ARB Agreement 14-614

Survey of Large Spark-Ignited (LSI) Engines Operating within California

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Prepared for the California Air Resources Board and the California Environmental Protection Agency

Prepared by the Social Science Research Center at CSU, Fullerton

DISCLAIMER

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ABSTRACT

Measures to reduce emissions from Large Spark-Ignition (LSI) equipment have played an important role in ARB's goal of achieving emission reductions from the mobile source sector within the State of California. Given that existing state mandates require emissions reductions, it is necessary to establish a baseline estimate of the contribution from different types of equipment (forklifts, industrial tow tractors, industrial sweeper/scrubbers), including LSI equipment, to the statewide total. There are no recent estimates of the size of the population of this equipment. To determine the contribution of such equipment to emissions, information must be collected regarding the population of this equipment as well as different factors that might impact the emissions contribution of each piece.

In order to establish an estimate of the population size of such equipment in the state of California, the contractor completed telephone surveys with 1,200 businesses throughout the state of California to determine the number of forklifts, industrial tow tractors, and industrial sweeper/scrubbers in the state (excluding those involved in the primary agricultural sector). Four separate lists of businesses were combined in an attempt to provide as extensive coverage of the true population of businesses as possible. The values obtained through the survey were then extrapolated to the full population of businesses within the state in order to obtain an equipment population estimate. Using this approach, it was determined that there are approximately 392,396 forklifts, 31,861 tow tractors, and 29,669 sweeper/scrubbers operating in the state of California. Additionally, data were collected on fuel type, horsepower, lift capacity, annual hours of operation, and time to retirement to assist in creating any emissions estimate in the future.

EXECUTIVE SUMMARY

BACKGROUND

California is a national leader in the effort to reduce air pollution and greenhouse gas (GHG) emissions to combat climate change. Bills and executive orders at the state level establish GHG reduction targets for 2020, 2030, and 2050. Measures to reduce emissions from forklifts, industrial tow tractors, and industrial sweeper/scrubbers play an important role in ARB's goal of achieving emissions reductions from the mobile source sector. Data from the ARB's OFFROAD2007 Inventory Model and 2011 Inventory Model for In-Use Off-Road Equipment indicate there are 59,789 diesel, gasoline, and propane forklifts in operation in the state. However, these measures have gaps in coverage and do not include battery-operated equipment. The study described in this report was carried out to create a comprehensive updated estimate of the size of this population and collect information on the fuel type, horsepower, lift capacity, annual hours of operation, and time to retirement for such equipment. The additional information collected can be used along with the population estimate of such equipment to determine current emissions. It can also help to quantify potential emissions offset by the usage of battery powered equipment.

METHODS

The contractor conducted a telephone survey with 1,200 businesses throughout the state of California, inquiring about the number of forklifts, industrial tow tractors, and industrial sweeper scrubbers each business had. The survey instrument was developed in collaboration with staff from the Air Resources Board's Mobile Source Control Division and pilot tested on a small list of businesses prior to full scale implementation. In addition to collecting information on the number of forklifts, tow tractors, and sweeper scrubbers, where possible, data were collected on the fuel type, horsepower, lift capacity, annual hours of operation, and time to retirement for equipment.

To ensure adequate coverage of the population of businesses that might have such equipment, four lists of businesses were to be included among those surveyed: a list of Uniform Commercial Code (UCC) filings for LSI equipment provided by Equipment Data Associates (EDA), a list of equipment provided by the California Department of Motor Vehicles (DMV), a list of LSI equipment from the ARB's Diesel Off-Road Online Reporting System (DOORS), and a list of businesses from the California Board of Equalization (BOE).

Eventually, 32,648 calls were made to complete surveys with 1,200 of the businesses in the combined lists. Representatives from these businesses self-reported on the items of interest, with varying success in terms of certainty and nonresponse. These values were then extrapolated to the full population of businesses in order to obtain an estimate of the number of pieces of equipment throughout the state.

RESULTS

Almost all businesses interviewed operated forklifts. The number of forklifts operated by each business ranged from one to 500 forklifts, with a mean of 7.1 and a median (the value above and below which half of all values fall) of 2 forklifts. Overall, there were 8,463 forklifts operating among the 1,194 business that had at least one lift. Greater than half of these forklifts were propane/LPG fueled, but sizeable proportions were also diesel and battery electric. Higher percentages of businesses in the Northern part of the state utilized diesel and gasoline forklifts than in other regions of the state.

Greater proportions of propane and gasoline forklifts were from lower horsepower categories, while the opposite was true (greater proportions from higher horsepower categories) for diesel forklifts. Similarly, gasoline and propane forklifts appear more often in the lowest lift capacity category, a pattern also observed for battery forklifts. In terms of annual hours of operation, both the mean and median number of hours followed the same pattern for the different fuel types. Battery electric forklifts were operated the greatest number of hours on average, followed by propane/LPG equipment and then diesel. Gasoline forklifts were operated the lowest number of hours per year on average. Again, both in terms of mean and median values, battery powered forklifts operated by businesses in the survey sample were the newest models on average, followed closed by propane/LPG and then diesel forklifts. Gasoline forklifts in the sample were more than a decade older, on average. The time before which forklifts were retired on average naturally followed the same pattern.

About one in twenty businesses in the survey sample operated industrial tow tractors. The number of tow tractors operated ranged from one to 394, with a mean of 12.2 and a median of 2 tow tractors. Overall, 853 pieces of equipment were reported by the 70 businesses that had tow tractors. Nearly 15% of businesses interviewed operated industrial sweeper/scrubbers. The number of sweeper/scrubbers operated ranged from one to 60, with a mean of 2.2 and a median of 1 sweeper/scrubber. Overall, 350 pieces of equipment were reported by the 159 businesses that had sweeper/scrubbers.

Nearly 15% of businesses indicated they already operate zero emissions fleets, with the highest proportions of those in nonclassifiable businesses, agriculture, and retail doing so. Additionally, the greatest percentage of companies in Southern California had such fleets when compared to other regions in the state. Cost was the most cited barrier to obtaining such a fleet.

Using the BOE data file as a proxy for the total population of businesses operating in California for the purpose of extrapolation and a rate of 16.4% of businesses in this file estimated to operate the study equipment, it was estimated that 149,381 businesses within the state of California operated such equipment. Weights were assigned to account for differences between the BOE file and the study sample. Additional weights were applied to align the full list from which the survey sample was drawn with the survey sample with regard to sample source and fleet size. After adjusting the data for high outlying values, it was estimated that there are 392,396 forklifts operating in the State, with a lower bound of 241,257 and an upper bound of 544,330 forklifts. Furthermore, a total of 31,861 tow tractors are believed to be operating in the state, with a lower bound of 10,250 and an upper bound of 62,023. Lastly, a total of 29,669 sweeper/scrubbers are believed to be operating in the state, with a lower bound of 18,125 and an upper bound of 41,780.

CONCLUSIONS

Using the sampling and extrapolation strategy described with telephone as the mode of survey administration, the contractor came up with an estimate several times higher than currently existing ones.

A few factors might contribute to this discrepancy. From the time prior estimates were created, businesses have undoubtedly continued to obtain new forklifts. Recent improvements in the overall economic situation in California have given some businesses the additional resources to make new purchases and take on more financial risk. Furthermore, the average time to retirement for forklifts is higher than previously thought, particularly for certain fuel types. Finally, it is possible that previous

studies of this population left out certain business or industry groups that were better covered by the current study. These factors account for at least some of the discrepancy between the current and past estimates and give the contractor confidence in the current one. Future studies should specifically examine these factors to ascertain their contribution to increases in this equipment population size.

INTRODUCTION

California is a national leader in the effort to reduce air pollution and greenhouse gas (GHG) emissions to combat climate change. In 2006, California Assembly Bill 32 established that statewide gas emissions need to reach 1990 levels by 2020.[1] Governor Brown's 2015 Executive Order B-30-15 set the most ambitious goal anywhere in North America at that point: to reduce levels below 40% of 1990 levels by 2030 and 40% further, to 80% of 1990 levels by 2050.[2] In September of 2016, the legislature passed Senate Bill 32, which codified the 40% pre-1990 level reduction by 2030.[3] As such, there are multiple, progressively intense legal requirements to decrease GHG emissions.

Measures to reduce emissions from forklifts, industrial tow tractors, and industrial sweeper/scrubbers (in particular off-road Large Spark-Ignition, or LSI, equipment) play an important role in ARB's goal of achieving emissions reduction from the mobile source sector. Data from the ARB's OFFROAD2007 Inventory Model and 2011 Inventory Model for In-Use Off-Road Equipment indicate there are 59,789 diesel, gasoline, and propane forklifts in operation in the state, and they are a significant contributor to NOx (oxides of nitrogen), THC (total hydrocarbons), and GHG emissions. However, these measures have gaps in coverage and do not include battery-operated equipment. No work has been done recently to provide a more precise estimate of the size of this population in order to quantify its contributions to statewide emissions.

To estimate the size of the population of LSI equipment and its contributions to emissions in the State of California, the California Air Resources Board (ARB) contracted with the Social Science Research Center (SSRC), at California State University, Fullerton to conduct telephone surveys with 1,200 businesses from various industries. The primary goal of this endeavor was to estimate the population size of forklifts, tow tractors, and industrial sweeper/scrubbers operating in California. A secondary goal was to obtain information on equipment life cycle, fuel source, and horsepower and lift capacity. The data collected as part of this survey, as well as the derived forklift population estimates, will help support potential future air pollutant emission-reduction programs.

[1] ftp://www.leginfo.ca.gov/pub/05-06/bill/asm/ab_0001-0050/ab_32_bill_20060927_chaptered.pdf
[2] https://www.gov.ca.gov/news.php?id=18938
[3] https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB32

DATA COLLECTION MATERIALS AND METHODS

SAMPLE FRAME DEVELOPMENT

The population of inference for the current study is all businesses within the State of California that currently operate the study equipment, including forklifts, industrial tow tractors, and industrial sweeper/scrubbers. As such, businesses that do not conduct any operations within the State of California were excluded. Additionally, businesses involved in the primary agricultural sector were not part of this study: these include not only businesses that grow or harvest crops from the soil and raise animals but also those involved in agricultural crop preparation services. Such services include only the first processing after harvest, with businesses such as packinghouses, cotton gins, nut hullers, nut processors, dehydrators, feed mills, and grain mills falling into this category. Primary agricultural businesses were not included as they will be surveying their own industry and providing the results to the ARB independent of the current study. Furthermore, it should be noted that airport ground support equipment (GSE) have not been included among the equipment types in the current study despite their contribution to the population of LSI equipment. ARB has access to existing sources of information on the population and emissions of GSE, making the inclusion of such equipment in the current study unnecessary.

In order to obtain an estimate of the fleet of this equipment within the State of California, the contractor and ARB opted to conduct a telephone survey with a sample of such businesses. Since a comprehensive list of the full population of such businesses does not readily exist, the contractor and ARB worked to create a list that could serve as a proxy for this population.

Initially, four sources were considered for inclusion in the full list of businesses from which the 1,200 surveys would be conducted: (1) a list of Uniform Commercial Code (UCC) filings for forklifts and other LSI equipment provided by Equipment Data Associates (EDA); (2) a list of forklift and work truck registrations provided by the California Department of Motor Vehicles (DMV); (3) a list of businesses using off-road industrial equipment provided from ARB's Diesel Off-Road Online Reporting System (DOORS); and (4) a list of all businesses for which the CA Board of Equalization (BOE) collects and pays out state income tax. Explanations of each sample source as well as the technique for merging the lists together follow.

EDA UCC FILING LIST

A list containing Uniform Commercial Code filings submitted for the type of equipment covered by the current study in the State of California was downloaded from Equipment Data Associates' (EDA) database on November 20, 2015. This list contained UCC filings for forklifts starting from January 1, 2001 and all filings for tow tractors, industrial sweepers/scrubbers, airport group support equipment, and generator sets starting from January 1, 2010. This list contained a total of 104,950 filings.

A UCC filing is made by a creditor or lender to the California Secretary of State when a piece of property is financed. If the item is not financed, a UCC filing will not be made. Furthermore, a filing is not always made for financed property, and the onus is on the lender or creditor to do so. However, it is in the financial interest of the lender to file the UCC filing because it can allow them to seize the property in the event of a default on the loan. For the reasons listed, the list of filings for equipment downloaded from EDA's database cannot be considered an exhaustive or comprehensive list of all such equipment in the state.

Within the list of 104,950 filings, filing type fell into one of six categories: lease, refinance, rental, sale, termination, or wholesale. Table 1 below shows the distribution of filing type. As shown, the majority of filings were either for the lease (*n* = 40,290; 38.4%) or sale (*n* = 40,283; 38.4%) of equipment. The remainder were loans made to wholesalers (*n* = 8,200, 7.8%), terminations of loans (*n* = 6,648, 6.3%), refinances of loans (*n* = 6,407; 6.1%), and rental agreements (*n* = 3,122; 3.0%).

Table 1. UCC Filings by Type

Filing Type	Count	Percent
Lease	40,290	38.4%
Sale	40,283	38.4%
Wholesale	8,200	7.8%
Termination	6,648	6.3%
Refinance	6,407	6.1%
Rental	3,122	3.0%
Total	**104,950**	**100.0%**

All filing types with the exception of wholesale were selected to be included in the final count of pieces of equipment enumerated by the EDA dataset. Loans on equipment to wholesalers were not included because it was assumed that this equipment is not actively in operation by an end user at the time the dataset was downloaded. To guess what the future use of this equipment might be is not useful for the current goal, which is to estimate the total population of such equipment operating in the state. After removing from the file 8,200 wholesale filings, a total of 96,750 filings remained.

Because a UCC filing can be filed for multiple purposes (those displayed in Table 1), each UCC filing does not necessarily represent a unique piece of equipment. A piece of equipment may be listed in the file multiple times under separate filings. For example, if a piece of equipment was sold, then the loan for the equipment was refinanced, and, finally, paid off (a termination), three filings would be shown for the same piece of equipment.

In order to obtain the most accurate estimate of pieces of equipment, those pieces of equipment with multiple filings needed to be accounted for. Fortunately, the EDA database included fields to help identify unique pieces of equipment. These included the equipment serial number given by the manufacturer, the equipment manufacturer, and the equipment model. Equipment serial number was not used alone to account for cases in which the same serial number was used by multiple manufacturers.

Filtering by these three fields, it was found that the file contained 88,913 unique forklifts and other pieces of equipment of interest for the current study. To obtain the number of businesses owning such equipment, multiple filings for equipment from the same business were collapsed into one case representing that business. Buyer ID (a unique identifier for each business or individual, provided by EDA) was used to identify duplicates, and a total of 29,271 unique businesses/persons were contained in the EDA data file. All businesses in Standard Industrial Code (SIC) Groups 1 and 2 were removed from

the data file to avoid interviewing businesses involved in agriculture. These included 3,376 businesses in Group 1: Agricultural Production of Crops and 443 in Group 2: Agricultural Production of Livestock and Animal Specialties. Additionally, all businesses from Group 7: Agricultural Services were removed *except* those from Subgroup 78: Landscape and Horticultural Services. A total of 341 businesses from Group 7 were removed. After these deletions 25,452 businesses remained, representing approximately 85,810 pieces of equipment. Of the 25,452 businesses, 6,187 had no telephone number associated with them. The remaining 19,265 were used to contribute to the final sample frame.[4]

Businesses in the EDA file for which telephone numbers were unavailable may differ in some way from those for which this information was available, introducing sampling bias. To address this possibility, analyses were conducted to determine the extent to which those businesses from the EDA file that were included in and excluded from the final sample frame differed from one another. Table 2 below shows the industry type of businesses for which numbers were available as well as those for which they were not. In general, the distribution of industries was similar for those records included in the final sample frame compared to those that were not. One notable exception is for those businesses in the nonclassifiable category. Only 6.4% (*n* = 1,234) of records included in the frame fit into this category, whereas nearly three times that proportion (*n* = 1,160; 18.7%) did among those businesses culled from the frame. This means that such businesses were underrepresented in the EDA records selected for inclusion in the sample frame. For this reason, any extrapolation strategy relying only on this data source would likely undercount such businesses.

[4] The sample frame is the full list of units, in this case businesses, from which the survey sample is drawn at random. Ideally, this list would contain all units that constitute the population of interest.

Table 2. Comparison of EDA Records with and without Telephone Numbers on File by Industry

Industry as SIC Code Division	Telephone # Available-Included in Frame Count	Telephone # Available-Included in Frame %	Telephone # Unavailable-Not Included in Frame Count	Telephone # Unavailable-Not Included in Frame %
Agriculture, Forestry and Fishing	1,235	6.4%	596	9.6%
Mining	138	0.7%	49	0.8%
Construction	2,057	10.7%	512	8.3%
Manufacturing	5,068	26.3%	1247	20.2%
Transportation, Communications, Electric, Gas and Sanitary service	2,070	10.7%	642	10.4%
Wholesale Trade	3,731	19.4%	1058	17.1%
Retail Trade	1,607	8.3%	327	5.3%
Finance, Insurance and Real Estate	161	0.8%	80	1.3%
Services	1,809	9.4%	486	7.9%
Public Administration	155	0.8%	30	0.5%
Nonclassifiable	1,234	6.4%	1160	18.7%
Total	**19,265**	**100.0%**	**6187**	**100.0%**

In addition to industry, estimated fleet size of businesses was used to determine differences between those EDA records included in the final sample frame and those that were excluded. As shown in Table 3, those businesses with only one piece of equipment represent over two thirds of those *without* numbers (*n* = 4,295; 69.4 %) but only 59.0% (*n* = 11,361) of those *with* numbers (which were included in the final sample frame). Therefore, any extrapolation strategy relying only on this data source would undercount businesses with smaller fleets and overcount those with larger ones.

Table 3. Comparison of EDA Records with and without Telephone Numbers on File by Fleet Size

Estimated Fleet Size	Telephone # Available-Included in Frame Count	Telephone # Available-Included in Frame %	Telephone # Unavailable-Not Included in Frame Count	Telephone # Unavailable-Not Included in Frame %
1	11,361	59.0%	4,295	69.4%
2	3,163	16.4%	919	14.9%
3	1,281	6.6%	290	4.7%
4 - 25	3,095	16.1%	635	10.3%
26 or more	365	1.9%	48	0.8%
Total	**19,265**	**100.0%**	**6,187**	**100.0%**

DMV (California Department of Motor Vehicles) Data File

The California Air Resources Board (ARB) provided data from the DMV's database to the contractor. This file contained forklift registrations as well as work trucks used to move forklifts from place to place. The file contained a total of 3,934 entries each representing a unique piece of equipment. This figure is substantially smaller than the number contained in the EDA file because forklifts were only reported to the DMV if they drove a distance of one-quarter mile or greater along public highways.

To maintain confidentiality, neither addresses nor telephone numbers were provided to the contractor with the file. The only identifying information provided was business name along with a zip code, county code, and county name. Searching for duplicates by all four of these fields, a total of 2,356 unique businesses were contained in the DMV data file.

This file was found to have 282 businesses in common with the EDA file. These duplicate businesses were eliminated from the DMV file, leaving 2,074 businesses remaining. These businesses represented a total of 3,458 pieces of equipment. Research assistants used internet searches to obtain phone numbers for as many businesses as possible. In total, numbers were obtained for a total of 1,483 businesses. The 1,483 records for which numbers were found were used to contribute to the final sample frame.

As with the EDA file, analyses were conducted to determine the extent to which those businesses from the DMV file that were excluded from the final sample frame differed from those that were included. Since industry was not provided for those businesses contained in the DMV file, fleet size was used in an attempt to identify any meaningful differences. Table 4 displays the differences in estimated fleet size (as indicated by the number of entries each business had in the original file) between those included and not included in the final sample frame. As shown, there were some minor differences between these two categories; the most notable of these being that there were half the proportion of businesses with estimated fleet sizes between four and 25 among those records for which numbers could be found (*n* =

56; 3.8%) compared to those for which they could not (n = 45; 7.6%); $\chi^2(4) = 22.39$, $p < .001$. This means that any extrapolation based on the DMV file would likely over count businesses with smaller fleets.

Table 4. Comparison of DMV Records with and without Telephone Numbers on File by Fleet Size

Estimated Fleet Size	Telephone # Available-Included in Frame Count	Telephone # Available-Included in Frame %	Telephone # Unavailable-Not Included in Frame Count	Telephone # Unavailable-Not Included in Frame %
1	1,180	79.6%	470	79.5%
2	192	12.9%	55	9.3%
3	53	3.6%	17	2.9%
4 - 25	56	3.8%	45	7.6%
26 or more	2	0.1%	4	0.7%
Total	**1,483**	**100.0%**	**591**	**100.0%**

DOORS (Diesel Off-Road Online Reporting System) Data File

The ARB also furnished the contractor with data from the Diesel Off-Road Online Reporting System. This database contains supplemental registration information not reported to the DMV for mobile off-road equipment that is powered by heavy duty off-road diesel engines. Although many types of diesel equipment fall into this category, the list provided to the contractor contained only those businesses known to possess at least one forklift. The list contained no vehicle information in order to maintain privacy, but did contain business and individual contact information, including name and telephone number.

The file provided contained 25,466 pieces of equipment representing 2,731 businesses at unique locations. Numbers were missing for 51 of these businesses, but were located for all but two**,** leaving a total of 2,729 businesses in the DOORS file. Of these 2,729, 389 were present in the other files, leaving a total of 2,340 unique businesses contributed by the DOORS file. These businesses represented a total of 22,083 pieces of equipment.

BOE (Board of Equalization) Data File

Lastly, the ARB provided the contractor with a file containing all businesses for which the CA Board of Equalization (BOE) collects and pays out state sales and use taxes. Not included in this file were those whose activities preclude them from paying such taxes, such as companies whose business mainly entails moving goods rather than selling them. This original file was extensive and contained 916,666 businesses of all sizes and industries. Of these businesses, telephone numbers were not available for 30,858 (3.4%) of them. These businesses were removed from this file, yielding 885,808 businesses remaining. As with the EDA and DMV files, analyses were conducted to determine differences between

businesses with and without telephone numbers. Table 5 below shows the industry type of businesses for which numbers were available as well as those for which they were not.[5] As shown, some industries are grossly overrepresented among the records containing telephone numbers, including wholesale trade and retail trade, while others such as services are underrepresented. This means that any survey sample garnered solely from this data file, even if in a completely random fashion, would thus over represent businesses in wholesale, retail and manufacturing and underrepresent all other industries.

Table 5. Comparison of BOE Records with and without Telephone Numbers on File by Industry[6]

Industry as SIC Code Division	Telephone # Available	Telephone # Available	Telephone # Unavailable	Telephone # Unavailable
Agriculture, Forestry and Fishing	7,475	0.8%	602	2.0%
Mining	558	0.1%	31	0.1%
Construction	15,600	1.8%	1,206	3.9%
Manufacturing	63,840	7.2%	1,379	4.5%
Transportation, Communications, Electric, Gas and Sanitary service	19,871	2.2%	2,533	8.2%
Wholesale Trade	379,259	42.9%	5,880	19.1%
Retail Trade	220,472	24.9%	2,789	9.0%
Finance, Insurance and Real Estate	8,965	1.0%	2,718	8.8%
Services	165,260	18.7%	13,495	43.8%
Nonclassifiable	3,782	0.4%	210	0.7%
Total	**885,082**	**100.00%**	**30,843**	**100.10%**

As previously noted, the BOE file contained all businesses for which the CA Board of Equalization (BOE) collects and pays out state sales and use taxes. Unlike the other three files, which were created specifically with the intention of contacting a high rate of businesses with the study equipment, the BOE file contained records from businesses regardless of existing knowledge of whether they possessed this equipment. Although the ideal would have been to include all BOE records in the list from which the survey sample was drawn to ensure representativeness of the total population, adding such a vast number of records of unknown eligibility to the sample file would have led to an extremely low eligibility and completion rate. To illustrate this point, consider the 2,667 businesses called from the BOE file early

[5] NAICS codes were not provided for 741 businesses in the BOE file. These businesses are excluded from the table.
[6] Industry was provided as a NAICS code for the BOE file. These NAICS codes were converted to SIC codes using the NAICS to SIC crosswalk provided by the NAICS Association. https://www.naics.com/naics-to-sic-crosswalk/

in the study. Of these businesses, 714 (26.8%) were confirmed to be ineligible because they did not possess the study equipment. Comparing this to the EDA file, for which only 10.0% of businesses called were ineligible, it is clear that it would be cost prohibitive to attempt to call such a large number of businesses in the time and with the budget allotted. Thus, an alternate approach was taken with regard to the BOE file.

In order to include the BOE data in some capacity while taking into account the low survey completion rate that would result from including all these businesses in the final file, a subsample of these businesses were taken from the larger file of 885,201. However, in lieu of simply sampling a given number of these businesses at random, a more tailored approach was taken to maximize eligibility among those contacted. For each two-digit SIC code group, a random sample of records equal to that in the EDA file was drawn. For example, if SIC Code Group 20: Food and Kindred Products contained 712 records in the EDA file, 712 records from this group would be randomly drawn from the BOE file. After conducting this process with all groups, and excluding Groups 1, 2, and a portion of records from Group 7 (as well as those from Group 99, which are those businesses for which a code cannot be determined), 22,399 businesses remained. Although this approach to sampling businesses from the BOE file for inclusion in the list of businesses to be called ensured the list was more efficient, it also introduced some degree of bias. This is because, due to the very nature of the approach, businesses similar to those from the EDA file were selected. Approaches to account for this bias when creating the population estimates are discussed in those sections of the current report.

Merging the Files

All four files were merged together on the fields they had in common (such as contact person, company name, address, etc.) with fields unique to only some of the files also incorporated to allow for reference back to the original data if necessary. Once all four files were merged together, the file contained 45,876 records. Research assistants manually searched through records with matching phone numbers and company names.

In cases for which the names were similar, internet searches were performed in an attempt to determine whether the two companies listed were indeed the same one. If the same company was listed multiple times, but with different addresses, both records were retained to account for cases in which fleet managers may only be able to report information for one location.

After this manual process of deduplication, the total number of records in the sample was 44,539. As shown in Table 6, about half of the records came from the Board of Equalization data set (*n* = 22,043; 49.5%), 42.8% (*n* = 19,067) came from the Equipment Data Associates file, 5.3% (*n* = 2,340) from the Diesel Off-Road Online Reporting System, and 2.4% (*n* = 1,089) from the DMV file.

Table 6. Number of Records from Each Data Source Before and After Deduplication			
Data Source	**Number Before Deduplication**	**Number After Deduplication**	**Proportion After Deduplication**
Board of Equalization	22,399	22,043	49.5%
Equipment Data Associates	19,265	19,067	42.8%
Diesel Off-Road Online Reporting System	2,729	2,340	5.3%
Department of Motor Vehicles	1,483	1,089	2.4%
Total	**45,876**	**44,539**	**100.0%**

SURVEY SAMPLE SIZE DETERMINATION

The population of inference for the current study was businesses in the state of California currently operating off-road LSI equipment, more specifically, forklifts, industrial tow tractors, and industrial sweeper and scrubbers. Businesses that do not conduct any operations within the State of California were excluded from the population of inference as were businesses involved in the primary agricultural sector: these include not only businesses that grow or harvest crops from the soil and raise animals but also those involved in agricultural crop preparation services.

In an ideal world, a comprehensive list of such businesses would exist from which to draw a random sample of businesses. Since a comprehensive list of the full population of such businesses does not readily exist, the contractor in collaboration with ARB worked to create a list that could serve as a proxy for the population of inference. This list served as the sample frame for the current study. As the purpose of the current study was to obtain updated estimates for the purpose of informing policy decisions, it was critical to attain as precise a sample estimate as possible within the budget parameters set forth in the contract. The precision of a sample estimate is determined by the sampling method utilized in a study, as well as the size of the sample obtained.

With respect to sample size determination, larger sample sizes up to a point, typically equate to smaller margins of error which represent the level of sampling accuracy obtained. For this study a margin of error, or confidence interval, of .03 was utilized to estimate the sample size needed. Additionally, the probability with which the margin of error was to be achieved was set to 95.0%. Finally, when determining sample size, consideration should be given to the likely distribution of responses to a particular survey item. For example, if 99% of the study sample reported maintaining 1 forklift while 1% reported maintaining 20 or more, the chances of error would be remote, irrespective of sample size. Because the likely distribution of responses to a particular survey question was unknown, the worst case scenario was used: a 50/50 distribution. This assumption is the most conservative that can be used for the purpose of sample size determination.

In order to estimate an adequate sample size, one must have some estimate of the population of inference. As mentioned previously, a comprehensive list all of the units contained in the population of inference was not available making it is impossible to know what the true size of the population. For the purpose of determining the appropriate sample size, it was assumed that the businesses contained in the BOE data file best reflect the number of businesses operating in the state of California. To obtain an estimate of what percentage of these businesses likely had a non-zero probability of operating the equipment, a random sample of 384 businesses contained in the BOE file were contacted by telephone and asked the following question, “Does your business operate fleets of forklifts, industrial sweeper/scrubbers, or tow tractors (tugs) in the state of California?” Sixty three (16.4%) respondents answered in the affirmative. Based on the results of this procedure and using a 95% confidence level, it was estimated that the number of businesses contained in the BOE likely to operate forklifts, sweeper/scrubbers, or tow tractors (tugs) in the state of California would be 149,381.

Assuming that the population of inference contained 149,381 businesses, it was estimated that 1,060 surveys would be required to obtain a 95% confidence level with a margin of error of .03. The formula used to derive this value is:

$$\frac{SS = Z^2\,(p) \times (1-p)}{C^2}$$

Where Z = Z score (for a 95% level of confidence a Z score of 1.96 was applied); p = percentage of picking a choice, expressed as a decimal (.50 in this case); and c = confidence interval expressed as a decimal (.03 in this case).

Given the high rate of missing data expected to result from the level of detail being requested from survey respondents, a final sample size of 1,200 surveys was set. Assuming no missing data, ARB can be 95.0% confident that the true population parameter lies between + or - 3.0 points from the sample estimate.

SURVEY INSTRUMENT DEVELOPMENT

The telephone survey instrument was developed over the course of several months, through a reiterative process of multiple recommendations and revisions provided by staff at both the contracted agency and ARB.

Primary items of interest initially proposed by the ARB included: number of pieces of LSI, compression-ignition, and zero emission vehicles; type and class of these vehicles; engine displacement, certification tier, model year, lift capacity, and power rating; as well as hours operated per vehicle per year. Secondary areas considered were industry classification, geographical location, whether equipment were leased/owned/rented, equipment life cycles, location of equipment repairs, refueling infrastructure, patterns of usage, and barriers to a zero-emissions fleet.

Staff at the contracted agency used these suggested areas of interest to construct a survey instrument that would extract this information from respondents in a streamlined and accurate fashion. Screening items were developed to filter out potential participants who did not have forklifts, industrial tow tractors, or industrial sweeper/scrubbers. Furthermore, items were added to exclude those organizations involved in primary agricultural activities. To determine the level at which data would represent a company, a progressive series of items were developed to designate a business as reporting for one site or multiple sites within the state. In addition to questions crafted to extract information on equipment types, several pilot items were included to gather respondent feedback on the instrument.

After final revisions, the survey instrument was pilot tested on a sample of respondents to determine its viability and appropriateness for the project purpose. The original survey instrument was first tested on a sample of 20 businesses, which was expanded to 50 and then 100 businesses after the initial pilot provided inconclusive results regarding the effectiveness of the instrument. The original survey instrument used in the pilot is reproduced in Appendix A.

After the completion of the initial 100 surveys, several changes were made to the instrument to further streamline the process of data collection. First, the majority of pilot questions (which were initially included to gauge the effectiveness of the instrument) were removed. For each equipment type (forklifts, tow tractors, and sweeper scrubbers), infrequently chosen fuel types were removed and such types were to be included under “other” types if mentioned. The fuel types removed varied by the type of equipment in accordance with the pilot results. The final survey instrument used for data collection is shown in Appendix B.

TECHNICAL APPROACH TO DATA COLLECTION

WINCATI SYSTEM

The contractor implements Computer Assisted Telephone Interviewing (CATI) through WinCATI® software to facilitate the control of the sample, track scheduled call-backs, and monitor progress regarding the completion of sample design quotas. Programming is carried out using Sensus software, which allows for the randomization of questions and question sets within a survey to eliminate response-order biases, response range limits to reduce recording errors, and complex interview navigation commands to ensure the proper administration of survey items.

Survey questions and response options appear on a computer screen while the interviewer is speaking to the respondent. Data are entered directly into the system so coding or keying errors are reduced. Supervisors are present during all interviewing shifts and random call-monitoring is routinely performed to verify the accuracy of the data. All supervisors previously worked as a telephone interviewer, and have received extensive training in telephone interviewing techniques and methodological considerations.

The CATI system includes a sophisticated call tracking and call-back scheduling procedure. This system assigns sample records to interviewing stations based on user configurable rules which include a randomization element, and also consider call history, and interviewer capability/training. An attempt history is maintained for each sample record which can be used to calculate productivity and other process-related statistics. If no contact is made, the call record will note the time of day and the interviewer who attempted the call. The call will then be automatically reassigned at a later time based upon an algorithm that reduces the probability that the call will come up again on the same day and time. When contact is made but the interview is not completed, call information is recorded that includes whether a call-back has been scheduled, who the interviewer spoke with, who they should talk to if the eligible respondent is not available, and the current disposition of the call (for example, immediate refusal, answering machine, mid- interview termination, etc.). In addition, the time of each call, the number of times the record has been called, and any interviewer-generated notes are recorded.

INTERVIEWER TRAINING

The contractor trains all telephone interviewing staff using standard procedures prior to initiating full-scale data collection. During this process, all supervisorial and interviewing staff working on a project are trained using a paper-and-pencil version of the developed survey instrument. Each question is critically examined in a read around process. After this process, the instrument may be refined to improve comprehensiveness, flow, length, and factors that influence respondent cooperation and interest. Prior to full scale administration, surveys are conducted with a sample of approximately 25 respondents as a pilot-test. Supervisors and management-level staff then conduct a debriefing which allows interviewers to discuss the overall progression of survey item sequencing as well as to comment on specific survey items that may have been unclear to survey respondents. During this process, the data gathered from pilot-participants is reviewed to ensure it is being collected as expected. If the debriefing process or review of the data suggests modifications, the instrument is quickly revised and reprogrammed into CATI software before full scale administration begins.

Given the unique nature of this particular project, all interviewers involved were given additional training beyond the scope of a traditional project. Interviewers were provided with documentation

explaining the background of the project and the different equipment types they would be inquiring about. Interviewers were given further training on how to deal with high non-response on certain items and to employ probing techniques as necessary to minimize this non-response. Despite these efforts, instances of non-response were still relatively high compared to projects on other topics and with different populations.

DATA COLLECTION OUTCOMES

A total of 32,648 call attempts were made to complete the 1,200 surveys (100 surveys completed during the pilot along with 1,100 completed thereafter), with an average of 2.6 calls per completed survey. Table 7 presents the number of attempts required to complete each interview. As shown, more than three quarters of surveys (*n* = 920; 76.7%) were completed in three or fewer call attempts. However, 7.3% (*n* = 87) took more than five attempts to complete. Surveys were considered complete if all applicable items were administered to the representative of the businesses, regardless of whether an answer was provided for all items. In other words, missing data did not preclude a case from inclusion in the study sample.

Table 7. Number of Attempts by Completed Interviews

Number of Attempts	Completed Interviews	% of all Completes
1	417	34.8%
2	325	27.1%
3	178	14.8%
4	123	10.3%
5	70	5.8
More than 5	87	7.3%
Total	**1,200**	**100.0%**

The contractor calculates survey response rates using the American Association for Public Opinion Research (AAPOR) Response Rate Calculation Method 3 (RR3), which includes an estimate of eligibility among unscreened sample records based on the eligibility rate among respondents for whom a final determination could be made.

The RR3 formula is:

$$Rate = \frac{C}{(C+I)+(R+N)+eU}$$

Where *C*= complete interviews, *I*= incomplete interviews, *R*= eligible refusals, *N*= other eligible non-complete records, *e*= estimate of eligibility, and *U*= records with unknown eligibility.

In addition to the Response Rate, a Cooperation Rate was also calculated for the study. This rate is the proportion of interviews completed of all eligible units. The contractor uses Cooperation Rate Method 3 (COOP3), which counts completed interviews, partial interviews, and refusals as eligible units.

Table 8 depicts the final dispositions of all 17,170 attempted records. The Response Rate for the sample was 12.2%, but the Cooperation Rate was 36.1%. In all, completed surveys comprised 7.0% (*n* = 1,200) of

all records attempted (*N* = 6,086). The largest proportion of all records attempted were business answering machines (*n* = 5,632, 32.8%).

Table 8. Final Disposition of All Call Attempts

Disposition	Count	%
Business Answering Machine	5,634	32.8%
Non-Working/Disconnected	2,638	15.4%
Ineligible - No LSI Equipment	2,316	13.5%
Soft Refusal	1,322	7.7%
Complete	1,200	7.0%
No Answer	777	4.5%
Callback	680	4.0%
Hang Up	641	3.7%
Call Blocking/Technological Barrier	497	2.9%
Busy Signal	369	2.1%
Not a Business	333	1.9%
Fax/Data Line	275	1.6%
Final Refusal	144	0.8%
Number Changed	133	0.8%
Language Problem	95	0.6%
Ineligible – Agricultural Company	75	0.4%
Partial	18	0.1%
Temporarily Out of Service	18	0.1%
Indicated Already Completed	5	< 0.0%
Total	**17,170**	**100.0%**

Ultimately, the distribution of records attempted varied somewhat from the originally proposed sample list. The most prominent difference was that, after extensive review of initial call outcomes, analysts determined that the BOE data file yielded drastically lower eligibility and completion rates than the other three sample sources. As previously noted, of the 2,667 businesses called from the BOE file early

in the study, 714 (26.8%) were confirmed to be ineligible because they did not possess the study equipment, and only 32 (1.2%) of these attempts resulted in completed surveys. If we compare this to the EDA file, for which only 10.0% of businesses called were ineligible and 7.6% completed surveys, it is clear that the BOE is a much less efficient source. For this reason, the BOE data was abandoned as a potential sample source for the study. Table 9 compares the proportions of surveys completed, records attempted, and overall records in the original sample file from each sample list.

Table 9. Completed Surveys, Attempted, and Overall Sample Frame Records by Source

Sample Source	Completed Interviews (%)	Attempted Sample Frame Records (%)	All Sample Frame Records (%)	Proportion of Sample Frame Records Attempted
EDA	932 (77.7%)	12,325 (71.8%)	19,046 (42.8%)	64.7%
DMV	69 (5.8%)	701 (4.1%)	1,089 (2.4%)	64.4%
DOORS	167 (13.9%)	1,477 (8.6%)	2,338 (5.3%)	63.2%
BOE	32 (2.7%)	2,667 (15.5%)	22,043 (49.5%)	12.1%
Total	**1,200 (100.0%)**	**17,170 (100.0%)**	**44,534 (100.0%)**	**38.6%**

RESULTS

The results presented in this section fall into three categories. First, general information about the 1,200 businesses interviewed is presented, including the fleet type, the region where their business is located, and the industry in which they operate. Second, more specific results of the types of equipment operated by these businesses (including forklifts, tow tractors, and sweeper/scrubbers) are detailed, followed by some additional information about those sites. Finally, the method for using these survey data to create an estimate of the equipment population within the state is presented along with the estimate itself.

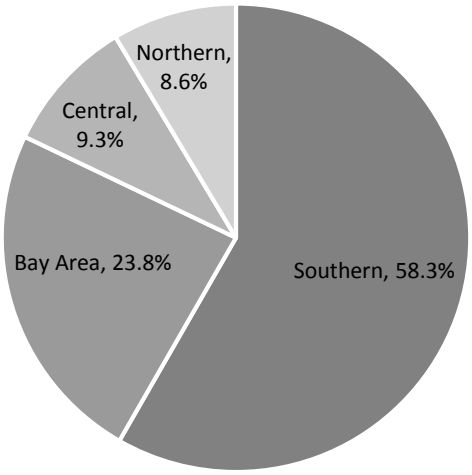
Each of the 1,200 respondents interviewed indicated whether their business had each of the types of equipment being investigated in this study: forklifts, tow tractors, and sweeper/scrubbers. As shown in Table 10, the vast majority of businesses interviewed had only forklifts (*n* = 987; 82.3%). One in ten (*n* = 136; 11.3%) had forklifts and sweeper/scrubbers, while 4.1% (*n* = 49) had forklifts and tow tractors. Twenty-two representatives noted their business had all three equipment types (1.8%), and three each indicated they had only tow tractors (0.3%) and only sweeper/scrubbers (0.3.%).

