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Determination of Usage Patterns and Emissions for Propane/LPG in California

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13. ABSTRACT *(Maximum 200 Words)*

The purpose of this study was to determine California usage patterns of Liquified Petroleum Gas (LPG), and to estimate propane emissions resulting from LPG transfer operations statewide, and by county and air basin. This study is the first attempt to quantify LPG transfer emissions for California. This was accomplished by analyzing data from a telephone survey of California businesses that use LPG, by extracting information from existing databases, and by using information provided by the Western Liquid Gas Association (WLGA) and the National Petroleum Gas Association (NPGA). This data and information were used to formulate an emissions model for six significant LPG use-categories: agriculture, commercial, engine fuel applications, industrial, residential, and LPG distributors. Usage patterns and related emissions were estimated for each of the 58 counties and 14 air basins in the state. Total transfer emissions for 1991 were estimated to be 3.11 tons per day (1,131 tons per year), or about 464,000 gallons of LPG emitted out of a total of 722 million gallons of LPG transferred.

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DETERMINATION OF USAGE PATTERNS AND EMISSIONS FOR PROPANE/LPG IN CALIFORNIA

Final Report
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CALIFORNIA AIR RESOURCES BOARD
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ABSTRACT

The purpose of this study was to determine the usage patterns of Liquified Petroleum Gas (LPG) and to estimate propane emissions resulting from LPG transfer operations for the entire state of California, and then for each of its counties and Air Basins. The importance of this study is that this is the first attempt to quantify LPG transfer emissions for California. No similar estimates exist in any prior government-sponsored or private industry research.

Freeman, Sullivan & Co. (FSC) and Systems Applications International (SAI) estimated state-wide propane emissions in three ways: by analyzing data collected through a telephone survey of businesses using LPG in California, by extracting information from existing data bases, and by using information provided by the Western Liquid Gas Association (WLGA), and the National Petroleum Gas Association (NPGA). These data and information contributed to the formulation of an emissions model which was used to calculate propane emissions for six significant LPG use-categories:

- Agricultural;
- Commercial;
- Engine Fuel Applications;
- Industrial;
- Residential; and
- LPG Distributors.

Usage patterns and related emissions were then estimated for each of the 58 counties and the 14 Air Basins in the state.

Results of this study concluded that the total estimated emissions for 1991 due to LPG transfers to be 1,131 tons per year (3.11 tons per day). The source distribution of this total amount among the six LPG-use categories is: industrial users, 456.3 tons per year; engine fuel use, 214.1 tons per year; residential use, 198.7 tons per year; distributors, 180.2 tons per year; agricultural use, 42.3 tons per year; and commercial use, 39.9 tons per year. The Air Basins with the largest emissions were South Coast at 345.5 tons per year (30.5% of total), San Francisco at 209.9 tons (18.6% of total), San Joaquin Valley at 146.9 tons (13% of total), and Southeast Desert at 144.9 tons per year (10.2% of total). The other Air Basins accounted for 314.4 tons per year (27.7% of total).

The 1,131 tons per year represents approximately 464,000 gallons of LPG. This is 0.064% of the 722 million gallons of LPG transferred in California last year.

These emissions should be viewed in light of propane's relatively low ozone forming ability (compared to other organic emissions) and the fact that there is virtually no likelihood of human toxic effects in outdoor atmospheric concentrations.

Outage/bleeder vapor valve emissions were found to have as much significance as filling line disconnect emissions. It is recommended that when filling LPG containers, safe alternatives which do not rely on the outage/bleeder valve should be used.

ACKNOWLEDGEMENTS

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FSC and SAI would like to acknowledge and thank the Western Liquid Gas Association (WLGA) and the National Petroleum Gas Association (NPGA) for their cooperation in voluntarily providing expert information and data to this project.

DISCLAIMER

The statements and conclusions in this report are those of the contractor and not necessarily those of the California Air Resources Board. The mention of commercial products, their source or their use in connection with material reported herein is not to be construed as either an actual or implied endorsement of such products.

Note: For further information on this project and its findings, questions can be directed to Charles DiSogra at Freeman Sullivan & Co. (FSC) or Lyle Chinkin and Bob Jackson at Systems Applications International (SAI).

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Section 1
Summary and Conclusions

This study was designed to identify existing Liquid Petroleum Gas (LPG) usage patterns in California and then, based on these patterns, estimate the quantity of emissions associated with LPG transfers. The importance of this study is that it is the first attempt to quantify LPG transfer emissions for California. No similar estimates exist in any prior government-sponsored or private industry research. This study presents estimates of LPG transfer emissions by county and Air Basin.

Data from the National Petroleum Gas Association (NPGA) regarding state-wide LPG usage provided the foundation for the emission estimates. The NPGA data were used to approximate state-wide LPG use for five broad categories: agricultural, commercial, engine fuel, industrial, and residential use. All category usages were split into urban and rural components. A sixth category, LPG distributors, was created to estimate the transfer emissions due to the distribution of LPG to end-users.

Cylinder and vehicle usage estimations were made based on a combination of NPGA data, information from the Western Liquid Gas Association (WLGA) and survey data that were collected as a part of this study. The survey was conducted by telephone during July-September in 1991. Interviewed in this survey was a stratified, random sample of 338 urban and rural businesses who either transferred LPG (as end-users) or who distributed LPG to end-users. These businesses were surveyed on both the transfer equipment they used and the volume and frequency of LPG transfers they made.

The outage/bleeder vapor valve and the nozzle disconnection subsequent to filling are known to be the two main sources of LPG transfer emissions. Outage valve emissions, based on the survey, were found to have as much significance as disconnect emissions. To estimate outage valve emissions, an equation was derived to compute the amount of propane released, given the amount of time the valve was open. Since, as found in the survey, the outage valve was not always used, an appropriate outage valve usage factor was determined for each type of transfer. Disconnect emission factors were generated for each transfer operation based on the survey findings and information supplied by the WLGA regarding equipment most likely to be used for that operation.

Using emission factors for outage valve usage and equipment disconnections, a propane emission amount per transfer was generated for each type of transfer (e.g., bulk transfers, small storage tanks, motor vehicles, etc.). Total emissions were determined for each transfer operation by multiplying the total number of transfers per operation by the amount of propane emissions per transfer.

State-wide emissions due to LPG transfers during 1991 have been calculated to be 1,131 tons per year. Emissions by use-category were highest among industrial users at 456.3 tons per year, followed by engine fuel use at 214.1 tons per year, residential use at 198.7 tons per year, distributors at 180.2 tons per year, agricultural use at 42.3 tons per year and finally commercial use at 39.9 tons per year.

The 1,131 tons per year represents approximately 464,000 gallons of LPG. This is 0.064% of the 722 million gallons of LPG transferred in California last year. The percentage of LPG transferred resulting in emissions is virtually identical for all urban and rural operations within each use-category. Across use-categories this percent emitted ranges from 0.044% to 0.057% with the exception of the Engine Fuel category as the highest with 0.101%.

The Air Basins with the highest propane emissions and accounting for 72.3% of total emissions are South Coast at 345.5 tons per year (30.5% of total), San Francisco at 209.9 tons per year (18.6% of total), San Joaquin Valley at 146.9 tons per year (13% of total), and Southeast Desert at 144.9 tons per year (10.2% of total). The other Air Basins accounted for 314.4 tons per year which is 27.7% of the total amount.

Assumptions regarding how the NPGA annual usage figures are distributed within categories for cylinder and motor vehicle use are critical to this study's estimates. Any changes in cylinder and vehicle use within a category would change the emissions estimates proportionately. For example, if rural agricultural cylinder usage is doubled, the emissions due to that source will also double. Since the overall industrial-use category represents approximately 40% of total emissions with industrial cylinders alone representing 17.5 percent, any increase or decrease in industrial cylinder use will change emissions estimates for the entire state. If possible, a further examination of industrial uses would obtain a more accurate picture of LPG applications and resulting emissions.

The model assumes that all LPG is delivered to end-users by the distributors. Since it is most likely that some unknown percentage of LPG does not pass through the traditional distribution system, actual distributor emissions may be less than determined in this study. Given the available data, it was not possible to estimate how much less distributor emissions would be reduced. However, this over-estimation of distributor emissions may be offset by the fact that emissions from non-standard procedures and/or equipment leakages have also not been included in the model. If a large proportion of operators do not adhere to standard operating procedures when making LPG transfers, emissions could be worse.

These estimated emissions should be viewed with regard to propane's ozone forming ability and potential toxic effects. The propane molecule is one of the common paraffins with lower than normal ozone-forming reactivity. Approximately 0.48 grams of ozone are produced per gram of propane emitted. This is equivalent to propane being less than half as reactive as the average paraffin. Paraffins, as a group, account for less than 25% of the total ozone formation potential from all organic emissions. With regard to toxicity, hazards due to propane are confined to settings with high concentrations of propane gas. However, in outdoor settings and in concentrations that are predicted by this model, no long-term human effects are likely.

It appears that emissions reductions can be achieved through reduced use of the outage valve and an increased use of low emissions transfer equipment. Since LPG transfer procedures can vary greatly depending on equipment, operator knowledge and experience, only methods for safe, low emission transfer of LPG should be encouraged.

Section 2
Recommendations

It is recommended that when filling LPG containers, safe alternatives which do not rely on the outage/bleeder valve should be used. This could achieve significant reductions in LPG transfer emissions. Two possible alternatives (should they be proven safe) are:

- o the use of containers equipped with an "automatic stop-fill" device that would prevent the user from overfilling; and
- o the use of either "weight when filled" or "volume when filled" measurement techniques.

Further emissions reductions may also be achieved through the use of low-emission transfer equipment such as the "quick-acting shutoff/quick-disconnect" type nozzles for bobtail truck, cylinder or motor vehicle transfers.

