even if manufacturing employment as a whole was a better surrogate for forklift populations in the U.S., which the current study shows is not, the MECS data indicates that it would still likely over-estimate LPG forklift emissions in the region.

The Commodity Flow Survey (CFS) can also be useful for future research. It provides extensive data on the quantities of goods shipped by mode, NAICS code, origin point, destination point, and distance travelled. Presumably, forklift activity would be associated with goods movement, so these data could be useful to correlate forklift populations directly based on the quantities of good an industry produces. If future surveys include data on the number of shipments per week or year, that could help further associate forklift data with a more directly relevant factor of production than employment.

LPG forklifts remain a difficult source category to accurately categorize due to the wide variety of businesses in which they are used. In the absence of local-specific shipment data and usage data, CAPCOG used existing data sets to the maximum extent possible to characterize emissions from this source type in CAPCOG's program area. CAPCOG is confident, however, that this inventory represents a substantial improvement over the existing estimates and will continue to pursue opportunities to refine emissions from this source category in the future.

Works Cited

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