Table 10. Fleet Type Among Businesses Interviewed

Fleet Type	Number of Businesses	% of Businesses
Forklifts Only	987	82.3%
Forklifts and Sweeper/Scrubbers	136	11.3%
Forklifts and Tow Tractors	49	4.1%
All Equipment Types	22	1.8%
Tow Tractors Only	3	0.3%
Sweepers/Scrubbers Only	3	0.3%
Total	**1,200**	**100.0%**

Businesses in the survey sample were classified into the four regions within the state based the county of the address on file. The four regions were Northern, Bay Area, Central, and Southern. A list of the counties grouped into each region can be found in Appendix C. Figure 1 shows the proportion of businesses located in each region. As shown, the largest proportion (*n* = 698; 58.3%) were located in Southern California, followed by about a quarter (*n* = 285; 23.8%) from the Bay Area. Similar proportions of businesses were located in Central California (*n* = 112; 9.3%) and Northern California (*n* = 103; 8.6%).

Figure 1. Geographical Region of Businesses Interviewed



For 964 businesses (80.3%) from the EDA and BOE sample lists, information on industry was provided as a SIC Code. For those from the DMV and DOORS files, respondents were asked to provide the industry of their business. All but one (*n* = 235; 19.6%) provided an answer, and these descriptions were then coded into SICs to provide uniformity with information already on file. Table 11 shows the industry of those businesses in the survey sample organized by SIC Code Division (the broadest category). More than one quarter of companies were involved in manufacturing (*n* = 322; 26.9%), and one in five (*n* = 250; 20.9%) were a part of the wholesale trade. Very small proportions were involved in mining (*n* = 8; 0.7%) and finance, insurance, and real estate (*n* = 5; 0.4%).

Table 11. Industry of Businesses Interviewed by SIC Code Division

Industry Division	Number of Businesses	% of Businesses
Manufacturing	322	26.9%
Wholesale Trade	250	20.9%
Transportation, Communications, Electric, Gas, and Sanitary Services	148	12.3%
Construction	134	11.2%
Retail Trade	127	10.6%
Services	122	10.2%
Nonclassifiable establishments	37	3.1%
Public Administration	32	2.7%
Agriculture, Forestry, and Fishing[7]	14	1.2%
Mining	8	0.7%
Finance, Insurance, and Real Estate	5	0.4%
Total	**1199**[8]	**100.0%**

Table 12 shows the proportion of each industry represented among those businesses with forklifts, tow tractors, and sweeper/scrubbers. As shown, among those businesses interviewed that had forklifts (*n* = 1,193), more than a quarter (*n* = 322; 27.0%) were from manufacturing. For those businesses with tow tractors (*n* = 74), the greatest proportion (*n* = 15; 20.3%) came from the transportation industry. Finally, for those companies with sweeper/scrubbers (*n* = 161), equal proportions came from manufacturing (*n* = 34; 21.1%) and the wholesale trade (*n* = 34; 21.1%).

[7] Throughout the report, this category does not include businesses involved in the primary agricultural sector, as those businesses were not included in the current study.
[8] Industry was not provided by one respondent.

Table 12. Equipment Operated by Businesses by SIC Code Division

Industry Division	Has Forklifts Count (%)	Has Tow Tractors Count (%)	Has Sweeper/ Scrubbers Count (%)
Agriculture, Forestry, and Fishing	13 (1.1%)	2 (2.7%)	1 (0.6%)
Mining	8 (0.7%)	1 (1.4%)	1 (0.6%)
Construction	133 (11.1%)	9 (12.2%)	10 (6.2%)
Manufacturing	322 (27.0%)	12 (16.2%)	34 (21.1%)
Transportation, Communications, Electric, Gas, and Sanitary Services	148 (12.4%)	15 (20.3%)	25 (15.5%)
Wholesale Trade	250 (21.0%)	7 (9.5%)	34 (21.1%)
Retail Trade	127 (10.6%)	9 (12.2%)	13 (8.1%)
Finance, Insurance, and Real Estate	4 (0.3%)	1 (1.4%)	0 (0.0%)
Services	121 (10.1%)	12 (16.2%)	20 (12.4%)
Public Administration	30 (2.5%)	5 (6.8%)	20 (12.4%)
Nonclassifiable establishments	37 (3.1%)	1 (1.4%)	3 (1.9%)
Total	**1,193 (100.0%)**	**74 (100.0%)**	**161 (100.0%)**

A series of items on the survey instrument inquired about the level at which respondents were reporting their information. This approach was taken because it was originally thought that the level for which businesses would report would vary substantially (thought ultimately it did not). The first item asked whether the business being represented was a single location or part of a related group of businesses. Two thirds of businesses indicated they were operated as a single location (*n* = 779; 65.3%), while the other third noted they were part of a related group (*n* = 414; 34.7%). Seven representatives did not know how to answer this item.

Those who indicated they were part of a group or did not know the answer to the first item (*n* = 421) were asked whether purchasing decisions for the equipment being studied were done locally or at some other central location. Nearly three quarters (*n* = 297; 73.2%) noted these decisions were made at their site locally, and another 6.7% (*n* = 27) indicated they were made at that location which was also the central headquarters for the group of businesses. One in five (*n* = 82; 20.2%) expressed that these decisions were made at central headquarters elsewhere. All of these respondents confirmed that they

were able to answer questions regarding their location's fleet. Fifteen respondents indicated they did not know where decisions were made. Based on the known distribution of responses, it was presumed these businesses reported at the site level.

Those locations which were the headquarters themselves (*n* = 27) were asked to provide the number of sites (outside their own location) the headquarters made purchasing decisions for. The number of sites ranged from one (*n* = 5; 23.8%) to 65 (*n* = 1; 4.8%), with a mean of 13.3 sites and a median of 5. Six representatives did not know the number of sites. Those respondents who did know the number of sites (*n* = 21) noted how many of these sites were outside California. This value ranged from zero sites (*n* = 13; 65.0%) to 44 sites (*n* = 1; 5.0%), with a mean of 3.0 sites and a median of 0.[9] Those locations with sites in other states (*n* = 7) confirmed that they could provide either data for their own site (*n* = 3; 42.9%) or data for all sites within California (*n* = 4; 57.1%). Of those with no sites outside California (*n* = 13), slightly more than half (*n* = 7; 53.8%) indicated they were answering for just one location, while the remainder (*n* = 6; 46.2%) answered for all locations.

Given this information, it can be said that the vast majority of representatives provided data at the site level (*n* = 1,172; 97.7%). For one percent of the sample, statewide data was provided (*n* = 12; 1.1%). Based on the items detailed, reporting status was unclear for fifteen respondents (1.3%). However, these respondents were asked to provide site level data only.

[9] One respondent did not know the number of sites location outside California, and this respondent provided data for all locations, meaning some forklifts outside California may have been included in the data provided by this respondent.

PIECES OF EQUIPMENT IN SURVEY SAMPLE

The following three subsections detail the results of the survey sample of 1,200 businesses with respect to the forklifts, industrial tow tractors, and industrial sweeper/scrubbers they operate. The data presented varies slightly between sections due to differences in the questions asked for each equipment type on the survey instrument. Most notably, much more detailed information was sought regarding forklifts than for industrial tow tractors or sweeper/scrubbers.

FORKLIFTS

Of the 1,200 businesses that completed interviews, 1,194 (99.5%) indicated they operate at least one forklift. Of these, 1181 (98.9%) provided information at the single location level, while 12 (1.0%) provided information at the statewide level and the remaining business at the national level. This one business's representative then indicated that 100% of their forklifts were located within California.

The number of forklifts possessed by each company ranged from one (*n* = 418; 35.0%) to 500 (*n* = 1; 0.1%), with a mean of 7.1 and a median of 2 forklifts. Table 13 displays a more detailed distribution of the number of forklifts possessed by each business interviewed. As shown, more than two thirds (*n* = 819; 68.6%) of businesses had between one and three forklifts, more than a quarter (*n* = 325; 27.2%) had between four and 25, and the remainder (*n* = 50; 4.2%) had 26 or more. The total number of forklifts reported among all businesses was 8,463.

Table 13. Forklift Fleet Size of Businesses Interviewed

Number of Forklifts	Number of Businesses	% of Businesses
1	418	35.0%
2	254	21.3%
3	147	12.3%
4 – 25	325	27.2%
26 or more	50	4.2%
Total	**1,194**	**100.0%**

Table 14 shows the number of forklifts operated by businesses in the survey sample categorized by the region in which they operated. As shown, the distribution of businesses operating each fleet size was similar regardless of region, with minor and statistically insignificant differences.

Table 14. Forklift Fleet Size of Businesses Interviewed by Region

Number of Forklifts	Northern Region	Bay Area Region	Central Region	Southern Region	Overall
1	41 (40.6%)	107 (37.7%)	39 (34.8%)	231 (33.2%)	418 (35.1%)
2	16 (15.8%)	62 (21.8%)	20 (17.9%)	156 (22.4%)	254 (21.3%)
3	15 (14.9%)	26 (9.2%)	14 (12.5%)	92 (13.2%)	147 (12.3%)
4 – 25	25 (24.8%)	78 (27.5%)	32 (28.6%)	189 (27.2%)	324 (27.2%)
26 or more	4 (4.0%)	11 (3.9%)	7 (6.3%)	27 (3.9%)	49 (4.1%)
Total	**101 (100.0%)**	**284 (100.0%)**	**112 (100.0%)**	**695 (100.0%)**	**1,192 (100.0%)**

Table 15 displays information regarding the number of forklifts used by businesses by industry. As shown, those businesses in the area of transportation had the highest average number of forklifts (M = 12.30, n = 148), followed by those businesses operating in the wholesale trade (M = 10.62, n = 250). Companies operating in finance (M = 2.50, n = 4) and mining (M = 2.25; n = 8) had a much lower number of forklifts on average, as well as nonclassifiable establishments (M = 2.11; n = 37); $F(10, 71.14) = 3.36$, p = .001

Table 15. Forklift Fleet Size of Businesses Interviewed by Industry

Industry	Mean	Median	Minimum	Maximum	Sum	# of Bus.
Agriculture, Forestry, and Fishing	7.00	3.0	1	30	91	13
Mining	2.25	1.5	1	6	18	8
Construction	4.64	2.0	1	50	617	133
Manufacturing	4.31	2.0	1	80	1,389	322
Trans., Comm., Elec., Gas, and San. Services	12.30	3.0	1	500	1,821	148
Wholesale Trade	10.62	2.0	1	350	2,655	250
Retail Trade	5.65	2.0	1	125	717	127
Finance, Insurance, and Real Estate	2.50	1.5	1	6	10	4
Services	7.17	2.0	1	146	868	121
Public Administration	5.77	3.0	1	80	173	30
Nonclassifiable Establishments	2.11	1.0	1	28	78	37
Total	**7.06**	**2.0**	**1**	**500**	**8,437**[10]	**1,193**

As noted in the Sample Frame Development section of the current report, businesses called were selected at random from one of the four lists shown in Table 16. The table displays the forklift fleet size among businesses interviewed from each source. As shown, the mean forklift fleet size was highest among those businesses from the DOORS list (M = 13.01, n = 167), followed by those from the EDA (M = 6.44, n = 928) and DMV (M = 3.35, n = 69) files. The mean number of forklifts reported was lowest among those businesses taken from the BOE dataset (M = 2.63, n = 30); Welch's $F(3,139.4) = 9.09$, $p < .001$. However, the differences should be interpreted with caution since the proportions of businesses sampled from the DMV and BOE files were small compared to the other two sources. Nonetheless, these values of some possible insight into the differences between these sources.

[10] One businesses for which industry was not available had 26 forklifts, which reflects the overall number of forklifts reported of 8,463.

Table 16. Forklift Fleet Size of Businesses Interviewed by Sample Frame Source

Sample Frame Source	Mean	Median	Minimum	Maximum	Sum	# of Bus.
EDA	6.44	2.0	1	500	5,980	928
DMV	3.35	2.0	1	17	231	69
DOORS	13.01	4.0	1	250	2,173	167
BOE	2.63	1.0	1	35	79	30
Total	**7.09**	**2.0**	**1**	**500**	**8,463**	**1,194**

Representatives for the businesses interviewed indicated the number or percentage of their business' forklifts that were owned, leased, or rented (either for more or less than a year). Table 17 displays these results by the proportion of forklifts businesses have in each category. As shown, the vast majority of businesses (*n* = 977; 83.1%) owned all of their forklifts, while much smaller proportions leased all of their forklifts (*n* = 79; 6.7%) and rented them for less (*n* = 8; 0.7%) or more (*n* = 5; 0.4%) than a year.

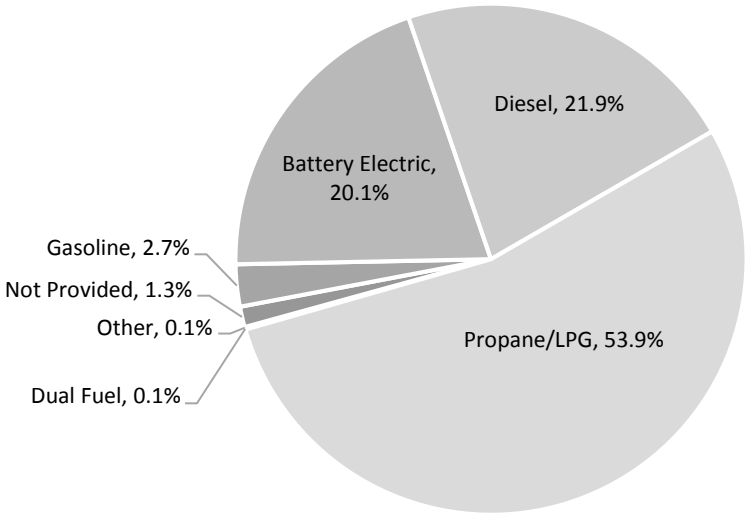
Table 17. Forklift Ownership Status among Businesses Interviewed

Percentage of Forklifts	…Owned Business Count (%)	…Leased Business Count (%)	….Rented for Less than a Year Business Count (%)	…Rented for More than a Year Business Count (%)
100%	977 (83.1%)	79 (6.7%)	8 (0.7%)	5 (0.4%)
76 – 99%	12 (1.0%)	6 (0.5%)	0 (0.0%)	0 (0.0%)
51 – 75%	32 (2.7%)	12 (1.0%)	4 (0.3%)	1 (0.1%)
26 – 50 %	49 (4.2%)	39 (3.3%)	5 (0.4%)	5 (0.4%)
1 – 25 %	10 (0.9%)	15 (1.3%)	8 (0.7%)	2 (0.2%)
None	95 (8.1%)	1,024 (87.1%)	1,150 (97.9%)	1,158 (98.9%)
Total	**1,175 (100.0%)**	**1,175 (100.0%)**	**1,174 (100.0%)**	**1,171 (100.0%)**

FUEL TYPES OF FORKLIFTS OPERATING IN CALIFORNIA

Representatives from businesses reported on the fuel type of their companies' forklifts. Of the 1,194 who indicated the number of forklifts their company had, 13 did not provide information on the type of fuel used by these forklifts. The fuel types were classified into six categories: diesel, LPG/propane, dual fuel, gasoline, battery powered, and other. Figure 2 shows the proportion of forklifts from each fuel type category as well as the proportion for which a fuel type was not provided. More than half of forklifts were fueled by propane/LPG (*n* = 4,563; 53.9%), followed by about one in five each powered by diesel (*n* = 1,851; 21.9%) and battery (*n* = 1,697; 20.1%). Much smaller proportions were gasoline fueled (*n* = 226; 2.7%), dual fuel powered (*n* = 7; 0.1%), and powered by some other means (*n* = 6; 0.1%). Fuel type information was not available for 113 of the forklifts reported (1.3%).

Figure 2. Proportion of Forklifts by Fuel Type



PROPANE/LPG FORKLIFTS

Table 18 shows the distribution of the number of propane/LPG forklifts operated among those businesses operating any type of forklift. The number of propane/LPG forklifts each company had ranged from zero (*n* = 293; 24.8%) to 280 (*n* = 1; 0.1%), with a mean of 3.9 and a median of 1 propane/LPG forklifts. The total number of propane/LPG forklifts among businesses interviewed was 4,563, or 53.9% of all forklifts.

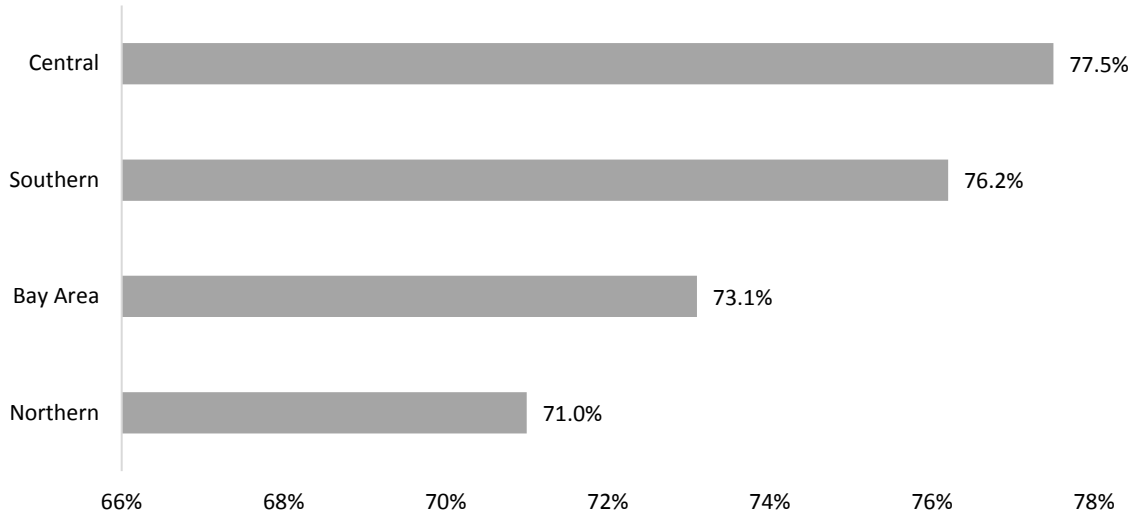
Table 18. Propane/LPG Forklift Fleet Size of Businesses Interviewed

Number of Propane/LPG Forklifts	Number of Businesses	% of Businesses
0	293	24.8%
1	373	31.6%
2	218	18.5%
3	92	7.8%
4 – 25	182	15.4%
26 or more	23	1.9%
Total	**1,181**	**100.00%**

Figure 3 shows the proportion of businesses with forklifts in each region that operate propane/LPG forklifts.[11] In Central (*n* = 86; 77.5%) and Southern California (*n* = 522; 76.2%), more than three quarters of forklift-operating businesses had propane/LPG forklifts. In the Bay Area, 73.1% (*n* = 207) operated propane/LPG forklifts, and 71.0% (*n* = 71) did in Northern California. The differences between regions were not statistically significant.

[11] There were no statistically significant differences in possession of propane/LPG forklifts by region.

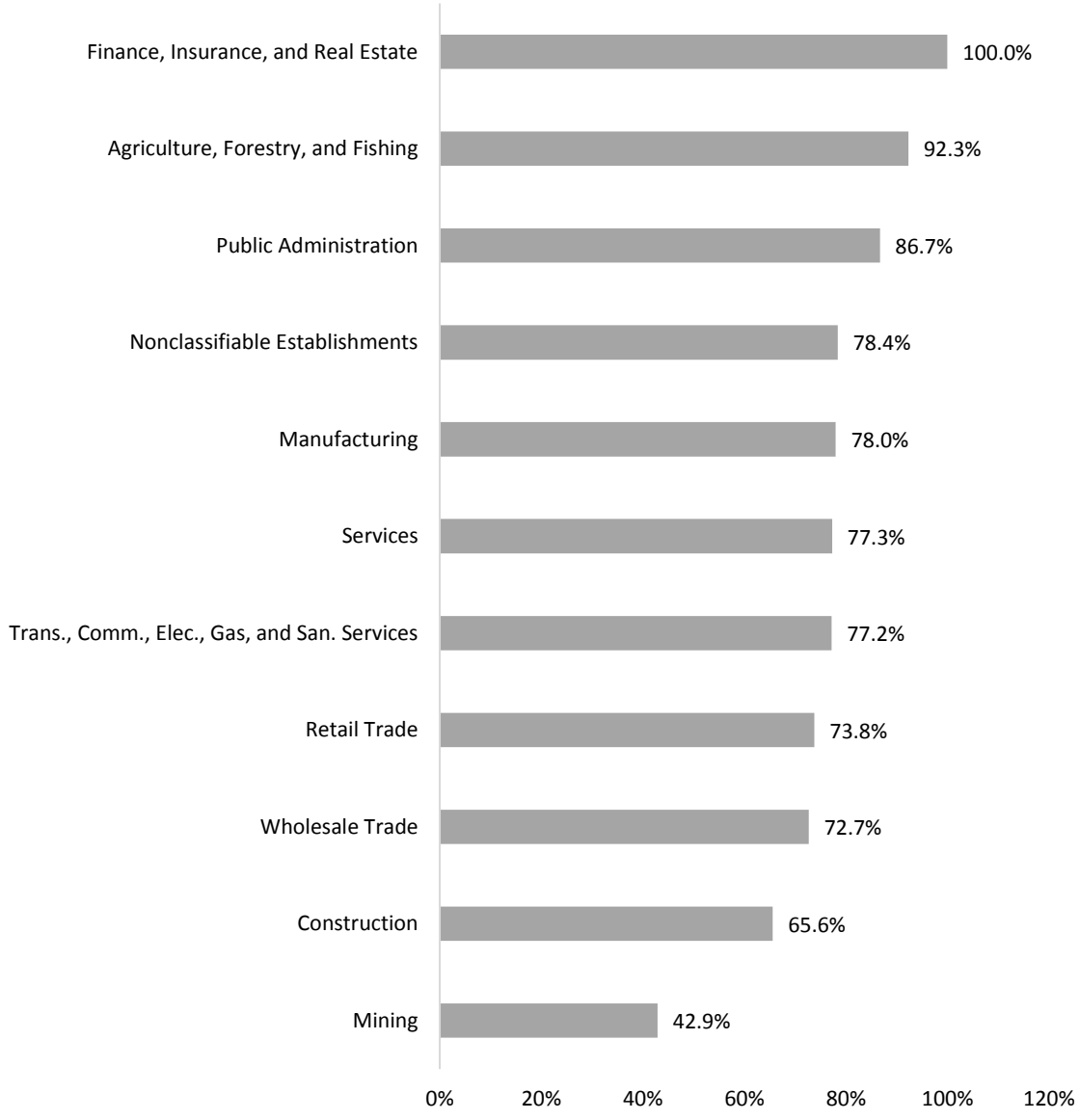
Figure 3. Proportion of Forklift-Utilizing Businesses with Propane/LPG Forklifts by Region



The percentage of businesses with forklifts that had propane/LPG forklifts in their fleets varied somewhat by industry (See Figure 4). All (*n* = 4; 100.0%) businesses in the field of finance with forklifts had propane/LPG forklifts, and nearly all of those in agriculture (*n* = 12; 92.3%) did. Conversely, a smaller proportion of forklift-utilizing businesses in construction (*n* = 87; 65.9%) and less than half (*n* = 3; 42.9%) of companies in mining had propane/LPG forklifts; $\chi^2(10) = 18.60$, $p = .046$.[12]

[12] These results are not completely reliable because certain categories had low overall counts (namely, agriculture, mining, and finance).

Figure 4. Proportion of Forklift-Utilizing Businesses with Propane/LPG Forklifts by Industry



The number of propane/LPG forklifts reported by businesses in the survey sample varied significantly by sample frame source of those businesses as shown in Table 19. The average number of propane/LPG forklifts was highest among those businesses from the DOORS (M = 6.33; n = 165) and EDA (M = 3.66; n = 918) files. Among those businesses from the BOE file, this value was slightly lower (M = 2.03; 30). Businesses from the DMV file had 1.45 propane/LPG powered forklifts on average (n = 69); Welch's $F(3,124.7) = 7.23$, $p < .001$.

Table 19. Propane/LPG Forklift Fleet Size of Businesses Interviewed by Sample Frame Source

Sample Frame Source	Mean	Median	Minimum	Maximum	Sum	# of Bus.
EDA	3.66	1.0	0	280	3,359	918
DMV	1.45	1.0	0	12	100	69
DOORS	6.33	1.0	0	250	1,045	165
BOE	2.03	1.0	0	30	59	29
Total	**3.86**	**1.0**	**0**	**280**	**4,563**	**1,181**

Respondents from businesses with propane/LPG forklifts indicated the number of such forklifts in each horsepower category. Less than half (*n* = 417; 47.0%) of the 888 businesses with propane/LPG forklifts provided valid answers for at least one of these categories. Because of this high level of nonresponse, information on horsepower was available for less than half (*n* = 2,028; 44.4%) of the 4,563 propane/LPG forklifts. Table 20 shows information on the number of propane/LPG forklifts in each horsepower category. As shown, there were 1,159 propane/LPG forklifts with less than 51 horsepower (57.1%), 738 with between 51 and 70 horsepower (36.4%), and 131 with more than 70 horsepower (6.5%).

Table 20. Horsepower of Propane/LPG Forklifts in the Survey Sample

Horsepower Category	Number of Businesses	Percentage of Businesses	Number of Forklifts	Percentage of Forklifts	Mean Propane/LPG Forklifts in Category
< 51 HP	296	71.0%	1,159	57.1%	2.79
51 – 70 HP	97	23.3%	738	36.4%	1.81
> 70 HP	45	10.8%	131	6.5%	0.32
Total	**417**[13]	**--**	**2,028**	**100.0%**	**--**

Among the 45 businesses with at least one propane/LPG forklift over 70 horsepower, 23 (51.1%) provided the average horsepower of these forklifts. The average horsepower ranged from 75 (*n* = 1; 4.3%) to 250 (*n* = 1; 4.3%), with a mean value of 111.4 horsepower and a median of 98 horsepower.

Representatives of companies with propane/LPG forklifts also noted the lift capacities of these forklifts. Information for at least one lift capacity category was provided by 89.2% (*n* = 792) of the 888 businesses with propane/LPG forklifts. Thus, information was available for 84.6% (*n* = 3,860) of the 4,563

[13] The values in this column do not sum to the total because some businesses had lifts in multiple categories. This is also the reason the percentages do not sum to 100.

propane/LPG forklifts. Table 21 shows information on the number of propane/LPG forklifts in each lift capacity category. As shown, there were 2,392 propane/LPG forklifts with a lift capacity under 5,001 pounds (62.0%), 1,157 with capacities between 5,001 and 8,000 pounds (30.0%), and 311 with capacities over 8,000 pounds (8.0%).

Table 21. Lift Capacity of Propane/LPG Forklifts in the Survey Sample

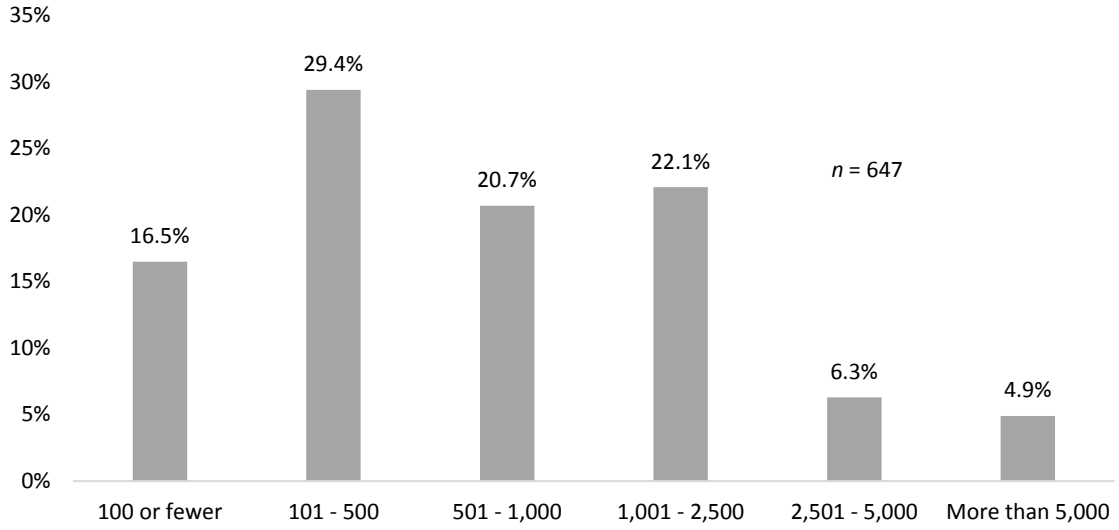
Lift Capacity Category	Number of Businesses	Percentage of Businesses	Number of Forklifts	Percentage of Forklifts	Mean Propane/LPG Forklifts in Category
< 5,001 lbs.	588	74.2%	2,392	62.0%	3.02
5,001 – 8,000 lbs.	251	31.7%	1,157	30.0%	1.47
> 8,000 lbs.	86	10.9%	311	8.0%	0.39
Total	**792**[14]	--	**3,860**	**100.0%**	--

Of the 86 businesses with at least one propane/LPG forklift with a lift capacity over 8,000 pounds, 65 (75.6%) gave the average lift capacity of these forklifts. The average capacity ranged from 8,000 (*n* = 5; 7.7%) to 65,000 (*n* = 1; 1.5%), with a mean capacity of 15,755 pounds and a median of 10,000 pounds.

Those companies with propane/LPG forklifts gave feedback regarding the average number of hours these forklifts were operated each year. Slightly less than three quarters (*n* = 647; 72.9%) of representatives provided this information; 32.6% (*n* = 211) provided an average and 67.4% (*n* = 436) gave the number of hours for each forklift. The mean number of hours propane/LPG forklifts were operated each year ranged from 1 (*n* = 1; 0.2%) to 8,760 (*n* = 17; 2.6%), with a mean of 1,221 and a median of 520. A more detailed illustration of the mean number of hours propane/LPG forklifts operated each year is shown in Figure 5: nearly a third of companies (*n* = 190; 29.4%) operated their propane/LPG forklifts between 101 and 500 hours per year. The sum of hours all propane/LPG forklifts operated per year was 6,327,294.

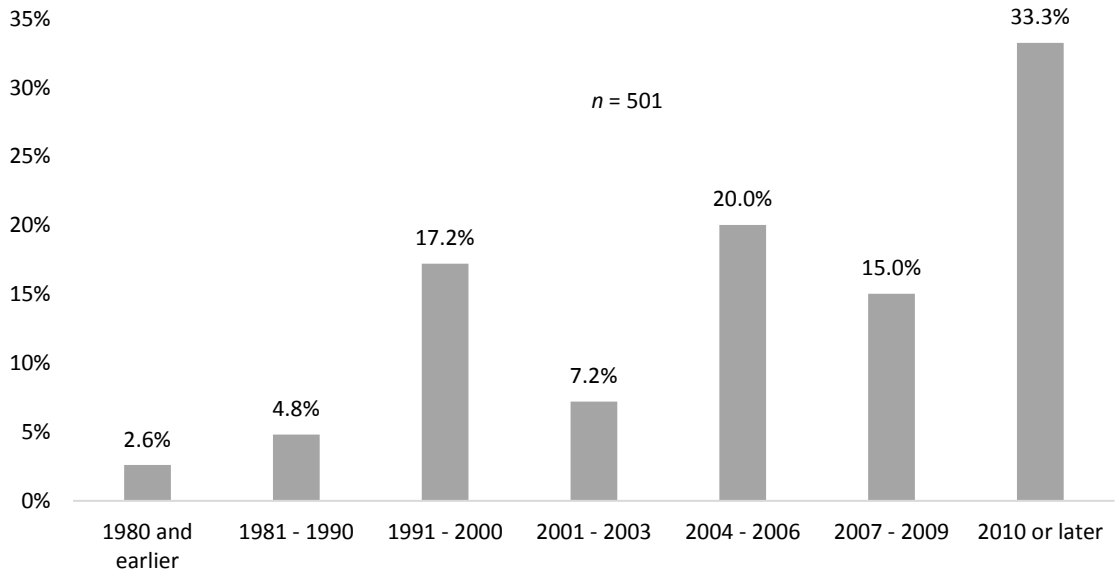
[14] The values in this column do not sum to the total because some businesses had lifts in multiple categories. This is also the reason the percentages do not sum to 100.

Figure 5. Mean Number of Hours
Propane/LPG Forklifts Operate Annually



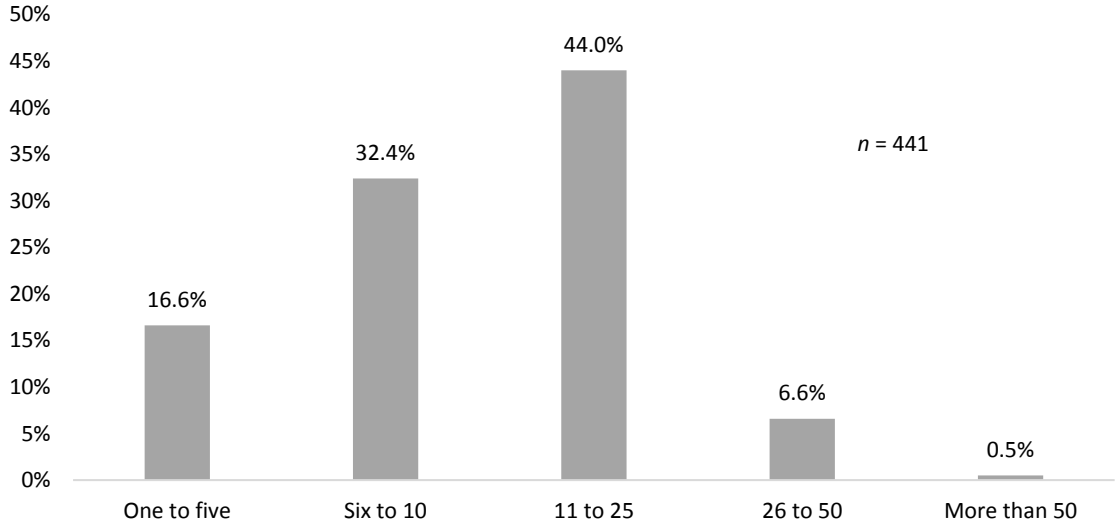
Businesses with propane/LPG forklifts indicated the average model year of these forklifts. Slightly more than half (*n* = 501; 56.4%) of respondents had this information: 60.3% (*n* = 302) gave an average and 39.7% (*n* = 199) gave the model year for each forklift. The mean model year of propane/LPG forklifts ranged from 1949 (*n* = 2; 0.4%) to 2016 (*n* = 7; 1.4%), with a mean of 2005 and a median of 2006. Figure 6 displays the distribution of the mean model year of propane/LPG forklifts in the survey sample. As shown, one third of businesses (*n* =167; 33.3%) had propane/LPG forklifts with average model years of 2010 or later.

Figure 6. Mean Model Year of Propane/LPG Forklifts



Finally, a total of 441 of the 888 (49.7%) representatives from businesses with propane/LPG forklifts provided information on the number of years these forklifts operate on average before being retired. The mean number of years of operation before retirement for such forklifts ranged from 1 (*n* = 3; 0.7%) to 80 (*n* = 1; 0.2%), with a mean of 14.0 years and a median of 12. Figure 7 shows a more detailed distribution of the average years before retirement for propane/LPG forklifts in the survey sample. As shown, the greatest proportion of businesses (*n* = 194; 44.0%) operated propane/LPG forklifts between 11 and 25 years.

Figure 7. Average Years of Operation Before Retirement for Propane/LPG Forklifts



DIESEL FORKLIFTS

Table 22 shows the distribution of the number of diesel forklifts operated among those companies operating any type of forklift. The number of diesel forklifts each company had ranged from zero (*n* = 907; 76.8%) to 300 (*n* = 1; 0.1%), with a mean of 1.6 and a median of 0 diesel forklifts. The total number of diesel forklifts among businesses interviewed was 1,851, or 21.9% of the overall 8,463 forklifts.

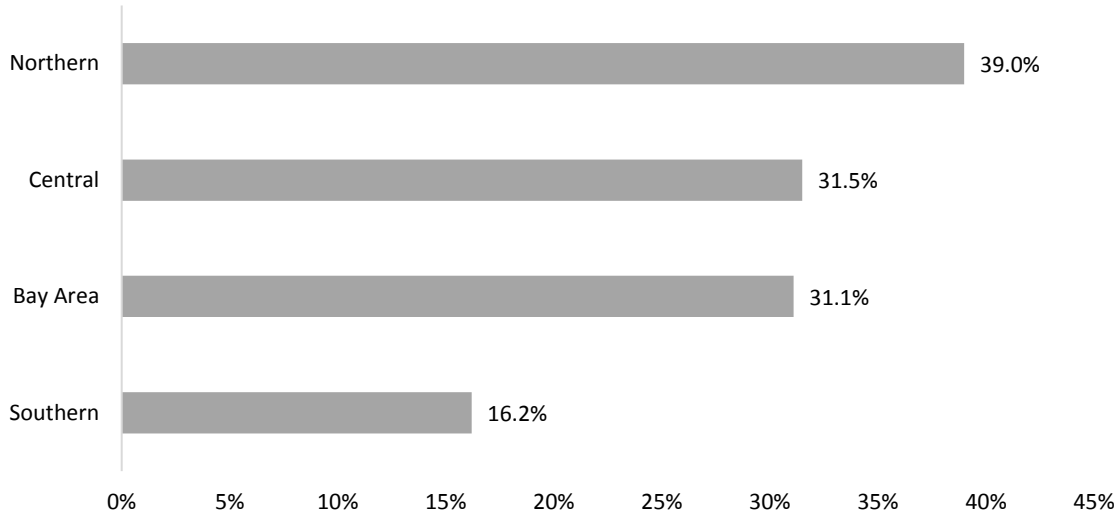
Table 22. Diesel Forklift Fleet Size of Businesses Interviewed

Number of Diesel Forklifts	Number of Businesses	% of Businesses
0	907	76.8%
1	101	8.6%
2	57	4.8%
3	28	2.4%
4 – 25	76	6.4%
26 or more	12	1.0%
Total	**1,181**	**100.00%**

Among the 1,179[15] businesses providing information on forklift fuel type, it was found that the proportion of businesses with diesel forklifts varied by region, as shown in Figure 8. Utilization of diesel forklifts was highest in the Northern California region, with 39.0% (*n* = 39) of these businesses having diesel forklifts in their fleets. Similar proportions of companies in the Bay Area (*n* = 88; 31.1%) and Central California (*n* = 35; 31.5%) had diesel forklifts, while a much smaller percentage of those in Southern California (*n* = 111; 16.2%) did; $\chi^2(3) = 47.11$, $p < .001$.

[15] Region could not be determined for two businesses.

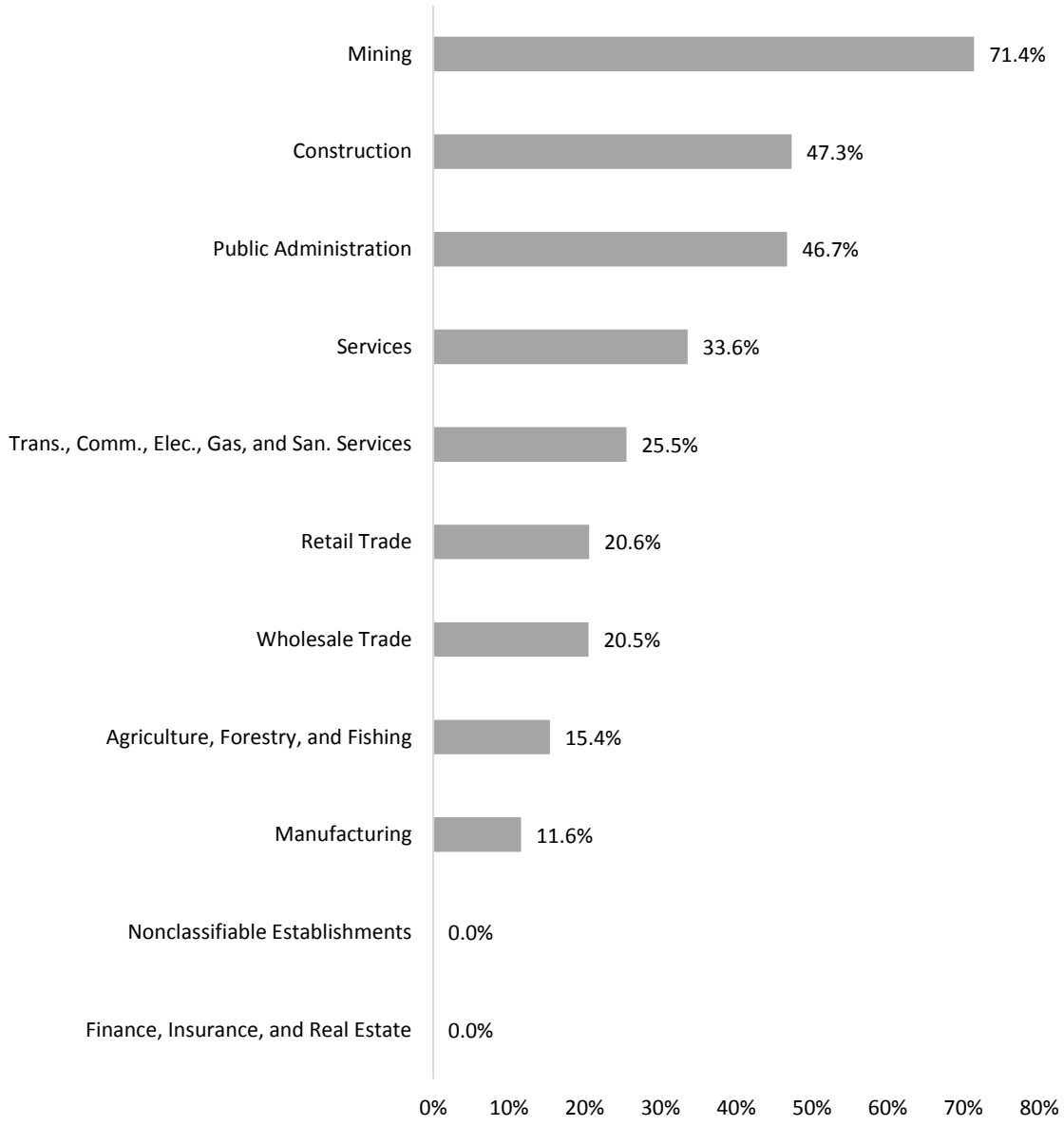
Figure 8. Proportion of Forklift-Utilizing Businesses with Diesel Forklifts by Region



The proportion of forklift-using businesses that had diesel forklifts in their fleets also varied by industry. As shown in Figure 9, nearly three quarters of those businesses involved in mining had diesel forklifts (n = 5; 71.4%), followed by nearly half of those in both construction (n = 62; 47.0%) and public administration (n = 14; 46.7%). Conversely, none of those businesses in the financial (n = 0; 0.0%) and nonclassifiable (n = 0; 0.0%) categories used diesel forklifts; $\chi^2(10) = 106.08$, $p < .001$.[16]

[16] These results are not completely reliable because certain categories had low overall counts (namely, agriculture, mining, finance, and nonclassifiable establishments).