Section 3
Project Overview

A. Background

From 1982 to 1988 sales of Liquified Petroleum Gas (LPG) in California increased annually by approximately 5%. Sales are expected to reach 837 million gallons by 1998. LPG is increasingly used because it is a versatile source of energy, portable and easily controlled. LPG, derived from petroleum products and sold in liquified form, is comprised mostly of propane but can also include some butane.

LPG is used in residential settings as a fuel to cook food (especially for barbecues), dry clothes and heat water. Commercial establishments, such as hotels and restaurants, use LPG in a similar fashion as residential users.

In agricultural applications, the use of LPG ranges from drying crops to powering farm equipment such as tractors, pumps and standby generators. LPG has a wide variety of applications in industrial processes where it is commonly used as a fuel for soldering, cutting and heat treating. LPG is also an alternative vehicle fuel for modified internal combustion engines. Such engines are increasingly and widely used to power fork-lift trucks and for powering fleets of city buses, delivery trucks and taxis.

The distribution of LPG involves several modes of transportation such as trucks and rail cars of varying sizes. LPG is transported from very large refinery storage tanks to the large and intermediate-sized storage tanks of wholesalers and large commercial users where it is held for further distribution. Although large wholesalers may deliver LPG directly to some high-volume users, it is usually transported by these wholesalers to smaller local distributors for retail sale through service stations and other LPG suppliers.

Given the increased distribution and usage of LPG, the California Air Resources Board (ARB) recognizes the enormous number of times that LPG is transferred (moved from large tanks to smaller tanks). Each transfer of LPG results in the release of small but quantifiable amounts of LPG vapor and/or liquid into the atmosphere. The quantity released, differs substantially depending upon the type of equipment used, the duration of the transfer operation and the frequency of connects-disconnects required per transfer. The ARB has requested that this study identify existing state-wide LPG usage patterns and then, based on these patterns, estimate the quantity of emissions associated with LPG transfers.

B. Purpose and Objectives

The purpose of this study was to determine state-wide Liquid Petroleum Gas (LPG) usage patterns and LPG emissions resulting from transfer operations. Usage and emissions estimates were to be made for each county and for each Air Basin in California. (Note: This study addressed only the emissions associated with the distribution or transfer of LPG taking place after the production phase was completed.)

The study objectives were:

- o to determine the volume and number of transfers of LPG by user type (herein called "use-category") in the State of California;
- o to determine the types of equipment used for LPG transfer and storage by use-category;
- o to estimate emission factors by county and air basin for the various types of activities that result in non-combustible emissions associated with LPG usage and transfer; and
- o to estimate emissions released into the atmosphere during LPG transfer and usage.

C. Theoretical Approach

In order to determine the state-wide LPG usage patterns and estimate resulting propane emissions, a multi-step process was employed. The first step involved a review of existing data reports provided by the Western Liquid Gas Association (WLGA) and several major LPG distributors. The purpose of this step was to identify the significant LPG use-categories in California and to locate the total volume of LPG used by each of these categories.

Based on this work, six "use-categories" were identified. Five use-categories consisted of LPG end-users and the sixth was made up of LPG distributors. The five end-user categories were:

1 Agricultural;
2 Commercial;
3 Engine Fuel Applications;
4 Industrial; and
5 Residential.

The sixth use-category, LPG distributors, was singularly significant because distributors were in the business of transferring LPG to other distributors and to LPG end-users.

The underlying theoretical approach to this study was that state-wide emission estimates can be made using data collected from a sample of LPG end-users and distributors in California for four of the six use-categories: Agricultural, Engine Fuel (fleets), Industrial and Distributors. Data for the residential and commercial use-categories were obtained from the 1990 Residential Appliance Saturation Survey (RASS). These 1990 RASS data were made available from the California Energy Commission (CEC). Although these RASS data were entirely residential findings, they were used to make estimates for the commercial use-category.

Using the above data sources, LPG usage patterns were constructed for each of the use-categories. Based on the number of transfers, related emissions were theoretically determined and estimates calculated by use-category, by county and by air basin.

In summary, data for this study were obtained from:

- a telephone survey on state-wide LPG use and transfer practices;
- the 1990 RASS data for residential usage and commercial estimates; and
- a review of existing LPG industry reports for California data and other pertinent information.

All the data from the telephone survey and from RASS were identified with their urban or rural county location. Collecting the data (telephone survey) or separating the data (RASS) by urban and rural designations provided the basis for making the county and air basin estimates in this study.

D. Limitations of Study

Estimation models, by definition, are built on a number of assumptions and commonly used surrogate data to produce results. These assumptions are specified in Section 4 where the methodology underlying this study's usage and emissions model is described. An expanded discussion of the model's uncertainties appears in Section 6 of this report.

The sampling frame for the field survey was limited to the available Standard Industrial Classification (SIC) code data base maintained by Dun and Bradstreet (D&B). A major assumption was that the D&B data base reflected the population of LPG end-users and distributors in California. In fact, it was a fairly good assumption that the large and significant LPG end-users and distributors were represented in this data base. Many smaller firms, however, may have been absent. In selecting the sample, only the primary SIC code for a business was used. Businesses with secondary or tertiary SIC codes which might have qualified as either end-users or distributors were not included.

No single data base was directly available to FSC and SAI as a comprehensive sampling frame for large motor vehicle fleets using LPG engines. To make estimates for motor vehicle fleets for the engine fuel use-category, three sources of data were utilized:

1. data were obtained through the telephone survey from a random sample of firms for two SIC codes from the D&B sampling frame (see Section 4, Methodology);

2. a non-random or "convenience" sample of large fleet operators was obtained from major LPG distributors to augment the telephone survey data (the data for the random and non-random samples were kept separate and are reported separately in this study); and

3. although it was not possible to directly access information from the Department of Motor Vehicles (DMV), staff at the ARB were able to obtain from the DMV frequency counts of registered LPG-fueled vehicles by county. The ARB provided to FSC and SAI a report of these counts for use in this study.

Section 4
Methodology

This section is divided into two parts. Part 1 addresses the data collection procedures and Part 2 addresses the LPG usage and emissions model.

Part 1
Data Collection

Data collection for this study consisted of:

- a state-wide telephone survey to obtain original data; and

- the use of pre-existing data from other surveys or data bases.

Telephone Survey

The emissions model and the related objective to develop an inventory of storage and transfer equipment required information about LPG end-users and distributors in California. An original survey was designed and conducted for the agricultural, industrial, engine fuel and distributor use-categories. (Sufficient information was available in the 1990 RASS data base to calculate estimates for both the residential and commercial use-categories.)

Survey Sampling Frame

The sampling frame for this survey consisted of the Dun & Bradstreet (D&B) data base of California businesses identified by their primary Standard Industrial Classification (SIC) codes. The use-categories selected were based on published reports and information from LPG industry contacts. The 4-digit SIC codes for inclusion in this survey by use-category were as follows:

Use-Category	SIC Code	Business Description
Agricultural	0711	Soil Preparation Service
	0721	Crop Planting, Cultivating, Protecting
	0722	Crop Harvesting (by machine)
	0723	Crop Preparation for Market
	0724	Cotton Ginning
Industrial	2911	Petroleum Refining
	1761	Roofing, Siding, and Sheet Metal Work
	3312	Steel Work, Blast Furnaces
	3441	Fabricated Structural Metal
	3443	Fabricated Plate Work
	3444	Sheet Metal
Distributors	5171	Petroleum Bulk Stations and Terminals
	5172	Petrol & Petrol Product Wholesalers
	5984	LPG (bottled gas) dealers
Engine Fuel	4225	General Warehousing and Storage
	4226	Special Warehousing and Storage

The Agricultural use-category contained all the SIC codes listed under soil preparation and crop services. The Industrial use-category, as reported by the National Petroleum Gas Association (NPGA), included LPG sold to manufacturing facilities for standby fuel, space heating, flame cutting, metallurgical furnaces, etc. It also included LPG sold to refineries for fuel use, therefore, petroleum refiners were listed under this category. Codes 34xx, "fabricated metal products," were chosen because the type of work involved in this category most closely matched LPG-related uses and processes. The roofing SIC code (1761) was chosen because roofers used LPG to heat tar and other materials, and to do sheet metal work. For Distributors, the SIC codes listed were all those that could possibly involve the distribution of LPG. Finally, the Engine Fuel use-category, according to the NPGA, consisted of SIC codes which identified a significant proportion of fork-lift and highway vehicle fleets. (The NPGA use-categories and descriptions can be found in Appendix A.)

Urban/Rural Counties

The businesses for the use-category SIC codes had county location specified in the D&B data base. The 58 counties in California were divided into 17 urban counties and 41 rural counties. The urban/rural distinction was based on population density and, to a lesser extent, the total population for the county. Using 1986 population data from the "1988 County and City Data Book," counties consisting of 150 persons or more per square mile and/or populations exceeding 500,000 persons were classified as urban -- all others were classified as rural. A list of these urban and rural counties can be found in Appendix B.

Available Sample

The maximum available sample in the D&B data base for 15 of the 16 SIC codes is shown in Table 1. Since there were only 31 refineries in California (SIC code 2911) all 31 refineries (23 urban and 8 rural) were entered in the sample.

Table 1. Number of Businesses by SIC Code in Urban and Rural Counties within Use-Categories

Use-Category	SIC Code	No. Urban	No. Rural
Agricultural	0711	87	93
	072x	635	1653
Industrial	2911	23	8
	1761	2536	651
	3312	153	39
	3441	300	96
	3443	195	46
	3444	740	102
Distributors	5171	110	160
	5172	515	267
	5984	160	171
Engine Fuel	4225	2287	551
	4226	355	81
Totals		**8136**	**3931**

Sample Size

The sample design used for the field survey had eight cells -- four use-categories for urban and four use-categories for rural. A calculated sample size of 50 interviews per cell provides an approximate plus or minus 12% level of precision (90% confidence) on resulting estimates within each cell. This improved to 8.5% for a use-category when the urban and rural data were combined (90% confidence).

When the survey was originally planned, it was anticipated that a LPG vehicle fleet data base (more precise than the D&B data base) would be available to target large highway fleets. For this reason only 25 interviews per cell were planned using the D&B sampling frame; these were to be augmented to a full 50 per cell if and when a more fleet-specific data base could be found.

Unfortunately, a superior LPG vehicle fleet data base was not available for sampling purposes. Instead, lists of major fleet operators were volunteered by some LPG distributors. These lists were used to obtain information from 21 urban businesses with vehicle fleets. Since customer lists are not random samples, the data could not be combined with the D&B random sample. The information was used, however, to provide further insight into fleet usage patterns. (Transfer equipment for this group is reported separately in this report under the heading "non-random fleet.")

The ARB was aware of this problem and eventually succeeded in obtaining information from the Department of Motor Vehicles on the distribution of registered LPG vehicles by county. A report consisting solely of the number of LPG vehicles by county was given to FSC/SAI by the ARB. This study's Engine Fuel use-category data were adjusted to reflect this DMV information.

Weighting

The final results were weighted to reflect the proportional distribution of businesses by SIC code *within category*. The formula used was:

$$[P_{ij} * S_{.j}]/S_{ij}$$

where:

P_{ij} = the natural proportion of SIC code businesses ($_i$) within a given urban or rural use-category ($_j$).

$S_{.j}$ = the final urban or rural sample number for an entire use-category ($_j$).

and:

S_{ij} = the final urban or rural sample for a given SIC code ($_i$) and use-category ($_j$).

The actual weights used for urban and rural data are shown in Appendix C and designated as "weight." When urban and rural data were combined it was done for an entire use-category only using *within category* weighted data. The formula used to weight urban and rural data in order to combine results was:

$$[(S_{uj} + S_{rj})/S_{(u \text{ or } r)j}] * [(N_{uj} + N_{rj})/N_{(u \text{ or } r)j}]$$

where:

S_{uj} = the urban sample for a use-category ($_j$).

S_{rj} = the rural sample for a use-category ($_j$).

N_{uj} = the total available number of urban SIC codes for a given use-category ($_j$).

and:

N_{rj} = the total available number of rural SIC codes for a given use-category ($_j$).

Questionnaire

The ARB LPG Usage Study Questionnaire for the field survey was developed to capture information necessary to meet the needs of the emissions model and to establish an inventory of transfer equipment. In order to make the content most relevant and have it reflect the operating terminology and situations existing in the real world, site visits to marketers and contacts with LPG users and distributors were conducted to verify the content and scope of the questions. Two large-scale industrial bulk plants and one smaller plant serving rural customers were visited. Various transfer and storage operations were observed and equipment such as nozzles, couplings, valves, etc., were examined.

Additionally, a preliminary set of questions and a list of "most widely used" LPG transfer equipment was reviewed at a Western Liquid Gas Association (WLGA) board meeting in June 1991. Input from this group as well as from experts with the National Propane Gas Association; American Petroleum Institute; Material Handling Equipment Distributors Association, and the Industrial Truck Association resulted in significant improvements.

A telephone survey field test of the questionnaire was carried out between June 24 - 27, 1991. This resulted in further revisions and improvements to the questionnaire. Areas that were strengthened related to bobtail truck transfers and LPG powered vehicles.

Data collection began on July 31, 1991. After two weeks of interviews it became apparent that questions about the use of a bleeder valve when filling tanks was not working as well as it did in the original field test. Also, the terminology and screening questions regarding small storage tanks versus screw-on cylinders for vehicles needed modification to capture more and better data. Given the wide variety of situations encountered and the fact that there was no precedent for this type of survey, these problems were not unusual. After 281 contacts looking for end-users and distributors of LPG, adjustments to the questionnaire were made and the survey continued successfully for the remaining

1,017 contacts. A total of 1,298 firms were surveyed yielding usage and inventory interviews from 338 end-users and distributors of LPG. A copy of the survey questionnaire is in Appendix D.

Non-Random Fleets

A list of 29 LPG-fueled vehicle fleet operators was obtained from major LPG distributors and the South Coast Air Quality Management District. All 29 LPG-fueled vehicle fleet operators were contacted and 21 of these operators (all in urban counties) were interviewed.

Residential Data

Data tapes were obtained from the California Energy Commission for the 1990 Residential Appliance Saturation Survey for the entire state. These data tapes were analyzed and results were obtained for the estimated percent of dwellings using any LPG for heating. The results were factored into the emissions model and used as a surrogate for the commercial use-category. Results for each county are in Appendix E.

Part 2
LPG Usage and Emissions Model

Formulation

The LPG usage and emissions model formulated in this study relied on state-wide LPG usage data supplied by the National Propane Gas Association (NPGA). The model used a variety of inputs to break down the state-wide use of each of five use-categories: Agriculture, Commercial, Engine Fuel, Industrial and Residential. In order to simplify the model, it was necessary to make several assumptions. Each of the assumptions, calculations and procedures used in this study are described in this section.

The following keys were used as a guide to the source of information or basis of the assumption for the calculations (transfers and calculated emissions) in Tables 3a - 3f in Section 5 (Results) of this report.

Key to Codes in the Use-Category Tables

A	Model assumption
AN	Model assumption using NPGA data
AS	Model assumption based on survey data
AW	Model assumption based on input from the WLGA
DN	Distribution of urban/rural SIC code used to disaggregate NPGA data
ES	Engineering factor using survey data
EW	Engineering factor using information supplied by the WLGA
M	Mathematical calculation based on other information in the table
MW	Mathematical calculation based on information supplied by the WLGA
S	Statistic taken directly from the survey data

Annual LPG Usage

The annual usage figures were taken from the 1989 NPGA data given for specific categories (see Appendix A for NPGA use-category descriptions). Agriculture, Industrial and Engine Fuel usage was split into urban and rural components in the same proportion as the distribution of SIC codes for each category between urban and rural counties.

Because the NPGA combined commercial and residential usage into one figure, Energy Information Administration data regarding the usage of several liquid petroleum gases was utilized to distribute values between commercial and residential use. The RASS data of total number of household users in urban and rural counties was used to allocate both commercial and residential usage into their urban and rural components.

Urban and rural distributor usages were determined by combining the urban and rural components of the five use-categories.

Percentage of Annual Usage

The distribution of SIC codes for each category between urban and rural counties served as a surrogate of the population of each category and was used to determine the distribution of LPG use between urban and rural counties. In this study, it was assumed that all LPG used in California was transferred from transport trucks to bulk storage tanks, to bobtail trucks, to small storage tanks. Cylinder and vehicle usage estimates were made based on the category descriptions provided by the NPGA and survey responses.

LPG Storage Tanks

As reported by the WLGA the standard transport truck size is 8,000 gallons. The sizes of bulk storage tanks, bobtail trucks and small storage tanks were determined from responses given in the survey. Residential small storage tank size, vehicle tank size and cylinder size were estimated based on information supplied by the WLGA. Survey data were used to check the accuracy of the vehicle and cylinder sizes. Commercial storage tanks were estimated to be twice as large as residential storage tanks.

Fill Factor

Standard safety procedures require that LPG containers be filled to 80% capacity (WLGA personal communication). It was assumed that transport trucks and cylinders are always empty when filled, while bobtail trucks, small storage tanks and vehicles were 20% full at the time of transfer. Therefore, empty containers were assigned a fill factor of 0.8. Partially full containers were assigned a fill factor of 0.6. Bulk storage tanks were assumed to receive an entire transport truck load.

LPG Transfer Quantity

In all cases, except for bulk storage tanks, the quantity of LPG transferred was equal to the fill factor multiplied by the container size. Bulk storage tanks received 100% of the transport truck load of 8,000 gallons.

Transfer Frequency

The number of transfers per year was determined by dividing the annual usage by the fill size.

Transfer Duration

The following filling rates, supplied by the WLGA, were used for estimating the duration of time to fill each storage tank class:

Transport truck/bulk storage tank	350.0 gallons/minute
Bobtail truck	80.0 gallons/minute
Small storage tank	60.0 gallons/minute
Cylinder	13.7 gallons/minute
Motor vehicle tank	36.9 gallons/minute

Disconnect Emission Factor

Current technology requires a small volume of space between the seal on the hose from the transfer storage tank to the receptacle on the receiving storage tank. For bulk LPG transfer operations, the disconnect emission factor was assumed to be equal to the amount of LPG contained in a "globe valve" (the most common type of valve in use based on WLGA information). The formula used was as follows:

$$\text{Propane emissions/transfer} = gv * pd = 134.5\text{g}$$

where:

gv = volume released from a globe valve = 14.02 cu.in.

pd = propane density = 9.59 g per cubic inch

For transfers to small storage tanks, cylinders and vehicles, survey data were used to determine the types of equipment used for transfer. From the survey it was determined that a "quick-acting shut-off nozzle" was used approximately 40% of the time, and an "extended safety filler coupling" was used approximately 60% of the time or served as a good surrogate for similar transfer coupling equipment. Furthermore, it was found that an adaptor was used in addition to a nozzle for approximately 25% of the transfers. The formulae used were:

Volume released/transfer = (0.4 * qv) + (0.6 * efv) + (0.25 * adv) = 1.13 cu.in.