Figure 9. Proportion of Forklift-Utilizing Businesses with Diesel Forklifts by Industry



The number of diesel forklifts reported by businesses in the survey sample varied significantly by sample frame source of those businesses as shown in Table 23. The average number of forklifts was highest among those businesses from the DOORS file (M = 4.23; n = 165), as might be expected given the fact that this source contains only businesses with at least one piece of diesel equipment. This value was much lower for businesses from the EDA (M = 1.17; n = 918), DMV (M = 0.96; n = 69), and BOE (M = 0.21; n = 29) files; Welch's $F(3,266.0) = 15.96$, $p < .001$.

Table 23. Diesel Forklift Fleet Size of Businesses Interviewed by Sample Frame Source

Sample Frame Source	Mean	Median	Minimum	Maximum	Sum	# of Bus.
EDA	1.17	0.0	0	300	1,072	918
DMV	0.96	0.0	0	7	66	69
DOORS	4.28	2.0	0	80	707	165
BOE	0.21	0.0	0	2	6	29
Total	**1.57**	**0.0**	**0**	**300**	**1,851**	**1,181**

Representatives from those companies with diesel forklifts indicated the number of diesel forklifts in each of the following categories: less than 51 horsepower, 51 to 70 horsepower, and more than 70 horsepower. Only two thirds (*n* = 180; 65.7%) of the 274 businesses with diesel forklifts provided valid answers for at least one of these categories. Because of this high level of nonresponse, information on horsepower was available for only about half (*n* = 999; 54.0%) of the 1,851 diesel forklifts. Table 24 shows information on the number of diesel forklifts in each horsepower category. As shown, there were 262 diesel forklifts with less than 51 horsepower (26.2%), 283 with between 51 and 70 horsepower (28.3%), and 454 with more than 70 horsepower (45.5%).

Table 24. Horsepower of Diesel Forklifts in the Survey Sample

Horsepower Category	Number of Businesses	Percentage of Businesses	Number of Forklifts	Percentage of Forklifts	Mean Diesel Forklifts in Category[17]
< 51 HP	82	45.6%	262	26.2%	1.52
51 – 70 HP	61	33.9%	283	28.3%	1.65
> 70 HP	65	36.1%	454	45.5%	2.65
Total	**180[18]**	**--**	**999**	**100.0%**	**--**

[17] This value is the mean number of forklifts operated by businesses that operate diesel forklifts and provided information on the horsepower of these lifts. The structure of this table is replicated in tables for the horsepower and lift capacities of all fuel types.

[18] The values in this column do not sum to the total because some businesses had lifts in multiple categories. This is also the reason the percentages do not sum to 100.

Among the 65 businesses with at least one diesel forklift over 70 horsepower, 43 (66.2%) provided the average horsepower of these forklifts. The average horsepower ranged from 74 (*n* = 1; 2.3%) to 400 (*n* = 1; 2.3%), with a mean value of 134.4 horsepower and a median of 110 horsepower.

Respondents from companies with diesel forklifts also noted the lift capacities of their diesel forklifts, designating these forklifts as having a capacity less than 5,001 pounds, 5,001 to 8,000 pounds, or more than 8,000 pounds. Information for at least one lift capacity category was provided by 92.0% (*n* = 252) of the 274 businesses with diesel forklifts. Thus, information was available for 83.3% (*n* = 1,542) of the 1,851 diesel forklifts. Table 25 shows information on the number of diesel forklifts in each lift capacity category. As shown, there were 248 diesel forklifts with a lift capacity under 5,001 pounds (16.1%), 465 with capacities between 5,001 and 8,000 pounds (30.2%), and 829 with capacities over 8,000 pounds (53.8%).

Table 25. Lift Capacity of Diesel Forklifts in the Survey Sample

Lift Capacity Category	Number of Businesses	Percentage of Businesses	Number of Forklifts	Percentage of Forklifts	Mean Diesel Forklifts in Category
< 5,001 lbs.	89	35.3%	248	16.1%	0.99
5,001 – 8,000 lbs.	102	40.5%	465	30.1%	1.88
> 8,000 lbs.	122	48.4%	829	53.8%	3.32
Total	**252**[19]	--	**1542**	**100.0%**	--

Of the 122 businesses with at least one diesel forklift with a lift capacity over 8,000 pounds, 98 (80.3%) gave the average lift capacity of these forklifts. The average capacity ranged from 8,000 (*n* = 8; 8.2%) to 50,000 (*n* = 2; 2.0%), with a mean capacity of 16,766 pounds and a median of 12,375 pounds.

Businesses with diesel forklifts provided information on the average number of hours these forklifts were operated each year. If the businesses had fewer than four forklifts, the representative had the option to provide information on each forklift. For the current report's purposes, these figures are presented as averages.[20] Nearly three quarters of representatives provided this information (*n* = 200; 73.0%), with 52.0% (*n* = 104) providing an average and 48.0% (*n* = 96) giving the number of hours for each forklift. The mean number of hours diesel forklifts were operated each year ranged from 10 (*n* = 3; 1.5%) to 8,760[21] (*n* = 4; 2.0%), with a mean of 1,005 and a median of 500. Figure 10 shows a more detailed distribution of the mean number of hours diesel forklifts were operated each year. As shown,

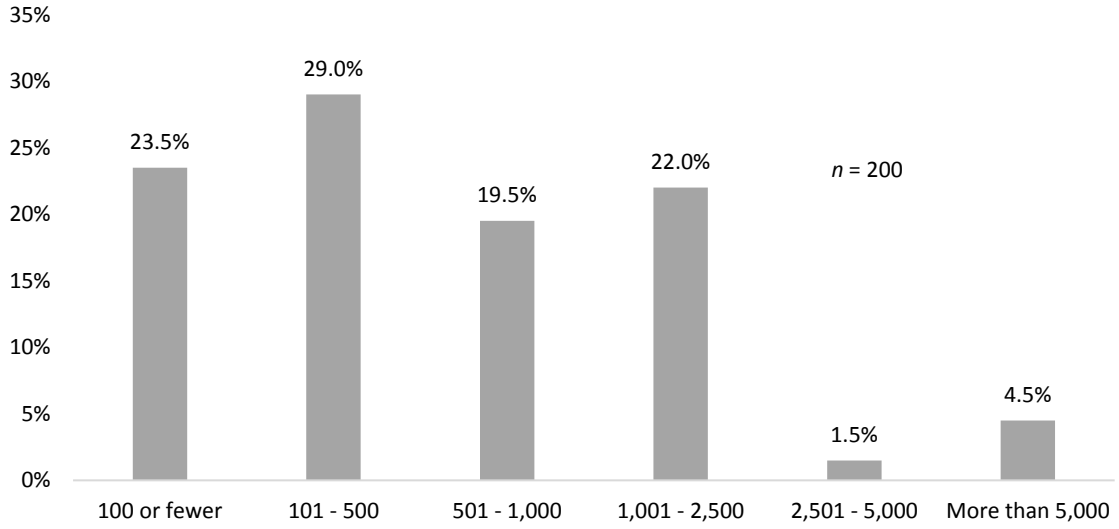
[19] This value is the mean number of forklifts operated by businesses that operate diesel forklifts and provided information on the horsepower of these lifts. The structure of this table is replicated in tables for the horsepower and lift capacities of all fuel types.

[20] If the businesses had only one forklift, the value provided is not an average, but the number of hours this individual forklift was operated.

[21] Some representatives provided a value in excess of 8,760, which is the maximum number of hours a forklift could be operated within one year. These values were adjusted downward to the possible maximum of 8,760.

the largest proportion of businesses (*n* = 58; 29.0%) operated their diesel forklifts between 101 and 500 hours per year. The total number of hours all diesel forklifts in the survey sample operated annually was 1,791,374.

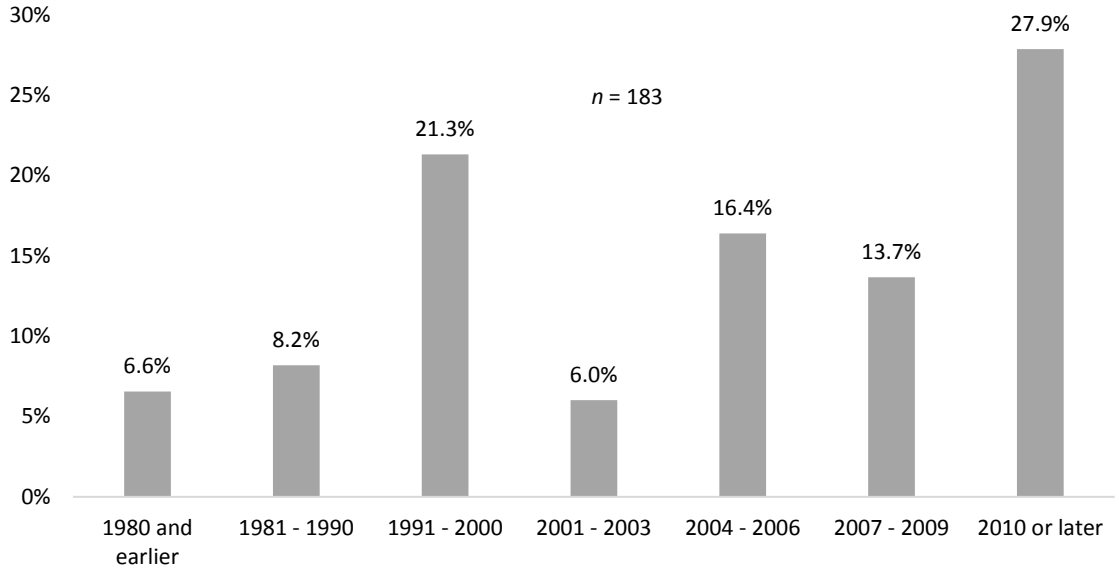
Figure 10. Mean Number of Hours Diesel Forklifts Operate Annually



Companies with diesel forklifts also provided information on the average model year of these forklifts. As with the number of hours forklifts were operated, representatives from companies with fewer than four forklifts could provide information for each one.[22] Two thirds of representatives had this information (*n* = 183; 66.8%), with 60.1% (*n* = 110) providing an average and 39.9% (*n* = 73) giving the model year for each forklift. The mean model year of diesel forklifts ranged from 1952 (*n* = 1; 0.5%) to 2016 (*n* = 2; 1.1%), with a mean of 2002 and a median of 2005. Figure 11 shows a more detailed distribution of the mean model year of diesel forklifts in the survey sample. As shown, the greatest proportion of businesses (*n* = 58; 29.0%) had diesel forklifts with average model years of 2010 or later.

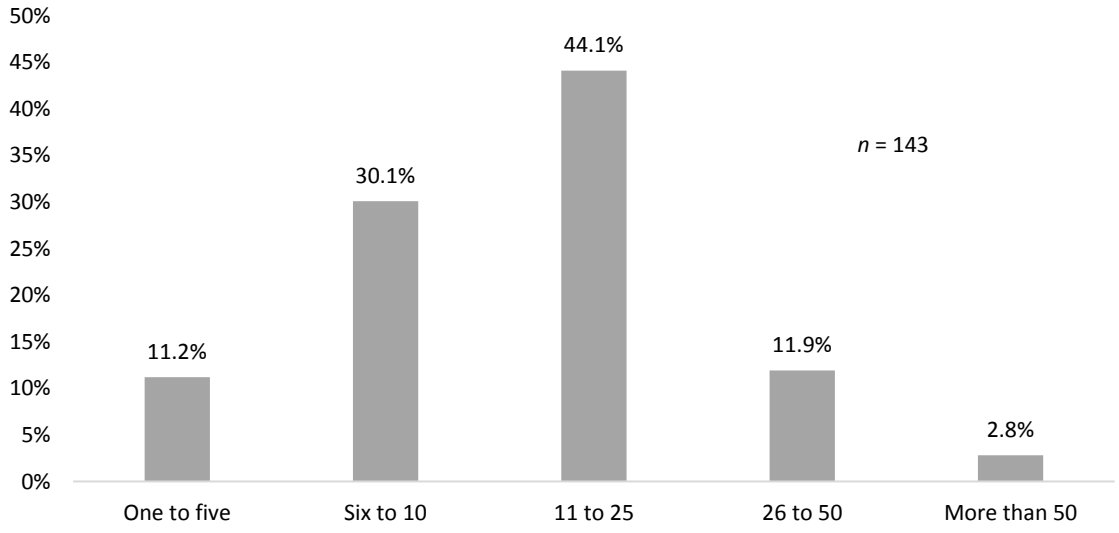
[22] As with hours of operation, these figures are provided as averages in this report.

Figure 11. Mean Model Year of Diesel Forklifts



Finally, a total of 143 of the 274 (52.2%) representatives from businesses with diesel forklifts provided information on the number of years these forklifts operate on average before being retired. The mean number of years of operation before retirement for diesel forklifts ranged from 1 (*n* = 2; 1.4%) to 75 (*n* = 1; 0.7%), with a mean of 17.3 years and a median of 15. Figure 12 shows a more detailed distribution of the average years before retirement for diesel forklifts in the survey sample. As shown, the greatest proportion of businesses (*n* = 63; 44.1%) operated diesel forklifts between 11 and 25 years.

Figure 12. Average Years of Operation Before Retirement for Diesel Forklifts



BATTERY POWERED FORKLIFTS

Table 26 shows the distribution of the number of battery electric forklifts operated among those businesses operating any type of forklift. The number of battery powered forklifts each company had ranged from zero (*n* = 880; 74.5%) to 100 (*n* = 1; 0.1%), with a mean of 1.4 and a median of 0 battery electric forklifts. The total number of battery forklifts among businesses interviewed was 1,697.

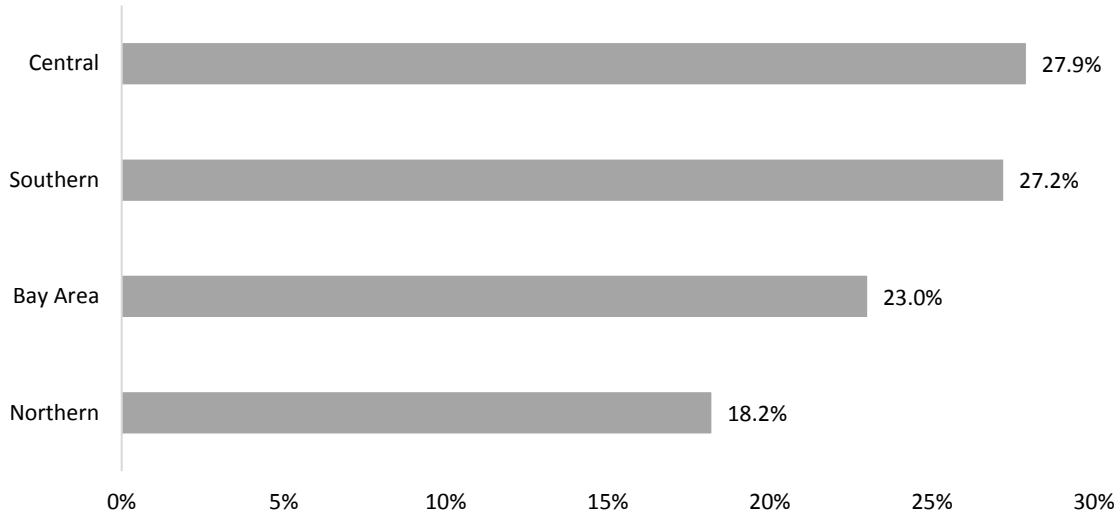
Table 26. Battery Powered Forklift Fleet Size of Businesses Interviewed

Number of Battery Forklifts	Number of Businesses	% of Businesses
0	880	74.5%
1	140	11.9%
2	64	5.4%
3	17	1.4%
4 – 25	63	5.3%
26 or more	17	1.4%
Total	**1,181**	**100.0%**

The proportion of forklift utilizing businesses in each region that operate battery forklifts is shown in Figure 13. More than a quarter of such companies in Central (*n* = 31; 27.9%) and Southern California (*n* = 186; 27.2%) had battery powered forklifts. In the Bay Area, less than a quarter (*n* = 65; 23.0%) had such forklifts, and about one in five (*n* = 18; 18.2%) in Northern California did.[23]

[23] There were no statistically significant differences in possession of battery powered forklifts by region.

Figure 13. Proportion of Forklift-Utilizing Businesses with Battery Forklifts by Region



The proportion of businesses with forklifts that had battery powered forklifts in their fleets differed by industry (See Figure 14). In the wholesale trade, more than a third of businesses with forklifts had battery powered ones (n = 86; 34.5%), followed by slightly less than a third (n = 9; 30.0%) in public administration. conversely, only 6.1% (n = 8) of construction businesses and none (n = 0; 0.0%) of those companies in finance and mining had battery powered forklifts; $\chi^2(10) = 43.26$, $p < .001$.[24]

[24] These results are not completely reliable because certain categories had low overall counts (namely, agriculture, mining, and finance).

Figure 14. Proportion of Forklift-Utilizing Businesses with Battery Powered Forklifts by Industry

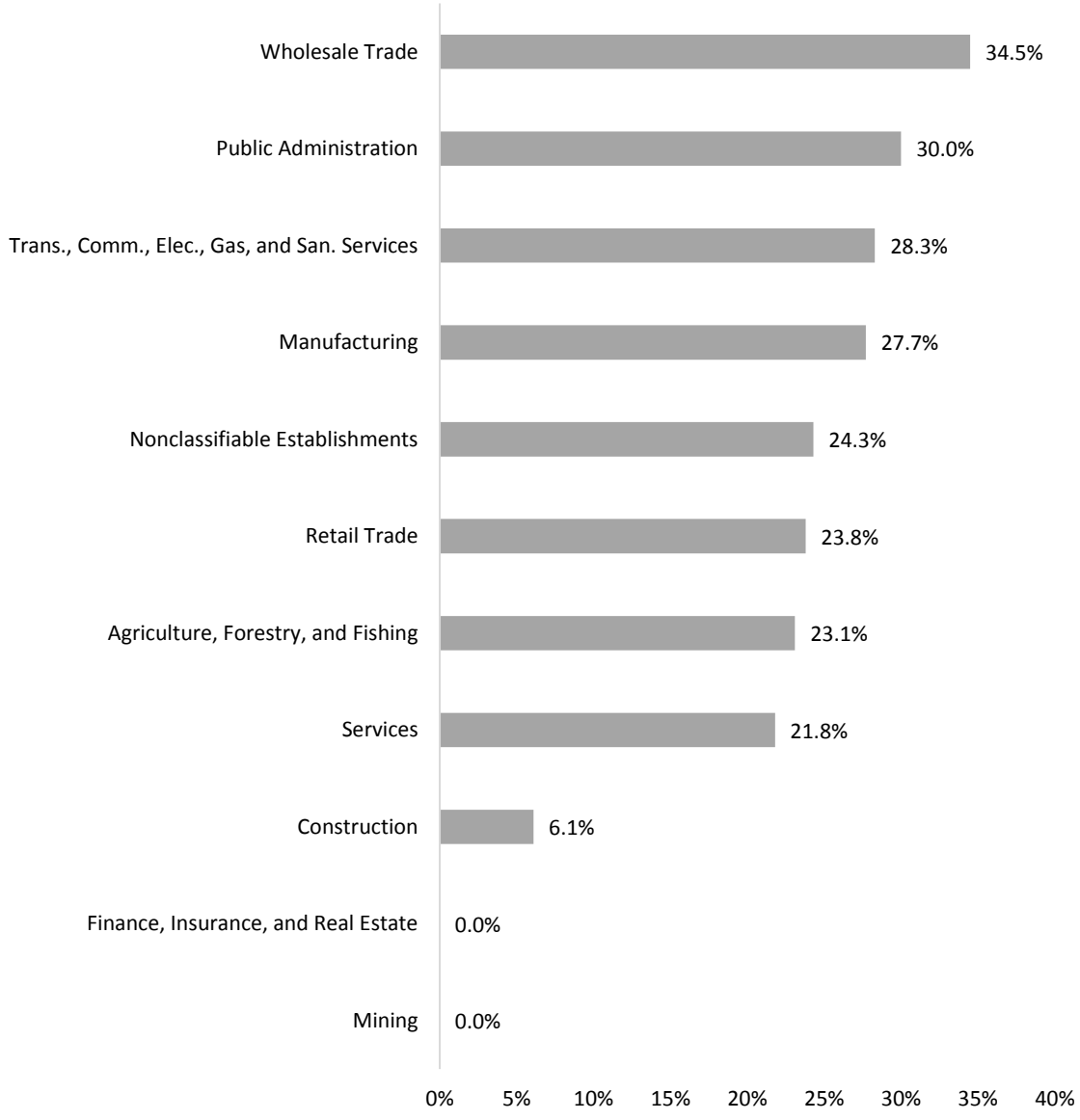


Table 27 shows the number of battery powered forklifts reported by businesses in the survey sample by sample frame source. Unlike other forklift fuel types, the sample frame source with the greatest number of battery powered forklifts was not DOORS, but EDA (*M* = 1.57; *n* = 918). However, businesses from the DOORS file did have the second highest mean battery powered lifts (*M* = 1.22; *n* = 165), followed by businesses from the DMV (*M* = 0.59; *n* = 69) and BOE (*M* = 0.34; *n* = 29) files; however, contrary to other forklift fuel types, these differences were not statistically significant.

Table 27. Battery Electric Forklift Fleet Size of Businesses Interviewed by Sample Frame Source

Sample Frame Source	Mean	Median	Minimum	Maximum	Sum	# of Bus.
EDA	1.57	0.0	0	100	1,445	918
DMV	0.59	0.0	0	10	41	69
DOORS	1.22	0.0	0	40	201	165
BOE	0.34	0.0	0	5	10	29
Total	**1.44**	**0.0**	**0**	**100**	**1,697**	**1,181**

Representatives from companies with battery-powered forklifts noted the number of forklifts in each lift capacity category. Nine in ten (*n* = 271; 90.0%) of the 301 businesses with battery powered forklifts provided valid answers for at least one of these categories. Lift capacity data was available for 79.2% (*n* = 1,345) of the 1,697 battery powered forklifts. Table 28 shows information on the number of forklifts in each lift capacity category. Overall, there were 994 battery-powered forklifts with capacities less than 5,000 pounds (73.9%), 332 between 5,001 and 8,000 pounds (24.7%), and 19 above 8,000 pounds (1.4%).

Table 28. Lift Capacity of Battery Powered Forklifts in the Survey Sample

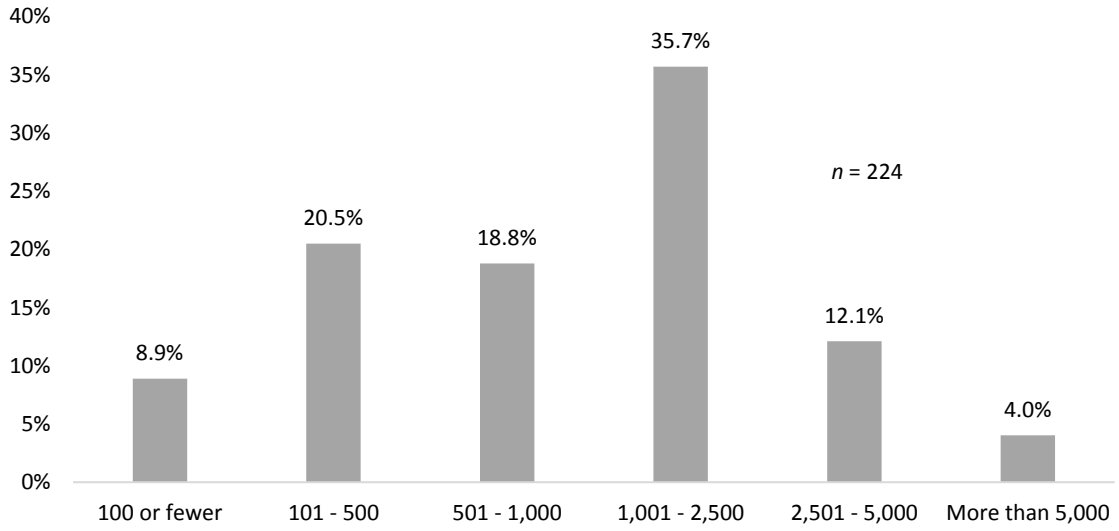
Lift Capacity Category	Number of Businesses	Percentage of Businesses	Number of Forklifts	Percentage of Forklifts	Mean Battery Forklifts in Category
< 5,001 lbs.	220	81.2%	994	73.9%	3.70
5,001 – 8,000 lbs.	64	23.6%	332	24.7%	1.23
> 8,000 lbs.	11	4.1%	19	1.4%	0.07
Total	**271**[25]	**--**	**1345**	**100.0%**	**--**

Respondents who worked for companies with battery electric forklifts in their fleets were asked to provide the maximum lift capacity of forklifts in their fleet. About two thirds (*n* = 203; 67.4%) of respondents from companies with battery operated forklifts provided this information. Answers ranged from 880 (*n* = 1; 0.5%) to 25,000 pounds (*n* = 1; 0.5%), with a mean of 4,918 pounds and a median of 4,500.

[25] The values in this column do not sum to the total because some businesses had lifts in multiple categories. This is also the reason the percentages do not sum to 100.

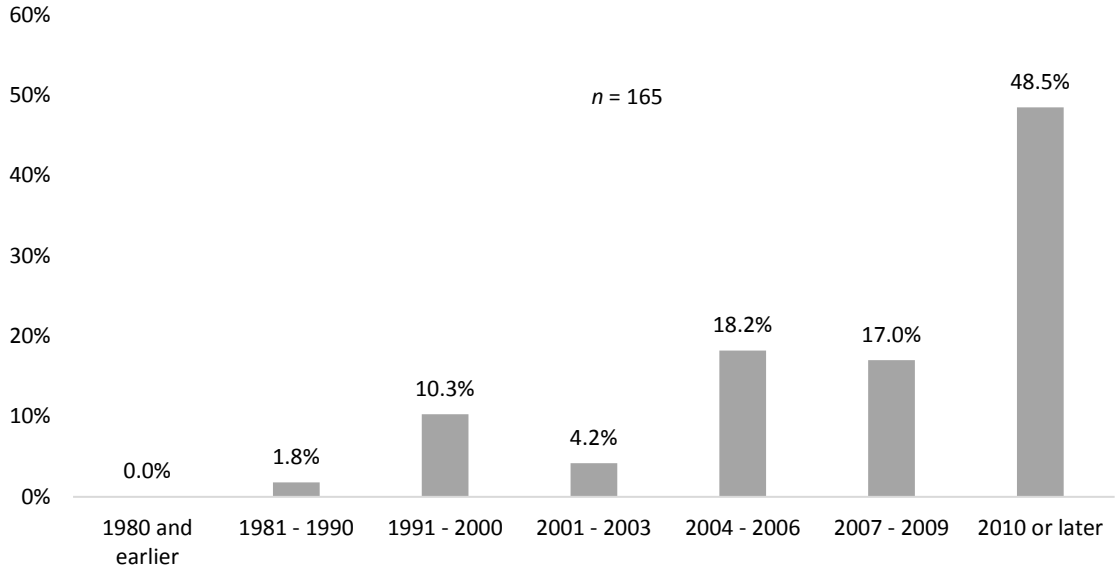
Representatives from companies with battery-powered forklifts gave information about the average number of hours these forklifts were operated each year. Three quarters (*n* = 224; 74.4%) of respondents provided this information, with 43.7% (*n* = 98) providing an average and 56.3% (*n* = 126) giving the number of hours for each forklift. Battery powered forklifts operated between four (*n* = 1; 0.4%) and 8,760 (*n* = 5; 2.2%) hours per year, with a mean of 1,562 and a median of 1,040. A more detailed depiction of the mean number of hours battery powered forklifts operated each year is displayed in Figure 15. As shown, more than a third of companies (*n* = 80; 35.7%) operated their battery electric forklifts between 1,001 and 5,000 hours per year. The sum of hours all battery electric forklifts operated per year was 3,067,473.

Figure 15. Mean Number of Hours
Battery Powered Forklifts Operate Annually



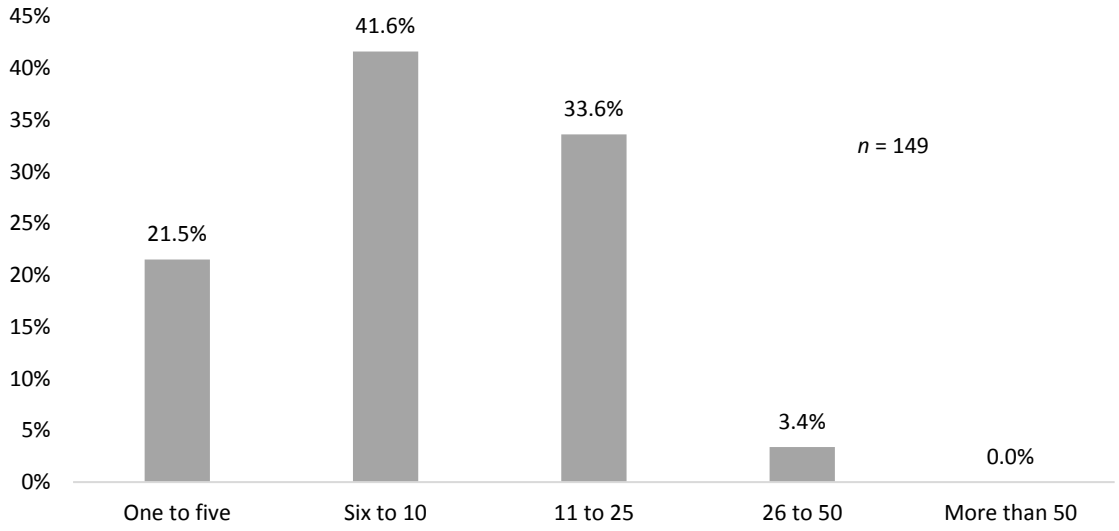
Employees from companies with battery electric forklifts indicated the average model year of these forklifts. More than half (*n* = 165; 54.8%) of representatives had this information, with 60.6% (*n* = 100) providing an average and 39.4% (*n* = 65) giving the model year for each forklift. The mean model year of battery powered forklifts ranged from 1982 (*n* = 1; 0.6%) to 2016 (*n* = 2; 1.2%), with a mean of 2008 and median of 2009. Figure 16 displays the distribution of the mean model year of battery electric forklifts in the survey sample. Nearly half of companies (*n* =80; 48.5%) had battery powered forklifts with average model years of 2010 or later.

Figure 16. Mean Model Year of Battery Powered Forklifts



Lastly, a total of 149 of the 301 (49.5%) respondents from businesses with battery powered forklifts provided information on the number of years these forklifts operate on average before being retired. The mean number of years of operation before retirement for such forklifts ranged from 1 (*n* = 1; 0.7%) to 30 (*n* = 5; 3.4%), with a mean of 11.4 years and a median of 10. Figure 17 shows a more detailed distribution of the average years before retirement for battery electric forklifts in the survey sample. As shown, two in five businesses (*n* = 62; 41.6%) operated battery powered forklifts between six and 10 years.

Figure 17. Average Years of Operation Before Retirement for Battery Powered Forklifts



GASOLINE FORKLIFTS

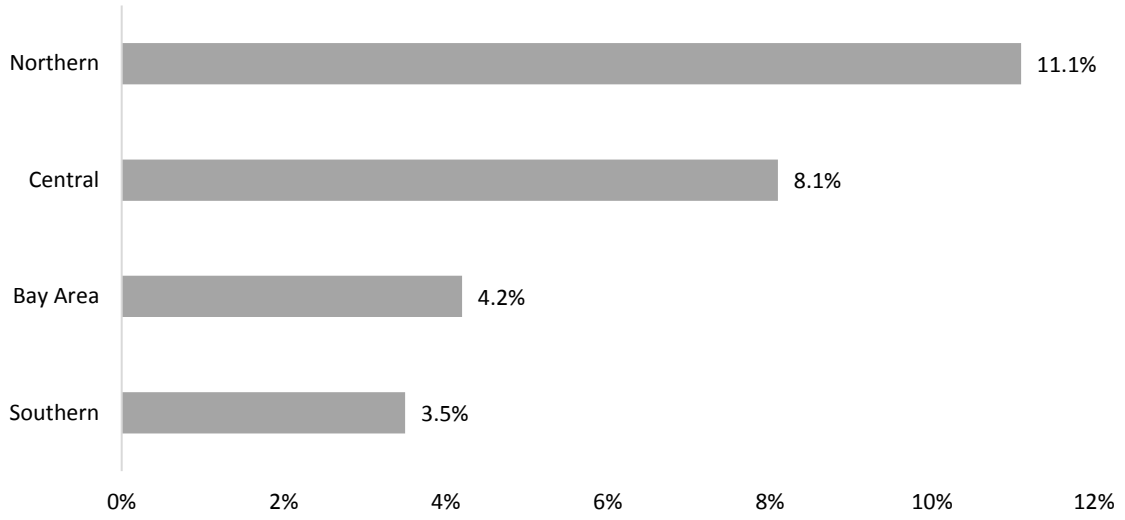
Table 29 shows the distribution of the number of gasoline forklifts operated among those companies operating any type of forklift. The number of gasoline forklifts each company had ranged from zero (*n* = 1,124; 95.2%) to 65 (*n* = 1; 0.1%), with a mean of 0.2 and a median of 0 gasoline forklifts. The total number of gasoline forklifts among businesses interviewed was 226, or 2.7% of all forklifts.

Table 29. Gasoline Forklift Fleet Size of Businesses Interviewed

Number of Gasoline Forklifts	Number of Businesses	% of Businesses
0	1,124	95.2%
1	35	3.0%
2	8	0.7%
3	7	0.6%
4 – 25	5	0.4%
26 or more	2	0.2%
Total	**1,181**	**100.0%**

Figure 18 shows the percent of businesses with forklifts in each region that operate gasoline forklifts. In Northern California, slightly more than one in ten (*n* = 11; 11.1%) forklift-operating businesses had gasoline forklifts, followed by 8.1% (*n* = 9) in Central California. Smaller proportions of businesses in the Bay Area (*n* = 12; 4.2%) and Southern California (*n* = 24; 3.5%) had such forklifts; $\chi^2(3) = 14.12$, $p = .003$.

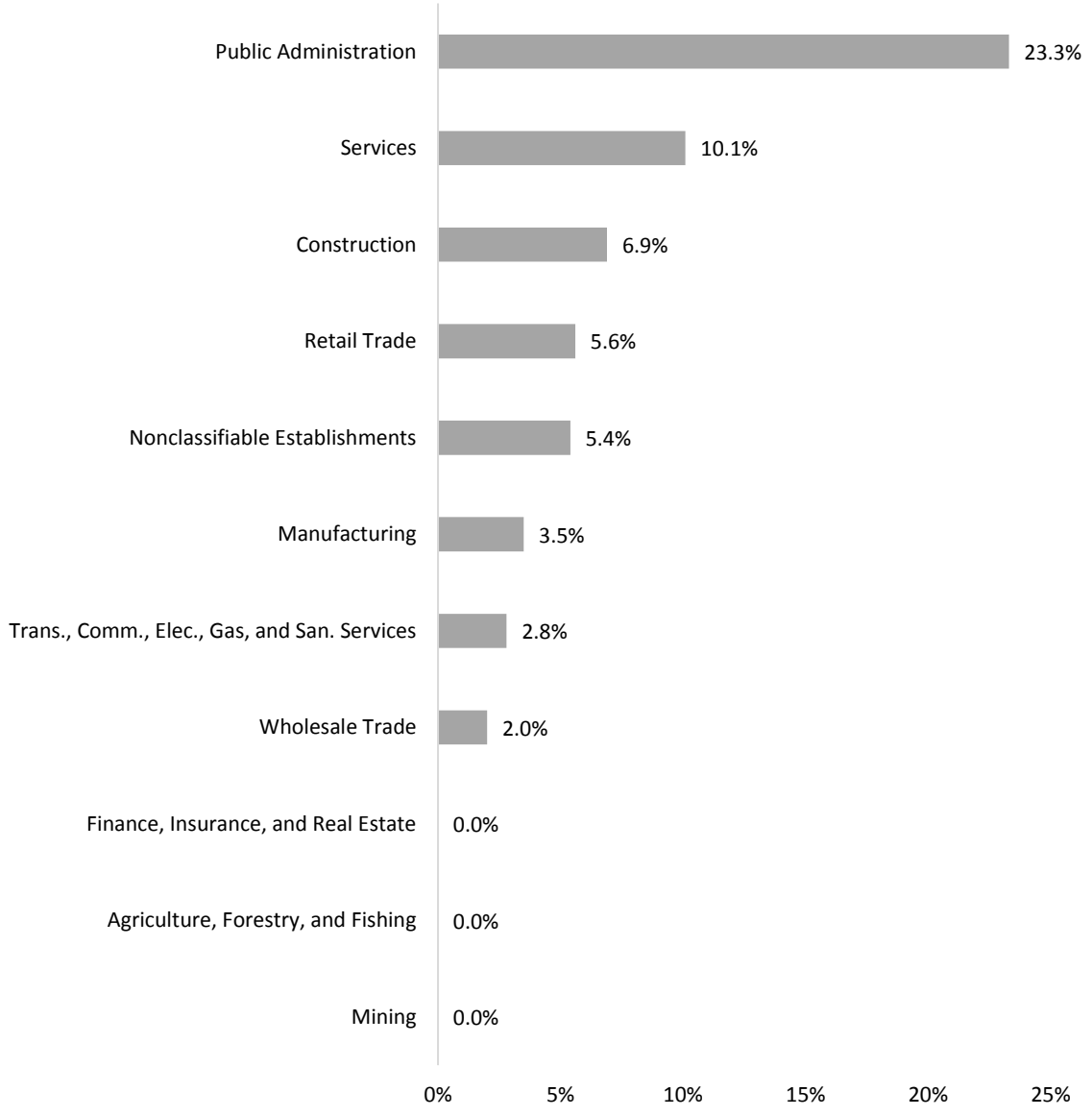
Figure 18. Proportion of Forklift-Utilizing Businesses with Gasoline Forklifts by Region



The proportion of businesses with forklifts that had gasoline forklifts in their fleets differed slightly by industry (See Figure 19). Almost a quarter (n = 7; 23.3%) of businesses in the field of public administration had gasoline forklifts, and one in ten (n = 12; 10.1%) of those in services did. On the other hand, none (n = 0; 0.0%) of those companies in finance, agriculture, and mining had gasoline forklifts; $\chi^2(10) = 39.00$, $p < .001$.[26]

[26] These results are not completely reliable because certain categories had low overall counts (namely, agriculture, mining, finance, public administration, and nonclassifiable establishments).

Figure 19. Proportion of Forklift-Utilizing Businesses with Gasoline Forklifts by Industry



The number of gasoline forklifts reported by businesses in the survey sample varied significantly by sample frame source of those businesses as shown in Table 30. As with diesel and propane/LPG lifts, the average number of gasoline forklifts was highest among those businesses from the DOORS (*M* = 1.04; *n* = 165) file. The average number of gasoline forklifts was much smaller among businesses from the other sample frame types; Welch's $F(3,89.7) = 3.19$, $p = .027$.