Propane emission/transfer = 1.13 cu.in. * pd = 10.9 g

where:

0.4	= quick acting shutoff usage frequency
qv	= volume released from a quick acting shutoff nozzle = 0.30 cu.in.
0.6	= extended safety filler coupling usage frequency
efv	= volume released from extended safety filler coupling = 1.37 cu.in.
0.25	= adaptor usage frequency
adv	= volume released from an adapter = 0.77 cu.in.
pd	= propane density = 9.59 g/cu.in.

Outage Valve Emission Factor

Standard safe transfer procedures require operators to use an outage valve (or bleeder valve) to signal the operator when the storage tank has reached its full level of 80%. Gas flow out of the outage valve and into the atmosphere is assumed to be equal to one quarter of the gas flow out of an unobstructed outlet (a hole) of the same size as the outage valve. This assumption is made based on two reasons. First, a fully open outage valve will have fewer emissions than an unobstructed outlet because of friction and the outage valve design. Second, outage valves need not be open more than half-way in order to observe the emission of liquid vapor. Field observations confirmed that in practice outage valves were rarely opened completely.

It has also been assumed that the valve is shut off after liquid propane is emitted for one second. This assumption is based on observations of propane transfer operations, inspection of an outage valve assembly and communications with WLGA representatives. Because of the hazards involved with fugitive emissions of propane, it is reasonable and usual to expect the operator who is directly observing the valve to immediately close it when liquid vapor is emitted. This action would be part of standard operating procedures.

Using separate mechanical engineering equations for an unobstructed valve, propane gas emission were determined to be 1.5g/sec (90.7g/min), while liquid emissions were determined to be 5.42 grams per transfer. The following equation was used in the model:

Outage Valve Emission = 0.25 * [(of * ft) + le] = [(22.68 * ft) + 1.36]g

where:

0.25	= outage valve flow reduction factor
of	= outage valve emission factor = 90.7 g/min
ft	= fill time (based on container size in minutes)
le	= liquid emissions of propane from the outage valve = 5.42g

Outage Valve Usage

When possible, survey results were used to determine the frequency of outage valve use. This number was used in the annual emissions calculation and was a critical element in determining the final emissions estimate.

Annual Emissions

$$\text{Annual Propane emissions} = tr * [de + (ou * oe)]$$

where:

tr	= LPG transfer frequency (transfers/year)
de	= disconnect emission factor (this is either 134.5g or 10.9g depending on the type of transfer)
ou	= outage valve usage percentage
ft	= fill time (based on container size in minutes)
oe	= outage valve emission [(22.68 * ft) + 1.36]g

County and Air Basin Usage and Emissions

LPG usage, transfer and emission totals were first calculated on a state-wide use-category basis. The state-wide use was then allocated to the county and Air Basin levels. Counties were first grouped by their urban/rural classification. State-wide urban/rural usage and emissions were distributed to the county level in one of two ways. First, for residential and commercial use-categories, totals were distributed based on RASS data that gave the number of households per county that used LPG. Second, for the industrial and agricultural categories, 1989 county census data were used to distribute the totals from the state level to the county level. State-wide engine fuel totals were broken down to the county level by incorporating DMV information on county totals of registered LPG vehicles. Air Basin totals were determined by combining county totals within each air basin. Air basins that contained counties split between them were given a percentage of the county total based on the area of the county in each Air Basin.

LPG Transfer and Storage Equipment

When transferring fuel to a transport truck, bulk storage tank or bobtail truck a "globe valve" was most often used to regulate the flow. Bobtail trucks typically used a "quick acting shut-off nozzle" to deliver fuel to a small storage tank. These nozzles minimized product loss and emissions. The survey determined that an "extended safety filler coupling" was the most common equipment type for filling motor vehicles. The "quick acting shut-off nozzle" and the "7141 male and female quick disconnect fitting" were the most common types of nozzles used for filling of cylinders. A variety of adapters were used when more than one type of container was filled at one location.

Please refer to Appendix F for information about common types of transfer equipment discussed. Typical container storage sizes were determined from survey responses and WLGA contacts.

Section 5
Results

Sample Findings

Table 2 displays the results of the Dun & Bradstreet sample for each of the SIC codes. Table 2 shows that 1,298 urban and rural firms were contacted and of these 338 (26%) transferred and/or distributed LPG. The sample distribution of these firms by SIC code is shown under the column "Transfers LPG." The in-depth interviews for this study were conducted with these 338 firms. The data from these firms made up the sample that was used for the analyses in this study. The original theoretical distribution of the desired sample for data analysis is shown under the heading "Desired Sample." Without knowing exactly what we would find, the desired sample allowed us to control for representation among the SIC codes. Only SIC code 0711 in Urban locations turned out to have no LPG Transfer firms in the random sample that was drawn. This is not considered a problem since this tells us that LPG transfers among those urban firms is most likely negligible. Also shown in Table 2 is the distribution of the 960 firms which reported that they did not transfer and/or distribute LPG.

Estimated LPG Usage, Transfers and Emissions

Tables 3a-3f show the estimated urban and rural annual usage, and number of transfers and calculated emissions for each of the five use-categories. Results were given for the typical type and size of storage container for the respective use-category application. (See Page 16 for Key to letter codes.)

Table 4 shows the state-wide totals for urban and rural annual usage, transfers and emissions. This table summarizes the five use-category totals from Tables 3a-3f. These summary results are displayed in Figure 1.

County and Air Basin Estimates

The estimates of LPG usage, transfers and emissions for each of the 58 counties in California can be found in Table 5.

Table 6 shows the estimates of LPG usage, transfers and emissions for the 14 Air Basins in California. These Air Basin results are displayed in Figure 2.

Percent of LPG Transferred Emitted

Table 7 presents the number of gallons of LPG used (i.e., transferred) and the corresponding gallons emitted as a percent of the amount used for five use-categories. Distributors are omitted because they are not technically "users" of LPG, however, the overall percent emitted, 0.064%, includes distributor emissions. Data are shown for urban and rural locations. Information in Table 7 is based on Table 4. These percents are graphically displayed in Figure 3.

LPG Transfer and Storage Equipment

Tables 7a-7f show the percentages of used transfer equipment for each of the five use-categories and the additional non-random fleet sample. Please refer to Appendix F for information about common types of transfer equipment.

Table 2. Results of Telephone Survey by Use-Category, SIC Code and Location

1,298 Firms surveyed. 338 Firms who transfered LPG included in sample for data analysis.

		FIRMS IN URBAN LOCATIONS						FIRMS IN RURAL LOCATIONS					
Use-Category	SIC Code	Desired Sample No.	Total Surveyed No.	Transfers LPG (Actual Sample) No.	%	Does Not Transfer LPG No.	%	Desired Sample No.	Total Surveyed No.	Transfers LPG (Actual Sample) No.	%	Does Not Transfer LPG No.	%
AGRICULTURAL:													
	0711	10	48	0		48		10	43	10		33	
	072X	40	152	50		102		40	159	52		107	
	Sub-Total	50	200	50	25%	150	75%	50	202	62	31%	140	69%
INDUSTRIAL:													
	2911	23	16	11		5		8	7	1		6	
	1761	19	79	19		60		28	101	29		72	
	3312	1	3	2		1		2	2	2		0	
	3441	2	10	1		9		5	10	3		7	
	3443	2	10	2		8		2	8	3		5	
	3444	3	12	3		9		5	10	4		6	
	Sub-Total	50	130	38	29%	92	71%	50	138	42	30%	96	70%
DISTRIBUTORS:													
	5171	6	32	5		27		8	40	9		31	
	5172	20	90	12		78		18	90	18		72	
	5984	24	32	27		5		24	28	26		2	
	Sub-Total	50	154	44	29%	110	71%	50	158	53	34%	105	66%
ENGINE FUEL:													
	4225	21	151	16		135		22	121	24		97	
	4226	4	20	3		17		3	24	6		18	
	Sub-Total	25	171	19	11%	152	89%	25	145	30	21%	115	79%
		175	655	151	23%	504	77%	175	643	187	29%	456	71%

Table 3a. Agricultural LPG Use: Estimated Urban and Rural Propane Emissions by Type of Container Transfer for 1991

Total Estimated Propane Emissions = 42.3 tons/year

Rural	Small Storage Tk		Cylinders		Vehicles		Totals
Annual usage (gal):	2.16E+07	DN	6.48E+06	AN	2.16E+06	AN	2.16E+07
% of Annual usage:	100%	A	30%	A	10%	A	
Container size (gal):	550	S	10	AS	40	AW	
Fill factor:	0.6	A	0.8	A	0.6	A	
Fill size (gal):	330	M	8	M	24	M	
Transfers/yr:	6.55E+04	M	8.10E+05	M	9.01E+04	M	9.66E+05
Approx time to fill (min):	5.5	MW	0.6	MW	0.7	MW	
Disconnect emis factor (gm/fill):	10.9	ES	10.9	ES	10.9	ES	
Outage valve emis factor (gm/fill):	126.1	EW	14.6	EW	16.1	EW	
% Using outage valve:	80.0%	A	75.0%	S	80.0%	A	
Annual emissions (gm/yr):	7.32E+06		1.77E+07		2.14E+06		2.71E+07
Annual emissions (tons/yr):	8.1		19.5		2.4		29.9
% of Total emissions:	19.1%		46.1%		5.6%		70.7%
Urban							
Annual usage (gal):	8.96E+06	DN	2.69E+06	AN	8.96E+05	AN	8.96E+06
% of Annual usage:	100%	A	30%	A	10%	A	
Container size (gal):	550	S	10	AS	40	AW	
Fill factor:	0.6	A	0.8	A	0.6	A	
Fill size (gal):	330	M	8	M	24	M	
Transfers/yr:	2.71E+04	M	3.36E+05	M	3.73E+04	M	4.00E+05
Approx time to fill (min):	5.5	MW	0.6	MW	0.7	MW	
Disconnect emission factor (gm/fill):	10.9	ES	10.9	ES	10.9	ES	
Outage valve emission factor (gm/fill):	126.1	EW	14.6	EW	16.1	EW	
% Using outage valve:	80.0%	A	75.0%	S	80.0%	A	
Annual emissions (gm/yr):	3.03E+06		7.33E+06		8.87E+05		1.12E+07
Annual emissions (tons/yr):	3.3		8.1		1.0		12.4
% of Total emissions:	7.9%		19.1%		2.3%		29.3%
Combined Totals							
Annual emissions (gm/yr):	1.04E+07		2.50E+07		3.03E+06		3.84E+07
Annual emissions (tons/yr):	11.4		27.6		3.3		42.3
% of Total emissions:	27.0%		65.2%		7.9%		100.0%