Table 30. Gasoline Forklift Fleet Size of Businesses Interviewed by Sample Frame Source

Sample Frame Source	Mean	Median	Minimum	Maximum	Sum	# of Bus.
EDA	0.03	0.0	0	3	30	918
DMV	0.32	0.0	0	7	22	69
DOORS	1.04	0.0	0	65	171	165
BOE	0.10	0.0	0	2	3	29
Total	**0.19**	**0.0**	**0**	**65**	**226**	**1,181**

Representatives of businesses operating gasoline forklifts indicated the number of such forklifts in each horsepower category. Forty (70.2%) of the 57 businesses with gasoline forklifts provided valid answers for at least one of these categories. Horsepower data was available for 54.4% (*n* = 123) of the 226 gasoline forklifts. Table 31 shows information on the number of gasoline forklifts in each horsepower category. In total, there were 93 gasoline forklifts with horsepowers less than 51 (75.6%), 24 between 51 and 70 (19.5%), and six above 70 horsepower (4.9%).

Table 31. Horsepower of Gasoline Forklifts in the Survey Sample

Horsepower Category	Number of Businesses	Percentage of Businesses	Number of Forklifts	Percentage of Forklifts	Mean Gasoline Forklifts in Category
< 51 HP	28	70.0%	93	75.6%	2.33
51 – 70 HP	9	22.5%	24	19.5%	0.60
> 70 HP	6	15.0%	6	4.9%	0.15
Total	**40**[27]	**--**	**123**	**100.0%**	**--**

Among the six businesses with at least one gasoline forklift over 70 horsepower, three (50.0%) provided the average horsepower of these forklifts. These values were 80, 130, and 130.

Individuals from businesses with gasoline forklifts noted the number of such forklifts in each lift capacity category. Fifty-one (91.2%) of the 57 businesses with gasoline forklifts provided valid answers for at least one of these categories. Lift capacity data was available for 46.9% (*n* = 106) of the 226 gasoline forklifts. Table 32 shows information on the number of gasoline forklifts in each lift capacity category. In

[27] The values in this column do not sum to the total because some businesses had lifts in multiple categories. This is also the reason the percentages do not sum to 100.

total, there were 58 gasoline forklifts with capacities less than 5,000 pounds (54.7%), 41 between 5,001 and 8,000 pounds (38.7%), and seven above 8,000 pounds (6.6%).

Table 32. Lift Capacity of Gasoline Forklifts in the Survey Sample

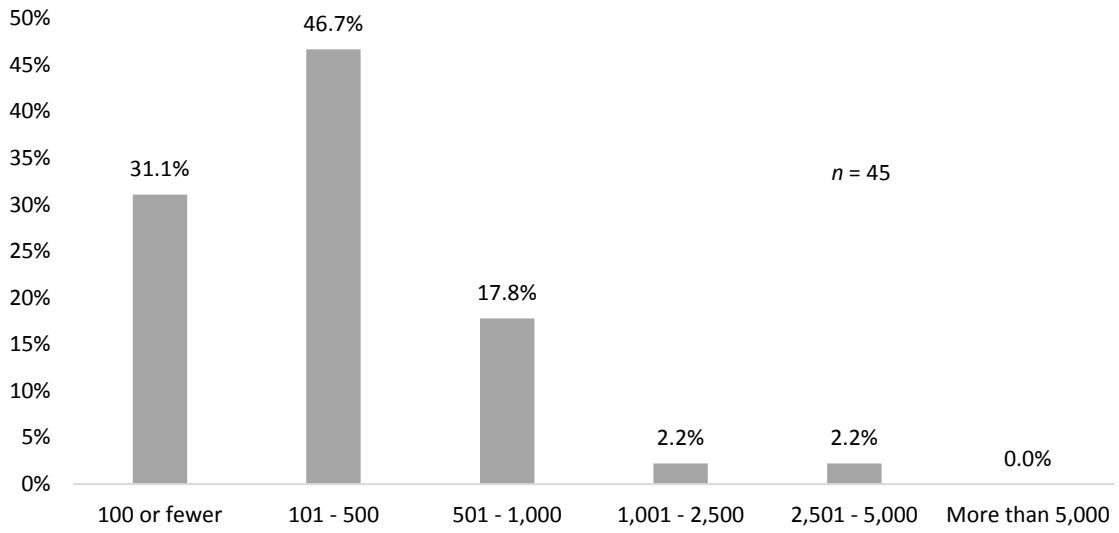
Lift Capacity Category	Number of Businesses	Percentage of Businesses	Number of Forklifts	Percentage of Forklifts	Mean Gasoline Forklifts in Category
< 5,001 lbs.	32	62.7 %	58	54.7%	1.16
5,001 – 8,000 lbs.	20	39.2%	41	38.7%	0.80
> 8,000 lbs.	7	13.7%	7	6.6%	0.14
Total	**51**[28]	**--**	**106**	**100.0%**	**--**

All businesses with at least one gasoline forklift with a lift capacity over 8,000 pounds provided the lift capacity of these forklifts. The capacity of these forklifts ranged from 8,000 (*n* = 1; 14.3%) to 20,000 (*n* = 1; 14.3%), with a mean capacity of 13,628 pounds and a median of 15,000 pounds.

Businesses with gasoline forklifts provided information about the average number of hours these forklifts were operated each year. Slightly less than 80% (*n* = 45; 78.9%) of representatives provided this information, with 35.6% (*n* = 16) providing an average and 64.4% (*n* = 29) giving the number of hours for each forklift. Gasoline forklifts operated between two (*n* = 1; 2.2%) and 3,000 (*n* = 1; 2.2%) hours per year, with a mean of 385 and a median of 208. A more detailed illustration of the mean number of hours gasoline forklifts operated each year is displayed in Figure 20. As shown, almost half of companies (*n* = 21; 29.5%) operated their gasoline forklifts between 101 and 500 hours per year. The sum of hours all gasoline forklifts operated per year was 46,193.

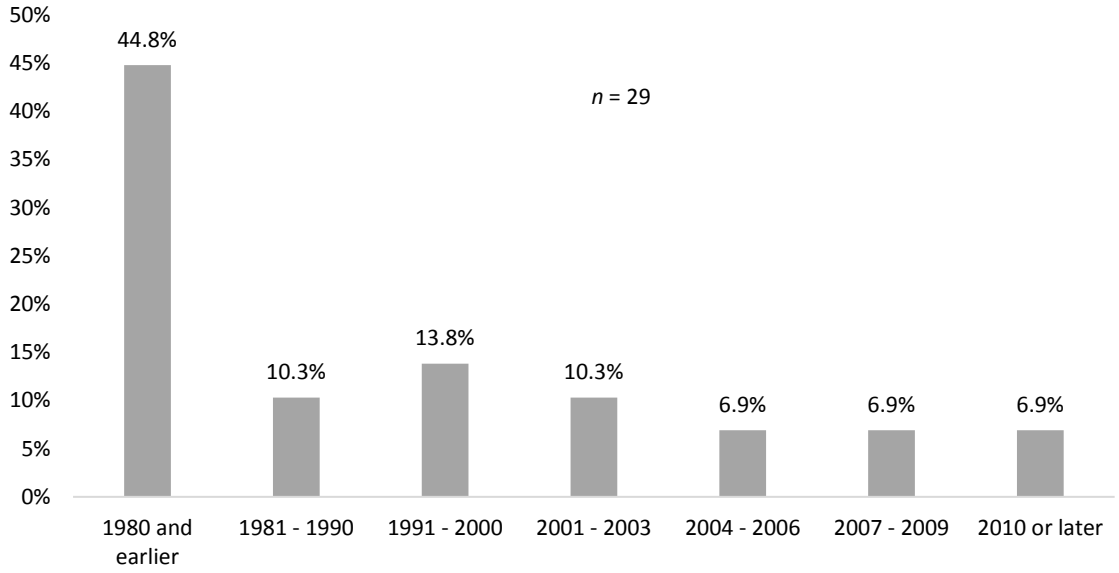
[28] The values in this column do not sum to the total because some businesses had lifts in multiple categories. This is also the reason the percentages do not sum to 100.

Figure 20. Mean Number of Hours Gasoline Forklifts Operate Annually



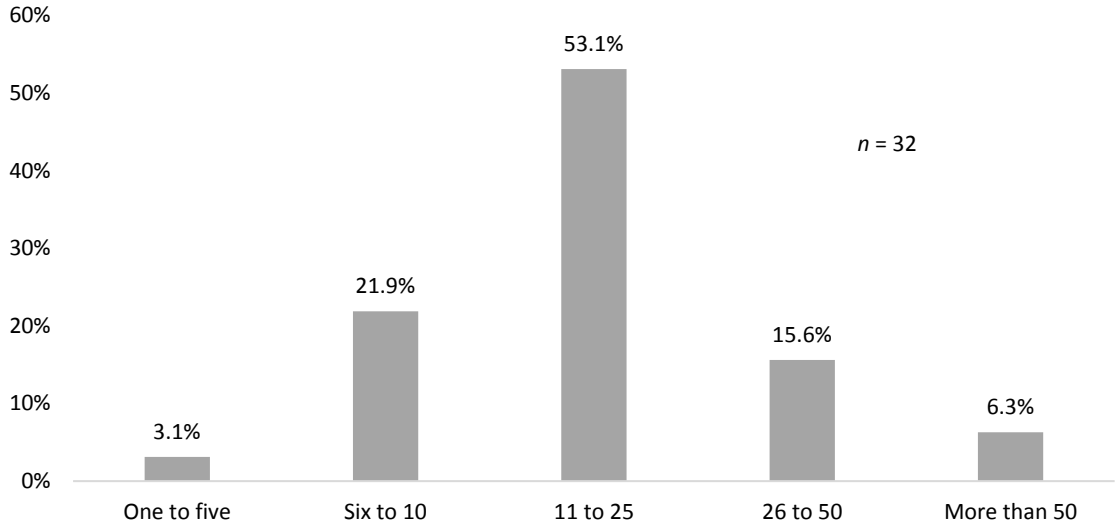
Representatives from companies with gasoline forklifts indicated the average model year of these forklifts. About half (*n* = 29; 50.9%) of respondents had this information, with 44.8% (*n* = 13) providing an average and 55.2% (*n* = 19) giving the model year for each forklift. The mean model year of gasoline forklifts ranged from 1960 (*n* = 3; 10.3%) to 2013 (*n* = 1; 3.4%), with a mean of 1988 and a median of 1985. Figure 21 displays the distribution of the mean model year of gasoline forklifts in the survey sample. Nearly half of companies (*n* =13; 44.8%) had gasoline forklifts with average model years of 1980 or earlier.

Figure 21. Mean Model Year of Gasoline Forklifts



Lastly, a total of 32 of the 57 (56.1%) representatives from businesses with gasoline forklifts provided information on the number of years these forklifts operate on average before being retired. The mean number of years of operation before retirement for such forklifts ranged from 5 (*n* = 1; 3.1%) to 67 (*n* = 1; 3.1%), with a mean of 23.3 years and a median of 20. Figure 22 shows a more detailed distribution of the average years before retirement for gasoline forklifts in the survey sample. As shown, more than half of businesses (*n* = 17; 53.1%) operated gasoline forklifts between 11 and 25 years.

Figure 22. Average Years of Operation Before Retirement for Gasoline Forklifts



DUAL FUEL FORKLIFTS

A total of five businesses reported using dual fuel (propane/gas) forklifts, with three (0.3%) using one and two (0.2%) using two. The remaining 99.6% (*n* = 1,174) of businesses reporting forklift fuel type did not use any dual fuel forklifts. The total number of dual fuel forklifts used was seven, or less than 0.1% of all forklifts.

Two (40.0%) of the businesses with dual fuel forklifts were in the Southern California area, while the other three (60.0%) were in the Bay Area. Two each were in the wholesale trade (40.0%) and construction (40.0%), while one (20.0%) was in services. Three of the businesses with dual fuel forklifts came from the EDA file (60.0%) and one each came from the DMV (20.0%) and DOORS (20.0%) files.

Only two (40.0%) of the five businesses with dual fuel forklifts provided information on the horsepower of their equipment: two dual fuel forklifts were under 51 horsepower, and one was over 70 horsepower[29]. All five businesses with dual fuel forklifts provided information on the lift capacity of these forklifts. All seven (100.0%) of the forklifts had lift capacities of less than 5,001 pounds.

Representatives from four of five (80.0%) companies with dual fueled forklifts provided information on the number of hours these forklifts operate annually. The number of hours each of these forklifts operated annually were zero, two, 120, 200, 5,200, and 8,760 hours, for a sum of 14,282 hours for all dual fueled forklifts. Similarly, four of five (80.0%) respondents also gave the model year of their forklifts: 1976, 1980, 2006, 2007, and two from 2012.

Finally, two (40.0%) of these five representatives provided the number of years dual fuel forklifts are operated on average before being retired. These values were 25 and 60 years.

[29] Information on the exact horsepower of this lift was not provided.

OTHER FUEL TYPES

A total of six businesses reported using forklifts of other fuel types, with all six having only one such forklift. All but one (*n* = 6; 83.3%) of these businesses with forklifts of other fuel types were located in Southern California; this other company (*n* = 1; 16.7%) was in the Bay Area. Two (33.3%) of the businesses with these forklifts were in manufacturing, two (33.3%) were in transportation, and one was in public administration (16.7%). Yet another (16.7%) of these businesses was not classifiable. Four of the six (66.7%) businesses with other types of forklifts came from the EDA file, while one each came from the DMV (16.7%) and DOORS (16.7%) files.

Information on horsepower was only provided for one of these forklifts, and this forklift was marked as being under 51 horsepower. Similarly, data on lift capacity was only provided for four forklifts with other fuel types, all of which had capacities under 5,001. Information on the number of hours forklifts of other fuel types were operated annually was only provided for two of these forklifts, and their annual hours of operation were 0 and 260 hours, respectively. The model year was only provided by one business with forklifts of other fuel types. This forklift was a 1986 model.

Lastly, two (33.3%) of these six representatives provided the number of years forklifts of other fuel types are operated on average before being retired. These values were 14 and 40 years.

Industrial Tow Tractors

Seventy-four businesses (6.2%) operated industrial tow tractors in the state as indicated by survey respondents. Table 33 depicts the number and percentage of businesses within each industry that operated industrial tow tractors as noted by the person who completed the survey on their behalves. As shown, a lower proportion of businesses classified as belonging to nonclassifiable industries (*n* = 1; 2.7%), wholesale trade (*n* = 7; 2.8%), and manufacturing (*n* = 12; 3.7%) operated this equipment compared to businesses in the remaining industries. Conversely, a greater proportion of those in finance (*n* = 1; 20.0%), public administration (*n* = 5; 15.6%), and agriculture (*n* = 2; 14.3%) operated this type of equipment compared to those outside of these industries. These differences are statistically significant; $\chi^2(10) = 24.83$, $p = .006$.

Table 33. Industry of Businesses in the Survey Sample with Industrial Tow Tractors

SIC Division	# of Businesses With Tow Tractors	Overall Survey Sample	% of Businesses with Tow Tractors
Finance	1	5	20.0%
Public Administration	5	32	15.6%
Agriculture	2	14	14.3%
Mining	1	8	12.5%
Transportation	15	148	10.1%
Services	12	122	9.8%
Retail	9	127	7.1%
Construction	9	134	6.7%
Manufacturing	12	322	3.7%
Wholesale	7	250	2.8%
Nonclassifiable	1	37	2.7%
Totals	**74**	**1199**	**100.0%**

Although a greater proportion of businesses located in the Northern part of the state (*n* = 9; 8.7%) operated tow tractors than those located in the Bay Area (*n* = 20; 7.0%), Central (*n* = 6; 5.4%), and the Southern portion of the state (*n* = 37; 5.3%), this difference is not statistically significant.

As noted in the Sample Frame Development section of the current report, businesses called were selected at random from one of the four lists shown in Table 34. The table displays the tow tractor fleet size among businesses interviewed from each source. As shown, more than one in ten (*n* = 11; 12.0%) businesses sourced from the DOORS file operated industrial tow tractors, while smaller proportions of

those from the other sample sources did. These differences were statistically significant; $\chi^2(3) = 13.05$, $p = .005$.

Table 34. Sample Source of Businesses in the Survey Sample with Industrial Tow Tractors

Sample Source	# of Businesses Operating Tow Tractors	Overall Survey Sample	% of Businesses Operating Tow Tractors
EDA	47	932	5.0%
DMV	6	69	8.7%
DOORS	20	167	12.0%
BOE	1	32	3.1%
Overall	**74**	**1,200**	**6.2%**

All but four of the businesses operating tow tractors in the state of California provided information on the number of pieces of equipment operated. That number ranged from one (*n* = 26; 37.1%) to 394 (*n* = 1; 1.4%) with a mean of 12.19 and a median of 2.0. As shown in Table 35, the greatest percentage of these businesses (*n* = 26; 37.1%) had only one tow tractor, while equal proportions had two (*n* = 13; 18.6%) and three (*n* = 2; 18.6%). Even so, more than a quarter (*n* = 18; 25.7%) had four or more tow tractors. These 70 businesses collectively had a total of 853 tow tractors.

Table 35. Tow Tractor Fleet Size of Businesses Interviewed

Number of Tow Tractors	Number of Businesses	% of Businesses
1	26	37.1%
2	13	18.6%
3	13	18.6%
4 or more	18	25.7%
Total	**70**	**100.0%**

As shown in Table 36, businesses in agriculture (*M* = 1.50; *n* = 2), manufacturing (*M* = 2.36; *n* = 11), and public administration (*M* = 2.60; *n* = 5) operated fewer tow tractors, on average, compared to the sample of businesses combined. Meanwhile those in construction (*M* = 11.25; *n* = 8) and retail (*M* =

39.86; *n* = 14) operated a larger number, on average. These differences were not statistically significant, however.

Table 36. Tow Tractor Fleet Size of Businesses Interviewed by Industry

Industry	Mean	Median	Minimum	Maximum	Sum	# of Bus.
Agriculture	1.50	1.5	1	2	3	2
Mining	--[30]	--	--	--	1	1
Construction	11.25	3.0	1	60	90	8
Manufacturing	2.36	3.0	1	5	26	11
Transportation	39.86	2.5	1	394	558	14
Wholesale Trade	7.29	3.0	1	24	51	7
Retail Trade	3.89	1.0	1	20	35	9
Finance	--	--	--	--	1	1
Services	3.18	2.0	1	18	35	11
Public Administration	2.60	2.0	1	5	13	5
Nonclassifiable Establishments	--	--	--	--	40	1
Total	**12.19**	**2.0**	**1**	**394**	**853**	**70**

Table 37 shows the number of tow tractors operated by businesses in the survey sample categorized by the region in which that business operated. There were no statistically significant differences in the fleet size of businesses by region; however, this lack of significance is likely due to small sample sizes.

[30] For those industry categories with only one business, mean, median, minimum, and maximum are not provided.

Table 37. Tow Tractor Fleet Size of Businesses Interviewed by Region

Number of Tow Tractors	Northern Region	Bay Area Region	Central Region	Southern Region	Overall
1	5 (62.5%)	8 (42.1%)	2 (33.3%)	11 (30.6%)	26 (37.7%)
2	3 (37.5%)	5 (26.3%)	0 (0.0%)	5 (13.9%)	13 (18.8%)
3	0 (0.0%)	5 (26.3%)	2 (33.3%)	6 (16.7%)	13 (18.8%)
4 or more	0 (0.0)	1 (5.3%)	2 (33.3%)	14 (38.9%)	17 (24.6%)
Total	**8 (100.0%)**	**19 (100.0%)**	**6 (100.0%)**	**36 (100.0%)**	**69 (100.0%)**

Table 38 displays the tow tractor fleet size among businesses interviewed from each source. As shown, the mean tow tractor fleet size was highest among those businesses from the DOORS list (*M* = 25.95, *n* = 19), followed by those from the EDA (*M* = 7.89, *n* = 44) and DMV (*M* = 1.33, *n* = 6) files; Welch's *F*(2,34.0) = 3.57, *p* = .039.[31] However, the differences should be interpreted with caution since the proportions of businesses sampled from the DMV and BOE files were small compared to the other two sources. Nonetheless, these values of some possible insight into the differences between these sources.

Table 38. Tow Tractor Fleet Size of Businesses Interviewed by Sample Frame Source

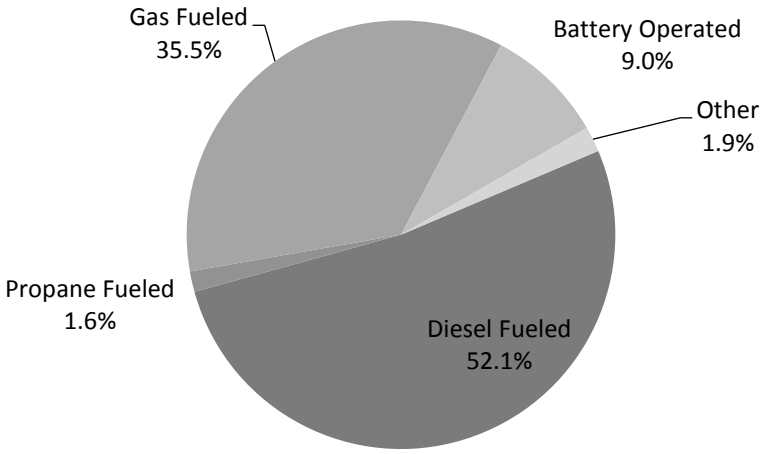
Sample Frame Source	Mean	Median	Minimum	Maximum	Sum	# of Bus.
EDA	7.89	2.0	1	100	347	44
DMV	1.33	1.0	1	2	8	6
DOORS	25.95	3.0	1	394	493	19
BOE	--	--	--	--	5	1
Total	**12.19**	**2.0**	**1**	**500**	**853**	**1,194**

[31] The business from the BOE dataset was not included because no average could be calculated for only one business.

FUEL TYPES OF TOW TRACTORS OPERATING IN CALIFORNIA

Of the 70 respondents that provided information on the number of tow tractors operated by their business, all but one provided information on how these pieces of equipment are fueled. Therefore, out of the 853 tow tractors in the survey sample, fuel type was only available for 837 (98.1%). As shown in Figure 23, more than half of tow tractors were diesel fueled (*n* = 436; 52.1%), while the next largest proportions are gasoline fueled (*n* = 297; 35.5%) and battery operated (*n* = 75; 9.0%). Much smaller proportions of tow tractors use propane/LPG (*n* = 13; 1.6%) or some "other" fuel type (*n* = 16; 1.9%). Of the three respondents who indicated their equipment was fueled by some "other" engine type, none provided further information on this fuel type.

Figure 23. Fuel Types of 837 Tow Tractors in the Survey Sample



In total, 58 (84.1%) respondents reported that their site operated at least one diesel-operated tow tractor. Looking just at the industries in which five or more businesses operated tow tractors, Table 39 illustrates greater proportions of businesses in construction (*n* = 8, 100.0%), transportation (*n* = 12; 92.3%), and retail (*n* = 8; 88.9%) operated diesel-fueled tow tractors, while lesser proportions of those in the wholesale trade (*n* = 5; 71.4%) and public administration (*n* = 3; 60.0%) did. These differences were not statistically significant, however.

Table 39. Businesses Operating Diesel-Fueled Tow Tractors by Industry			
SIC Division	**Businesses with Diesel Tow Tractors**	**Businesses with Tow Tractors**	**Percent of Businesses with Diesel Tow Tractors**
Construction	8	8	100.0%
Transportation	12	13	92.3%
Retail	8	9	88.9%
Services	9	11	81.8%
Manufacturing	9	11	81.8%
Wholesale	5	7	71.4%
Public Administration	3	5	60.0%

Fifteen businesses operated some type of tow tractor in addition to or aside from diesel powered tow tractors. Of the five businesses operating propane/LPG tow tractors, two were in the field of transportation (*n* = 2; 40.0%), while one each (20.0%) were from manufacturing, public administration, and a nonclassifiable industry. Seven businesses used gasoline tow tractors, with the majority of these businesses involved in services (*n* = 4; 57.1%) and one business each (14.3%) from manufacturing, transportation, and public administration. Of the four businesses that used battery powered tow tractors, one each (25.0%) was involved in transportation, wholesale trade, retail trade, and nonclassifiable establishments. Finally, three businesses had tow tractors fueled by some other means: one each (33.3%) from the industries of transportation, wholesale trade, and retail trade.

TOW TRACTOR CHARACTERISTICS

Representatives from companies with tow tractors were asked to provide the average horsepower of tow tractors of each fuel type (excluding battery operated ones). Of the 58 businesses with diesel tow tractors, less than half (*n* = 26; 44.8%) provided an average horsepower. The average horsepower of the sweeper/scrubbers operating in an organization's fleet ranged from 25 (*n* = 1; 3.8%) to 500 (*n* = 4; 15.4%), with a mean of 224.4 and a median of 162.5. None of the five businesses with propane/LPG or gasoline tow tractors provided the horsepower of this equipment. Of the three businesses with tow tractors of other fuel types, only two (66.6%) provided the average horsepower: these values were 90 and 320.

Due to the high proportion of missing data for non-diesel fuel types, further analyses of horsepower were only conducted for diesel tow tractors. The 26 respondents who provided information on the average horsepower of diesel tow tractors operating in their organizations' fleets were classified as having either a small, medium, or large fleet. Those organizations operating one diesel tow tractor were categorized as maintaining a "small fleet," while those operating between two and three were categorized as maintaining a "medium sized" fleet. Those with more than three diesel tow tractors were considered to have a large fleet.

As shown in Table 40, those with larger fleet sizes indicated that the average horsepower of the diesel tow tractors in those fleets was largest (*M* = 285.0; *n* = 8), on average, followed by those with small fleets (*M* = 229.8; *n* = 14) and medium fleets (*M* = 123.8; *n* = 6). This difference was not statistically significant, however.

Table 40. Average Horsepower of Diesel Tow Tractors by Fleet Size

Fleet Size	Average Horsepower	Number of Businesses
Small	229.8	12
Medium	132.8	6
Large	285.0	8
Totals	**224.4**	**46**

As shown in Table 41, the highest average horsepower was found among diesel tow tractors in the Central region of the state (*M* = 251.0; *n* = 2), followed by those in the Northern (*M* = 228.0; *n* = 5) and Southern (*M* = 242.9; *n* = 15) regions. Those in the Bay Area (*M* = 137.5; *n* = 4) had the lowest average horsepower. While those operating in the Bay Area appeared to have a lower average horsepower than those operating in the remaining three regions, this difference may be due to chance on account of the small sample size available here. Therefore, these results should be interpreted with caution.

Table 41. Average Horsepower of Diesel Tow Tractors by Region		
Region	**Average Horsepower**	**Number of Businesses**
Northern	228.0	5
Bay Area	137.5	4
Central	251.0	2
Southern	242.9	15
Totals	**224.4**	**26**

Removing the industries for which less than five businesses reportedly operated diesel tow tractors, Table 42 illustrates that diesel tow tractors operating in companies involved in transportation (M = 304.2; *n* = 5) had greater horsepower, on average, than those operating in businesses from retail (*M* = 230.0; *n* = 5) and services (*M* = 148.8; *n* = 5). These results were not statistically significant, however, likely due to small sample size.

Table 42. Average Horsepower of Diesel Tow Tractors by Industry		
SIC Division	**Average Horsepower**	**Number of Businesses**
Transportation	304.2	5
Retail	230.0	5
Services	148.8	5

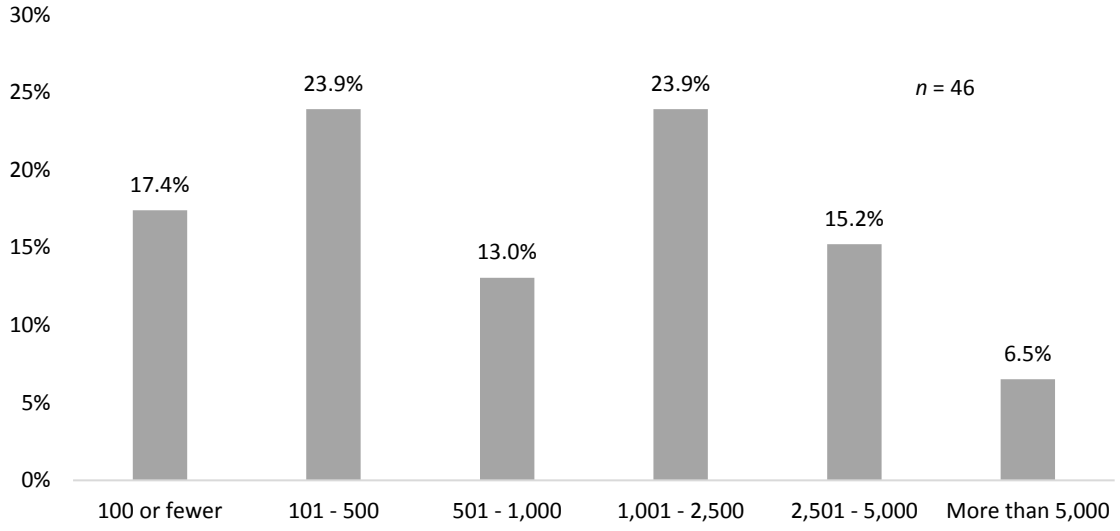
Businesses with tow tractors of all fuel types provided information on the average number of hours these tow tractors were operated each year. If the businesses had fewer than four, the representative had the option to provide information on each tow tractor. For the current report's purposes, these figures are presented as averages.[32] Nearly two thirds of representatives provided this information (*n* = 46; 64.8%), with 28.3% (*n* = 13) providing an average and 71.7% (*n* = 33) giving the number of hours for each tow tractor. The mean number of hours tow tractors were operated each year ranged from 4 (*n* = 1; 2.2%) to 8,760[33] (*n* = 3; 6.5%), with a mean of 1,686 and a median of 1,000. Figure 24 shows a more detailed distribution of the mean number of hours tow tractors were operated each year. As shown, the

[32] If the businesses had only one tow tractor, the value provided is not an average, but the number of hours this individual tow tractor was operated.

[33] Some representatives provided a value in excess of 8,760, which is the maximum number of hours a tow tractor could be operated within one year. These values were adjusted downward to the possible maximum of 8,760.

largest proportions of businesses operated their tow tractors between 101 and 500 (*n* = 11; 23.9%) and 1,001 and 2,500 (*n* = 11; 23.9%) hours per year. The total number of hours all tow tractors in the survey sample operated annually was 685,210.

Figure 24. Mean Number of Hours Tow Tractors Operate Annually



Looking just at the industries in which five or more businesses operated tow tractors, Table 43 illustrates that the average number of hours per year organizations operated their tow tractors varies depending on the industry to which they belonged. Caution is warranted, however, when interpreting these results as they are based on small sample sizes and are not statistically significant.

Table 43. Average Number of Hours Tow Tractors Are Operated Per Year by Industry

SIC Division	Average Number of Hours	Number of Businesses
Transportation	2,617.5	8
Retail	1,962.5	8
Manufacturing	1,462.9	9
Services	647.5	8

Table 44 illustrates that tow tractors operating in the Southern (*n* = 2,352.8; *n* = 26) and Central (*M* = 1,600.0; *n* = 4) parts of the state do so for a larger number of hours per year, on average, than do those operating in the Bay Area (*M* = 727.7; *n* = 10) or Northern region (*M* = 449.2; *n* = 6) of the state. Again, likely on account of the sample sizes available for analysis the differences portrayed in Table 44, while meaningful, are not statistically significant.

Table 44. Average Number of Hours Tow Tractors Are Operated Per Year by Region

Region	Average Number of Hours	Number of Businesses
Northern	449.2	6
Bay Area	727.7	10
Central	1,600.0	4
Southern	2,352.8	26

As shown in Table 45, a positive relationship between tow tractor fleet size and the average number of hours tow tractors operated per year exists, such that those with large fleet sizes (*M* = 3,550.8; *n* = 14) report that their equipment runs for a greater number of hours per year than do those with medium (*M* = 1,065.9; *n* = 13) and small (*M* = 866.4; *n* = 14) fleets, a difference that is statistically significant; Welch's $F(2, 23.16) = 4.50$, $p = .022$.

Table 45. Average Number of Hours Tow Tractors Are Operated Per Year by Fleet Size

Fleet Size	Average Number of Hours	Number of Businesses
Small	866.4	19
Medium	1,065.9	14
Large	3,550.8	13
Totals	**1,685.8**	**46**

The final question in the section addressing tow tractors operating in the state inquired, "on average, how long do the industrial sweeper/scrubbers in your fleet operate before they are retired?" Forty two of the 65 (64.6%) respondents provided this information. The number of years equipment was operated before being retired ranged from two (*n* = 1; 2.4%) to 50 years (*n* =1; 2.4%), with a mean of 14.7 years and a median of 10.0 years.

Table 46 shows that businesses in the services industry operate their tow tractors for a greater number of years on average (*M* = 20.9; *n* = 7) than those in other industries. However, caution is warranted when interpreting these results given the fact that this difference is not statistically significant.

Table 46. Average Number of Years Tow Tractors Operate Before Being Retired by Industry

SIC Division	Average Number of Years	Number of Businesses
Services	20.9	7
Transportation	14.3	7
Manufacturing	12.2	6
Wholesale	11.2	5
Retail	11.1	9

As shown in Table 47, those businesses located in Northern California operated their tow tractors for more years (*M* = 24.3; *n* = 7) before retiring them than did those in the remaining three regions of the state. As with industry, however, this difference was not statistically significant.

Table 47. Average Number of Years Tow Tractors Operate Before Being Retired by Region

Region	Average Number of Years	Number of Businesses
Northern	24.3	7
Bay Area	17.1	10
Central	13.4	5
Southern	10.5	42

Finally, Table 48 illustrates that businesses that maintained smaller fleets of tow tractors maintained them for a larger number of years (*M* = 18.4; *n* = 14) than did those with medium (*M* = 14.8; *n* = 18) or large fleets (*M* = 9.3; *n* = 10), a difference that is not quite statistically significant.

Table 48. Years Tow Tractors Operate Before Being Retired by Region by Fleet Size		
Fleet Size	**Average Number of Years**	**Number of Businesses**
Small	18.4	14
Medium	14.8	18
Large	9.3	10
Totals	**14.7**	**42**

Industrial Sweeper/Scrubbers

One hundred sixty-one businesses (13.4%) operated industrial sweeper/scrubbers in the state as indicated by survey respondents. Table 49 depicts the number and percentage of businesses within each industry that operated industrial sweeper/scrubbers as noted by the person who completed the survey on their behalves. As shown, a lower proportion of businesses classified as belonging to the finance (*n* = 0; 0.0%), agriculture (*n* = 1; 7.1%), construction (*n* = 10; 7.5%), and nonclassifiable industries (*n* = 3; 8.1%) operated this equipment compared to businesses in the remaining industries. Conversely, a greater proportion of those in the transportation (*n* = 25; 16.9%), service (*n* = 20; 16.4%), and public administration industries (*n* = 20; 62.5%) operated this type of equipment compared to those outside of these industries. These differences are statistically significant; $\chi^2(10) = 78.4$, $p < .001$.

Table 49. Industry of Businesses in the Survey Sample with Industrial Sweeper/Scrubbers

SIC Division	Businesses with Sweeper/Scrubbers	Overall Survey Sample	Percent of Businesses with Sweeper/Scrubbers
Public Administration	20	32	62.5%
Transportation	25	148	16.9%
Services	20	122	16.4%
Wholesale	34	250	13.6%
Mining	1	8	12.5%
Manufacturing	34	322	10.6%
Retail	13	127	10.2%
Nonclassifiable	3	37	8.1%
Construction	10	134	7.5%
Agriculture	1	14	7.1%
Finance	0	5	0.0%
Totals	**161**	**1,199**	**13.4%**

Although a lower proportion of businesses located in the Southern part of the state (*n* = 81; 11.6%) operated sweeper/scrubbers than those located in the Central (*n* = 19; 17.0%), Northern (*n* = 16; 15.5%), and the Bay Area of the state (*n* = 44; 15.4%), this difference is not statistically significant.

As noted in the Sample Frame Development section of the current report, businesses called were selected at random from one of the four lists shown in Table 50. The table displays the sweeper/scrubber fleet size among businesses interviewed from each source. As shown, more than a

quarter of businesses from the DMV (*n* = 18; 26.1%) and DOORS (*n* = 43; 25.7%) datasets operated industrial sweeper/scrubbers, while smaller proportions of those from the BOE (*n* = 5; 15.6%) and EDA (*n* = 95; 10.2%) files did. These differences were statistically significant; $\chi^2(3) = 39.87$, $p < .001$.

Table 50. Sample Source of Businesses in the Survey Sample with Industrial Sweeper/Scrubbers

Sample Source	# of Businesses Operating Sweeper/Scrubbers	Overall Survey Sample	% of Businesses Operating Sweeper/Scrubbers
EDA	95	932	10.2%
DMV	18	69	26.1%
DOORS	43	167	25.7%
BOE	5	32	15.6%
Overall	**161**	**1,200**	**13.4%**

All but two of the businesses operating sweeper/scrubbers in the state of California provided information on the number of pieces operated. That number ranged from one (*n* = 102; 64.2%) to 60 (*n* = 1; 0.6%) with a mean of 2.20 and a median of 1.00. As shown in Table 51, nearly two thirds of these businesses (*n* = 102; 64.2%) had only one tow tractor, while one in five had two (*n* = 32; 20.1%). Together these 159 businesses represented 350 sweepers/scrubbers.

Table 51. Sweeper/Scrubber Fleet Size of Businesses Interviewed

Number of Sweeper/ Scrubbers	Number of Businesses	% of Businesses
1	102	64.2%
2	32	20.1%
3	12	7.5%
4 or more	13	8.2%
Total	**159**	**100.0%**

As shown in Table 52, businesses in manufacturing (*M* = 1.36; *n* = 33), services (*M* = 1.55; *n* = 20), and wholesale industries (*M* = 1.65; *n* = 34) operated fewer sweeper/scrubbers, on average, compared to the sample of businesses overall. Meanwhile those in public administration (*M* = 2.85; *n* = 20) and retail

(*M* = 5.77; *n* = 13) operated a larger number, on average. These differences were not statistically significant, however.

Table 52. Sweeper/Scrubber Fleet Size of Businesses Interviewed by Industry

Industry	Mean	Median	Minimum	Maximum	Sum	# of Bus.
Agriculture	--[34]	--	--	--	2	1
Mining	--	--	--	--	1	1
Construction	2.50	1.5	1	10	25	10
Manufacturing	1.36	1.0	1	3	45	33
Transportation	2.13	1.0	1	21	51	24
Wholesale Trade	1.65	1.0	1	6	56	34
Retail Trade	5.77	1.0	1	60	75	13
Finance	--	--	--	--	0	0
Services	1.55	1.0	1	7	31	20
Public Administration	2.85	2.0	1	8	57	20
Nonclassifiable Establishments	2.33	2.0	1	4	7	3
Total	**2.20**	**1.0**	**1**	**60**	**350**	**159**

Table 53 shows the number of sweeper/scrubbers operated by businesses in the survey sample categorized by the region in which that business operated. There were no statistically significant differences in the sweeper/scrubber fleet size of businesses by region; however, this lack of significance may be due to small sample sizes.

[34] For those industry categories with only one business, mean, median, minimum, and maximum are not provided.

Table 53. Sweeper/Scrubber Fleet Size of Businesses Interviewed by Region

Number of Sweeper/ Scrubbers	Northern Region	Bay Area Region	Central Region	Southern Region	Overall
1	11 (68.8%)	30 (69.8%)	10 (52.6%)	51 (63.8%)	102 (64.6%)
2	2 (12.5%)	6 (14.0%)	7 (36.8%)	16 (20.0%)	31 (19.6%)
3	1 (6.3%)	5 (11.6%)	1 (5.3%)	5 (6.3%)	12 (7.6%)
4 or more	2 (12.5%)	2 (4.7%)	1 (5.3%)	8 (10.0%)	13 (8.2%)
Total	**16 (100.0%)**	**43 (100.0%)**	**19 (100.0%)**	**80 (100.0%)**	**158 (100.0%)**

Table 54 displays the sweeper/scrubber fleet size among businesses interviewed from each source. As shown, the mean sweeper/scrubber fleet size was highest among those businesses from the DOORS list (M = 3.60, n = 42) and lowest among those from the EDA (M = 1.50, n = 94) file. However, these differences were not statistically significant.