Table 3b. Commercial LPG Use: Estimated Urban and Rural Propane Emissions by Type of Container Transfer for 1991

Total Estimated Propane Emissions = 39.9 tons/year

Rural	Small Stor Tank		Cylinders		Vehicles		Totals
Annual usage (gal):	1.25E+07	DN	3.12E+06	AN	6.23E+05	AN	1.25E+07
% of Annual usage:	100.0%	A	25.0%	A	5.0%	A	
Container size (gal):	500	A	10	AW	40	AW	
Fill factor:	0.6	A	0.8	A	0.6	A	
Fill size (gal):	300	M	8	M	24	M	
Transfers/yr:	4.16E+04	M	3.90E+05	M	2.60E+04	M	4.57E+05
Approx time to fill (min):	5.0	MW	0.6	MW	0.7	MW	
Disconnect emission factor (gm/fill):	10.9	ES	10.9	ES	10.9	ES	
Outage valve emission factor (gm/fill):	114.7	EW	14.6	EW	16.1	EW	
% Using outage valve:	80.0%	A	85.0%	A	80.0%	A	
Annual emissions (gm/yr):	4.27E+06		9.07E+06		6.17E+05		1.39E+07
Annual emissions (tons/yr):	4.7		10.0		0.7		15.4
% of Total Emissions:	11.8%		25.1%		1.7%		38.6%
Urban							
Annual usage (gal):	1.99E+07	DN	4.97E+06	AN	9.94E+05	AN	1.99E+07
% of Annual usage:	100%	A	25%	A	5%	A	
Container size (gal):	500	A	10	AW	40	AW	
Fill factor:	0.6	A	0.8	A	0.6	A	
Fill size (gal):	300	M	8	M	24	M	
Transfers/yr:	6.62E+04	M	6.21E+05	M	4.14E+04	M	7.29E+05
Approx time to fill (min):	5.0	MW	0.6	MW	0.7	MW	
Disconnect emission factor (gm/fill):	10.9	ES	10.9	ES	10.9	ES	
Outage valve emission factor (gm/fill):	114.7	EW	14.6	EW	16.1	EW	
% Using outage valve:	80.0%	A	85.0%	A	80.0%	A	
Annual emissions (gm/yr):	6.80E+06		1.45E+07		9.83E+05		2.22E+07
Annual emissions (tons/yr):	7.5		15.9		1.1		24.5
% of Total Emissions:	18.8%		39.9%		2.7%		61.4%
Combined Totals							
Annual emissions (gm/yr):	1.11E+07		2.35E+07		1.60E+06		3.62E+07
Annual emissions (tons/yr):	12.2		25.9		1.8		39.9
% of Total Emissions:	30.6%		65.0%		4.4%		100.0%

Table 3c. LPG Distributors: Estimated Urban and Rural Propane Emissions by Type of Container Transfer for 1991

Total Estimated Propane Emissions = 180.2 tons/year

Rural	Transport Trucks		Bulk Storage Tks		Bobtail Trucks		Totals
Annual usage (gal):	2.80E+08	DN	2.80E+08	AN	2.80E+08	AN	2.80E+08
% of Annual usage:	100%	A	100%	A	100%	A	
Container size (gal):	10000	AW	22000	S	2200	S	
Fill factor:	0.8	A			0.6	A	
Fill size (gal):	8000	M	8000	A	1320	M	
Transfers/yr:	3.49E+04	M	3.49E+04	M	2.12E+05	M	2.82E+05
Approx time to fill (min):	23.0	MW	23.0	MW	16.5	MW	
Disconnect emission factor (gm/fill):	134.5	ES	134.5	ES	134.5	ES	
Outage valve emission factor (gm/fill):	522.9	EW	522.9	EW	375.5	EW	
% Using outage valve:	26.0%	S	26.0%	S	20.0%	S	
Annual emissions (gm/yr):	9.45E+06		9.45E+06		4.44E+07		6.33E+07
Annual emissions (tons/yr):	10.4		10.4		48.9		69.8
% of Total emissions:	5.8%		5.8%		27.2%		38.7%
Urban							
Annual usage (gal):	4.43E+08	DN	4.43E+08	AN	4.43E+08	AN	4.43E+08
% of Annual usage:	100%	A	100%	A	100%	A	
Container size (gal):	10000	AW	22000	S	2200	S	
Fill factor:	0.8	A			0.6	A	
Fill size (gal):	8000	M	8000	A	1320	M	
Transfers/yr:	5.53E+04	M	5.53E+04	M	3.35E+05	M	4.46E+05
Approx time to fill (min):	23.0	MW	23.0	MW	16.5	MW	
Disconnect emission factor (gm/fill):	134.5	ES	134.5	ES	134.5	ES	
Outage valve emission factor (gm/fill):	522.9	EW	522.9	EW	375.5	EW	
% Using outage valve:	26.0%	S	26.0%	S	20.0%	S	
Annual emissions (gm/yr):	1.50E+07		1.50E+07		7.02E+07		1.00E+08
Annual emissions (tons/yr):	16.5		16.5		77.4		110.4
% of Total emissions:	9.2%		9.2%		43.0%		61.3%
Combined Totals							
Annual emissions (gm/yr):	2.44E+07		2.44E+07		1.15E+08		1.63E+08
Annual emissions (tons/yr):	26.9		26.9		126.4		180.2
% of Total emissions:	14.9%		14.9%		70.1%		100.0%

Table 3d. LPG Engine Fuel Use: Estimated Urban and Rural Propane Emissions by Type of Container Transfer for 1991

Total Estimated Propane Emissions = 214.1 tons/year

Rural	Small Storage Tk		Cylinders		Vehicles		Totals
Annual usage (gal):	2.82E+07	DN	1.69E+07	AN	1.13E+07	AN	2.82E+07
% of Annual usage:	100.0%	A	60.0%	A	40.0%	A	
Container size (gal):	750	S	10	AS	40	AW	
Fill factor:	0.6	A	0.8	A	0.6	A	
Fill size (gal):	450	M	8	M	24	M	
Transfers/yr:	6.27E+04	M	2.12E+06	M	4.70E+05	M	2.65E+06
Approx time to fill (min):	7.5	MW	0.6	MW	0.7	MW	
Disconnect emission factor (gm/fill):	10.9	ES	10.9	ES	10.9	ES	
Outage valve emission factor (gm/fill):	171.4	EW	14.6	EW	16.1	EW	
% Using outage valve:	80.0%	A	75.0%	A	80.0%	A	
Annual emissions (gm/yr):	9.28E+06		4.62E+07		1.12E+07		6.66E+07
Annual emissions (tons/yr):	10.2		50.9		12.3		73.5
% of Total emissions:	4.8%		23.8%		5.8%		34.3%
Urban							
Annual usage (gal):	5.83E+07	DN	2.92E+07	AN	2.92E+07	AN	5.83E+07
% of Annual usage:	100.0%	A	50.0%	A	50.0%	A	
Container size (gal):	750	S	10	AS	40	AW	
Fill factor:	0.6	A	0.8	A	0.6	A	
Fill size (gal):	450	M	8	M	24	M	
Transfers/yr:	1.30E+05	M	3.64E+06	M	1.21E+06	M	4.99E+06
Approx time to fill (min):	7.5	MW	0.6	MW	0.7	MW	
Disconnect emission factor (gm/fill):	10.9	ES	10.9	ES	10.9	ES	
Outage valve emission factor (gm/fill):	171.4	EW	14.6	EW	16.1	EW	
% Using outage valve:	80.0%	A	75.0%	A	80.0%	A	
Annual emissions (gm/yr):	1.92E+07		7.95E+07		2.89E+07		1.28E+08
Annual emissions (tons/yr):	21.1		87.7		31.8		140.6
% of Total emissions:	9.9%		40.9%		14.9%		65.7%
Combined Totals							
Annual emissions (gm/yr):	2.85E+07		1.26E+08		4.00E+07		1.94E+08
Annual emissions (tons/yr):	31.4		138.6		44.1		214.1
% of Total emissions:	14.7%		64.7%		20.6%		100.0%

Table 3e. Industrial LPG Use: Estimated Urban and Rural Propane Emissions by Type of Container Transfer for 1991

Total Estimated Propane Emissions = 456.3 tons/year

Rural	Small Stor Tank		Cylinders		Vehicles		Totals
Annual usage (gal):	7.51E+07	DN	1.50E+07	AN	1.13E+07	AN	7.51E+07
% of Annual usage:	100%	A	20%	A	15%	A	
Container size (gal):	500	S	10	AS	40	AW	
Fill factor:	0.6	A	0.8	A	0.6	A	
Fill size (gal):	300	M	8	M	24	M	
Transfers/yr:	2.50E+05	M	1.88E+06	M	4.70E+05	M	2.60E+06
Approx time to fill (min):	5.0	MW	0.6	MW	0.7	MW	
Disconnect emission factor (gm/fill):	10.9	ES	10.9	ES	10.9	ES	
Outage valve emission factor (gm/fill):	114.7	EW	14.6	EW	16.1	EW	
% Using outage valve:	80.0%	A	82.4%	S	80.0%	A	
Rural emissions (gm/yr):	2.57E+07		4.30E+07		1.12E+07		7.99E+07
Rural emissions (tons/yr):	28.3		47.4		12.3		88.1
% of Total emissions:	6.2%		10.4%		2.7%		19.3%
Urban							
Annual usage (gal):	3.14E+08	DN	6.28E+07	AN	4.71E+07	AN	3.14E+08
% of Annual usage:	100%	A	20%	A	15%	A	
Container size (gal):	500	S	10	AS	40	AW	
Fill factor:	0.6	A	0.8	A	0.6	A	
Fill size (gal):	300	M	8	M	24	M	
Transfers/yr:	1.05E+06	M	7.85E+06	M	1.96E+06	M	1.09E+07
Approx time to fill (min):	5.0	MW	0.6	MW	0.7	MW	
Disconnect emission factor (gm/fill):	10.9	ES	10.9	ES	10.9	ES	
Outage valve emission factor (gm/fill):	114.7	EW	14.6	EW	16.1	EW	
% Using outage valve:	80.0%	A	82.4%	S	80.0%	A	
Urban emissions (gm/yr):	1.08E+08		1.80E+08		4.66E+07		3.34E+08
Urban emissions (tons/yr):	118.5		198.3		51.4		368.2
% of Total emissions:	26.0%		43.5%		11.3%		80.7%
Combined Totals							
Total emissions (gm/yr):	1.33E+08		2.23E+08		5.78E+07		4.14E+08
Total emissions (tons/yr):	146.9		245.7		63.7		456.3
% of Total emissions:	32.2%		53.8%		14.0%		100.0%

Table 3f. Residential LPG Use: Estimated Urban and Rural Propane Emissions by Type of Container Transfer for 1991

Total Estimated Propane Emissions = 198.7 tons/year

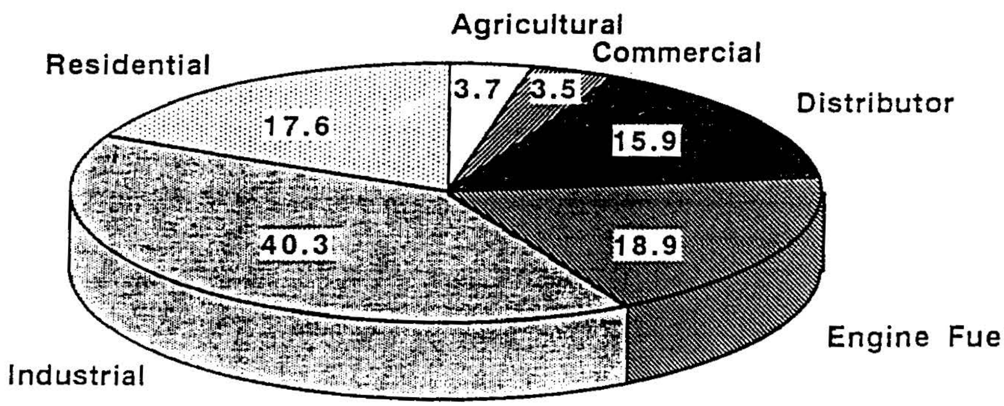
Rural	Small Stor Tank		Cylinders		Vehicles		Totals
Annual usage (gal):	7.06E+07	DN	1.41E+07	AN	1.41E+06	AN	7.06E+07
% of Annual usage:	100%	A	20%	A	2%	A	
Container size (gal):	250	AW	10	AW	40	AW	
Fill factor:	0.6	A	0.8	A	0.6	A	
Fill size (gal):	150	M	8	M	24	M	
Transfers/yr:	4.71E+05	M	1.77E+06	M	5.89E+04	M	2.30E+06
Approx time to fill (min):	2.5	MW	0.6	MW	0.7	MW	
Disconnect emission factor (gm/fill):	10.9	ES	10.9	ES	10.9	ES	
Outage valve emission factor (gm/fill):	58.0	EW	14.6	EW	16.1	EW	
% Using outage valve:	80.0%	A	85.0%	A	80.0%	A	
Annual emissions (gm/yr):	2.70E+07		4.11E+07		1.40E+06		6.95E+07
Annual emissions (tons/yr):	29.8		45.3		1.5		76.6
% of Total emissions:	15.0%		22.8%		0.8%		38.5%
Urban							
Annual usage (gal):	1.13E+08	DN	2.25E+07	AN	2.25E+06	AN	1.13E+08
% of Annual usage:	100%	A	20%	A	2%	A	
Container size (gal):	250	AW	10	AW	40	AW	
Fill factor:	0.6	A	0.8	A	0.6	A	
Fill size (gal):	150	M	8	M	24	M	
Transfers/yr:	7.51E+05	M	2.82E+06	M	9.38E+04	M	3.66E+06
Approx time to fill (min):	2.5	MW	0.6	MW	0.7	MW	
Disconnect emission factor (gm/fill):	10.9	ES	10.9	ES	10.9	ES	
Outage valve emission factor (gm/fill):	58.0	EW	14.6	EW	16.1	EW	
% Using outage valve:	80.0%	A	85.0%	A	80.0%	A	
Annual emissions (gm/yr):	4.30E+07		6.55E+07		2.23E+06		1.11E+08
Annual emissions (tons/yr):	47.4		72.2		2.5		122.1
% of Total emissions:	23.9%		36.3%		1.2%		61.5%
Combined Totals							
Annual emissions (gm/yr):	7.00E+07		1.07E+08		3.63E+06		1.80E+08
Annual emissions (tons/yr):	77.2		117.6		4.0		198.7
% of Total emissions:	38.8%		59.1%		2.0%		100.0%

Table 4. Summary of LPG Usage (volume), Frequency of Transfers and Propane Emissions for Six Use-Categories in California (1991 data)

Total Estimated Propane Emissions = 1,131.5 tons/year

	Agricultural	Commercial	Distributor	Engine Fuel	Industrial	Residential	Totals
Rural usage (gal/yr)	2.16E+07	1.25E+07	----	2.82E+07	7.51E+07	7.06E+07	2.08E+08
Urban usage (gal/yr)	8.96E+06	1.99E+07	----	5.83E+07	3.14E+08	1.13E+08	5.14E+08
Total usage (gal/yr)	3.06E+07	3.23E+07	----	8.65E+07	3.89E+08	1.83E+08	7.22E+08
Rural transfers/year	9.66E+05	4.57E+05	2.82E+05	2.65E+06	2.60E+06	2.30E+06	9.26E+06
Urban transfers/year	4.00E+05	7.29E+05	4.46E+05	4.99E+06	1.09E+07	3.66E+06	2.11E+07
Total transfers/year	1.37E+06	1.19E+06	7.28E+05	7.64E+06	1.35E+07	5.96E+06	3.04E+07
Rural emissions (tons/yr)	29.9	15.4	69.8	73.5	88.1	76.6	353.3
Urban emissions (tons/yr)	12.4	24.5	110.4	140.6	368.2	122.1	778.2
Total emissions (tons/yr)	42.3	39.9	180.2	214.1	456.3	198.7	1131.5

Figure 1. Percent Distribution of Annual Propane Emissions by LPG Use-Category



Total Emissions = 1,131.5 tons/year (1991 Estimates based on Annual LPG Transfers)

Table 5. LPG Usage (volume), Frequency of Transfers and Estimated Propane Emissions for 58 Counties in California (1991 data)