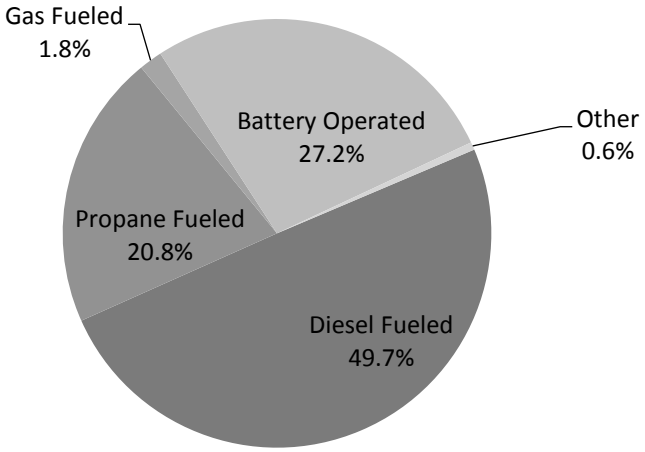
Table 54. Sweeper/Scrubber Fleet Size of Businesses Interviewed by Sample Frame Source

Sample Frame Source	Mean	Median	Minimum	Maximum	Sum	# of Bus.
EDA	1.50	1.0	1	10	141	94
DMV	2.72	1.0	1	21	49	18
DOORS	3.60	1.5	1	60	151	42
BOE	1.80	2.0	1	3	9	5
Total	**2.20**	**1.0**	**1**	**60**	**350**	**159**

FUEL TYPES OF SWEEPER/SCRUBBERS OPERATING IN CALIFORNIA

Of the 159 respondents that provided information on the number of sweeper/scrubbers operated by their business, all but three provided information on how these pieces of equipment are fueled. Consequently, out of the 350 sweeper/scrubbers represented in the survey sample, the type of fuel by which they are operated was available for 342 (97.7%). As shown in Figure 25, the largest proportion of sweeper/scrubbers is diesel fueled (*n* = 170; 49.7%), while the next largest proportions are battery operated (*n* = 93; 27.2%) and propane fueled (*n* = 70; 20.8%). Six respondents (1.8%) noted their sweeper/scrubbers are fueled by gasoline. Of the two respondents who indicated that their equipment was fueled by some "other" engine type, only one described further. This person, representing one piece of equipment, indicated that it was powered by hydraulics.

Figure 25. Fuel Types of 342 Sweeper/Scrubbers in the Survey Sample



In total, 49 (31.4%) respondents reported that their site operated at least one diesel-operated sweeper/scrubber. Looking just at the industries in which ten or more businesses operated sweeper/scrubbers, Table 55 illustrates that a lower proportion of businesses classified as belonging to the manufacturing (*n* = 4, 12.9%), wholesale (*n* = 7; 20.7%), transportation (*n* = 5; 20.8%), and retail divisions (*n* = 3; 23.1%) operated diesel-fueled sweeper scrubbers than those in services (*n* = 12; 60.0%) and public administration (*n* = 12; 60.0%); $\chi^2(5) = 24.02$, $p < .001$.

Table 55. Businesses Operating Diesel-Fueled Sweeper/Scrubbers by Industry			
SIC Division	**Businesses with Diesel Sweeper/Scrubbers**	**Businesses with Sweeper/Scrubbers**	**Percent of Businesses with Diesel Sweeper/Scrubbers**
Public Administration	12	20	60.0%
Services	12	20	60.0%
Retail	3	13	23.1%
Transportation	5	24	20.8%
Wholesale	7	34	20.7%
Manufacturing	4	31	12.9%

Although diesel-operated equipment constitutes nearly half of the total number of sweepers/scrubbers represented by the businesses for which data is available, the largest proportion of businesses reportedly used battery operated equipment (*n* =68; 43.6% compared to *n* = 49; 31.4% that operated diesel fueled sweeper/scrubbers). Again, removing the industries for which less than ten businesses reportedly operated sweeper/scrubbers, Table 56 illustrates that a lower proportion of those classified as belonging to the public administration (*n* = 3; 15.0%) and services industries (*n* = 7; 35.0%) maintained battery operated sweeper/scrubbers compared to the group as a whole. Meanwhile a larger proportion of those operating in the area of wholesale (*n* = 17; 50.0%), retail (*n* = 7; 53.8%) and manufacturing (*n* = 18; 58.1%) utilized this type of equipment compared to the group as a whole.[35]

[35] This result was nearly statistically significant; $\chi^2(5) = 11.05$, $p = .05$.

Table 56. Businesses Operating Battery-Powered Sweeper/Scrubbers by Industry

SIC Division	Businesses with Battery Sweeper/Scrubbers	Businesses with Sweeper/Scrubbers	Percent of Businesses with Battery Sweeper/Scrubbers
Retail	7	13	53.8%
Manufacturing	18	31	58.1%
Wholesale	17	34	50.0%
Transportation	10	24	41.7%
Services	7	20	35.0%
Public Administration	3	20	15.0%

Slightly less than three in ten businesses (*n* = 45; 28.8%) reportedly operated propane/LPG fueled sweeper/scrubbers. Again focusing on those industries for which ten or more businesses operated this type of equipment (See Table 57), it was observed that a lower proportion of those in the fields of service (*n* = 1; 5.0%) and retail (*n* = 2; 15.4%) utilized propane operated sweeper/scrubbers than the group as a whole, while the inverse was true of those in manufacturing (*n* = 10; 32.3%), wholesale (*n* = 12; 35.3%), transportation (*n* = 9; 39.1%), and public administration (*n* = 7; 36.8%). While meaningful, these differences are not statistically significant.

Table 57. Businesses Operating Propane/LPG Sweeper/Scrubbers by Industry

SIC Division	Businesses with Propane/LPG Sweeper/Scrubbers	Businesses with Sweeper/Scrubbers	Percent of Businesses with Propane/LPG Sweeper/Scrubbers
Public Administration	8	20	40.0%
Transportation	9	24	37.5%
Wholesale	12	34	35.3%
Manufacturing	10	31	32.3%
Retail	2	13	15.4%
Services	1	20	5.0%

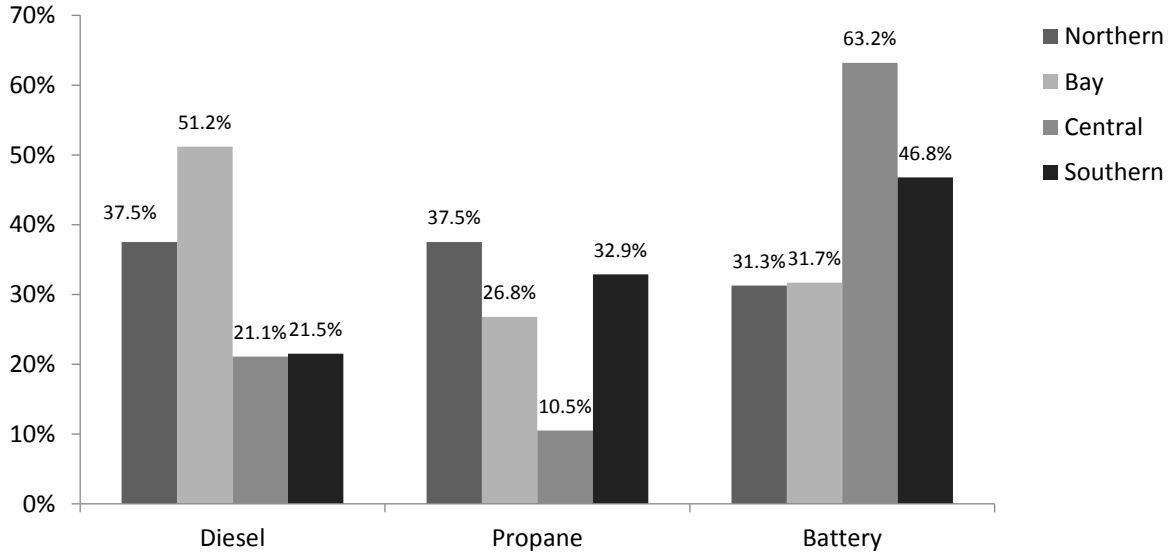
Figure 26 illustrates the proportion of businesses within each region of the state operating diesel, propane, and battery operated sweeper/scrubbers. As shown, a greater percentage of businesses located in the Bay Area (*n* = 21; 51.2%) maintained diesel fueled sweeper/scrubbers than those in the

Northern part of the state (*n* = 6; 37.5%). Conversely, a lower proportion of businesses operating in the Central (*n* = 4; 21.1%) and Southern (*n* = 17; 21.5%) parts of the state reported maintaining this type of equipment than those in both the Bay and Northern areas; $\chi^2(3) = 12.36$, $p = .006$.

Looking at propane operated equipment, a smaller proportion of businesses in the Central region (*n* = 2; 10.5%) maintained this type of equipment compared to those in the remaining three regions of the state. Conversely, a larger proportion of businesses in Central California (*n* = 12; 63.2%) maintained battery operated sweeper/scrubbers compared to those in the southern parts (*n* = 37; 46.8%). On the other hand, a lower proportion of businesses located in the Bay (*n* = 13; 31.7%) and Northern parts (*n* = 5; 31.3%) of the state maintained battery-operated sweepers/scrubbers than those in both the Central and southern Regions. None of these differences are statistically significant, however.

Figure 26 also illustrates that while the businesses in the Central and Southern regions are more apt to rely on battery operated sweeper/scrubbers over those fueled by propane or diesel, the same cannot be said by those in the Northern and Bay areas of the state. While those in the Bay area appear to rely more heavily on diesel fueled sweeper/scrubbers, those in the Northern part of the state seem to rely equally on sweeper/scrubbers run on battery, diesel, and propane.

Figure 26. Proportion of Businesses Within Each Region Operating Sweeper/Scrubbers by Three Engine Types



SWEEPER/SCRUBBER CHARACTERISTICS

An item on the survey instrument inquired, "what is the average horsepower of the industrial sweeper/scrubbers operating in your organization's fleet?" As might be expected, the majority (*n* = 101; 62.7%) of the 161 respondents from companies with sweeper/scrubbers were unable to provide a response, leaving 60 valid responses. These 60 respondents represented 160 or less than half (45.7%) of all sweeper scrubbers reflected in the data. The average horsepower of the sweeper/scrubbers operating in an organization's fleet ranged from zero (*n* = 3; 5.0%) to 400 (*n* = 1; 1.7%), with a mean of 74.7 and a median of 42.0. The modal, or most frequently occurring response, is 50.0.

The sixty respondents who provided information on the average horsepower of sweeper/scrubbers operating in their organizations fleet were classified as having either a small, medium, or large fleet. Those organizations operating one industrial sweeper/scrubber were categorized as maintaining a "small fleet," while those operating between two and three were categorized as maintaining a "medium sized" fleet. Those with more than three sweeper/scrubbers were considered to have a large fleet of industrial sweeper/scrubbers.

As shown in Table 58, those with larger fleet sizes indicated that the average horsepower of the sweeper/scrubbers in those fleets was larger (*M* = 158.9; *n* = 7), on average, compared to those with medium (*M* = 73.6; *n* = 14), and small fleets (*M* = 60.0; *n* = 39), a difference that is statistically significant, $F(2,57) = 4.22$, $p = .02$.

Table 58. Average Horsepower of Industrial Sweeper/Scrubbers by Fleet Size

Fleet Size	Average Horsepower	Number of Businesses
Small	60.0	39
Medium	73.6	14
Large	158.9	7
Totals	**74.7**	**60**

As shown in Table 59, there were no differences in the average horsepower of industrial sweeper/scrubbers operating in the Southern and Northern parts of the state. While those operating in the North appeared to have a higher average horsepower than those operating in the remaining three regions, this difference may be due to chance on account of the small sample size available here. For the same reason, the smaller average horsepower of the scrubber/sweepers operating in the Central region should be interpreted with caution.

Table 59. Average Horsepower of Industrial Sweeper/Scrubbers by Region		
Region	**Average Horsepower**	**Number of Businesses**
Northern	75.0	8
Bay Area	88.3	16
Central	21.0	6
South	78.1	30
Totals	**74.7**	**60**

Table 60 illustrates that businesses who maintained diesel fueled sweeper/scrubbers in their fleet reported a higher average horsepower (M = 125.8; n = 26) than those who did not (M = 35.6; n = 34); $t(58) = 35.6$, $p < .001$. Conversely, those whose fleets included battery operated sweeper/scrubbers reported a lower average horsepower (M = 10.11; n = 18) than those who did not (M = 102.4; n = 42); $t(58) = 6.4$, $p < .001$.

Table 60. Average Horsepower of Industrial Sweeper/Scrubbers by Presence of Diesel, Propane and Battery Operated Forklifts		
Fleet Contains…	**Yes** **Mean** **(# of Businesses)**	**No** **Mean** **(# of Businesses)**
Diesel Fueled Sweeper/ Scrubber	125.8 (26)	35.6 (34)
Propane Fueled Sweeper/Scrubber	71.4 (19)	76.2 (41)
Battery Operated Sweeper/Scrubber	10.11 (18)	102.4 (42)

Again, removing the industries for which less than ten businesses reportedly operated sweeper/scrubbers, Table 61 illustrates that sweeper/scrubbers operating in public administration organizations (M = 153.8; n = 13) had larger horsepower, on average than those operating in organizations within the remaining five industries; $F(5,27.0) = 17.1$, $p = .01$.

Table 61. Average Horsepower of Sweeper/Scrubbers by Industry		
SIC Division	**Average Horsepower**	**Number of Businesses**
Public Administration	153.8	13
Transportation	48.8	5
Services	41.9	8
Retail	31.5	6
Manufacturing	32.0	7
Wholesale	30.8	14

Asked to provide information on the average number of hours the industrial sweeper/scrubbers maintained by their organization operated per year, 36 respondents indicated not knowing. Of the remainder, the average number of hours sweeper/scrubbers operated per year ranged from zero (*n = 1*; 0.8%) to 6,000 (*n* = 1; 0.8%) with a mean of 562.8 hours per year and a median of 312 hours per year. The modal, or most frequently occurring response, was 200.

Looking just at the industries in which ten or more businesses operate sweeper/scrubbers, Table 62 illustrates that the average number of hours per year organizations operated their sweeper/scrubbers varies widely depending on the industry to which they belonged. While the differences in Table 62 appear large, caution is warranted when interpreting them as they are not statistically significant.

Table 62. Average Number of Hours Sweeper/Scrubbers Are Operated Per Year by Industry		
SIC Division	**Average Number of Hours**	**Number of Businesses**
Retail	841.1	12
Manufacturing	837.3	26
Public Administration	590.3	15
Transportation	446.6	18
Wholesale	442.6	28
Services	180.3	12

Table 63 illustrates that sweeper/scrubbers operating in the Central and Southern parts of the state do so for a larger number of hours per year, on average, than do those operating in the Northern or Bay areas of the state. Again, likely on account of the sample sizes available for analysis the differences portrayed in Table 63, while meaningful, are not statistically significant.

Table 63. Average Number of Hours Sweeper/Scrubbers Are Operated Per Year by Region

Region	Average Number of Hours	Number of Businesses
Northern	322.4	11
Bay Area	356.6	33
Central	553.3	16
Southern	715.0	63

Table 64 illustrates that the average number of hours sweeper/scrubbers reportedly operated per year does not vary based on the presence or absence of diesel, propane, or battery operated equipment.

Table 64. Average Number of Hours Per Year Industrial Sweeper/Scrubbers Operate by Presence of Diesel, Propane, and Battery Operated Equipment

Fleet Contains…	Yes Mean (# of Businesses)	No Mean (# of Businesses)
Diesel Fueled Sweeper/ Scrubber	484.2 (34)	536.6 (87)
Propane Fueled Sweeper/Scrubber	536.5 (36)	487.4 (85)
Battery Operated Sweeper/Scrubber	553.3 (52)	498.1 (69)

As shown in Table 65, a positive relationship between fleet size and the average number of hours sweeper/scrubbers operated per year exists, such that those with larger fleet sizes report that their equipment runs for a greater number of hours per year than do those with smaller fleets, a difference that is statistically significant; $F(2,120) = 4.16$, $p = .018$.

Table 65. Average Number of Hours Per Year of Industrial Sweeper/Scrubbers Operate by Fleet Size		
Fleet Size	**Average Number of Hours**	**Number of Businesses**
Small	423.1	82
Medium	793.1	33
Large	1045.0	8
Totals	**562.8**	**123**

The final question in the section addressing sweeper/scrubbers operating in the state inquired, "on average, how long do the industrial sweeper/scrubbers in your fleet operate before they are retired?" Sixty respondents reportedly did not know or have access to this information. Of the remaining 99 businesses, the number of years equipment was operated before being retired ranged from one (*n* = 1; 1.0%) to 50 years (*n* =1; 1.0%), with a mean of 12.2 years and a median of 10.0 years. The modal or most frequently occurring response was ten.

Table 66 illustrates that businesses in the services industry may operate their sweeper/scrubbers for a greater number of years on average (*M* = 15.9; *n* = 13) than those in other industries, however given the fact that this difference is not statistically significant caution is warranted when interpreting these results.

Table 66. Average Number of Years Sweeper/Scrubbers Operate Before Being Retired by Industry		
SIC Division	**Average Number of Years**	**Number of Businesses**
Services	15.9	13
Retail	12.8	11
Public Administration	12.1	16
Wholesale	11.7	21
Manufacturing	11.4	18
Transportation	11.4	11

As shown in Table 67, those businesses operating in Bay area operated their sweeper/scrubbers for significantly longer (*M* = 16.3; *n* = 28) before retiring them than did those in the remaining three regions of the state, a difference that is statistically significant; $F(3,95) = 3.90$, $p = .012$.

Table 67. Average Number of Years Sweeper/Scrubbers Operate Before Being Retired by Region		
Region	**Average Number of Years**	**Number of Businesses**
Northern	10.8	9
Bay Area	16.3	28
Central	11.0	15
Southern	10.3	47

With respect to the fuel types used to operate sweeper/scrubbers, Table 68 illustrates that businesses operating battery operated sweeper/scrubbers in their fleets retired this equipment an average of three years sooner (*M* = 9.6 years; *n* = 37) than those who did not maintain equipment powered by batteries (*M* = 13.6; *n* = 60), a difference that is statistically significant; $t(94.8) = 2.73$, $p = .008$.

Table 68. Average Number of Years Sweeper/Scrubbers Operate Before Being Retired by Region by Presence of Diesel, Propane and Battery Operated Forklifts		
Fleet Contains…	**Yes Mean (Count)**	**No Mean (Count)**
Diesel Fueled Sweeper/ Scrubber	13.6 (36)	11.1 (61)
Propane Fueled Sweeper/Scrubber	12.1 (26)	12.1 (71)
Battery Operated Sweeper/Scrubber	9.6 (37)	13.6 (60)

Finally, Table 69 illustrates that businesses that maintained smaller fleets of sweeper/scrubbers maintained them for a slightly larger number of years (*M* = 13.6; *n* = 63) than do those with medium (*M* = 9.8; *n* = 25) or large fleets (*M* = 9.6; *n* = 11), a difference that is statistically significant; Welch's $F(2,35.6) = 3.94$, $p = .028$.

Table 69. Years Sweeper/Scrubbers Operate Before Being Retired by Fleet Size		
Fleet Size	**Average Number of Years**	**Number of Businesses**
Small	13.6	63
Medium	9.8	25
Large	9.6	11
Totals	**12.2**	**99**

ADDITIONAL SURVEY RESULTS

An additional six questions in the survey instrument addressed a variety of topics from the square footage of the organization's property to whether a representative from each business would like to be contacted by ARB staff about an incentive program to replace old equipment.

The first question asked respondents to select barriers their organization faces in converting to a zero-emission fleet from five predetermined choices with an option to specify some "other" barrier. In total, 426 "other" responses were specified. These responses were grouped into the existing categories where appropriate and placed into seven additional groups based on content. As shown in Figure 27, nearly 15% of those businesses in the survey sample (*n* = 175; 14.6%) indicated there were no barriers, and they already had a zero emissions fleet.

Nearly a third of companies (*n* = 382; 31.8%) cited cost was a barrier to maintaining such a fleet, with respondents mentioning the costs of converting to zero emissions as well as maintaining that equipment (for example, the cost of replacing old batteries). More than one in ten (*n* = 144; 12.0%) noted there was no space for charging stations or a battery room, and 8.4% (*n* = 101) said there was not enough time to charge battery powered equipment. Combined, more than 15% of representatives described issues with the capabilities of such equipment, with 5.9% (*n* = 71) indicating they had insufficient lift capacity or power to perform necessary tasks, 3.4% (*n* = 41) noting they were not appropriate for the terrain or environment the company works in, and another 5.9% (*n* = 71) mentioning that they could not perform some other important function. Examples of this last category included responses such as "[There are] restrictions by [the] trucking company where they are only allowed to use propane forklifts to load and unload trailers," "limited capabilities," and "the technology doesn't fit our needs." Other barriers are detailed in Figure 27.

Figure 27. Barriers to Converting to a Zero Emissions Fleet

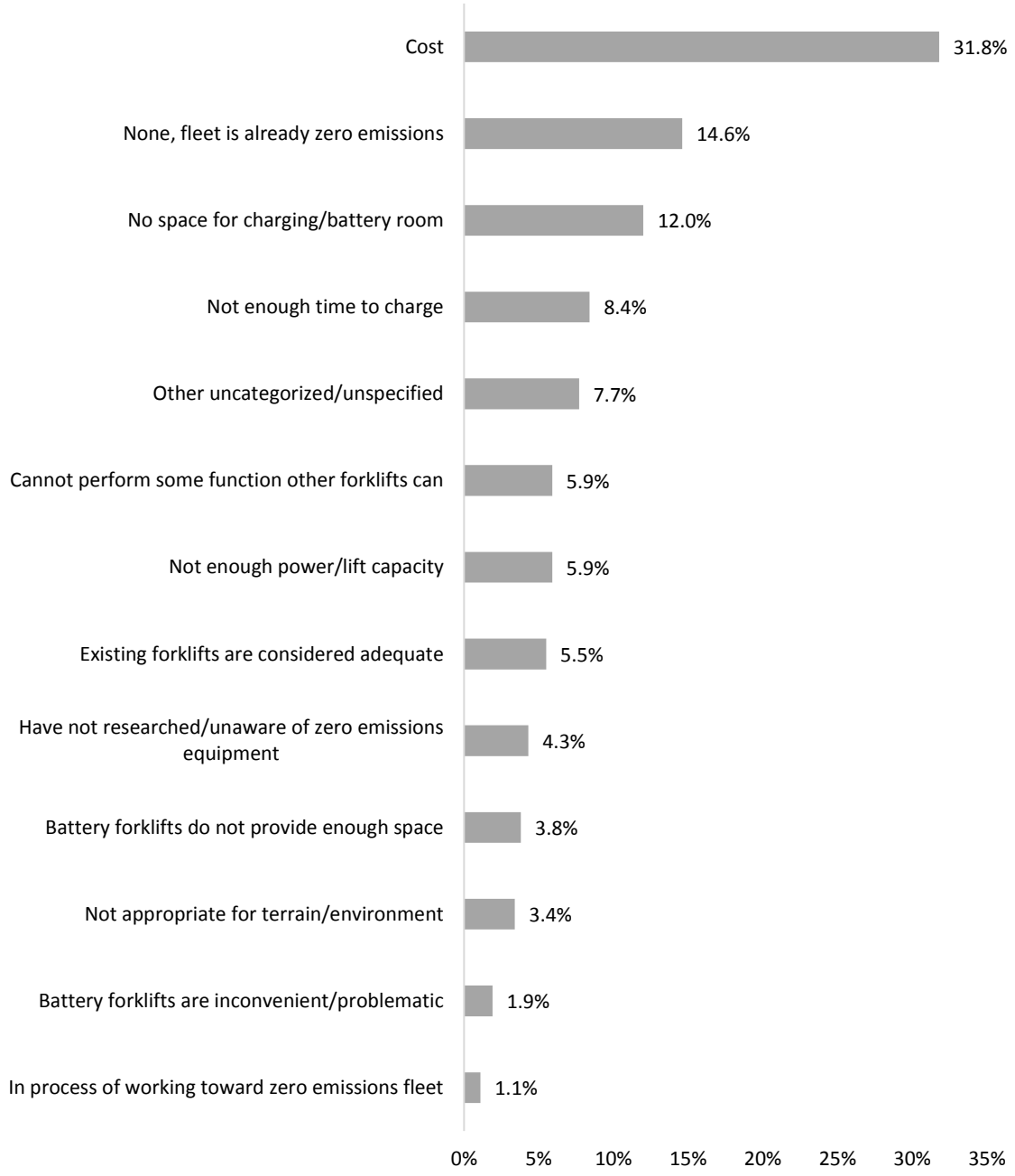
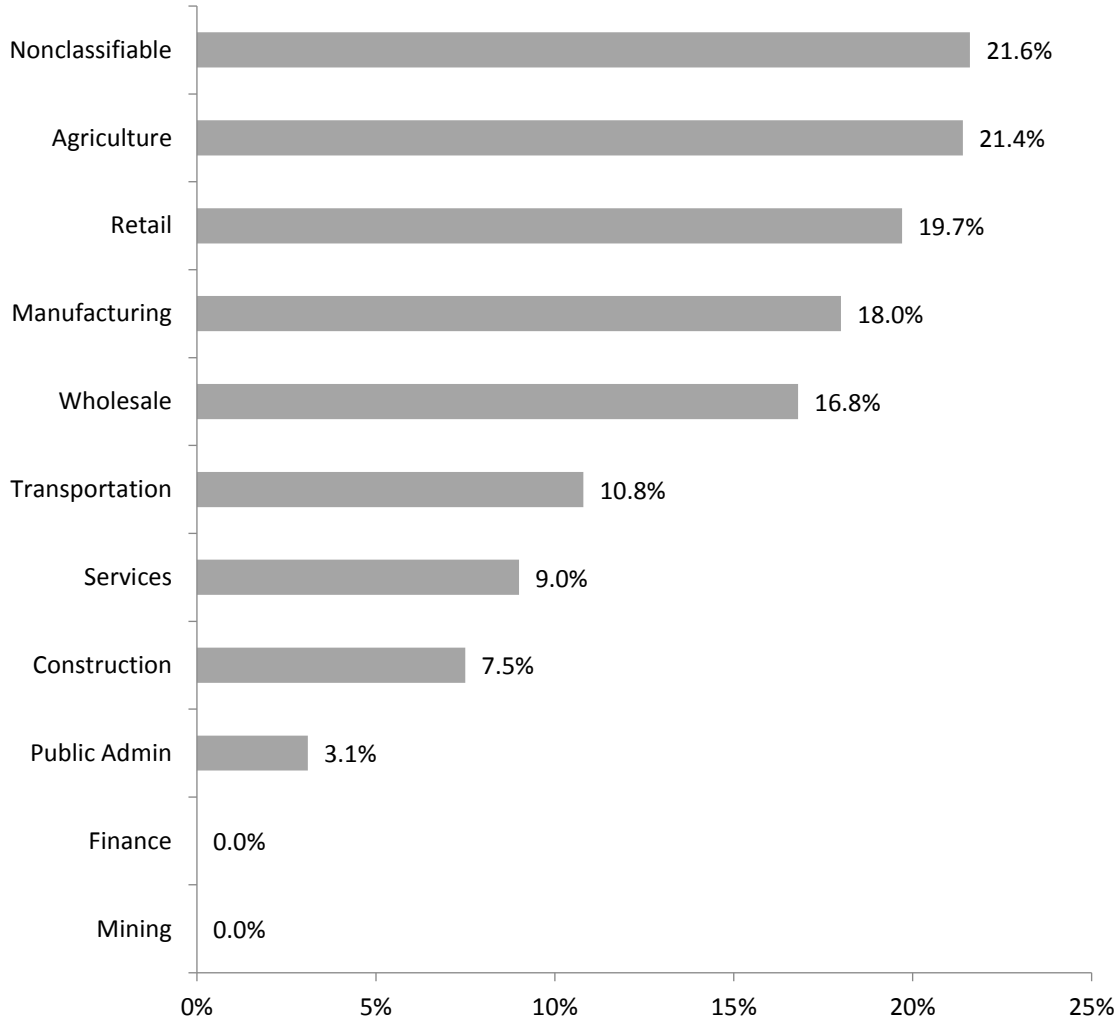


Figure 28 illustrates the proportion of respondents who indicated that their organization already operates a zero-emission fleet by SIC division. Note that a greater proportion of businesses in nonclassifiable industries (*n* = 8; 21.6%), agriculture (*n* = 3; 21.4%), retail (*n* = 25; 19.7%), and manufacturing (*n* = 58; 18.0%) already operate a zero-emission fleet than those whose businesses fall under another industry code. Conversely, none of those that belong to the finance (n = 0; 0.0%) or

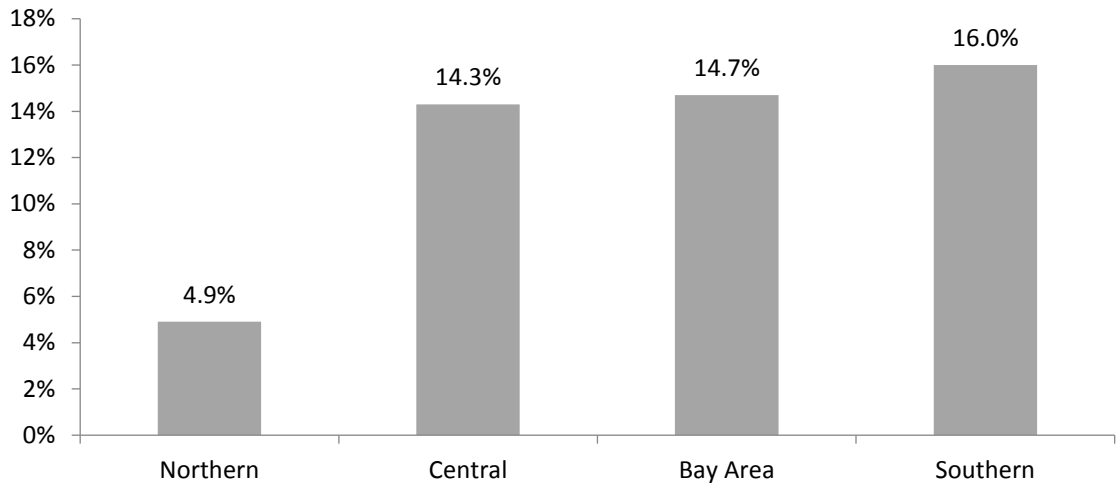
mining industry (*n* = 0; 0.0%) operate fleets that are zero-emission. These differences are statistically significant; $\chi^2(10) = 24.54$, *p* = 006.

Figure 28. Percentage of Businesses Operating Zero-Emission Fleets by Industry



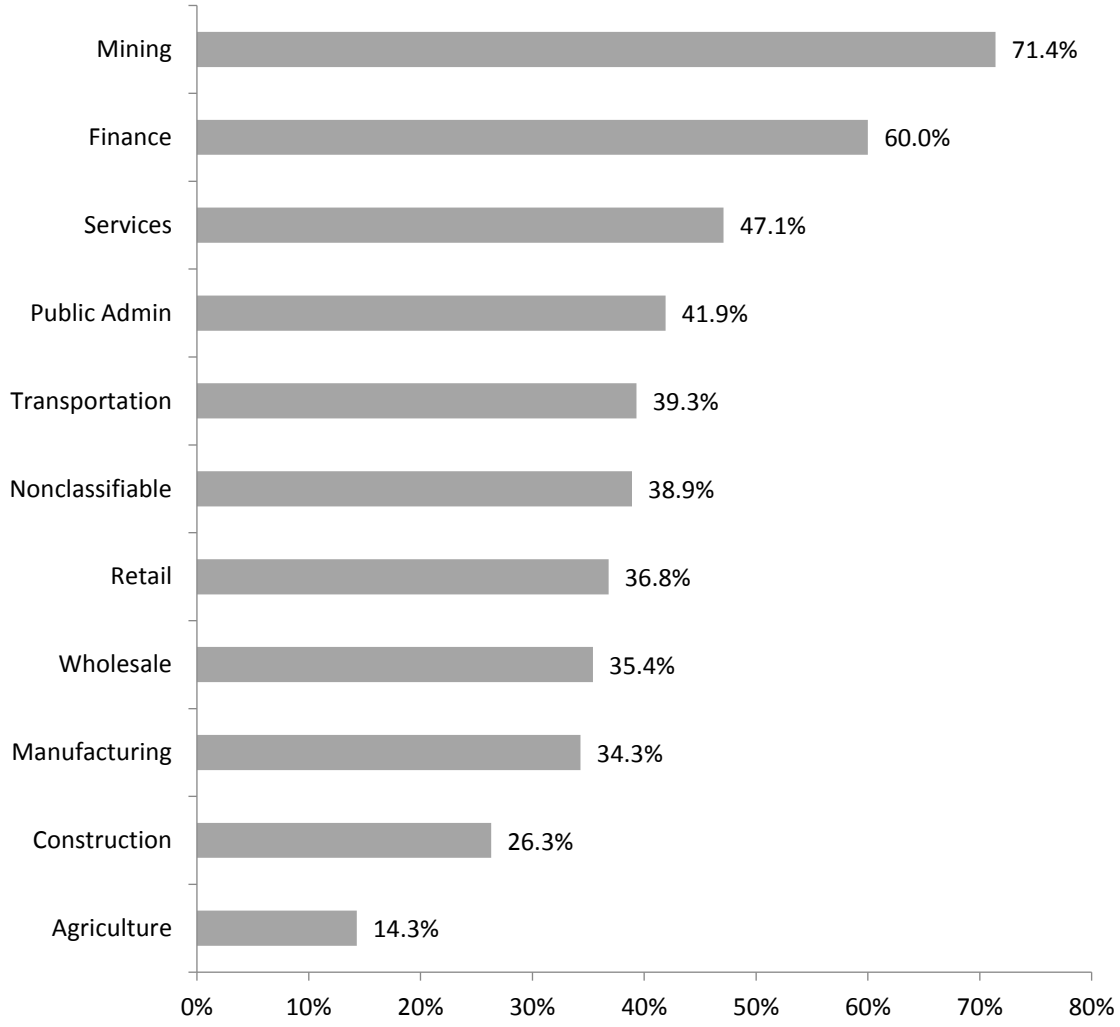
As shown in Figure 29, a greater proportion of businesses located in Southern California (*n* = 112; 16.0%) the Bay Area (*n* = 42; 14.7%), and Central California (*n* = 16; 14.3%) already operate zero-emission fleets than those operating in the Northern part of the state (*n* =5; 4.9%), a difference that is statistically significant; $\chi^2(3) = 9.03$, *p* = 029.

Figure 29. Percentage of Businesses Operating Zero-Emission Fleets by Region



Asked if they would like to be put on a list of businesses to be contacted by an ARB staff member in the event that incentives for upgrading or replacing older equipment become available, 424 (36.2%) responded in the affirmative. Thirty respondents declined to provide a response. The percentage of respondents interested in being contacted varied by the industry represented by the businesses being sampled, as illustrated in Figure 30. As shown, those in mining (*n* =5; 71.4%), finance (*n* = 3; 60.0%), services (*n* = 56; 47.15), and public administration (*n* = 13; 41.9%) were most interested in being contacted as measured by the percent who responded in the affirmative. On the other hand those who represented construction and agriculture were least interested as only 26.3% (*n* = 35) and 14.3% (*n* = 2) responded in the affirmative; $\chi^2(10) = 21.3$, *p* =019.

Figure 30. Respondents Interested in Being Contacted by ARB Staff by Industry



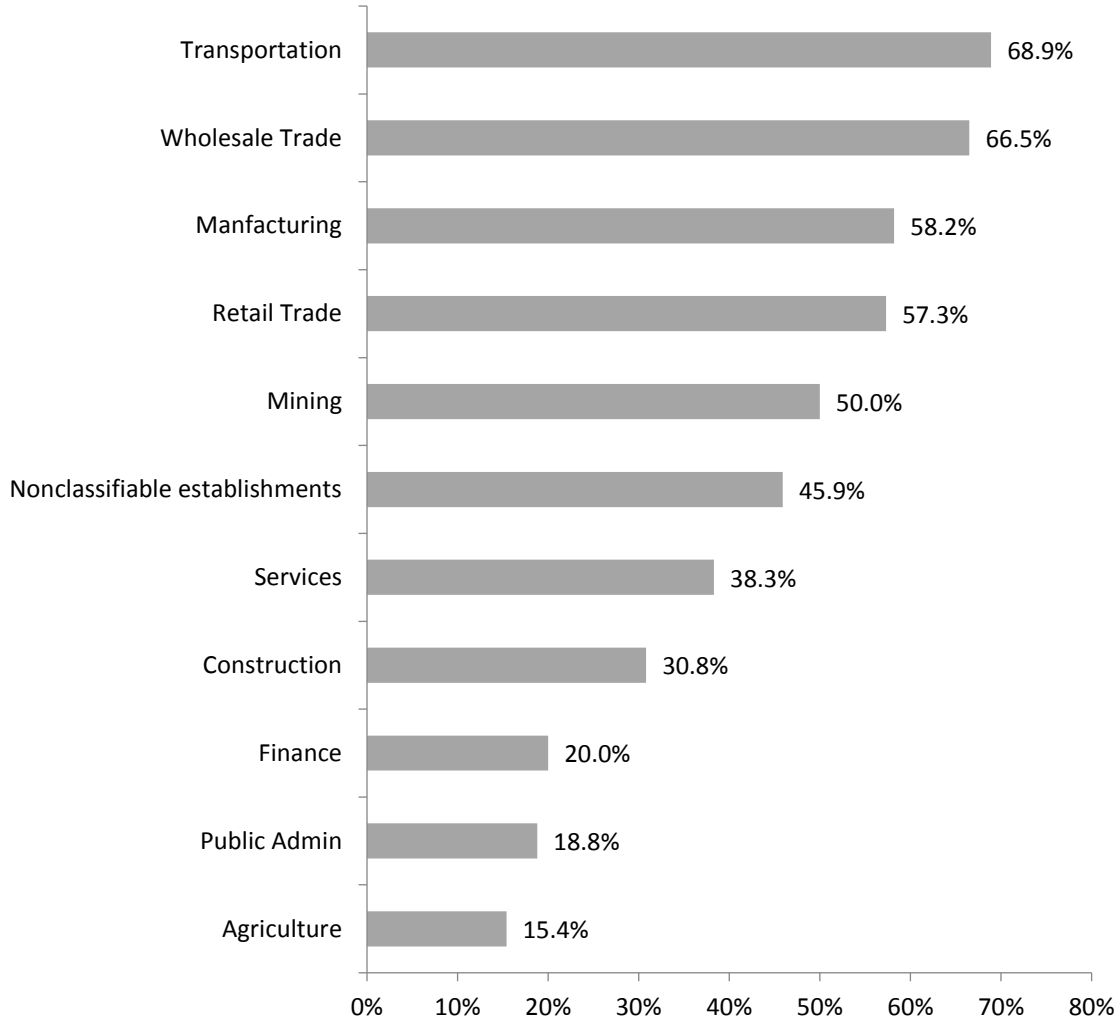
Although a slightly greater proportion of businesses operating in Northern California were interested in being contacted by ARB (*n* = 44; 43.6%) than those in the Bay Area (*n* = 105; 37.2%), Central (*n* = 39; 35.5%) and Southern California (*n* = 236; 34.9%), these differences were not statistically significant.

Representatives from all companies interviewed were asked the question: "Is your business a warehouse or distribution center that handles freight?" More than half of respondents (*n* = 639; 54.1%) answered this question in the affirmative. Seventeen respondents did not know the answer to this question, and one refused to answer.

As might be expected, there were differences in whether companies were considered warehouse or distribution centers that handled freight by industry (See Figure 31). Notably, higher proportions of businesses in the industries of transportation (*n* = 102; 68.9%), the wholesale trade (*n* = 165; 66.5%), manufacturing (*n* = 184; 58.2%), and the retail trade (*n* = 71; 57.3%) were warehouse or distribution centers than in other industries. Conversely, much smaller percentages of representatives from

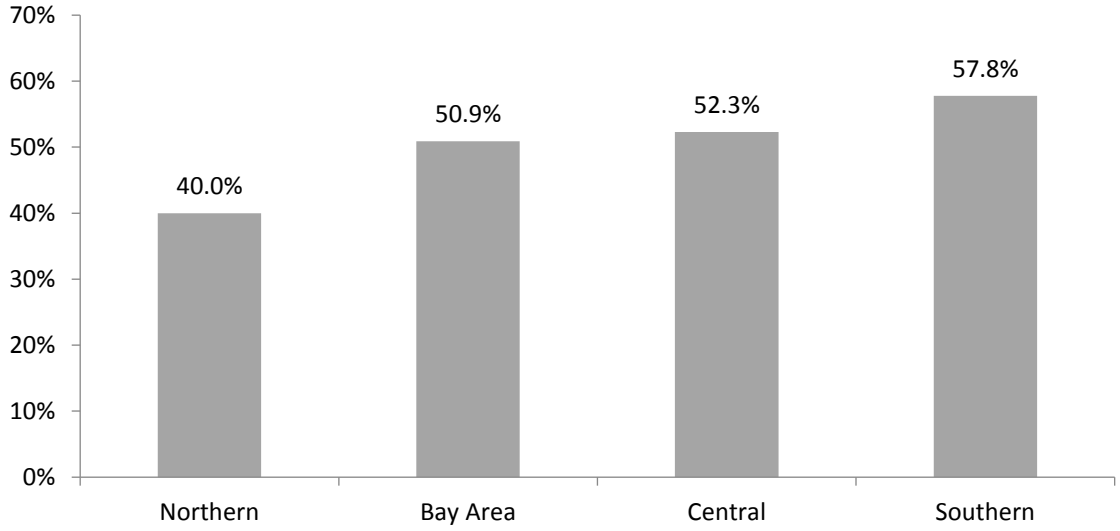
companies in finance (*n* = 1; 20.0%), public administration (*n* = 6; 18.8%), and agriculture (*n* = 2; 15.4%) identified their facilities as such; $\chi^2(10) = 99.0$, $p < .001$.

Figure 31. Warehouse/Distribution Center Status by Industry



As shown in Figure 32, the greatest proportion of considered warehouse or distribution centers that handle freight are located in Southern California (*n* = 398; 57.8%), followed by those in Central California (*n* = 57; 52.3%) and the Bay Area (*n* = 144; 50.9%). The smallest percent of businesses with this characteristic were located in Northern California (*n* = 40; 40.0%). These differences are statistically significant; $\chi^2(3) = 13.2$, $p = 004$.

Figure 32. Warehouse/Distribution Center Status by Region



Individuals representing the businesses in the survey sample were asked to provide the total square footage of the building on their business' property. A total of 859 (71.6%) provided this information; however, five provided a value of zero, which was interpreted to mean their property had no buildings. These values were dropped from the analysis, leaving 854 businesses to analyze. The number of square feet ranged from 45 (*n* = 1; 0.1%) to 1,000,000 (*n* = 1; 0.1%), with a mean of the 35,995 and a median of 15,000 square feet. Figure 33 displays a more detailed distribution of the square footages of businesses in the survey sample. As shown, nearly a quarter of businesses (*n* = 213; 24.9%) had square footages between 501 and 5,000.

Figure 33. Building Square Footage of Businesses in the Survey Sample

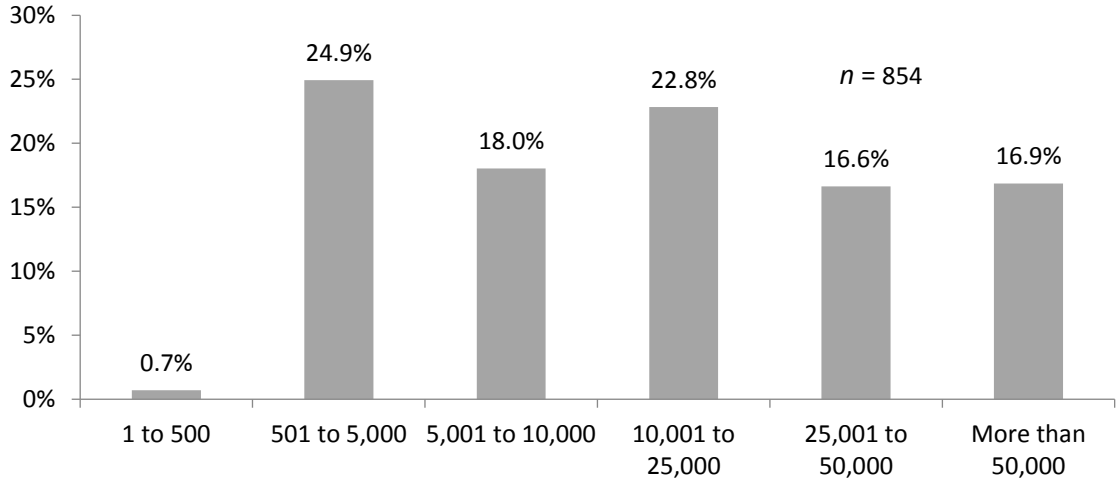


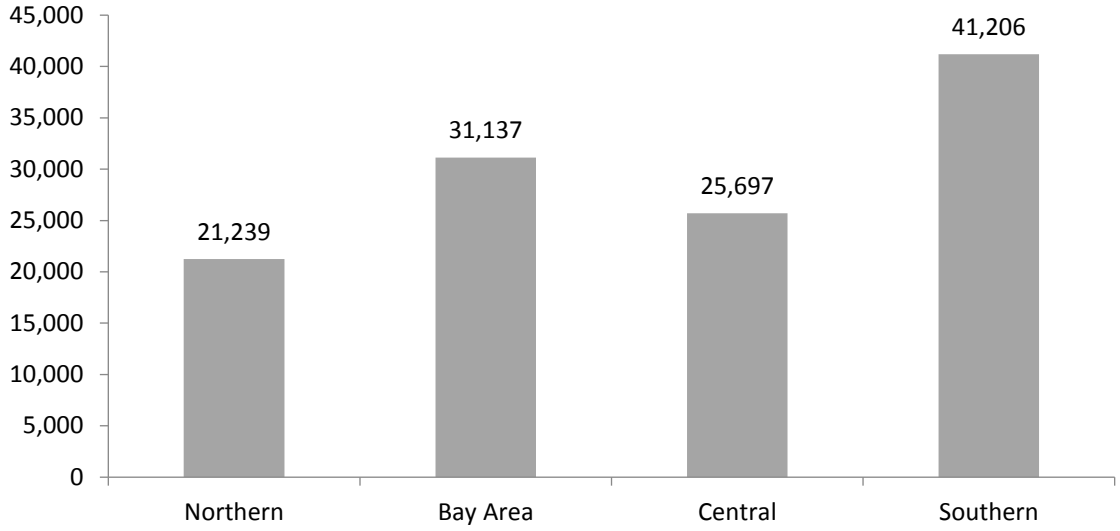
Table 70 displays the average square footage of businesses in the survey sample by industry. As shown, businesses in transportation (M = 66,149.4; n = 108) had the largest mean square footage of all industries, followed by those companies in services (M = 39,523.0; n = 78) and manufacturing (M = 38,319.0; n = 245). Those involved in mining (M = 9,333.3; n = 6) had the smallest average square footage; Welch's $F(10,63.23) = 8.23$, $p < .001$.

Table 70. Average Square Footage of Businesses by Industry

SIC Division	*n*	Mean
Transportation	108	66,149.40
Services	78	39,522.95
Manufacturing	245	38,319.04
Retail Trade	87	34,037.41
Agriculture	11	33,785.45
Wholesale Trade	177	30,558.60
Public Administration	19	21,973.68
Nonclassifiable establishments	31	18,980.65
Construction	87	14,336.15
Finance	4	13,433.50
Mining	6	9,333.33
Total	**853**	**36,013.76**

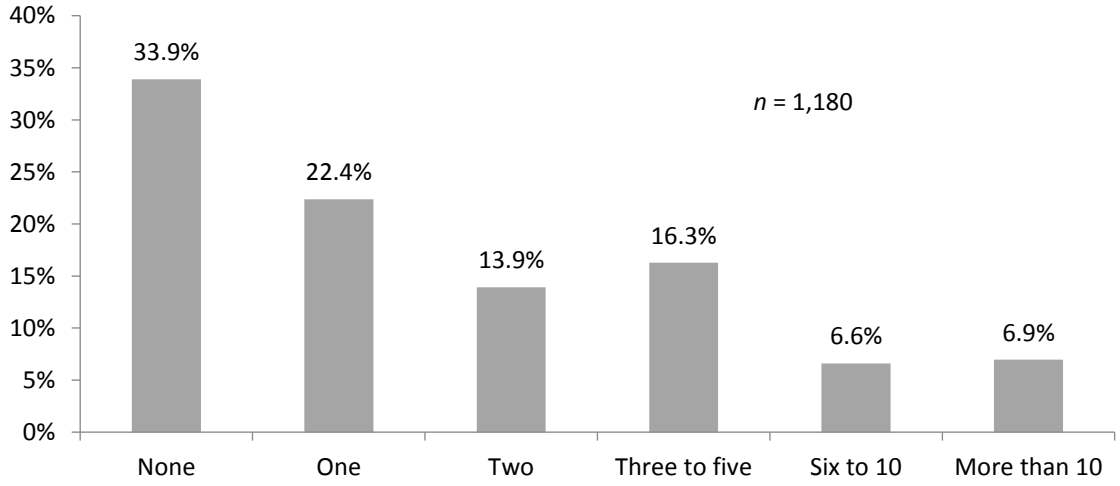
The average square footage of businesses interviewed also varied by region, as shown in Figure 34, with companies in Southern California (M = 41,206.0; n = 512) having the largest size and those in Northern California (M = 21,239.7; n = 68) being the smallest in terms of square footage; Welch's $F(3,224.9) = 6.78$, $p < .001$.

Figure 34. Average Square Footage of Businesses by Region



A final question on the survey instrument asked how many docks or bays the respondent's business' facility had. Overall, 98.4% (*n* = 1,181) of respondents provided a response to this item, while 17 indicated they did not know, and three refused to provide an answer. The number of docks/bays ranged from zero (*n* = 400; 33.9%) to 136 (*n* = 1; 0.1%), with a mean of 3.5 docks/bays and a median of one. Figure 35 displays a more detailed distribution of the number of docks/bays facilities had. As shown, the largest proportion of businesses did not have any docks or bays (*n* = 400; 33.9%), followed by about a quarter (*n* = 264; 22.4%) that had only one dock or bay.

Figure 35. Docks/Bays at Businesses in the Survey Sample



CREATING THE POPULATION ESTIMATE

Because it would be impossible to visit every business within the state and tally the number of forklifts, tow tractors (tugs), and industrial sweeper/scrubbers operating therein, the results of the survey data as described in an earlier section of this report were used to derive an estimate of the population of this type of equipment. The method utilized to create the population estimate was based on principles underlying inferential statistics, namely that sample data can be used under certain conditions to make a prediction about a larger population. This method is similar to extrapolation methods that attempt to estimate some value based on extending a known sequence of values or facts beyond what is certainly known, in a sense moving beyond the data. Sampling involves selecting a subset of some population of inference in order to gain information about the entire population. A good sample will be representative of the population from which it was drawn. However, the sample that is actually obtained varies greatly depending on time and financial constraints as well as logistical challenges.

ESTIMATING THE SIZE OF THE POPULATION OF INFERENCE

For the purpose of this study, the population of inference is defined as all businesses operating fleets of forklifts, tow tractors (tugs), or industrial sweeper/scrubbers in the state of California. In addition to defining the population of inference, adequate sampling requires the researcher have a list enumerating all of the units contained in the population of inference. As mentioned in a previous section of this report, no exhaustive list of businesses operating fleets of such equipment is currently available at the state level, the ones that do exist being biased in some way. For example, the Equipment Data Associates (EDA) list only contains businesses that financed this type of equipment, thus those that rent or purchase their fleet equipment outright would not be represented. The lack of such a list posed the first major challenge to creating a sample design that would produce an accurate estimate of the number of forklifts, tow tractors (tugs), and industrial sweeper/scrubbers operated by businesses in the state. As discussed in the Sample Frame Development section of this report, this challenge was addressed by combining the EDA, DOORS, DMV and BOE data files and treating the resulting file as the sample frame from which businesses would be sampled for participation in the current study.

Another requisite to one's ability to use survey data to obtain a population estimate is that a random sample of businesses contained in the sample frame be selected for inclusion in the study sample, such that each business has an equal probability of getting into the study. Recall that BOE data was removed from the sample frame after extensive review of initial call outcomes during the pilot phase of data collection revealed that it yielded drastically lower eligibility and completion rates than the other three sample sources. Leaving this data in the sample frame would have increased the time and financial resources needed to administer the target number of surveys. The businesses contained in the remaining three files resulted in a more efficient sample frame, where efficiency is measured by the probability of reaching a business operating one of the three equipment types during the telephone interviewing process. In depending upon these three data sources to serve as the sample frame for the current study, researchers assumed that businesses contained in one or more of these three data files would also be found in the larger BOE data file. Of the 1,200 telephone surveys that were completed, only 32 came from the BOE data file. Thus the majority of the survey sample was drawn from the combined EDA, DOORS, and DMV files.

While taking this approach proved more feasible in terms of both cost and time, it introduced yet another challenge to applying the sample estimates to the population, as it was assumed that these

three files did not contain an exhaustive list of all businesses operating the equipment under investigation in the State of California. Although the size of the BOE data file posed a problem with regard to including it in the sample frame, it offered utility for estimating the size of the population of inference. Aside from the presumed small proportion of businesses that do not pay sales and use taxes (which includes government organizations), the BOE data file contains all businesses within the State of California. ***For this reason, the BOE data file was assumed to contain a near exhaustive list of the businesses operating in the state.*** This assertion requires us to make several assumptions regarding the BOE data file:

> ***Assumption 1: The BOE data file reflects the most valid available list of businesses operating in the state of California;***
>
> ***Assumption 2: The BOE data file contains most of the businesses in the EDA, DMV, and DOORS files (with some minor exceptions), and therefore contains the businesses in the study sample; and***
>
> ***Assumption 3: An unknown, but small percentage of the businesses contained in the BOE data file operate forklifts, tow tractors, and industrial sweeper/scrubbers.***

Recall that extrapolating sample estimates back to a population of inference requires knowledge of the size of that population. The three aforementioned assumptions were used to justify the use of the BOE file as a tool for estimating the size of the population of inference. An estimate of the size of the population of inference was sought by posing the question: What percentages of businesses contained in the BOE data file are likely to be operating fleets of forklifts, tow tractors (tugs), or industrial sweeper/scrubbers?

In order to create a valid estimate of the percentage of businesses contained in the BOE file that likely maintain the study equipment, a random sample of 384 businesses contained in the BOE file were contacted by telephone and asked the following question, "Does your business operate fleets of forklifts, industrial sweeper/scrubbers, or tow tractors (tugs) in the state of California?" Sixty-three (16.4%) business representatives answered in the affirmative. Based on the results of this procedure and using a 95% confidence level, it was estimated that the percentage of businesses contained in the BOE file that would operate forklifts, sweeper/scrubbers, or tow tractors (tugs) in the state of California would be 16.4% with a lower and upper bound of 11% and 21%, respectively. Applying an eligibility rate of 16.4% to the BOE file, 149,381[36] businesses were estimated to have some non-zero probability of maintaining at least one piece of such equipment. Applying the confidence interval to this estimate, we can be 95% certain that the actual eligibility rate expected ranges from between 100,194 and 191,281. Thus, the fourth assumption on which the population estimate is based is that:

> ***Assumption 4: Approximately 149,381 businesses in the state of California operate fleets of forklifts, tow tractors (tugs) or industrial sweeper/scrubbers.***

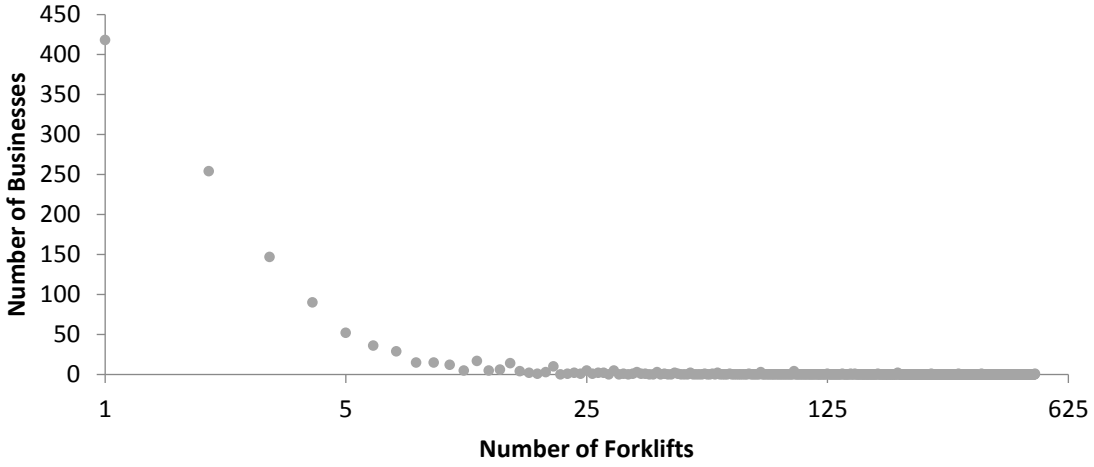
[36] This value comes from applying an eligibility rate of .164 to 910,860 businesses in the BOE file. This value of 910,860 businesses overall includes those businesses that did not have telephone numbers, but does not include those businesses involved in the primary agricultural sector, which is why it is different from the original total of 916,666.

A limitation of using the BOE data file as the basis for creating a valid estimate of the size of the population of inference is that it does not include businesses whose activities preclude them from paying such taxes; in particular, this group would include companies whose business mainly entails moving goods rather than selling them. Additionally, government run organizations are not included. Therefore, the results of the current study will not generalize to such businesses and organizations. A final limitation of using the BOE file as a proxy population of inference is that this file contained no data regarding the number of sites each business operated. In the absence of available information, it should be noted that the results of this report take for granted that the businesses in the study sample and BOE file are roughly equivalent with regard to this characteristic.

Addressing Outlying Values in the Survey Data

Before applying sample estimates to a population of inference, it is critical that analysts examine the distribution of the survey data, as severe outlying values can distort the results. As noted in the survey results, the distributions of forklifts, industrial tow tractors, and industrial sweeper/scrubbers were all heavily skewed to the left, meaning that most of the values were concentrated near the bottom of the distribution while a small number of outlying values fell at the top of the distribution. Figure 36 shows this condition in the distribution of forklifts.

Figure 36. Distribution of Forklifts Operated by Businesses in the Survey Sample



Two measures are predominately used to calculate measures of central tendency: the mean and the median. The mean is calculated by taking the sum of all values and dividing this by the number of values present. For example, if we want the average of the number of forklifts operated by five businesses we would take the number of forklifts used by each business, add them all together, and divide by five. To demonstrate this, consider that we have five businesses with 4, 5, 5, 6, and 100 forklifts. The mean for these businesses would be 24, or (4+5+5+6+100)/5, which clearly demonstrates the undue influence of the business with 100 forklifts. If we continued to sample businesses, and each batch of new businesses followed a similar pattern (a few low values and one high one), we would eventually be able to say that the mean was truly reflective of the overall population mean. Alternatively, it is possible that the next

five values sampled would all be in the lower range (around 5) and that this pattern would continue. In other words, the value of 100 forklifts was an anomaly and was having undue influence on the mean.

On the other hand, let us consider the use of the median. To calculate the median, all values are first ordered from lowest to highest. The value in center of this reordered distribution is the median. In our previous example of 4, 5, 5, 6, and 100, the median value is simply calculated as 5 (the distribution is already in order). It is clear that the high value has much less influence on the median than the mean, as a value of 7 instead of 100 would have yielded the same median (conversely, the mean would be 5.4). If we continued to sample values, and most were in the lower range, we could consider this value of 100 to be anomalous and use the median as an alternate measure. However, consider what might happen if one of the values from each new batch of businesses was on the higher end but not as high (for example, around 10). In this case, using the median would not capture the fact that there are consistently some values on the higher end of the distribution (though not to an extreme extent).

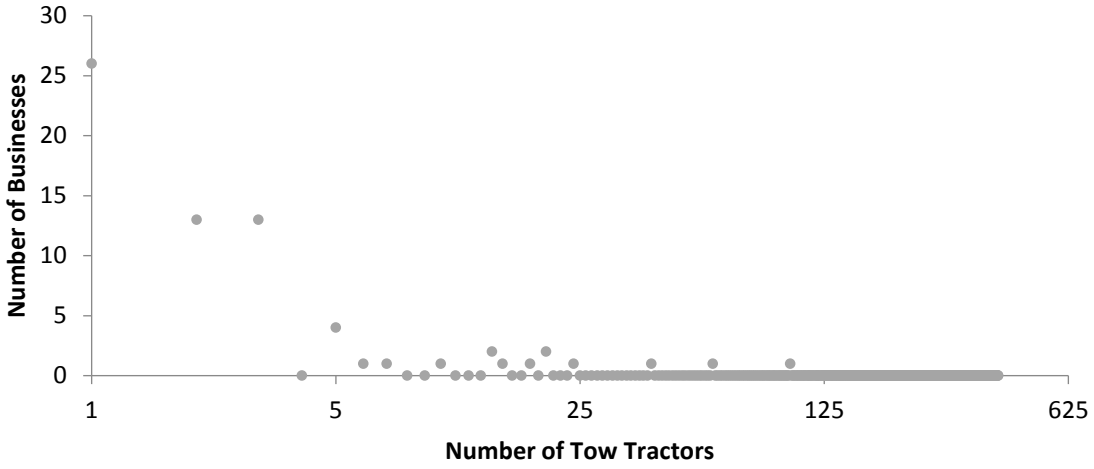
To address the extreme outlying value while still taking into account the more moderate high values, another approach must be taken. One alternative is to simply drop extreme outlying values from the distribution (a process known as trimming). This approach is particularly useful if the outlying values are believed to be a result of measurement error. Consider, on the other hand, that we know this value of 100 to be accurate, but it is still an anomaly in the data. In order to include it in the data but lessen its impact on the mean, another technique known as winsorization can be used. To winsorize the data values, a threshold is selected (commonly the 90^{th} or 95^{th} percentile, though other cutoffs can be used), and all data points above this threshold are set to the cutoff value. Duan (1998) notes that this has an advantage over dropping these values in that it allows the sample size to remain constant by retaining values that would otherwise be lost.

Take, for example, a theoretical distribution of 20 values that are mostly in the lower range, with some in the middle and very few at the top. Consider the following distribution: 4, 5, 5, 5, 5, 5, 6, 6, 7, 8, 8, 8, 9, 9, 10, 10, 25, 25, 50, and 100. The mean of these values is 15.5. However, if we move the all values above the 90^{th} percentile to the 90^{th} percentile value (changing both 50 and 100 to 27.5), we get a mean of 10.8. Here, the impact of the extreme outliers is lessened, sample size is retained, and more moderate outliers maintain their influence on the mean. Using the median of 8 would not have taken these more moderate values into consideration.

Given these advantages of winsorization over other proposed approaches, the method was applied to the forklift data, using a 95^{th} percentile cutoff. Applying this technique to the forklift data, the highest number of forklifts was adjusted to 21, with 59 cases above 21 receiving this value. This method reduced the mean number of forklifts among businesses in the survey sample to from 7.09 to 4.20.

Figure 37 shows the distribution of tow tractors in the survey sample. Similar to the distribution of forklifts, large numbers of businesses had fewer tow tractors, while few businesses had large numbers of tow tractors.

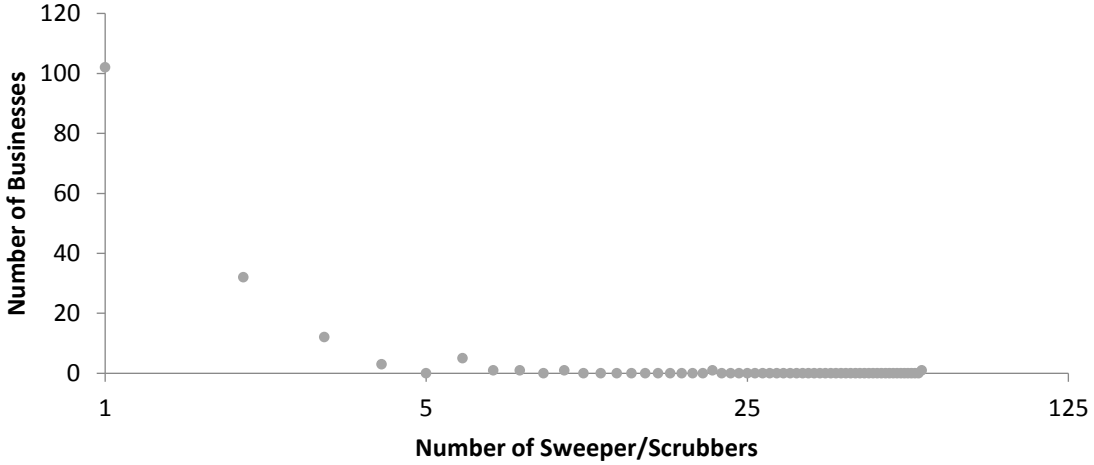
Figure 37. Distribution of Tow Tractors Operated by Businesses in the Survey Sample



Applying the same winsorization technique as for the forklift estimate, five tow tractor values were changed to the 95th percentile value of 21. This method reduced the mean number of tow tractors among businesses in the survey sample from 12.19 to 4.86.

Lastly, Figure 38 shows the distribution of sweeper/scrubbers in the survey sample. As with the distributions of forklifts and tow tractors, more businesses had fewer sweeper/scrubbers, while fewer businesses had large numbers of sweeper/scrubbers.

Figure 38. Distribution of Sweeper/Scrubbers Operated by Businesses in the Survey Sample



Winsorizing the distribution of sweeper scrubbers (as was done with forklifts and tow tractors), five sweeper/scrubber values were changed to the 95th percentile value of 4. This method reduced the mean number of tow tractors among businesses in the survey sample from 2.20 to 1.60.

Addressing Bias Resulting from Issues in Representativeness by Sample Source

When drawing a study sample from a list comprised of multiple data sources, the proportion of completed surveys from each source should be equivalent to the proportion that source represents in the complete list. For example, if 9.0% of the businesses in the combined data file derived from the DOORS data file, then 9.0% of the study sample (or 9.0% * 1200 = 108) should as well. In an ideal world, this would happen as a result of random selection. However, the situation for this study was less than ideal because of the way the sample frame was constructed: for this study, each sample source had its own unique characteristics that, on the whole, determined the likelihood that a call attempt to a business would result in a completed survey. As shown, the proportion of surveys completed with businesses sourced from the DOORS file (*n* = 167; 13.4%) was substantially higher than for that file's contribution to the sample frame (*n* = 2,731; 9.0%). This difference in completion rate for this group is intuitive because these businesses have a prior relationship with the ARB.

Because the proportion of businesses contained in survey sample were known not to be representative of the businesses contained in the combined EDA, DOORS, and DMV data file, an adjustment to the study sample needed to be employed such that it more closely mirrored the businesses contained in the combined EDA, DOORS and DMV data file. Without any adjustments, the types of equipment from smaller sample sources with higher completion rates would be overrepresented. The necessary adjustment was accomplished through a process known in survey research as weighting.[37] This technique is applied to survey data to make statistics calculated from this data (in this case the mean number of pieces of equipment) more representative of the sample frame from which it was obtained. In this method, a value is assigned to each case in the dataset that tells the person or program analyzing the data how much each case will count. For example, a case with a weight of two will be counted as two cases (that is, twice).

To construct weights, the proportion of cases from each data source in the combined EDA, DOORS and DMV file is divided by proportion of cases from each source observed in the survey sample. For a more general example, consider a population consisting of 50% males and 50% females. If a survey sample of this population is made up of 25% males and 75% females, the input of males within this population will be underrepresented and that of females overrepresented. To account for this through weighting, the proportion of the population that is male (.5) should be divided be the proportion of the survey sample that is male (.25) to yield a weight to apply to all male cases in the survey sample (.5 / .25 = 2). This means all male cases will be counted twice. Conversely, each female case will be counted at 0.67 times (.5 / .75 = .67). Values above 1 indicate a case will be counted more than once, and values below 1 mean that case will be counted less than once. A value of exactly 1 indicates the survey sample and population are matched on the variable and level of interest.

The combined sample frame consisting of the EDA, DMV and DOORS datasets was used to develop the sample weights to address the potential bias that might be introduced by oversampling businesses from one data source and under-sampling those from another. Recall that the BOE file was abandoned as a contributor to the sample frame early in the study due to low eligibility and completion rates for that sample source. As such, the BOE file was not utilized to calculate weights by sample source, and the 32

[37] For a detailed explanation of the process of weighting survey data, see publicly available lecture slides for "Using Weights in the Analysis of Survey Data" by Dr. David Johnson of the Population Research Institute at Pennsylvania State University.

cases in the survey sample originating from the BOE file were removed from the process of calculating the population estimate.

As shown in Table 71, EDA records comprised 84.1% of all records in the sample frame, but only 79.8% of those in the study sample. To address this discrepancy, the proportion of EDA records in the sample frame (.841) was divided by the proportion of EDA records represented in the survey sample (.798) to yield a weight for that category (.841 / .798 = 1.05). This means that each EDA record will be counted 1.05 times when conducting analyses of the survey data. Consider the following hypothetical example using our survey weights: *If 20 businesses from the EDA file indicate they have sweeper/scrubbers, the analysis will show instead that 21 businesses did (20 * 1.05 = 21). Conversely, we can apply the DOORS weight to 20 businesses from that source. In this case, if 20 businesses from this file indicate they have sweeper/scrubbers, the analysis will show that only 12.6 businesses did (20 * .63 = 12.6).* In this way, underrepresented groups are given greater weight while overrepresented groups are given less. The weights in the fourth column of Table 73 reflect the adjustments to be made for each group.

Table 71. Sample Frame and Study Sample by Sample Source

Sample Source	Study Sample Count (%)	Combined Sample Frame Count (%)	Category Weight (Sample Frame /Study Sample Proportion)
EDA	932 (79.8%)	25,452 (84.1%)	1.05
DMV	69 (5.9%)	2,074 (6.9%)	1.17
DOORS	167 (14.3%)	2,731 (9.0%)	0.63
Totals	**1,168 (100.0%)**	**30,257 (100.0%)**	**--**

Addressing Bias Resulting from Issues in Representativeness by Fleet Size

Comparing the businesses contained in the study sample to the businesses contained in the list from which it was drawn, it was also found that they were mismatched in terms of business fleet size (including forklifts, industrial tow tractors, and industrial tow tractors). As shown in Table 72 , businesses with only one piece of equipment were underrepresented in the survey sample, in which they constituted less than a third (*n* = 381; 32.6%) of the survey sample compared to 60.8% (*n* = 18,394) of the sample frame. All other fleet sizes were overrepresented to varying degrees. To address this potential source of error, the same type of weighting procedure described above was applied here, so that the study sample more closely mirrored the sample frame from which it was drawn with respect to fleet size.

For example, businesses with a fleet size of 26 or more pieces of equipment represented only 1.9% of the sample frame but 4.9% of those in the study sample. To address this discrepancy, the sample frame proportion for businesses with fleets of 26 or more (.019) was divided by the proportion of the study

sample with this estimated fleet size (.049), yielding a weight of 0.39 for each business with 26 or more pieces of equipment. This means, for example, that if 20 businesses with fleets of 26 or more pieces of equipment indicate they have sweeper/scrubbers, the analysis will show instead that 7.8 businesses did (20 * 0.39 = 7.8). The values in the Column 4 of Table 72 display the adjustments to be made for these differences.

Table 72. Sample Frame and Study Sample by Fleet Size (Including Forklifts, Industrial Tow Tractors, and Industrial Sweeper/Scrubbers)

Fleet Size	Study Sample Count (%)	Combined Sample Frame Count (%)	Category Weight (Sample Frame/Study Sample Proportion)
One	381 (32.6%)	18,394 (60.8%)	1.87
Two	235 (20.1%)	4,772 (15.8%)	0.79
Three	144 (12.3%)	1,908 (6.3%)	0.51
Four to 25	351 (30.1%)	4,623 (15.3%)	0.51
26 or more	59 (4.9%)	560 (1.9%)	0.39
Totals	**1,168 (100.0%)**	**30,257**[38] **(100.0%)**	--

Addressing Bias Resulting From Representativeness by Industry

While sampling from the combined EDA, DOORS, and DMV files resulted in a study that was more cost and time feasible, it also introduced a unique challenge, namely that the researchers were trying to apply the estimates obtained from sampling businesses in one list to businesses contained in another list. While it was assumed that some of the businesses contained in the combined EDA, DOORS, and DMV data files would also be included in the BOE file, it was also known that the overlap between the files would not be 100%. Thus, an additional assumption on which the extrapolation method is based was:

> ***Assumption 5: The businesses contained in the EDA, DOORS and DMV data files are not fully representative of the businesses contained in the BOE file.***

Recall that 79.8% of the survey sample represents businesses that were contained in the EDA file, followed by 14.3% that were contained in the DOORS file, and 5.9% in the DMV file. Consequently, it was assumed that the industries contained in the study sample would not be representative of the

[38] This value **does not** include the BOE records from the original sample frame. For other sample sources, it includes **all** records from the original sample frame, regardless of whether they contained sufficient contact information.

approximately 149, 381 businesses to which the estimates were being applied. In order assess the extent to which this was the case, an analysis comparing the study sample and to the businesses in the BOE file with respect to industry was conducted. As shown in Table 73, the study sample vastly over-represented businesses in construction, manufacturing, and transportation. Conversely, the study sample grossly under-represented those in wholesale, retail, and services. Because the businesses contained in the combined EDA, DOORS, and DMV data file were known not to be representative of the businesses in the BOE data file with respect to industry type, an adjustment to the study sample needed to be employed such that it more closely mirrored the businesses contained in the BOE file.

To this end, the 32 businesses representing public administration were purged from the survey sample leaving 1,138 cases on which to derive the population estimates. To account for the differences in the proportion of businesses represented by the remaining six industries between the BOE and the study sample, the data file was weighted such that values provided by businesses in construction, manufacturing, and transportation would carry *less* weight and that those provided by those in wholesale, retail, and services would carry *more*. The weights assigned to each industry were calculated by dividing the proportion of businesses classified as belonging to each industry in the BOE file (*N* = 910,860 businesses[39]) by the proportion of businesses from each industry in the study sample. In the weighting procedure, data for businesses from each category is counted according to its weight. This means, for example, that responses for businesses involved in agriculture are counted at one quarter their original value (See Table 73).

[39] This value does not include businesses involved in the primary agricultural sector or businesses without a designated industry code.

Table 73. BOE Data File and Study Sample by Industry			
SIC Division	**Study Sample Count (%)**	**BOE Data File Count (%)**	**Category Weight (BOE/Study Sample Proportion)**
A: Agriculture	14 (1.2%)	2,993 (0.3%)	0.25
B: Mining	8 (0.7%)	589 (0.06%)	0.09
C: Construction	134 (11.2%)	16,806 (1.8%)	0.16
D: Manufacturing	322 (26.9%)	65,219 (7.2%)	0.27
E: Trans., Comm., Elec., Gas, and San. Serv.	148 (12.3%)	22,404 (2.5%)	0.20
F: Wholesale Trade	250 (20.9%)	385,138 (42.3%)	2.02
G: Retail Trade	127 (10.6%)	223,261 (24.5%)	2.31
H: Finance, Insurance, and Real Estate	5 (0.4%)	11,683(1.2%)	3.00
I: Services	122 (10.2%)	178,775 (19.6%)	1.92
J: Public Administration	32 (2.7%)	0 (0.0%)	0.00
Nonclassifiable	37 (3.1%)	3,992 (0.4%)	0.13
Totals	**1,199 (100.0%)**	**910,860 (100.0%)**	**--**

The three aforementioned categories of weights were combined for each case in a procedure known as iterative proportional fitting or raking weights. In this process, weights for each category are applied in turn, and new weights are estimated across each set of items until the weights converge and, in essence, match the known values in the population. For a more detailed explanation of raking, see the referenced article[40]. Combining all three weights (for industry, fleet size, and sample source), a total of 1,138 cases were available for analysis. This reduced total results from the exclusion of 32 cases sourced from the BOE file[41] and 38 from the public administration industry group plus one for which the industry group could not be determined (three cases fit into both categories).

To demonstrate the effect of applying these raked weights to the survey data, the mean number of forklifts after applying the combined weights was 4.04, compared to 7.22 forklifts for this same group without the weights. Thus, it can be gleaned that applying these weights helped to adjust for characteristics of the survey sample that inflated the initial forklift estimate.

[40] http://faculty.nps.edu/rdfricke/docs/RakingArticleV2.2.pdf

[41] These cases were removed because fleet size data were not available in the BOE file, so a fleet size weight could not be calculated.

Estimating the Population of Forklifts Operating in California

Recall that it was estimated that approximately 149,381 businesses in the BOE file would have some non-zero probability of operating a forklift, tow tractor, or sweeper/scrubber, with a lower and upper bound of 100,194 and 191,281 respectively. Also recall that 99.5% of the businesses sampled in the current survey maintained a fleet of forklifts. Based on this estimate it was assumed that the values obtained through the survey data should be extrapolated to (149,381*.995) = 148,635 businesses, with a lower and upper bound of 99,693 and 190,325 businesses.

Applying the unweighted mean of 7.22 to this population, it is estimated that 1,073,145 forklifts operate in the state of California, a clear overestimate. The lower and upper bound on this estimate ranges from 563,265 to 1,672,957. In order to adjust for this overestimate, the aforementioned raked weights were applied to the data, yielding a weighted mean of 4.04 forklifts and an overall population estimate of 600,485 forklifts with a lower bound of 299,079 and an upper bound of 966,851 (See Table 74).

Additionally, to account for the aforementioned issues with extreme outlying values, the winsorized forklift distribution was utilized. Weighting this winsorized distribution resulted in a mean value of 2.64 forklifts per eligible business.

Applying the weighted winsorized mean, we estimate that there are approximately 392,396 forklifts operating in the state of California, as shown in Table 74. Based on the sample size and the standard deviation of the mean value we can be 95% certain that the actual value lies between 241,257 and 544,330, barring any non-sampling error.

Table 74. Estimated Forklift Population Averages and Lower and Upper Bounds			
	Population Lower Bound (-5)	**Population Average**	**Population Upper Bound (+5)**
	99,693	148,635	190,325
Unweighted Non-Winsorized Mean			
Lower Bound (-1.57) = 5.65	563,265	839,788	1,075,336
Average = 7.22	719,783	1,073,145	1,374,147
Upper Bound (+1.57) = 8.79	876,301	1,306,502	1,672,957
Weighted Non-Winsorized Mean			
Lower Bound (-1.04) = 3.0	299,079	445,905	570,975
Average = 4.04	402,760	600,485	768,913
Upper Bound (+1.04) = 5.08	506,440	755,066	966,851
Weighted Winsorized Mean			
Lower Bound (-.22) = 2.42	241,257	359,697	460,587
Average = 2.64	263,190	392,396	502,458
Upper Bound (+.22) = 2.86	285,122	425,096	544,330

Table 75 depicts the estimated number of forklifts fueled by diesel, propane, gasoline and battery operated based on an estimated population of 392,396 forklifts. As shown the largest proportion is fueled by propane, followed by diesel, and those that are battery operated.

Table 75. Estimated Forklift Population Averages and Lower and Upper Bounds by Fuel Type			
	Population Lower Bound (-5)	**Population Average**	**Population Upper Bound (+5)**
	263,190	392,396	502,458
Propane/LPG Fueled			
53.9%	141,859	211,502	270,825
Diesel Fueled			
21.9%	57,639	85,935	110,038
Battery Operated			
20.1%	52,901	78,872	100,994
Gasoline Fueled			
2.7%	7,106	10,595	13,566
Unknown Fuel Type			
1.3%	3,421	5,101	6,532
Other Fuel Type			
0.1%	263	392	502
Dual Fueled			
0.1%	263	392	502

Recall that data on the horsepower of propane/LPG lifts operated was provided by 417 businesses in the survey sample. This number was sufficient to draw conclusions about the number of these forklifts falling into each horsepower category. Table 76 shows the estimated number of propane/LPG forklifts from each horsepower category, with the largest number in the 50 HP and below category.

Table 76. Estimated Propane/LPG Forklift Population Averages and Lower and Upper Bounds by Horsepower Category			
	Population Lower Bound (-5)	**Population Average**	**Population Upper Bound (+5)**
	141,859	211,502	270,825
< 51 HP			
57.1%	81,001	120,767	154,641
51 – 70 HP			
36.4%	51,637	76,987	98,580
> 70 HP			
6.5%	9,221	13,748	17,604

Data on the lift capacity of propane/LPG lifts operated was provided by 792 businesses in the survey sample, a quantity sufficient to draw conclusions about the number of these forklifts falling into each lift capacity category. Table 76 shows the estimated number of propane/LPG forklifts from each lift capacity category, with the largest number in the 5,000 pound and below category.

Table 77. Estimated Propane/LPG Forklift Population Averages and Lower and Upper Bounds by Lift Capacity Category

	Population Lower Bound (-5)	Population Average	Population Upper Bound (+5)
	141,859	211,502	270,825
< 5,001 lbs.			
62.0%	87,952	131,131	167,911
5,001 – 8,000 lbs			
30.0%	42,558	63,451	81,248
> 8,000 lbs.			
8.0%	11,349	16,920	21,666

Sample sizes were insufficient (less than 384) to compute estimated populations for the remaining forklift fuel types by horsepower and lift capacity.

Estimating the Population of Tow Tractors in California

Only 6.2% of businesses represented in the study sample operated industrial tow tractors. Multiplying this value (.062) by the estimated number of businesses assumed to be eligible for the current study resulted in 9,262 businesses (with a lower and upper bound of 6,212 and 11,859) to which the extrapolation method could be applied.