County	Urban/Rural Classification	Usage Totals (gal/yr)	Usage Percent	Transfers Totals (tran/yr)	Transfers Percent	Emissions Totals (tons/yr)	Emissions Percent
Alameda	U	3.35E+07	4.6%	1.34E+06	4.4%	47.8	4.3%
Alpine	R	1.43E+05	0.0%	5.20E+03	0.0%	0.2	0.0%
Amador	R	1.44E+06	0.2%	5.69E+04	0.2%	2.2	0.2%
Butte	R	6.40E+06	0.9%	2.79E+05	0.9%	10.2	0.9%
Calaveras	R	2.71E+06	0.4%	1.02E+05	0.3%	3.8	0.3%
Colusa	R	5.83E+05	0.1%	2.52E+04	0.1%	1.0	0.1%
Contra Costa	U	2.04E+07	2.8%	8.22E+05	2.7%	29.6	2.6%
Del Norte	R	5.95E+05	0.1%	2.75E+04	0.1%	1.1	0.1%
El Dorado	R	7.02E+06	1.0%	2.81E+05	0.9%	11.0	0.9%
Fresno	R	2.33E+07	3.2%	1.01E+06	3.3%	47.5	3.4%
Glenn	R	7.08E+05	0.1%	3.24E+04	0.1%	1.4	0.1%
Humboldt	R	3.35E+06	0.5%	1.55E+05	0.5%	5.3	0.5%
Imperial	R	3.10E+06	0.4%	1.47E+05	0.5%	5.1	0.5%
Inyo	R	7.48E+05	0.1%	3.16E+04	0.1%	1.4	0.1%
Kern	R	1.52E+07	2.1%	7.05E+05	2.3%	25.5	2.4%
Kings	R	4.42E+06	0.6%	1.83E+05	0.6%	7.2	0.6%
Lake	R	3.22E+06	0.4%	1.27E+05	0.4%	4.9	0.4%
Lassen	R	1.22E+06	0.2%	5.11E+04	0.2%	2.1	0.2%
Los Angeles	U	1.81E+08	25.0%	7.58E+06	25.0%	277.5	24.8%
Madera	R	3.95E+06	0.5%	1.63E+05	0.5%	7.0	0.5%
Marin	U	5.12E+06	0.7%	2.13E+05	0.7%	8.5	0.7%
Mariposa	R	1.29E+06	0.2%	4.84E+04	0.2%	2.0	0.2%
Mendocino	R	2.04E+06	0.3%	9.66E+04	0.3%	4.2	0.3%
Merced	R	5.96E+06	0.8%	2.62E+05	0.9%	10.7	0.9%
Modoc	R	2.95E+05	0.0%	1.33E+04	0.0%	0.6	0.0%
Mono	R	8.76E+05	0.1%	3.27E+04	0.1%	1.3	0.1%
Monterey	R	1.11E+07	1.5%	4.98E+05	1.6%	18.9	1.7%
Napa	R	2.76E+06	0.4%	1.32E+05	0.4%	5.0	0.5%
Nevada	R	4.71E+06	0.7%	1.86E+05	0.6%	7.3	0.6%
Orange	U	4.15E+07	5.7%	1.80E+06	5.9%	66.6	5.9%
Placer	R	5.28E+06	0.7%	2.35E+05	0.8%	9.3	0.8%
Plumas	R	1.19E+06	0.2%	4.69E+04	0.2%	2.2	0.2%
Riverside	U	2.69E+07	3.7%	1.08E+06	3.6%	40.3	3.5%
Sacramento	U	2.58E+07	3.6%	1.04E+06	3.4%	42.6	3.3%
San Benito	R	1.07E+06	0.1%	4.89E+04	0.2%	1.8	0.2%
San Bernardino	R	3.86E+07	5.3%	1.79E+06	5.9%	63.0	6.2%
San Diego	U	5.17E+07	7.2%	2.16E+06	7.1%	76.4	7.1%
San Francisco	U	1.95E+07	2.7%	7.78E+05	2.6%	25.3	2.5%
San Joaquin	U	1.29E+07	1.8%	5.13E+05	1.7%	20.8	1.6%
San Luis Obispo	R	6.38E+06	0.9%	2.92E+05	1.0%	10.4	1.0%
San Mateo	U	1.63E+07	2.3%	6.57E+05	2.2%	22.7	2.1%
Santa Barbara	R	1.05E+07	1.5%	4.78E+05	1.6%	16.7	1.6%
Santa Clara	U	3.66E+07	5.1%	1.48E+06	4.9%	52.3	4.8%
Santa Cruz	U	5.69E+06	0.8%	2.31E+05	0.8%	9.8	0.7%
Shasta	R	6.92E+06	1.0%	2.84E+05	0.9%	10.0	0.9%
Sierra	R	2.30E+05	0.0%	8.94E+03	0.0%	0.3	0.0%
Siskiyou	R	2.21E+06	0.3%	8.99E+04	0.3%	3.6	0.3%
Solano	U	8.76E+06	1.2%	3.51E+05	1.2%	12.8	1.1%
Sonoma	U	9.68E+06	1.3%	3.90E+05	1.3%	15.4	1.3%
Stanislaus	U	9.40E+06	1.3%	3.77E+05	1.2%	14.3	1.2%
Sutter	R	2.23E+06	0.3%	9.74E+04	0.3%	3.5	0.3%
Tehama	R	1.58E+06	0.2%	7.03E+04	0.2%	2.5	0.2%
Trinity	R	4.26E+05	0.1%	1.94E+04	0.1%	0.7	0.1%
Tulare	R	1.31E+07	1.8%	5.48E+05	1.8%	20.9	1.8%
Tuolumne	R	2.86E+06	0.4%	1.13E+05	0.4%	4.5	0.4%
Ventura	U	1.16E+07	1.6%	6.06E+05	1.7%	21.8	1.7%
Yolo	R	4.12E+06	0.6%	1.87E+05	0.6%	7.3	0.6%
Yuba	R	1.96E+06	0.3%	8.60E+04	0.3%	2.8	0.3%
Totals		7.22E+08	100.0%	3.04E+07	100.0%	1131.6	100.0%

Table 6. LPG Usage (volume), Frequency of Transfers and Estimated Propane Emissions by Air Basin for California (1991 data)

Air Basin	Usage		Transfers		Emissions	
	Totals (gal/yr)	Percent	Totals (tran/yr)	Percent	Totals (tons/yr)	Percent
Great Basin Valley	1.77E+06	0.2%	6.95E+04	0.2%	2.9	0.3%
Lake County	3.22E+06	0.4%	1.27E+05	0.4%	4.9	0.4%
Lake Tahoe	9.66E+05	0.1%	3.98E+04	0.1%	1.6	0.1%
Mountain Counties	2.42E+07	3.3%	9.70E+05	3.2%	38.2	3.4%
N. Central Coast	1.78E+07	2.5%	7.78E+05	2.6%	30.6	2.7%
North Coast	1.03E+07	1.4%	4.54E+05	1.5%	17.4	1.5%
Northeast Plateau	3.74E+06	0.5%	1.54E+05	0.5%	6.2	0.5%
S. Central Coast	2.85E+07	3.9%	1.28E+06	4.2%	48.8	4.3%
Sacramento Valley	5.41E+07	7.5%	2.26E+06	7.5%	87.4	7.7%
San Diego	5.17E+07	7.2%	2.16E+06	7.2%	76.4	6.7%
San Francisco	1.47E+08	20.3%	5.66E+06	18.8%	209.9	18.6%
San Joaquin Valley	8.38E+07	11.6%	3.55E+06	11.8%	146.9	13.0%
South Coast	2.23E+08	30.9%	9.43E+06	31.3%	345.5	30.5%
Southeast Desert	7.25E+07	10.0%	3.18E+06	10.6%	114.9	10.2%
Totals	7.22E+08	100.0%	3.01E+07	100.0%	1131.6	100.0%

Figure 2. Percent Distribution of Annual Propane Emissions by Air Basin

Total Emissions = 1,131.5 tons/year

(1991 Estimates based on Annual LPG Transfers)

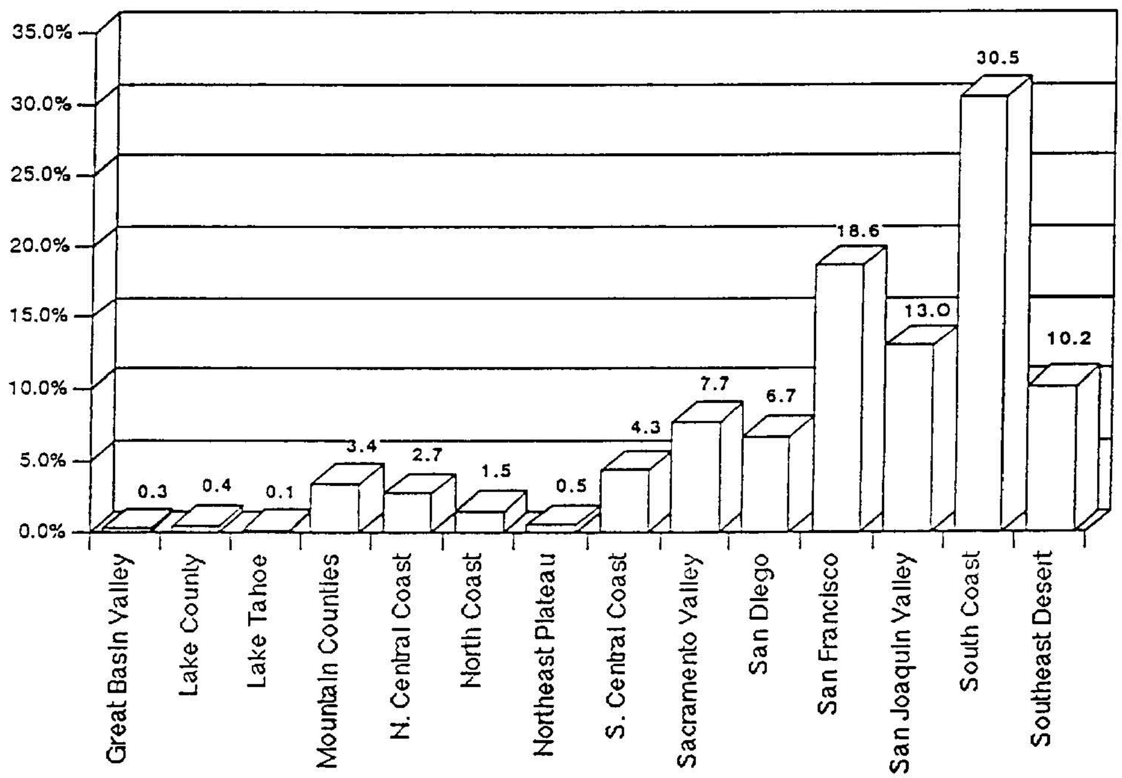


Table 7. Amount of LPG Transferred and Emitted, and the Percent Emitted for Five Urban and Rural Use-Categories (1991 data)

	Transferred (gal. used/yr.)			Emitted (gal./yr.)			Percent Emitted		
Category	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total
Agricultural	2.16E+07	8.96E+06	3.06E+07	1.22E+04	5.08E+03	1.73E+04	0.057%	0.057%	0.057%
Commercial	1.25E+07	1.99E+07	3.23E+07	6.31E+03	1.00E+04	1.63E+04	0.050%	0.050%	0.050%
Engine Fuel	2.82E+07	5.83E+07	8.65E+07	3.01E+04	5.76E+04	8.77E+04	0.107%	0.099%	0.101%
Industrial	7.51E+07	3.14E+08	3.89E+08	3.61E+04	1.51E+05	1.87E+05	0.048%	0.048%	0.048%
Residential	7.06E+07	1.13E+08	1.83E+08	3.14E+04	5.00E+04	8.14E+04	0.044%	0.044%	0.044%
Totals *	2.08E+08	5.14E+08	7.22E+08	1.45E+05	3.19E+05	4.64E+05	0.070%	0.062%	0.064%

* Totals for Gallons Emitted and Percent Emitted include Distributor emissions (see Table 4).