The number of tow tractors was available for 70 businesses in the survey sample, but six were excluded because they were either involved in public administration or came from the BOE file, yielding 64 cases for analysis. Among these cases, a mean value of 13.05 tow tractors per organization was observed. As with the forklift estimate, the three raked weights were applied to yield a mean value of 4.78. Additionally, to account for extreme outlying values, the winsorized tow tractor distribution was utilized. Weighting this winsorized distribution resulted in a mean value of 3.44 tow tractors per eligible business.

Table 78 illustrates the estimated value of tow tractors operating in the state of California when applying that average value as well and upper and lower bounds on that estimate. As shown, the likely estimate of tow tractors operating in the state of California is 31,861 with an upper and lower bound of 10,250 and 62,023.

Table 78. Estimated Tow Tractor Population Averages and Lower and Upper Bounds

	Population Lower Bound (-5)	Population Average	Population Upper Bound (+5)
	6,212	9,262	11,859
Winsorized Mean (Weighted)			
Lower Bound (-1.79) = 1.65	10,250	15,282	19,567
Average = 3.44	21,369	31,861	40,795
Upper Bound (+1.79) = 5.23	32,489	48,440	62,023

Using the survey data on sources of fuel used to operate this equipment, it is estimated that 16,600 tow tractors are diesel fueled, 11,311 are fueled by gasoline, 2,867 are battery operated, and 510 are propane fueled. Six hundred five tow tractors are fueled by other sources. Sample sizes were insufficient (less than 384) to compute estimated populations for the tow tractors by horsepower and lift capacity.

Estimating the Population of Sweeper/Scrubbers in California

Only 13.4% of businesses represented in the study sample operated industrial sweeper/scrubbers. Multiplying this value (.134) by the estimated number of businesses assumed to be eligible for the current study resulted in 19,912 businesses (with a lower and upper bound of 13,426 and 25,632) to which the extrapolation method could be applied.

The number of sweeper/scrubbers was available for 159 businesses in the survey sample, but 22 were excluded because they were either involved in public administration or came from the BOE file, yielding 137 cases for analysis. Among these cases, a mean value of 2.10 sweeper/scrubbers per organization was observed. As with the forklift and tow tractor estimates, the three raked weights were applied to the data. This yielded a slightly lower mean of 2.08. Additionally, to account for extreme outlying values, the winsorized sweeper/scrubber distribution was used. Weighting this winsorized distribution resulted in a mean value of 1.49 sweeper/scrubbers per eligible business.

Table 79 illustrates the estimated value of sweeper/scrubbers operating in the state of California when applying that average value as well and upper and lower bounds on that estimate. As shown, the likely estimate of sweeper/scrubbers operating in the state of California is 29,669 with an upper and lower bound of 18,125 and 41,780.

Table 79. Estimated Sweeper/Scrubber Population Averages and Lower and Upper Bounds

	Population Lower Bound (-5)	Population Average	Population Upper Bound (+5)
	13,426	19,912	25,632
Winsorized Mean (Weighted)			
Lower Bound (-0.14) = 1.35	18,125	26,881	34,603
Average = 1.49	20,005	29,669	38,192
Upper Bound (+0.14) = 1.63	21,884	32,457	41,780

Using the survey data on sources of fuel used to operate this equipment, it is estimated that 14,745 sweeper/scrubbers are diesel fueled, 8,070 are battery operated, 6,171 are fueled by propane, and 534 are propane fueled. One thousand seven hundred eighty sweeper/scrubbers are fueled by other sources. Sample sizes were insufficient (less than 384) to compute estimated populations for the sweeper/scrubbers by horsepower and lift capacity.

DISCUSSION

The original goal of the current study was to establish updated estimates of the number of forklifts, industrial tow tractors, and industrial sweeper/scrubbers operating within the State of California. A parallel goal was to gather information on life cycle, fuel source, and horsepower and lift capacity. This information is to be used to assist in creating an emissions estimate within the state. A telephone survey of businesses within the state that might operate this equipment was selected as the method believed to provide the best balance of accuracy and time/cost savings. Because no exhaustive list of businesses that operate this type of equipment exists, ARB and the contractor engaged in considerable discussion regarding what source(s) should be used to create a comprehensive list from which to draw the study sample.

Ultimately, the list was compiled from four sources: UCC filings for the study equipment from the company Equipment Data Associates (EDA), a list of equipment provided by the California Department of Motor Vehicles (DMV), a list of LSI equipment from the ARB's Diesel Off-Road Online Reporting System (DOORS), and a list of businesses from the California Board of Equalization (BOE). The contractor collected survey data from 1,200 businesses known to operate the study equipment and statewide estimates were created by extrapolating the survey data back to the number of eligible businesses from within the BOE file. Though considerable work was done post-collection to adjust for shortcomings in methodology, the results of the study should be interpreted with the following in mind:

> ***The use of a telephone methodology presented both advantages and challenges in gathering the data.***

The type of data collected in this survey was predominately numerical and often very specific in nature. Using a telephone methodology made collecting such data particularly challenging. Sometimes, telephone interviewers would need to call a business multiple times to be put in touch with the person who had best knowledge of and access to such information. For some businesses, multiple individuals completed the survey, as there was no single person who had access to all information covered by the questionnaire. Furthermore, the specificity of information covered led many respondents to refrain from providing answers for some items, resulting in high item non-response for these questions. This occurred despite interviewers' best efforts to probe and obtain estimates at the very least.

Some respondents indicated that gathering all necessary information would require extensive background work prior to completing the survey. In certain cases, this is precisely what happened: the interviewer told the respondent they could call them back when the best-suited person was available or once some background research had been done on the part of the company. However, at other times, the representative simply completed the survey at that time and refrained from answering any questions for which they did not have adequate responses.

It is for these reasons that an online methodology should be considered as a supplement to any future telephone studies of this or similar equipment and business populations. An exclusive online methodology is not recommended because of the high rate of non-response that would result at the business (rather than specific item) level. That is, reached only through email, it is expected an even lower proportion of eligible businesses would participate in the study than did so by phone. However, offering the option of an online survey to those businesses that did not have the information at hand

may have decreased item non-response without any substantial impact on accuracy or overall business non-response.

The use of multiple data sets to create the sample frame presented issues in data collection and the process of extrapolating survey results to the full population.

During data collection, the rates of eligibility, participant cooperation, and survey completion were different for businesses from each data file that formed the overall list. During the pilot phase of the data collection process, the decision was made to discontinue calls to businesses in the BOE file because the rates of eligibility and thus survey completion were so low compared to other files. While lists from the other three files were crafted specifically with the study needs in mind (only businesses believed to operate at least one of the types of study equipment were included), the BOE file contained records from businesses regardless of existing knowledge of whether they possessed this equipment. Though the original purpose of including this file was to provide additional coverage of the population that may not have been provided by the other three files, using this list was eventually deemed not to be financially feasible due to a high rate of ineligibility.

Ideally, all calls would have been made using the BOE list (which is a near comprehensive list of businesses in the state with some exceptions, as noted previously). This would have permitted a simpler extrapolation from those records with which surveys were completed to the full survey sample. However, as noted, the eligibility and thus completion rate for businesses in the BOE file was abysmal, and thus, using this file as the unique source for the survey sample was not financially feasible. As such, a combination of the other three data sources was used to obtain the remainder of the survey sample, with the largest proportion coming from the EDA file. Because filings of non-forklift equipment in the EDA file started with dates in 2010, it is possible that businesses with only older tow tractors and sweeper/scrubbers were missed, creating the issue of a potential undercount of businesses with only this equipment (and not forklifts) in the survey sample.

In contrast to the situation with the BOE file, the rates of eligibility and completion for businesses sourced from the DOORS file was much higher than any of the other files. This was due to the intrinsic nature of that file: namely that these businesses were registered with ARB as having the study equipment (increasing the rate of eligibility) and that they had a prior relationship or interaction with the agency (potentially increasing the rate of cooperation). It is partially for this reason that a weighting procedure was applied to adjust for the representativeness of the survey sample to the original sample frame. Though the weighting procedure helps to account for differences in rates of completion for each data set, the ideal would be for rates of completion to be even across all sources, so they would be equally represented.

The very nature of telephone survey research led to an overrepresentation of businesses with larger fleets in the final survey sample.

As previously noted, using the estimated fleet size values provided with the sample frame sources (excluding the BOE file), it was determined that businesses with smaller fleets (particularly fleets of only one piece of equipment) were underrepresented in the final survey sample. There are a few potential explanations for this circumstance. With some exceptions, it can be surmised that those businesses with smaller fleets are smaller businesses in general, meaning they would have fewer resources to participate in a study that took 20 to 30 minutes to complete without any immediate reimbursement. Many small

companies have certain staff members carrying out multiple roles, and these employees have limited time to engage in tasks outside their job descriptions. Conversely, larger companies likely have a member on their team whose responsibility is to engage in activities such as involvement in the current study.

Additionally, those businesses with larger fleets of the study equipment have a vested interest in being involved in a survey on such equipment. Whereas a businesses with only one lightly used forklift may not be severely affected by future emissions standards changes, a business with several heavily used forklifts that will need to be replaced regularly will be severely impacted by such regulations. The possibility of being highly impacted by future regulations may have also led to greater participation amongst those businesses with larger fleets. As with the issue of overrepresentation of certain sample types, overrepresentation of businesses with larger fleets was adjusted through a weighting process that matched the survey sample to the sample frame on this variable.

> ***Despite the aforementioned shortcomings of the current study, the adjustments made to the final dataset accounted for the majority of issues of representativeness and permitted an extrapolation and estimate of the total number of forklifts, tow tractors, and sweeper/scrubbers in which the contractor has high confidence.***

The estimated values calculated based on the data from this study of 392,396 forklifts, 31,861 tow tractors, and 29,669 sweeper scrubbers are substantially higher than previous estimates of the populations of this equipment operating in the state. For comparison, data from the ARB's OFFROAD2007 inventory model and 2011 Inventory Model for In-Use Off-Road equipment provide estimates of 29,883 propane forklifts, 14,507 diesel, and 15,399 gasoline (or 59,789 for these three fuel types). However, the estimate based on newly collected data from the current study puts the estimate for these three groups at 308,032, several times higher than this previous estimate.

There are a few explanations for what might contribute to the estimate being much higher than the established inventory values. Since these values were calculated, businesses have without question continued to obtain (at least some) new forklifts. With recent improvements in the current economic status and outlook in California and across the nation, businesses have the additional resources to make new equipment purchases. Furthermore, the average time to retirement for forklifts is higher than previously thought, particularly for certain fuel types. Finally, it is possible that previous studies of this population left out certain business or industry groups that were more thoroughly covered by the current study. This assertion is especially credible given that the current study is the first of its kind, obtaining end user data from businesses operating such equipment in the state rather than basing estimates on data from equipment dealers or manufacturers. These three factors combined account for at least some of the discrepancy between the current and past estimates and give the contractor confidence in the current one.

SUMMARY AND CONCLUSION

State mandates require that overall statewide emissions of ozone precursors and greenhouse gases be reduced. Given that Large Spark Ignition (LSI) equipment contribute to these emissions, it is necessary to establish a baseline population size from which reductions in emissions can be made. In order to quantify the population of forklifts, industrial tow tractors, and industrial sweeper scrubbers (including LSI equipment) operating within the State of California and obtain information relevant to their emissions contributions, the ARB contracted with a third party to conduct a telephone survey of businesses within the state that operate such equipment.

In collaboration with staff from the ARB's Mobile Source Control Division, the contractor worked to create a questionnaire to be administered by telephone. This questionnaire was designed not only to quantify the number of forklifts possessed by businesses interviewed but also to obtain information on various aspects pertinent to equipment emissions including equipment fuel type, horsepower, model year, lift capacity, hours operated per year, and average number of years to equipment retirement. The questionnaire included three broad classifications of equipment: forklifts, industrial tow tractors, and industrial sweeper/scrubbers. The original survey instrument was pilot tested on a group of 100 representatives from businesses throughout the state. After initial testing, pilot items were removed and efforts were made to streamline the survey.

To create a comprehensive list of businesses believed to operate the equipment being studied, the contractor compiled businesses from four sources: a list of Uniform Commercial Code (UCC) filings for forklifts and other LSI equipment, provided by Equipment Data Associates (EDA); (2) a list of forklift and work truck registrations provided by the California Department of Motor Vehicles (DMV); (3) a list of businesses using off-road industrial equipment provided from ARB's Diesel Off-Road Online Reporting System (DOORS); and (4) a list of all businesses for which the CA Board of Equalization (BOE) collects sales and use taxes. For the former three sources, all businesses with valid contact information were included. On the other hand, a targeted sample of records from the Board of Equalization file was assembled with the intention of increasing the proportion of businesses contacted that would operate the equipment in question. The four files were combined and duplicate entries were removed.

Aside from standard training provided to survey telephone interviewers, efforts were made to familiarize interviewers with the equipment types covered by the survey instrument. Additionally, supervisorial staff trained interviewers in probing methods in an attempt to minimize item nonresponse. Despite these efforts, several challenges presented throughout the course of the project. Firstly and most importantly, a large proportion of businesses contacted did not have the equipment in question. Second, among those eligible businesses with which contact was made, a similar proportion refused to participate in the study. Lastly, among those businesses for which survey data was collected, there were some variables for which the percentage of missing data was particularly high (even with probing techniques employed).

Despite these challenges, representatives from 1,200 businesses provided data on their companies' forklifts, industrial tow tractors, and industrial sweeper/scrubbers, with the vast majority of these businesses having only forklifts. More than half of these businesses came from the Southern California region. The most represented industries were manufacturing and the wholesale trade, with nearly half

of businesses interviewed coming from these two categories. Most businesses provided data for only one location, with very few providing information for multiple sites under the same ownership.

Nearly all businesses included in the survey sample operated forklifts; this number ranged from one to 500 forklifts, with a mean of 7.1 and a median (the value above and below which half of all values fall) of 2 forklifts. Two thirds of businesses interviewed had between one and three. Overall, 8,463 forklifts were reported among the 1,194 business that had at least one.

The vast majority of businesses owned all their forklifts. More than half of these forklifts were propane/LPG fueled, but substantial proportions were also diesel and battery electric. Greater percentages of businesses in Northern California utilized diesel and gasoline forklifts than in other regions of the state.

Examination of the characteristics of this equipment revealed differences between the fuel types in question. Overall, larger proportions of propane and gasoline forklifts belonged to the lower horsepower categories, while the reverse was true for diesel forklifts, with the greatest percentage in the highest category. Similarly, propane and gasoline forklifts tended to fall more frequently in the lowest lift capacity category, with the same being true for battery forklifts (but to an even further extent). The greatest proportion of diesel forklifts again fell in the highest lift capacity category.

In terms of annual hours of operation, both the mean and median number of hours followed the same pattern for the different fuel types. Battery electric forklifts were operated the greatest number of hours on average, followed by propane/LPG equipment and then diesel. Gasoline forklifts were operated the lowest number of hours per year on average. Again, both in terms of mean and median values, battery powered forklifts operated by businesses in the survey sample were the newest models on average, followed closed by propane/LPG and then diesel forklifts. Gasoline forklifts in the sample were more than a decade older, on average. The time before which forklifts were retired on average naturally followed the same pattern.

About one in twenty businesses in the survey sample operated industrial tow tractors, with greater proportions of those companies in the areas of agriculture, finance, and public administration operating this equipment than among other industries. The number of tow tractors operated ranged from one to 394, with a mean of 12.2 and a median of 2 tow tractors. Overall, 853 pieces of equipment were reported by the 70 businesses that had tow tractors.

More than half of industrial tow tractors in the survey sample were diesel fueled, followed by about a quarter that were powered by gasoline and one in ten being battery powered. The mean horsepower of diesel tow tractors was 224.4 while the median was 162.5. Tow tractors of all fuel types (including diesel) were operated a mean of 1,686 hours annually and a median of 1,000 hours. Those companies with larger fleets operate their tow tractors a greater number of hours on average. Before being retired, tow tractors in the survey sample were operated a mean of nearly 15 years and a median value of 10 years.

Nearly 15% of businesses interviewed operated industrial sweeper/scrubbers, with the greatest proportions of those in the public administration, services, and transportation industries doing so. The number of sweeper/scrubbers operated ranged from one to 60, with a mean of 2.2 and a median of 1 sweeper/scrubber. Overall, 350 pieces of equipment were reported by the 159 businesses that had

sweeper/scrubbers. Half of sweeper/scrubbers in the survey sample were fueled by diesel, while slightly more than a quarter were battery powered, and one in five was propane/LPG fueled.

Nearly 15% of businesses indicated they already operated zero emissions fleets, with the highest proportion of those in nonclassifiable industries and agriculture doing so. Additionally, the greatest percentage of companies in Southern California had such fleets when compared to other regions in the state. The most common barrier among those businesses that were not zero emissions was cost, with nearly a third citing this concern. More than half of companies interviewed were warehouses or distribution centers that handle freight, with the greatest proportions of these businesses being involved in transportation and the wholesale trade. Warehouse/distribution centers were found in higher proportions among businesses in Southern California than other regions.

Given that no list of businesses operating the equipment of interest in this study exists and such a list would be necessary to extrapolate from the survey sample to the population, those businesses in the BOE data file served as a proxy for the total population for the purpose of extrapolation. The assumption was made that businesses in the EDA, DOORS, and DMV files would also be contained in the BOE file (with the exception of those businesses in Public Administration).

To perform the extrapolation accurately, it was necessary to determine what proportion of businesses in the BOE file operated the study equipment. After contacting 384 businesses from within the BOE file at random, it was estimated that 149,381 businesses within the state of California operated such equipment, with a lower bound of 100,194 and an upper bound of 191,281 businesses. A comparison of the BOE data file and study sample revealed that the sample over-represented businesses in construction, manufacturing and transportation and under-represented those in wholesale, retail, and services. Weights were assigned to account for these differences, such that the number of businesses represented in each industry group matched the distribution in the BOE file. Additional weights were applied to align the full list from which the survey sample was drawn with the survey sample with regard to sample source and fleet size.

After adjusting the data for high outlying values for each equipment type through winsorization, it was estimated that there are 392,396 forklifts operating in the State, with a lower bound of 241,257 and an upper bound of 544,330 forklifts. Furthermore, a total of 31,861 tow tractors are believed to be operating in the state, with a lower bound of 10,250 and an upper bound of 62,023. Lastly, a total of 29,669 sweeper/scrubbers are believed to be operating in the state, with a lower bound of 18,125 and an upper bound of 41,780.

Using the sampling and extrapolation strategy described with telephone as the mode of survey administration, the contractor came up with an estimate several times higher than currently existing ones. The contractor surmises that there are a few factors that might contribute to this discrepancy. Firstly, since that estimate was created, businesses have undoubtedly continued to acquire new forklifts. With recent improvements in the overall economic situation in the state, businesses have the additional resources to make new purchases and can afford to take on more financial risk. Furthermore, the average time to retirement for forklifts is higher than previously thought, particularly for certain fuel types (from over 20 years on average for gasoline forklifts to greater than 15 for propane/LPG and over 10 for newer, battery powered lifts). Additionally, it is possible that previous studies of this population left out certain business or industry groups that were more thoroughly covered by the current study, which was the first of its kind for this equipment population. Rather than basing estimates on data from

equipment dealers or manufacturers, it obtained end user data from businesses operating such equipment in the state. These three factors combined account for at least some of the discrepancy between the current and past estimates and give the contractor confidence in the current one.

RECOMMENDATIONS

The contractor developed the following recommendations for using and expanding upon the findings of this study:

- ***Recommendations for Using the Study Data***
  1) *Take into account the groups excluded from the current study when interpreting these data.* The estimates of forklifts, tow tractors and sweeper/scrubbers contained within this report exclude some categories of businesses worth noting. Firstly, those businesses involved in the primary agricultural sector were intentionally excluded from the outset of the project. In creating the population estimates, it was necessary to exclude those organizations in public administration in order to use the BOE file as a proxy for the population. Therefore, any interpretations of and applications using the study estimates should take these facts into account.
  2) *Keep in mind that the unweighted study data over represent certain industries as well as businesses with larger fleets and those sampled from certain sources.* The purpose of using multiple data sources was to gain adequate coverage of businesses from different industries and with different fleet sizes. An unforeseen consequence of this approach was that those businesses sampled from sources all but confirmed to have the study equipment were represented at a higher rate than those from other sources. In particular, the DOORS dataset was overrepresented in the final study sample, potentially inflating any information obtained on diesel equipment. For this reason, these data should be interpreted with caution and taking this fact into account.
  3) *Be aware of the fact that population estimates based on small sample sizes have wide confidence intervals and thus are of questionable accuracy.* The large overall sample size of businesses operating forklifts gives credibility to the broad estimate of that population. However, other estimates, such as those for certain fuel types and for tow tractors and sweeper/scrubbers should be interpreted with caution, as those estimates are based on much smaller samples and thus have wider confidence intervals.

- ***Recommendations for Future Study***
  4) *Make adjustments to study design in order to increase confidence in population estimates.* If more reliable estimates of particular subgroups of equipment (for example, by fuel type) are desired, increase the number of businesses interviewed if at all possible. This would make the sample size for each subgroup larger and shrink the confidence intervals on this subgroups. Alternatively, if financially feasible, separate studies could be conducted on larger samples from these subgroups.
  5) *In advance of future studies, proactively work to ensure representativeness of the study sample across various criteria.* For the current study, adjustments were made to the study data to ensure the study sample represented the population in terms of industry, fleet size, and sample source. A different, more rigorous (albeit more costly) approach would be to create quotas for groups based on these variables of concern. This would increase the representativeness of the study sample and eliminate the necessity of weighting the study sample to obtain accurate estimates.

6) *Include alternate modes of data collection to increase study response rate and decrease item nonresponse.* The current study was conducted using telephone as the sole mode of data collection. As noted, this presented unique challenges for the population and topic being studied. In particular, some businesses' representatives did not have 20 to 30 minutes to take out of their work days to complete the study. It is possible that an online or mail survey, which could be filled out over the course of several days (or even weeks), would have increased the rate of participation. Furthermore, it would allow respondents to research the information requested, thus lowering the proportion of questions left unanswered and allowing for more accurate values to be provided (rather than estimates).

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GLOSSARY OF TERMS, ABBREVIATIONS, AND SYMBOLS

AAPOR: American Association for Public Opinion Research, the leading author on survey research in the US

ARB: California Air Resources Board, the clean air agency of the State of California, tasked with maintaining air quality in the state

BOE: California Board of Equalization, the public agency that oversees tax administration and fee collection in the State of California

CATI: Computer Assisted Telephone Interviewing, software used in telephone survey research to facilitate data gathering in telephone surveys by allowing interviewers to input pre-designated and open-ended responses directly into the database

Confidence Interval: the estimated range of values likely to include an unknown population parameter, calculated from a given set of sample data; the confidence interval is usually expressed with a percentage to indicate the level of confidence

DMV: California Department of Motor Vehicles, the state agency that registers motor vehicles and boats and issues driver's licenses in the State of California

DOORS: Diesel Off-road Online Reporting System, ARB's online system for registering off-road diesel fleets

EDA: Equipment Data Associates, a firm that compiles and provides data from UCC filings and other sources

Eligibility Rate: the proportion of all cases in the sample frame known to meet the inclusion criteria for a study

GHG: Greenhouse Gas, a gas that absorbs and emits radiation within the thermal infrared range; greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide, and ozone; greenhouse gases contribute to global warming and climate change

GSE: Ground Support Equipment, support equipment found at an airport, used to service the aircraft between flights

Item Non-Response: the extent to which data for particular items within a survey are missing (with the respondent either refusing to answer or indicating they do not know the answer)

LPG: Liquefied Petroleum Gas, also known as propane or butane; used as fuel in heating appliances, cooking, and vehicles

LSI: Large Spark-Ignition Equipment, including self-propelled gasoline, propane, and clean natural gas fueled equipment of 25 horsepower or greater, and engine displacement of greater than one liter

Mean: the sum of a collection of values divided by the number of values in the collection; commonly referred to the "arithmetic mean" or simply "average"

Median: the value at the midpoint of a frequency distribution, such that half of all values in the distribution lie above it and the other half below

NOx: Oxides of nitrogen, a major contributor to air pollution in areas with high motor vehicle traffic, such as large cities

Population of Inference: the population or universe to which the results from a sample survey are meant to generalize

Raking: a process used in survey weighting that involves repeatedly estimating weights across multiple sets of variables until the weights converge and stop changing; raking allows the survey totals to match known population totals on multiple variables, rather than just one

Random Sampling: the basic sampling technique in which a group of subjects is selected at random from a comprehensive list of a larger group (the population); in this process, each respondent is chosen entirely by chance and each member has an equal chance of being included in the survey sample

Response Rate: the number of eligible sample units that cooperate in a survey; the contractor uses AAPOR Response Rate Calculation Method 3 (RR3), which includes an estimate of eligibility among unscreened sample records based on the eligibility rate among respondents for whom a final determination could be made

Sample Frame: the complete list of entries from which a survey sample is drawn; ideally, the sample frame should contain all members of the population of inference

Sensus: survey programming software used in tandem with the WinCATI sample management program, which allows for complex survey programming and ensures minimal avoidable error

SIC Code: Standard Industrial Classification Code, a system for classifying industries by four-digit code

SIP: California State Implementation Plan, a comprehensive plan that describes how an area will attain national air quality standards

Statistically Significant: a condition attained whenever the observed p-value of a test statistic is less than the significance level defined for the study; the presence of statistical significance does not necessarily mean that a difference detected is meaningful or important

THC: Total hydrocarbons, a term used to describe a large family of several hundred chemical compounds originally from crude oil; these compounds are important with regards to overall air quality

UCC filing: Uniform Commercial Code Filing, a filing made by a creditor or lender to the California Secretary of State when a piece of property is financed

Validity: the degree to which a construct or tool measures what it is intended to measure

Weighting: a process by which a survey sample is adjusted to match the population of inference on a particular variable; in this process, underrepresented groups are given a larger weight (meaning they are counted more) and overrepresented groups are given a smaller weight

WinCATI: the CATI software system used by the contractor to aid in carrying out administration of telephone survey

Winsorization: a process through which extreme values in a dataset are altered to reduce their impact on the calculation of sample statistics; typically, all extreme values are set to a specified percentile of the data.

APPENDICES

APPENDIX A: PILOT SURVEY INSTRUMENT

SHELLO Hello, this is _____, calling from the Social Science Research Center at California State University, Fullerton. We're conducting a study sponsored by the state of California.

CONFIRMB Have I reached [CONTACT NAME] at [BUSINESS NAME] and [ADDRESS]?

SCONTCT May I please speak with [CONTACT PERSON'S NAME/FORKLIFT FLEET MANAGER]?

1. YES, AVAILABLE NOW [SKIP TO INTRO]
2. NO, NOT AVAILABLE NOW [SKIP TO CALLBAK1]
3. NO SUCH PERSON
4. NEW PHONE NUMBER OBTAINED [ENTER NEW NUMBER]
7. DON'T KNOW
9. REFUSED

WHO Can you please direct me to the person in your business who could answer questions about its forklift fleet operations? This might be your businesses' warehouse, fleet, or forklift equipment manager.

1. SPECIFY NAME>
2. SPECIFY TITLE>
7. DON'T KNOW/NO RESPONSE
8 OUR BUSINESS DOES NOT OPERATE INDUSTRIAL EQUIPMENT OF ANY KIND [SKIP TO DISQUAL]
9. REFUSED

SCONTCT Is [INSERT NAME] available now?

1. YES, AVAILABLE NOW [SKIP TO INTRO]
2. NO, NOT AVAILABLE NOW

CALLBAK1 Can you suggest a better time to call back to reach [CONTACT NAME]?

ALTERNAT Alternatively, this person can call us back at (657) 278-3185 to schedule a convenient time for him/her complete the telephone survey.

[RECORD UPDATED INFORMATION IN UDF FIELD-INCLUDE IN SHIFT NOTES].

INTRO We are conducting a scientific study of businesses operating fleets of forklifts, sweepers/scrubbers, and tow tractors in the State of California. The purpose of this study is to update estimates of the industrial equipment population in the state and their contribution to statewide emissions. While this study is sponsored by the State of California, the data being collected in this survey will be kept strictly confidential to the extent permitted by law and in no case will be used to single out any one business/agency.

INTRO2 Your participation in this study is completely voluntary. Should you choose to participate in this survey, you may decline to provide a response to any question should you choose to.

INTRO3 When we have completed surveys with all eligible businesses, a data file will be produced which will not contain the name of your business. All of the information provided by participating businesses will be reported to the state in the aggregate which means that the responses associated with your business will not be known to anyone outside of our center.

CONT Finally, this call may be monitored for quality control purposes. If you have questions about your rights as a research participant, I have some numbers you can call. [IF REQUESTED] The number for the California State University, Fullerton Regulatory Compliance Coordinator is (657) 278-7640, and the Institutional Review Board (IRB) Chair can be reached (657) 278-5062. For any other questions about the study, contact Laura Gil-Trejo at 657-278-7691.Is it okay to ask you these questions now?

1. YES [SKIP TO TRANS1]
2. NO [CONTINUE]
3. NO, OTHER DISPOSITION

CALLBAK2 When might we call you back?
SCHEDULE CALLBACK>

PILOT1 How likely would you be to complete the survey if we made it available online?

1. Very likely
2. Somewhat likely
3. Somewhat unlikely
4. Very unlikely

PILOT2 Because we are attempting to estimate the total population forklifts and other equipment in the State of California, it is important for us to know a little about the business that choose not to participate in this survey. So we can do this, can you tell us how many forklifts operate at your location?

_. <SPECIFY
777. DON'T KNOW
999. REFUSED
[END SURVEY]

TRANS1 To begin, I'd like to ask you a few general questions about your business.

ELIG1 Does your business operate in the agriculture industry?

1. YES
2. NO [SKIP TO Q1]
7. DON'T KNOW
9. REFUSED

ELIG2 Does your business activity include growing or harvesting of crops from soil or the raising of animals for profit? This would also include the raising of plants at wholesale nurseries?

1. YES [SKIP TO INELG1]
2. NO
7. DON'T KNOW
9. REFUSED

ELIG3 Does your business operate in agricultural crop preparation services? Agricultural crop preparation services include only the first processing after harvest, and not subsequent processing, canning, or other similar activities. This includes businesses such as packinghouses, cotton gins, nut hullers, nut processors, dehydrators, feed mills and grain mills. Distribution centers are not considered first processing facilities. Some other examples of first processing facilities are:

1) A winery that receives unprocessed grapes to make wine;
2) A grain mill that receives a grain or hay to make animal feed; and
3) A facility that receives whole tomatoes to make tomato paste

1. YES [SKIP TO INELG1]
2. NO
7. DON'T KNOW
9. REFUSED

Q1 Does your business operate any of the following types of equipment?

A. Forklifts
B. Tow tractors
C. Sweepers/scrubbers

1. YES
2. NO
7. DON'T KNOW [BACK UP AND CONFIRM CORRECT CONTACT]
9. REFUSED [BACK UP AND CONFIRM CORRECT CONTACT]

[IF Q2 A THROUGH C = 0 SKIP TO INELG2]

[IF SIC CODE PROVIDED, SKIP TO Q3]

Q2 In what industry does your business belong?

_____ ENTER DESCRIPTION
7. DON'T KNOW
9. REFUSED

[IF BUSINESS IS CLEARLY PART OF A RELATED GROUP MARK AS Q3 = 2]

Q3 Is your business a single service location, or is it part of a related group of locations?

1. SINGLE LOCATION [SKIP TO Q10]
2. PART OF A RELATED GROUP
7. DON'T KNOW [BACK UP AND CONFIRM CORRECT CONTACT]
9. REFUSED [BACK UP AND CONFIRM CORRECT CONTACT]

[IF Q3 = 1 CODE AS GROUP 1-REPORTING LOCALLY]

Q4 Are the equipment purchasing decisions for your business' fleet done locally or at some other central location?

1. AT THIS SITE, LOCALLY [SKIP TO Q10]
2. AT CENTRAL HEADQUARTERS ELSEWHERE [CONTINUE]
3. AT CENTRAL HEADQUARTERS THIS LOCATION [SKIP TO Q6]
7. DON'T KNOW [BACK UP AND CONFIRM CORRECT CONTACT]
9. REFUSED [BACK UP AND CONFIRM CORRECT CONTACT]

[IF Q4 = 1 CODE AS GROUP 1-REPORTING LOCALLY]

Q5 Are you able to answer questions regarding the equipment operated in your businesses' fleet?

1. YES [SKIP TO Q10]
2. NO [OBTAIN CONTACT INFORMATION FOR CORPORATE OFFICE, CROSS REFERENCE WITH SAMPLE FRAME, AND DISPOSITION APPROPRIATELY]

[IF Q5 = 1, CODE AS GROUP 1-REPORTING LOCALLY]

Q6 For how many other sites, outside your own location, does your headquarters make equipment purchase decisions?

_____ ENTER VALUE [IF VALUE = 0 SKIP TO Q10]
7. DON'T KNOW [CONFIRM CORRECT CONTACT THEN SKIP TO Q10]
9. REFUSED [CONFIRM CORRECT CONTACT THEN SKIP TO Q10]

[IF Q 6 = 0, CODE AS GROUP 1 – REPORTING LOCALLY]

Q7 Approximately, how many of these locations are located outside the state of California?

___. <SPECIFY [IF VALUE = 0, SKIP TO Q9, OTHERWISE CONTIUE]
777. DON'T KNOW [REQUEST BEST ESTIMATE AND SKIP TO Q9]
999. REFUSED [REQUEST BEST ESTIMATE AND SKIP TO Q9]

Q8 Although your business location may purchase and/or maintain fleets that operate outside of the state of California, we are interested only in those that operate within the state. Are you able to provide this information for the sites that only operate in the State of California?

1. YES [SKIP TO Q11]
2. NO ONLY NATIONWIDE DATA AVAILABLE [SKIP TO Q12]
3. NO ONLY SITE DATA AVAILABLE [SKIP TO Q10]
7. DON'T KNOW [CONFIRM CORRECT CONTACT THEN SKIP TO Q10]
9. REFUSED [CONFIRM CORRECT CONTACT THEN SKIP TO Q10]

[IF Q8=1, CODE AS GROUP 2 – REPORTING STATE WIDE]
[IF Q8 = 2, CODE AS GROUP 3-REPORTING NATIONWIDE]
[IF Q8 = 3, CODE AS GROUP 1-REPORTING LOCALLY]

Q9 The next few questions are meant to help us estimate the population of forklifts and other equipment that contribute to emissions **in the State of California**. Are you able to provide this information for all of the sites in California, including your own, for which your headquarters makes purchasing decisions for, or are you only able to provide this information for your own location.

1. FOR MY OWN LOCATION [GO TO Q10]
2. FOR ALL LOCATIONS OUR HEADQUARTERS MAKE PURCHASING DECISIONS FOR [SKIP TO Q11]
7. DON'T KNOW [CONFIRM CORRECT CONTACT]
9. REFUSED [CONFIRM CORRECT CONTACT]

[IF Q9 = 1, CODE AS GROUP 1-REPORTING LOCALLY]
[IF Q9 = 2, CODE AS GROUP 2-REPORTING STATEWIDE]

[IF Q1A = 0, SKIP TO Q50]

Q10 How many forklifts in your location's fleet currently operate in California? Forklifts do not include Pallet Jacks, Walkies, or any other equipment one walks with or possesses a handle. **Please do not include forklits that are retired or no longer operational.**

__. <SPECIFY [IF VALUE = 0, SKIP TO Q50]
777. DON'T KNOW [REQUEST BEST ESTIMATE OR CHANGE CONTACT]
999. REFUSED [REQUEST BEST ESTIMATE OR CHANGE CONTACT]

[CONTINUE TO Q13A]

Q11 How many forklifts currently operate in the fleets maintained by your organization? Include fleets that operate at your site as well as other sites located in the state of California your organization makes purchasing decisions for. Forklifts do not include Pallet Jacks, Walkies, or any other equipment one walks with or possesses a handle. **Please do not include forklits that are retired or no longer operational.**

___. <SPECIFY [IF VALUE = 0, SKIP TO Q50]
777. DON'T KNOW [REQUEST BEST ESTIMATE OR CHANGE CONTACT]
999. REFUSED [REQUEST BEST ESTIMATE OR CHANGE CONTACT]

[CONTINUE TO Q13A]

Q12 The next few questions are meant to help us estimate the population of forklifts and other equipment that contribute to emissions in the State of California. That means we are not interested in equipment that is purchased for locations operating for your business outside of California.

However, because you indicate being unable to report data for the fleets your business maintains just for the state of California, I will assume that the information you are providing will be for the fleets operating at your site as well as those operating nationwide. Is this correct?

1. YES
2 NO, PROVIDING DATA AT SITE LEVEL [GO BACK TO Q10]
3. NO, SPECIFY OTHER REASON [REASK QUESTION OR CLARIFY ANSWERS TO PREVIOUS QUESTIONS]

Q13 How many forklifts currently operate in the fleets maintained by your organization? This would inlcude **fleets that operate at your site as well as those located nationwide** for which your organization makes purchasing decisions. Forklifts do not include Pallet Jacks, Walkies, or any other equipment one walks with or possesses a handle. **Please do not include forklits that are retired or no longer operational.**

___. <SPECIFY [IF VALUE = 0, SKIP TO Q50]
777. DON'T KNOW [REQUEST BEST ESTIMATE OR CHANGE CONTACT]
999. REFUSED [REQUEST BEST ESTIMATE OR CHANGE CONTACT]

Q13A What percentage of these [INSERT NUMBER] forklifts operate primarily in California?

___. <SPECIFY %
777. DON'T KNOW [REQUEST BEST ESTIMATE]
999. REFUSED [REQUEST BEST ESTIMATE]

Q14 What percentage of these [INSERT NUMBER] forklifts are…

1. Owned
2. Leased
3. Rented for less than a year
4. Rented for more than a year.

___. <SPECIFY PERCENTAGE
___. <SPECIFY NUMBER [CHOICE IF # OF LIFTS < 4]
777. DON'T KNOW
999. REFUSED

Q15 Of the [INSERT VALUE] forklifts you reported, what number are powered by…

[INTERVIEWER, IF NUMERICAL VALUE IS NOT KNOWN ASK RESPONDENT TO ESTIMATE THE PERCENTAGE]

1. Diesel fuel
2. Propane/LPG
3. Dual Fuel (gas tank and propane tank with a switch)
4. Gasoline
5. Battery electric
6. Another fuel type SPECIFY TYPE?
   ___. <SPECIFY NUMBER
   ___. <SPECIFY PERCENTAGE
   777. DON'T KNOW
   999. REFUSED

[IF Q15_1 = 0 SKIP TO Q23, OTHERWISE CONTINUE]

Q16 Of your diesel-fueled forklifts, how many have a horsepower of…
a. <51 HP
b. 51-70 HP
c. >70 HP
777. DON'T KNOW
999. REFUSED

[IF Q16_c > 0, CONTINUE, OTHERWISE SKIP TO Q18]

Q17 Of the diesel-fuel forklifts in your fleet with a horsepower greater than 70, what is the average horsepower?
___. <SPECIFY
777. DON'T KNOW
999. REFUSED

Q18 Of the diesel-fueled forklifts in your fleet, how many have a lift capacity of…
a. <5,001 lbs
b. 5,001 to 8,000 lbs
c. >8,000 lbs

[IF Q18_c > 0, CONTINUE, OTHERWISE SKIP TO Q20]

Q19 Of the diesel-fuel forklifts in your fleet with a lift capacity over 8,000 pounds, what is the average lift capacity?
___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS < 4, SKIP TO Q20B]

Q20A On average, how many hours do the diesel-fueled forklifts in your organization's fleet operate per year?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS > 3, SKIP Q21A]

Q20B How many hours do each of the diesel-fueled forklifts in your organization's fleet operate per year?

1. FORKLIFT #1>
2. FORKLIFT #2>
3. FORKLIFT #3>
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS < 4, SKIP TOQ21B]

Q21A What is the average model year of the diesel-fueled forklifts in your organization's fleet?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS > 3, SKIP Q22]

Q21B What is the model year of each of the diesel-fueled forklifts in your organization's fleet?

1. FORKLIFT #1>
2. FORKLIFT #2>
3. FORKLIFT #3>
777. DON'T KNOW
999. REFUSED

Q22 On average how long do the diesel-fueled forklifts in your fleet operate before they are retired?

___. <SPECIFY HOURS
___. <SPECIFY YEARS
777. DON'T KNOW
999. REFUSED

[IF Q15_2 = 0, SKIP TO Q30, OTHERWISE CONTINUE]

Q23 Of your propane/LPG-fueled forklifts, how many have a horsepower of…

a. <51 HP
b. 51-70 HP
c. >70 HP
777. DON'T KNOW
999. REFUSED

[IF Q23_c > 0, CONTINUE, OTHERWISE SKIP TO Q25]

Q24 Of the propane/LPG fueled forklifts in your fleet with a horsepower greater than 70, what is the average horsepower?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

Q25 Of your propane/LPG-fueled forklifts, how many have a lift capacity of…
a. <5,001 lbs
b. 5,001 to 8,000 lbs
c. >8,000 lbs

[IF Q25_c > 0, CONTINUE, OTHERWISE SKIP TO Q27]

Q26 Of the propane/LPG fueled forklifts in your fleet with a lift capacity over 8,000 pounds, what is the average lift capacity?
___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS < 4, SKIP TO Q27B]

Q27A On average, how many hours do the propane/LPG fueled forklifts in your organization's fleet operate per year?
___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS > 3, SKIP TO Q28A]

Q27B How many hours do each of the propane/LPG fueled forklifts in your organization's fleet operate per year?
1. FORKLIFT #1>
2. FORKLIFT #2>
3. FORKLIFT #3>
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS < 4, SKIP TO Q28B]

Q28A What is the average model year of the propane/LPG fueled forklifts in your organization's fleet?
___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS > 3, SKIP TO Q29]

Q28B What is the model year of each of the propane/LPG fueled forklifts in your organization's fleet?

1. FORKLIFT #1>
2. FORKLIFT #2>
3. FORKLIFT #3>
777. DON'T KNOW
999. REFUSED

Q29 On average how long do the propane/LPG-fueled-forklifts in your fleet operate before they are retired?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF Q15_3 = 0 SKIP TO Q37, OTHERWISE CONTINUE]

Q30 Of your dual-fueled forklifts, how many have a horsepower of…

a. <51 HP
b. 51-70 HP
c. >70 HP
777. DON'T KNOW
999. REFUSED

[IF Q30_c > 0, CONTINUE, OTHERWISE SKIP TO Q32]

Q31 Of the dual- fueled forklifts in your fleet with a horsepower greater than 70, what is the average horsepower?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

Q32 Of your dual- fueled forklifts, how many have a lift capacity of…

a. <5,001 lbs
b. 5,001 to 8,000 lbs
c. >8,000 lbs

[IF Q32_c > 0, CONTINUE, OTHERWISE SKIP TO Q34]

Q33 Of the dual- fueled forklifts in your fleet with a lift capacity over 8,000 pounds, what is the average lift capacity?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS < 4, SKIP TO Q34B]

Q34A On average, how many hours do the dual- fueled forklifts in your organization's fleet operate per year?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS > 3, SKIP TO Q35A]

Q34B How many hours do each of the dual- fueled forklifts in your organization's fleet operate per year?

1. FORKLIFT #1>
2. FORKLIFT #2>
3. FORKLIFT #3>
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS < 4, SKIP TO Q35B]

Q35A What is the average model year of the dual- fueled forklifts in your organization's fleet?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS > 3, SKIP TO Q36]

Q35B What is the model year of each of the dual- fueled forklifts in your organization's fleet?

4. FORKLIFT #1>
5. FORKLIFT #2>
6. FORKLIFT #3>
777. DON'T KNOW
999. REFUSED

Q36 On average how long do the dual-fueled forklifts in your fleet operate before they are retired?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF Q15_4 = 0 SKIP TO Q44, OTHERWISE CONTINUE]

Q37 Of your gasoline-fueled forklifts, how many have a horsepower of…

a. <51 HP
b. 51-70 HP
c. >70 HP
777. DON'T KNOW
999. REFUSED

[IF Q37_c > 0, CONTINUE, OTHERWISE SKIP TO Q39]

Q38 Of the gasoline- fueled forklifts in your fleet with a horsepower greater than 70, what is the average horsepower?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

Q39 Of your gasoline- fueled forklifts, how many have a lift capacity of…
a. <5,001 lbs
b. 5,001 to 8,000 lbs
c. >8,000 lbs

[IF Q39_c > 0, CONTINUE, OTHERWISE SKIP TO Q41]

Q40 Of the gasoline- fueled forklifts in your fleet with a lift capacity over 8,000 pounds, what is the average lift capacity??
___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS < 4, SKIP TO Q41B]
Q41A On average, how many hours do the gasonline - fueled forklifts in your organization's fleet operate per year?
___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS > 3, SKIP TO Q42A]
Q41B How many hours do each of the gasoline - fueled forklifts in your organization's fleet operate per year?
1. FORKLIFT #1>
2. FORKLIFT #2>
3. FORKLIFT #3>
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS < 4, SKIP TO Q42B]
Q42A What is the average model year of the gasoline - fueled forklifts in your organization's fleet?
___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS > 3, SKIP TO Q43]Q42B What is the model year of each of the gasoline - fueled forklifts in your organization's fleet?
7. FORKLIFT #1>
8. FORKLIFT #2>
9. FORKLIFT #3>
777. DON'T KNOW
999. REFUSED

Q43 On average how long do the gasoline-fueled forklifts in your fleet operate before they are retired?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF Q15_5 = 0 SKIP TO QREPEAT, OTHERWISE CONTINUE]

Q44 Of your battery electric- fueled forklifts, how many have a lift capacity of…

a. <5,001 lbs
b. 5,001 to 8,000 lbs
c. >8,000 lbs

Q45 What is the maximum lift capacity of the battery electric-fueled forklifts in your fleet?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

Q46 What is the average lift capacity of the battery electric-fueled forklifts in your fleet?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS < 4, SKIP TO Q47B]

Q47A On average, how many hours do the battery electric- fueled forklifts in your organization's fleet operate per year?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS > 3, SKIP TO Q48A]

Q47B How many hours do each of the battery electric- fueled forklifts in your organization's fleet operate per year?

1. FORKLIFT #1>
2. FORKLIFT #2>
3. FORKLIFT #3>
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS < 4, SKIP TO Q48B]

Q48A What is the average model year of the battery electric- fueled forklifts in your organization's fleet?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS > 3, SKIP TO Q49]

Q48B What is the model year of each of the battery electric- fueled forklifts in your organization's fleet?

1. FORKLIFT #1>
2. FORKLIFT #2>
3. FORKLIFT #3>
777. DON'T KNOW
999. REFUSED

Q49 On average how long do the battery electric-fueled forklifts in your fleet operate before they are retired?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF Q15_6 = 0 SKIP TO Q50, OTHERWISE CONTINUE]

QREPEAT For all other fuel types, re-ask the previous series of questions.

[IF Q1B = 0, SKIP TO Q57]

[FOR GROUPS 1 ONLY]

Q50 How many industrial tow tractors (or tugs) <u>in your location's fleet</u> currently operate in California? **<u>Please do not include tractors or tows that are retired or no longer operational.</u>**

__. <SPECIFY [IF VALUE = 0, SKIP TO Q57]
777. DON'T KNOW
999. REFUSED

[CONTINUE TO Q52B]
[FOR GROUP 2 ONLY]

Q51 How many industrial tow tractors (or tugs) currently operate in the fleets maintained by your organization? Include industrial tow tractors (or tugs) that <u>operate at your site as well as other sites located in the state of California your organization makes purchasing decisions for</u>. **<u>Please do not include industrial tow tractors (or tugs) that are retired or no longer operational.</u>**

___. <SPECIFY [IF VALUE = 0, SKIP TO Q57]
777. DON'T KNOW
999. REFUSED

[CONTINUE TO Q52B]

[FOR GROUP 3 ONLY]

Q52 How many industrial tow tractors (tugs)currently operate in the fleets maintained by your organization? This would inlcude **industrial tow tractors (tugs) that operate at your site as well as those located nationwide** for which your organization makes purchasing decisions for. **Please do not include industrial tow tractors (tugs) that are retired or no longer operational.**

___. <SPECIFY [IF VALUE = 0, SKIP TO Q57]
777. DON'T KNOW
999. REFUSED

Q52A What percentage of these [INSERT NUMBER] industrial tow tractors (tugs) operate primarily in California?

___. <SPECIFY %
777. DON'T KNOW
999. REFUSED

Q52B Approximately what percentage of the [INSERT NUMBER] industrial tow tractors (tugs) in your fleet exclusively provide ground support for airlines [these are industrial tow tractors (tugs) that actually see the tarmack]?

___. <SPECIFY %
777. DON'T KNOW
999. REFUSED

Q53 Of the [INSERT VALUE] industrial tow tractors (or tugs) you reported, what number are powered by…

[INTERVIEWER, IF NUMERICAL VALUE IS NOT KNOWN ASK RESPONDENT TO ESTIMATE THE PERCENTAGE]

1. Diesel fuel
2. Propane/LPG
3. Dual Fuel (gas tank and propane tank with a switch)
4. Gasoline
5. Battery electric
6. Another fuel type SPECIFY TYPE?
   ___. <SPECIFY NUMBER
   ___. <SPECIFY PERCENTAGE
   777. DON'T KNOW
   999. REFUSED

Q54 What is the average horsepower of the [INSERT TYPE] industrial tow tractors (tugs) operating in your organization's fleet.

1. Diesel fuel
2. Propane/LPG
3. Dual Fuel (gas tank and propane tank with a switch)

4. Gasoline
5. Another fuel type

___. <SPECIFY VALUE
777. DON'T KNOW
999. REFUSED

[IF # OF TOW TRACTORS < 4, SKIP TO Q55B]

Q55A On average, how many hours do the industrial tow tractors (tugs) in your organization's fleet operate per year?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF TOW TRACTORS > 3, SKIP TO Q56]

Q55B How many hours do each of the industrial tow tractors (tugs) in your organization's fleet operate per year?

1. TRACTOR #1>
2. TRACTOR #2>
3. TRACTOR #3>
777. DON'T KNOW
999. REFUSED

Q56 On average how long do the industrial tow tractors (tugs) in your fleet operate before they are retired?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF Q2C = 0, SKIP TO TRANS2]
[FOR GROUP 1 ONLY]

Q57 How many industrial sweeper/scrubbers in your location's fleet currently operate in California? **Please do not include industrial sweeper/scrubbers that are retired or no longer operational.**

__. <SPECIFY [IF VALUE = 0, SKIP TO TRANS2]
777. DON'T KNOW
999. REFUSED

[CONTINUE TO Q61]
[FOR GROUP 2 ONLY]

Q58 How many industrial sweeper/scrubbers currently operate in the fleets maintained by your organization? Include industrial sweeper/scrubbers that operate at your site as well as other sites located in the state of California your organization makes purchasing decisions for. **Please do not include industrial sweeper/scrubbers that are retired or no longer operational.**

___. <SPECIFY [IF VALUE = 0, SKIP TO TRANS2]
777. DON'T KNOW
999. REFUSED

[CONTINUE TO Q61]
[FOR GROUP 3 ONLY]

Q59 How many industrial sweeper/scrubbers currently operate in the fleets maintained by your organization? This would inlcude industrial sweeper/scrubbers **that operate at your site as well as those located nationwide** for which your organization makes purchasing decisions for. **Please do not include industrial sweeper/scrubbers that are retired or no longer operational.**

___. <SPECIFY [IF VALUE = 0, SKIP TO TRANS2]
777. DON'T KNOW
999. REFUSED

Q60 What percentage of these [INSERT NUMBER] industrial sweeper/scrubbers operate primarily in California?

___. <SPECIFY %
777. DON'T KNOW
999. REFUSED

Q61 Of the [INSERT VALUE] industrial sweeper/scrubbers you reported, what number are powered by…

[INTERVIEWER, IF NUMERICAL VALUE IS NOT KNOWN ASK RESPONDENT TO ESTIMATE THE PERCENTAGE]

1. Diesel fuel
2. Propane/LPG
3. Dual Fuel (gas tank and propane tank with a switch)
4. Gasoline
5. Battery electric
8. Another fuel type SPECIFY TYPE?
   ___. <SPECIFY NUMBER
   ___. <SPECIFY PERCENTAGE
   777. DON'T KNOW
   999. REFUSED

Q62 What is the average horsepower of the [INSERT VALUE] industrial sweeper/scrubbers) operating in your organizations's fleet.

___. <SPECIFY VALUE
777. DON'T KNOW
999. REFUSED

[IF # OF SWEEPERS < 4, SKIP TO Q63B]

Q63A On average, how many hours do the industrial sweeper/scrubbers in your organization's fleet operate per year?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF SWEEPERS > 3, SKIP TO Q64]

Q63B How many hours do each of the industrial sweeper/scrubbers in your organization's fleet operate per year?

1. SWEEPER #1>
2. SWEEPER #2>
3. SWEEPER #3>
777. DON'T KNOW
999. REFUSED

Q64 On average how long do the industrial sweeper/scrubbers in your fleet operate before they are retired?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

TRANS2 Thank you for your patience so far. We are almost completed with the survey. Just a few more questions and we will be done.

Q65 What barriers does your organization face in converting to a zero-emission fleet?

1. None, fleet is already zero-emission.
2. Not enough time to charge
3. Cost
4. Battery forklifts do not provide enough space
5. Lack of space for charging/ battery room
6. Other reasons SPECIFY>
777. DON'T KNOW
999. REFUSED

Q66 There are currently incentive programs under development which would provide money for upgrading or replacing older equipment. Would you like to be put on a list to be contacted by an ARB staff member when incentive opportunities become available?

1. YES
2. NO
777. DON'T KNOW
999. REFUSED

Q67 Is your business a warehouse or distribution center that handles freight?

1. YES
2. NO
777. DON'T KNOW
999. REFUSED

Q68 What is the total square footage of the building on your business' property? If you don't know the exact value, give your best estimate.

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

Q69 How many docks or bays does your business' facility have?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

TRANS3 Lastly, I would like to ask you for some feedback on the quality of our survey. Please be as honest and forward as possible, as these responses may be used to improve this survey for future respondents.

Q70 How easy or difficult was it to understand the questions throughout the survey? Would you say it was…

1. Extremely easy [SKIP TO Q72]
2. Somewhat easy [SKIP TO Q72]
3. Somewhat difficult
4. Extremely difficult
7. DON'T KNOW
9. REFUSED

Q71 What aspects of the survey made it difficult to understand? Please provide as much feedback as you like.

1. SPECIFY ASPECTS>
7. DON'T KNOW
9. REFUSED

Q72 As I mentioned at the beginning of this survey, the purpose of this study is to update estimates of the industrial equipment population in California and their contribution to

statewide emissions, with a focus on fleets of forklifts, sweepers/scrubbers, and tow tractors.

Are there any questions we did not ask or topics we did not cover that you feel are important to this purpose?

1. SPECIFY QUESTIONS/TOPICS>
2. NO
7. DON'T KNOW
9. REFUSED

Q73 I only have a couple more questions for you, and we will be done with the survey. Overall, would you say the survey took…

1. Less time than you expected
2. About as long as you expected
3. Longer than you expected
7. DON'T KNOW
9. REFUSED

Q74 And finally, in your opinion, are there any changes we could make to the survey to improve it?

1. SPECIFY IMPROVEMENTS>
2. NO
7. DON'T KNOW
9. REFUSED

[SKIP TO CONCLU]

INELG1 Thank you for your responses. We are not surveying farming or agricultural businesses or organizations performing these services at this time. Your organization may be approached at another time requesting your participation in a separate survey not conducted by our center.

INELG2 Thank you for your responses. We are not surveying businesses that do not operate this kind of equipment at their location. Your organization may be approached at another time requesting your participation in a separate survey not conducted by our center.

CONCLU This concludes our survey. Thank you for your time.

APPENDIX B: POST-PILOT SURVEY INSTRUMENT

SHELLO Hello, this is _____, calling from the Social Science Research Center at California State University, Fullerton. We're conducting a study sponsored by the state of California.

CONFIRMB Have I reached [CONTACT NAME] at [BUSINESS NAME] and [ADDRESS]?

SCONTCT May I please speak with [CONTACT PERSON'S NAME/FORKLIFT FLEET MANAGER]?

1. YES, AVAILABLE NOW [SKIP TO INTRO]
2. NO, NOT AVAILABLE NOW [SKIP TO CALLBAK1]
3. NO SUCH PERSON
4. NEW PHONE NUMBER OBTAINED [ENTER NEW NUMBER]
7. DON'T KNOW
9. REFUSED

WHO Can you please direct me to the person in your business who could answer questions about its forklift fleet operations? This might be your businesses' warehouse, fleet, or forklift equipment manager.

1. SPECIFY NAME>
2. SPECIFY TITLE>
7. DON'T KNOW/NO RESPONSE
8 OUR BUSINESS DOES NOT OPERATE INDUSTRIAL EQUIPMENT OF ANY KIND [SKIP TO DISQUAL]
9. REFUSED

SCONTCT Is [INSERT NAME] available now?

1. YES, AVAILABLE NOW [SKIP TO INTRO]
2. NO, NOT AVAILABLE NOW

CALLBAK1 Can you suggest a better time to call back to reach [CONTACT NAME]?

ALTERNAT Alternatively, this person can call us back at (657) 278-5990 to schedule a convenient time for him/her complete the telephone survey.

[RECORD UPDATED INFORMATION IN UDF FIELD-INCLUDE IN SHIFT NOTES].

INTRO We are conducting a scientific study of businesses operating fleets of forklifts, sweepers/scrubbers, and tow tractors in the State of California. The purpose of this study is to update estimates of the industrial equipment population in the state and their contribution to statewide emissions. While this study is sponsored by the State of California, the data being collected in this survey will be kept strictly confidential to the extent permitted by law and in no case will be used to single out any one business/agency.

INTRO2 Your participation in this study is completely voluntary. Should you choose to participate in this survey, you may decline to provide a response to any question should you choose to.

INTRO3 When we have completed surveys with all eligible businesses, a data file will be produced which will not contain the name of your business. All of the information provided by participating businesses will be reported to the state in the aggregate which means that the responses associated with your business will not be known to anyone outside of our center.

CONT Finally, this call may be monitored for quality control purposes. If you have questions about your rights as a research participant, I have some numbers you can call. [IF REQUESTED] The number for the California State University, Fullerton Regulatory Compliance Coordinator is (657) 278-7640, and the Institutional Review Board (IRB) Chair can be reached (657) 278-5062. For any other questions about the study, contact Laura Gil-Trejo at 657-278-7691.Is it okay to ask you these questions now?

1. YES [SKIP TO TRANS1]
2. NO [CONTINUE]
3. NO, OTHER DISPOSITION

CALLBAK2 When might we call you back?
SCHEDULE CALLBACK>

PILOT2 Because we are attempting to estimate the total population forklifts and other equipment in the State of California, it is important for us to know a little about the business that choose not to participate in this survey. So we can do this, can you tell us how many forklifts operate at your location?

_. <SPECIFY
777. DON'T KNOW
999. REFUSED
[END SURVEY]

TRANS1 To begin, I'd like to ask you a few general questions about your business.

ELIG1 Does your business operate in the agriculture industry?

1. YES
2. NO [SKIP TO Q1]
7. DON'T KNOW
9. REFUSED

ELIG2 Does your business activity include growing or harvesting of crops from soil or the raising of animals for profit? This would also include the raising of plants at wholesale nurseries?

1. YES [SKIP TO INELG1]
2. NO
7. DON'T KNOW
9. REFUSED

ELIG3 Does your business operate in agricultural crop preparation services? Agricultural crop preparation services include only the first processing after harvest, and not subsequent processing, canning, or other similar activities. This includes businesses such as

packinghouses, cotton gins, nut hullers, nut processors, dehydrators, feed mills and grain mills. Distribution centers are not considered first processing facilities. Some other examples of first processing facilities are:

4) A winery that receives unprocessed grapes to make wine;
5) A grain mill that receives a grain or hay to make animal feed; and
6) A facility that receives whole tomatoes to make tomato paste

1. YES [SKIP TO INELG1]
2. NO
7. DON'T KNOW
9. REFUSED

Q1 Does your business operate any of the following types of equipment?

A. Forklifts
B. Tow tractors
C. Sweepers/scrubbers

1. YES
2. NO
7. DON'T KNOW [BACK UP AND CONFIRM CORRECT CONTACT]
9. REFUSED [BACK UP AND CONFIRM CORRECT CONTACT]

[IF Q2 A THROUGH C = 0 SKIP TO INELG2]

[IF SIC CODE PROVIDED, SKIP TO Q3]

Q2 In what industry does your business belong?

_____ ENTER DESCRIPTION
7. DON'T KNOW
9. REFUSED

[IF BUSINESS IS CLEARLY PART OF A RELATED GROUP MARK AS Q3 = 2]

Q3 Is your business a single service location, or is it part of a related group of locations?

1. SINGLE LOCATION [SKIP TO Q10]
2. PART OF A RELATED GROUP
7. DON'T KNOW [BACK UP AND CONFIRM CORRECT CONTACT]
9. REFUSED [BACK UP AND CONFIRM CORRECT CONTACT]

[IF Q3 = 1 CODE AS GROUP 1-REPORTING LOCALLY]

Q4 Are the equipment purchasing decisions for your business' fleet done locally or at some other central location?

1. AT THIS SITE, LOCALLY [SKIP TO Q10]
2. AT CENTRAL HEADQUARTERS ELSEWHERE [CONTINUE]
3. AT CENTRAL HEADQUARTERS THIS LOCATION [SKIP TO Q6]
7. DON'T KNOW [BACK UP AND CONFIRM CORRECT CONTACT]
9. REFUSED [BACK UP AND CONFIRM CORRECT CONTACT]

[IF Q4 = 1 CODE AS GROUP 1-REPORTING LOCALLY]

Q5 Are you able to answer questions regarding the equipment operated in your businesses' fleet?

1. YES [SKIP TO Q10]
2. NO [OBTAIN CONTACT INFORMATION FOR CORPORATE OFFICE, CROSS REFERENCE WITH SAMPLE FRAME, AND DISPOSITION APPROPRIATELY]

[IF Q5 = 1, CODE AS GROUP 1-REPORTING LOCALLY]

Q6 For how many other sites, outside your own location, does your headquarters make equipment purchase decisions?

_____ ENTER VALUE [IF VALUE = 0 SKIP TO Q10]
7. DON'T KNOW [CONFIRM CORRECT CONTACT THEN SKIP TO Q10]
9. REFUSED [CONFIRM CORRECT CONTACT THEN SKIP TO Q10]

[IF Q 6 = 0, CODE AS GROUP 1 – REPORTING LOCALLY]

Q7 Approximately, how many of these locations are located outside the state of California?

___. <SPECIFY [IF VALUE = 0, SKIP TO Q9, OTHERWISE CONTIUE]
777. DON'T KNOW [REQUEST BEST ESTIMATE AND SKIP TO Q9]
999. REFUSED [REQUEST BEST ESTIMATE AND SKIP TO Q9]

Q8 Although your business location may purchase and/or maintain fleets that operate outside of the state of California, we are interested only in those that operate within the state. Are you able to provide this information for the sites that only operate in the State of California?

1. YES [SKIP TO Q11]
2. NO ONLY NATIONWIDE DATA AVAILABLE [SKIP TO Q12]
3. NO ONLY SITE DATA AVAILABLE [SKIP TO Q10]
7. DON'T KNOW [CONFIRM CORRECT CONTACT THEN SKIP TO Q10]
9. REFUSED [CONFIRM CORRECT CONTACT THEN SKIP TO Q10]

[IF Q8=1, CODE AS GROUP 2 – REPORTING STATE WIDE]
[IF Q8 = 2, CODE AS GROUP 3-REPORTING NATIONWIDE]
[IF Q8 = 3, CODE AS GROUP 1-REPORTING LOCALLY]

Q9 The next few questions are meant to help us estimate the population of forklifts and other equipment that contribute to emissions **in the State of California**. Are you able to

provide this information for all of the sites in California, including your own, for which your headquarters makes purchasing decisions for, or are you only able to provide this information for your own location.

1. FOR MY OWN LOCATION [GO TO Q10]
2. FOR ALL LOCATIONS OUR HEADQUARTERS MAKE PURCHASING DECISIONS FOR [SKIP TO Q11]
7. DON'T KNOW [CONFIRM CORRECT CONTACT]
9. REFUSED [CONFIRM CORRECT CONTACT]

[IF Q9 = 1, CODE AS GROUP 1-REPORTING LOCALLY]
[IF Q9 = 2, CODE AS GROUP 2-REPORTING STATEWIDE]

[IF Q1A = 0, SKIP TO Q50]

Q10 How many forklifts in your location's fleet currently operate in California? Forklifts do not include Pallet Jacks, Walkies, or any other equipment one walks with or possesses a handle. **Please do not include forklits that are retired or no longer operational.**

__. <SPECIFY [IF VALUE = 0, SKIP TO Q50]
777. DON'T KNOW [REQUEST BEST ESTIMATE OR CHANGE CONTACT]
999. REFUSED [REQUEST BEST ESTIMATE OR CHANGE CONTACT]

[CONTINUE TO Q13A]

Q11 How many forklifts currently operate in the fleets maintained by your organization? Include fleets that operate at your site as well as other sites located in the state of California your organization makes purchasing decisions for. Forklifts do not include Pallet Jacks, Walkies, or any other equipment one walks with or possesses a handle. **Please do not include forklits that are retired or no longer operational.**

___. <SPECIFY [IF VALUE = 0, SKIP TO Q50]
777. DON'T KNOW [REQUEST BEST ESTIMATE OR CHANGE CONTACT]
999. REFUSED [REQUEST BEST ESTIMATE OR CHANGE CONTACT]

[CONTINUE TO Q13A]

Q12 The next few questions are meant to help us estimate the population of forklifts and other equipment that contribute to emissions in the State of California. That means we are not interested in equipment that is purchased for locations operating for your business outside of California.

However, because you indicate being unable to report data for the fleets your business maintains just for the state of California, I will assume that the information you are providing will be for the fleets operating at your site as well as those operating nationwide. Is this correct?

1. YES
2 NO, PROVIDING DATA AT SITE LEVEL [GO BACK TO Q10]
3. NO, SPECIFY OTHER REASON [REASK QUESTION OR CLARIFY ANSWERS TO PREVIOUS QUESTIONS]

Q13 How many forklifts currently operate in the fleets maintained by your organization? This would inlcude **fleets that operate at your site as well as those located nationwide** for which your organization makes purchasing decisions. Forklifts do not include Pallet Jacks, Walkies, or any other equipment one walks with or possesses a handle. **Please do not include forklits that are retired or no longer operational.**

___. <SPECIFY [IF VALUE = 0, SKIP TO Q50]
777. DON'T KNOW [REQUEST BEST ESTIMATE OR CHANGE CONTACT]
999. REFUSED [REQUEST BEST ESTIMATE OR CHANGE CONTACT]

Q13A What percentage of these [INSERT NUMBER] forklifts operate primarily in California?

___. <SPECIFY %
777. DON'T KNOW [REQUEST BEST ESTIMATE]
999. REFUSED [REQUEST BEST ESTIMATE]

Q14 What percentage of these [INSERT NUMBER] forklifts are…

1. Owned
2. Leased
3. Rented for less than a year
4. Rented for more than a year.

___. <SPECIFY PERCENTAGE
___. <SPECIFY NUMBER [CHOICE IF # OF LIFTS < 4]
777. DON'T KNOW
999. REFUSED

Q15 Of the [INSERT VALUE] forklifts you reported, what number are powered by…

[INTERVIEWER, IF NUMERICAL VALUE IS NOT KNOWN ASK RESPONDENT TO ESTIMATE THE PERCENTAGE]

1. Diesel fuel
2. Propane/LPG

3. Battery electric
4. Another fuel type SPECIFY TYPE?
___. <SPECIFY NUMBER
___. <SPECIFY PERCENTAGE
777. DON'T KNOW
999. REFUSED

[IF Q15_1 = 0 SKIP TO Q23, OTHERWISE CONTINUE]

Q16 Of your diesel-fueled forklifts, how many have a horsepower of…
a. <51 HP
b. 51-70 HP
c. >70 HP
777. DON'T KNOW
999. REFUSED

[IF Q16_c > 0, CONTINUE, OTHERWISE SKIP TO Q18]

Q17 Of the diesel-fuel forklifts in your fleet with a horsepower greater than 70, what is the average horsepower?
___. <SPECIFY
777. DON'T KNOW
999. REFUSED

Q18 Of the diesel-fueled forklifts in your fleet, how many have a lift capacity of…
a. <5,001 lbs
b. 5,001 to 8,000 lbs
c. >8,000 lbs

[IF Q18_c > 0, CONTINUE, OTHERWISE SKIP TO Q20]

Q19 Of the diesel-fuel forklifts in your fleet with a lift capacity over 8,000 pounds, what is the average lift capacity?
___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS < 4, SKIP TO Q20B]

Q20A On average, how many hours do the diesel-fueled forklifts in your organization's fleet operate per year?
___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS > 3, SKIP Q21A]

Q20B How many hours do each of the diesel-fueled forklifts in your organization's fleet operate per year?

4. FORKLIFT #1>
5. FORKLIFT #2>
6. FORKLIFT #3>
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS < 4, SKIP TOQ21B]

Q21A What is the average model year of the diesel-fueled forklifts in your organization's fleet?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS > 3, SKIP Q22]

Q21B What is the model year of each of the diesel-fueled forklifts in your organization's fleet?

4. FORKLIFT #1>
5. FORKLIFT #2>
6. FORKLIFT #3>
777. DON'T KNOW
999. REFUSED

Q22 On average how long do the diesel-fueled forklifts in your fleet operate before they are retired?

___. <SPECIFY HOURS
___. <SPECIFY YEARS
777. DON'T KNOW
999. REFUSED

[IF Q15_2 = 0, SKIP TO Q30, OTHERWISE CONTINUE]

Q23 Of your propane/LPG-fueled forklifts, how many have a horsepower of…

a. <51 HP
b. 51-70 HP
c. >70 HP
777. DON'T KNOW
999. REFUSED

[IF Q23_c > 0, CONTINUE, OTHERWISE SKIP TO Q25]

Q24 Of the propane/LPG fueled forklifts in your fleet with a horsepower greater than 70, what is the average horsepower?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

Q25 Of your propane/LPG-fueled forklifts, how many have a lift capacity of…

a. <5,001 lbs
b. 5,001 to 8,000 lbs

c. >8,000 lbs

[IF Q25_c > 0, CONTINUE, OTHERWISE SKIP TO Q27]

Q26 Of the propane/LPG fueled forklifts in your fleet with a lift capacity over 8,000 pounds, what is the average lift capacity?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS < 4, SKIP TO Q27B]

Q27A On average, how many hours do the propane/LPG fueled forklifts in your organization's fleet operate per year?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS > 3, SKIP TO Q28A]

Q27B How many hours do each of the propane/LPG fueled forklifts in your organization's fleet operate per year?

4. FORKLIFT #1>
5. FORKLIFT #2>
6. FORKLIFT #3>
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS < 4, SKIP TO Q28B]

Q28A What is the average model year of the propane/LPG fueled forklifts in your organization's fleet?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS > 3, SKIP TO Q29]

Q28B What is the model year of each of the propane/LPG fueled forklifts in your organization's fleet?

10. FORKLIFT #1>
11. FORKLIFT #2>
12. FORKLIFT #3>
777. DON'T KNOW
999. REFUSED

Q29 On average how long do the propane/LPG-fueled-forklifts in your fleet operate before they are retired?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF Q15_3 = 0 SKIP TO QREPEAT, OTHERWISE CONTINUE]

Q44 Of your battery electric- fueled forklifts, how many have a lift capacity of…
a. <5,001 lbs
b. 5,001 to 8,000 lbs
c. >8,000 lbs

Q45 What is the maximum lift capacity of the battery electric-fueled forklifts in your fleet?
___. <SPECIFY
777. DON'T KNOW
999. REFUSED

Q46 What is the average lift capacity of the battery electric-fueled forklifts in your fleet?
___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS < 4, SKIP TO Q47B]

Q47A On average, how many hours do the battery electric- fueled forklifts in your organization's fleet operate per year?
___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS > 3, SKIP TO Q48A]

Q47B How many hours do each of the battery electric- fueled forklifts in your organization's fleet operate per year?
4. FORKLIFT #1>
5. FORKLIFT #2>
6. FORKLIFT #3>
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS < 4, SKIP TO Q48B]

Q48A What is the average model year of the battery electric- fueled forklifts in your organization's fleet?
___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF LIFTS > 3, SKIP TO Q49]

Q48B What is the model year of each of the battery electric- fueled forklifts in your organization's fleet?

4. FORKLIFT #1>
5. FORKLIFT #2>
6. FORKLIFT #3>
777. DON'T KNOW
999. REFUSED

Q49 On average how long do the battery electric-fueled forklifts in your fleet operate before they are retired?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF Q15_4 = 0 SKIP TO Q50, OTHERWISE CONTINUE]

QREPEAT For all other fuel types, re-ask the previous series of questions.

[IF Q1B = 0, SKIP TO Q57]

[FOR GROUPS 1 ONLY]

Q50 How many industrial tow tractors (or tugs) in your location's fleet currently operate in California? **Please do not include tractors or tows that are retired or no longer operational.**

__. <SPECIFY [IF VALUE = 0, SKIP TO Q57]
777. DON'T KNOW
999. REFUSED

[CONTINUE TO Q52B]
[FOR GROUP 2 ONLY]

Q51 How many industrial tow tractors (or tugs) currently operate in the fleets maintained by your organization? Include industrial tow tractors (or tugs) that operate at your site as well as other sites located in the state of California your organization makes purchasing decisions for. **Please do not include industrial tow tractors (or tugs) that are retired or no longer operational.**

___. <SPECIFY [IF VALUE = 0, SKIP TO Q57]
777. DON'T KNOW
999. REFUSED

[CONTINUE TO Q52B]

[FOR GROUP 3 ONLY]

Q52 How many industrial tow tractors (tugs)currently operate in the fleets maintained by your organization? This would inlcude **industrial tow tractors (tugs) that operate at your site as well as those located nationwide** for which your organization makes

purchasing decisions for. **Please do not include industrial tow tractors (tugs) that are retired or no longer operational.**

___. <SPECIFY [IF VALUE = 0, SKIP TO Q57]
777. DON'T KNOW
999. REFUSED

Q52A What percentage of these [INSERT NUMBER] industrial tow tractors (tugs) operate primarily in California?

___. <SPECIFY %
777. DON'T KNOW
999. REFUSED

Q52B Approximately what percentage of the [INSERT NUMBER] industrial tow tractors (tugs) in your fleet exclusively provide ground support for airlines [these are industrial tow tractors (tugs) that actually see the tarmack]?

___. <SPECIFY %
777. DON'T KNOW
999. REFUSED

Q53 Of the [INSERT VALUE] industrial tow tractors (or tugs) you reported, what number are powered by…

[INTERVIEWER, IF NUMERICAL VALUE IS NOT KNOWN ASK RESPONDENT TO ESTIMATE THE PERCENTAGE]

1. Diesel fuel
2. Gasoline
3. Another fuel type SPECIFY TYPE?
   ___. <SPECIFY NUMBER
   ___. <SPECIFY PERCENTAGE
   777. DON'T KNOW
   999. REFUSED

Q54 What is the average horsepower of the [INSERT TYPE] industrial tow tractors (tugs) operating in your organization's fleet.

1. Diesel fuel
2. Gasoline
3. Another fuel type

   ___. <SPECIFY VALUE
   777. DON'T KNOW
   999. REFUSED

[IF # OF TOW TRACTORS < 4, SKIP TO Q55B]

Q55A On average, how many hours do the industrial tow tractors (tugs) in your organization's fleet operate per year?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF TOW TRACTORS > 3, SKIP TO Q56]

Q55B How many hours do each of the industrial tow tractors (tugs) in your organization's fleet operate per year?

4. TRACTOR #1>
5. TRACTOR #2>
6. TRACTOR #3>
777. DON'T KNOW
999. REFUSED

Q56 On average how long do the industrial tow tractors (tugs) in your fleet operate before they are retired?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF Q2C = 0, SKIP TO TRANS2]
[FOR GROUP 1 ONLY]

Q57 How many industrial sweeper/scrubbers in your location's fleet currently operate in California? **Please do not include industrial sweeper/scrubbers that are retired or no longer operational.**

__. <SPECIFY [IF VALUE = 0, SKIP TO TRANS2]
777. DON'T KNOW
999. REFUSED

[CONTINUE TO Q61]
[FOR GROUP 2 ONLY]

Q58 How many industrial sweeper/scrubbers currently operate in the fleets maintained by your organization? Include industrial sweeper/scrubbers that operate at your site as well as other sites located in the state of California your organization makes purchasing decisions for. **Please do not include industrial sweeper/scrubbers that are retired or no longer operational.**

___. <SPECIFY [IF VALUE = 0, SKIP TO TRANS2]
777. DON'T KNOW
999. REFUSED

[CONTINUE TO Q61]
[FOR GROUP 3 ONLY]

Q59 How many industrial sweeper/scrubbers currently operate in the fleets maintained by your organization? This would inlcude industrial sweeper/scrubbers **that operate at your site as well as those located nationwide** for which your organization makes

purchasing decisions for. **Please do not include industrial sweeper/scrubbers that are retired or no longer operational.**

___. <SPECIFY [IF VALUE = 0, SKIP TO TRANS2]
777. DON'T KNOW
999. REFUSED

Q60 What percentage of these [INSERT NUMBER] industrial sweeper/scrubbers operate primarily in California?

___. <SPECIFY %
777. DON'T KNOW
999. REFUSED

Q61 Of the [INSERT VALUE] industrial sweeper/scrubbers you reported, what number are powered by…

[INTERVIEWER, IF NUMERICAL VALUE IS NOT KNOWN ASK RESPONDENT TO ESTIMATE THE PERCENTAGE]

1. Diesel fuel
2. Propane/LPG
3. Battery electric
4. Another fuel type SPECIFY TYPE?
   ___. <SPECIFY NUMBER
   ___. <SPECIFY PERCENTAGE
   777. DON'T KNOW
   999. REFUSED

Q62 What is the average horsepower of the [INSERT VALUE] industrial sweeper/scrubbersoperating in your organizations's fleet.

___. <SPECIFY VALUE
777. DON'T KNOW
999. REFUSED

[IF # OF SWEEPERS < 4, SKIP TO Q63B]

Q63A On average, how many hours do the industrial sweeper/scrubbers in your organization's fleet operate per year?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

[IF # OF SWEEPERS > 3, SKIP TO Q64]

Q63B How many hours do each of the industrial sweeper/scrubbers in your organization's fleet operate per year?

4. SWEEPER #1>
5. SWEEPER #2>
6. SWEEPER #3>
777. DON'T KNOW
999. REFUSED

Q64 On average how long do the industrial sweeper/scrubbers in your fleet operate before they are retired?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

TRANS2 Thank you for your patience so far. We are almost completed with the survey. Just a few more questions and we will be done.

Q65 What barriers does your organization face in converting to a zero-emission fleet?

1. None, fleet is already zero-emission.
2. Not enough time to charge
3. Cost
4. Battery forklifts do not provide enough space
5. Lack of space for charging/ battery room
6. Other reasons SPECIFY>
777. DON'T KNOW
999. REFUSED

Q66 There are currently incentive programs under development which would provide money for upgrading or replacing older equipment. Would you like to be put on a list to be contacted by an ARB staff member when incentive opportunities become available?

1. YES
2. NO
777. DON'T KNOW
999. REFUSED

Q67 Is your business a warehouse or distribution center that handles freight?

1. YES
2. NO
777. DON'T KNOW
999. REFUSED

Q68 What is the total square footage of the building on your business' property? If you don't know the exact value, give your best estimate.

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

Q69 How many docks or bays does your business' facility have?

___. <SPECIFY
777. DON'T KNOW
999. REFUSED

Q72 As I mentioned at the beginning of this survey, the purpose of this study is to update estimates of the industrial equipment population in California and their contribution to statewide emissions, with a focus on fleets of forklifts, sweepers/scrubbers, and tow tractors.

Are there any questions we did not ask or topics we did not cover that you feel are important to this purpose?
1. SPECIFY QUESTIONS/TOPICS>
2. NO
7. DON'T KNOW
9. REFUSED

CONCLU This concludes our survey. Thank you for your time.

INELG1 Thank you for your responses. We are not surveying farming or agricultural businesses or organizations performing these services at this time. Your organization may be approached at another time requesting your participation in a separate survey not conducted by our center.

INELG2 Thank you for your responses. We are not surveying businesses that do not operate this kind of equipment at their location. Your organization may be approached at another time requesting your participation in a separate survey not conducted by our center.

APPENDIX C: LIST OF CALIFORNIA COUNTIES BY REGION

Northern California

- Amador
- Calaveras
- Colusa
- Butte
- Del Norte
- El Dorado
- Glenn
- Humboldt
- Lake
- Lassen
- Mendocino
- Modoc
- Nevada
- Placer
- Plumas
- Shasta
- Sierra
- Siskiyou
- Sutter
- Tehama
- Trinity
- Yuba

Bay Area

- Alameda
- Contra Costa
- Marin
- Napa
- Sacramento
- San Benito
- San Francisco
- San Joaquin
- San Mateo
- Santa Clara
- Santa Cruz
- Solano
- Sonoma
- Stanislaus
- Yolo

Central California

- Alpine
- Fresno
- Inyo
- Kings
- Madera
- Mariposa
- Merced
- Mono
- Monterey
- San Luis Obispo
- Santa Barbara
- Tulare
- Tuolumne

Southern California

- Imperial
- Kern
- Los Angeles
- Orange
- Riverside
- San Bernardino
- San Bernardino
- San Diego
- Ventura