Note: 1 ton of emitted propane = 409.67 gallons of LPG

Figure 3. Percent of Used LPG Emitted as Propane for Five User Categories

Overall percent including Distributor related emissions = 0.064%

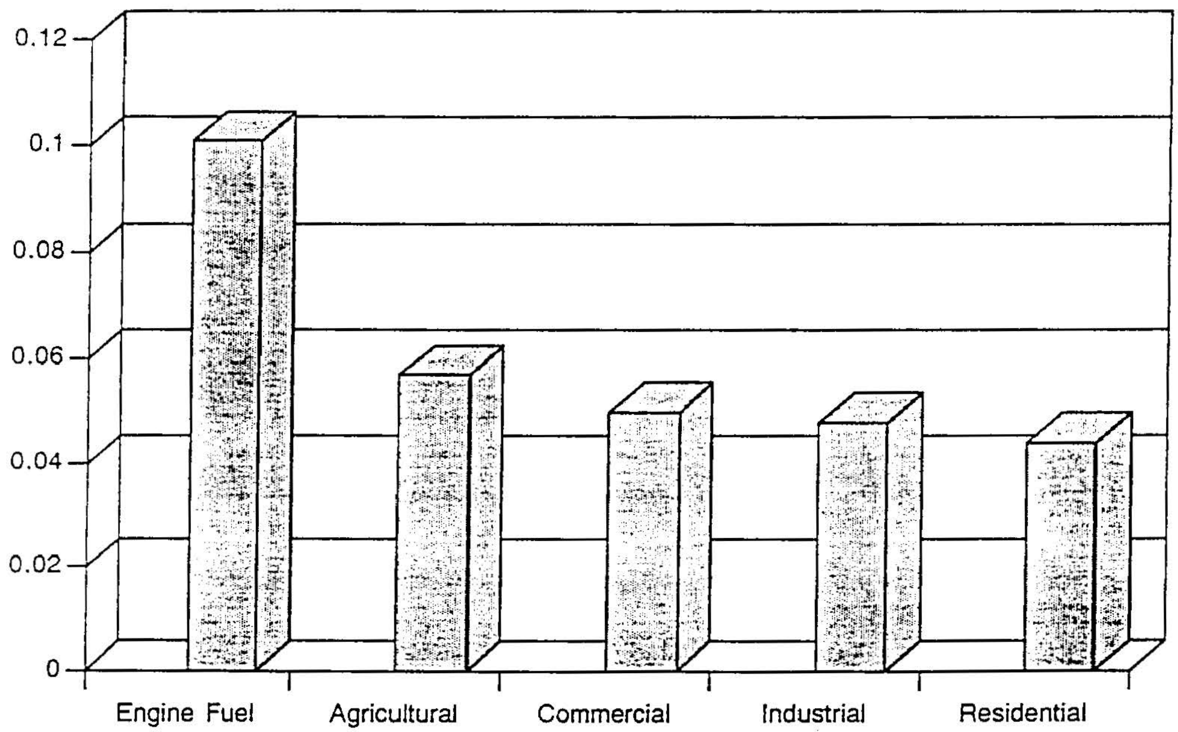


Table 7a. Motor Vehicle Filling Equipment - Survey Responses (Percent) for Agricultural Use-Category

Agriculture Motor vehicle filling equipment	
7141 male & female quick disconnect fitting	5.2%
quick acting shut-off nozzle	10.3%
compact acme filler coupling	4.1%
extended safety filler coupling	23.1%
something else	40.7%
don't know	16.6%
% using an adapator	19.7%

Table 7b. Motor Vehicle Filling Equipment - Survey Responses (Percent) for LPG Distributors

Distributors Motor vehicle filling equipment	
7141 male & female quick disconnect fitting	5.7%
quick acting shut-off nozzle	37.0%
compact acme filler coupling	11.4%
extended safety filler coupling	15.1%
something else	22.2%
don't know	8.5%
% using an adapator	14.6%

Table 7c. Motor Vehicle Filling Equipment - Survey Responses (Percent) for Industrial Use-Category

Industrial Motor vehicle filling equipment	
7141 male & female quick disconnect fitting	0.0%
quick acting shut-off nozzle	5.5%
compact acme filler coupling	1.6%
extended safety filler coupling	37.0%
something else	38.0%
don't know	17.9%
% using an adapator	52.2%

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Table 7d. Motor Vehicle Filling Equipment - Survey Responses (Percent) for LPG Engine Fuel Use-Category (Random Sample of Fleets)

Random Fleets Motor vehicle filling equipment	
7141 male & female quick disconnect fitting	1.6%
quick acting shut-off nozzle	12.1%
compact acme filler coupling	1.6%
extended safety filler coupling	37.7%
something else	30.1%
don't know	16.7%
% using an adapator	22.9%

Table 7e. Motor Vehicle Filling Equipment - Survey Responses (Percent) for LPG Engine Fuel Use-Category (Non-Random List of Fleets)

Non-Random Fleets Motor vehicle filling equipment	
7141 male & female quick disconnect fitting	11.6%
quick acting shut-off nozzle	29.4%
compact acme filler coupling	0.0%
extended safety filler coupling	0.0%
something else	58.8%
don't know	0.0%
% using an adapator	23.5%

Table 7f. Bobtail Truck Transfer Equipment - Survey Responses (Percent) for LPG Distributors

Distributors Bobtail transfer equipment	
quick acting shut-off nozzle	55.0%
compact acme filler coupling	20.9%
extended safety filler coupling	6.8%
something else	12.0%
don't know	5.2%
% using an adapator	17.6%

Section 6
Discussion

Propane Reactivity

Propane is a member of a class of carbon molecules called paraffins that are the most widely emitted form of hydrocarbon. However, none of the individual molecules of propane (containing three carbon atoms) are highly reactive towards ozone formation. As a rule, paraffins account for 50% - 60% of the total volatile organic emissions. But when using the reactivity factors developed for the Air Resources Board by Dr. William P. L. Carter of U.C., Riverside, the paraffins account for less than 25% of the total ozone formation potential from organic emissions. Propane is one of the common paraffins with lower than normal reactivity. According to the reactivity factors developed by Dr. Carter, paraffins that have 4 and 10 carbons have an average reactivity of 1.14 grams ozone per gram emitted with a standard deviation of 0.3. Propane has a value of 0.48 grams ozone per gram propane emitted, which is somewhat less than half the average paraffin and more than two standard deviations less than average.

For the Carbon Bond Mechanism (CBM) all paraffins are treated with the same chemistry on a per carbon basis except methane, ethane and propane. Propane is treated as one half "unreactive" paraffins and the other half as "other" paraffins. On a weight basis, propane would be treated in the CBM as slightly less than half as reactive as the average paraffin with higher carbons. In particular, if the reactivity of butane were the same in the CBM (according to Dr. Carter's chemistry 1.03 gram ozone per gram emitted) then propane in the CBM treatment would have a value of 0.5 gram ozone per gram emitted -- a value very close to the 0.48 grams derived previously. Hence, both chemistries treat propane as roughly half the reactivity of the bulk of paraffin emissions, meaning that as a rule a ton of propane emissions is equivalent to only a half ton of paraffin emissions.

Propane Toxicity

Toxic hazards due to propane are confined to a setting with high concentrations of propane gas. In these areas, short-term central nervous system effects, such as headaches, nausea or dizziness, can occur. As with all gaseous materials, high concentrations of gas vapor will reduce the amount of oxygen present, thus leading to asphyxiation. Additional risk is associated with propane because of its highly explosive nature (flash point = -156 F) and its ability to ignite by reacting vigorously with oxidizing materials. However, in outdoor settings and in concentrations that are predicted by this model, no long-term human effects are likely.

Emissions Model Uncertainty

While many assumptions were required to complete the calculations in this study, it should be noted that the highest confidence levels are associated with state-wide estimates of usage, transfers and emissions. Lesser confidence is associated with the dis-aggregation of state-wide totals to counties and Air Basins. Category usage figures supplied by the National Propane Gas

Association provided a solid foundation for the integrity of our estimates. The use of RASS data and SIC code distributions to allocate urban and rural usage is an accepted approach for dis-aggregating regional totals to finer resolution.

The category transfer figures were generated from annual usage and fill sizes. The fill sizes used should represent typical sizes used in the marketplace. The assumed annual usage of cylinders and vehicles was the single largest determinant in the number of transfers per year. The disconnect and outage valve emission factors were designed to provide conservative estimates given correct operating procedures.

As seen in the use-category tables, the single largest use-category was that of industrial users. In this study we estimated that the industrial category accounts for 40% of all LPG transfer emissions in California. Within this category, the estimates for refineries (the single largest component of LPG industrial users) is somewhat critical. We are less confident with our estimate of LPG used by refineries because most refineries were reluctant to provide "volume of use" information in our survey. It should be noted that this large volume of LPG used by refineries requires very few, if any, transfer operations. A change in the distribution of the amount of LPG used between refineries and the other industrial SIC codes would result in a large change in the emissions calculations for the entire category.

The size and the extent of the telephone survey was limited by the available resources. This necessitated the broad aggregation of LPG use into only six categories. A larger sample would also have yielded more precise estimates for the types of LPG usage and related transfer equipment within each category. However, we consider the results of this study, within the precision limits of the study design, as a valuable first effort to quantify LPG usage patterns and transfer emissions for California.

Section 7
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Section 8
Glossary of Abbreviations and Symbols

ARB The California Air Resources Board

CBM Carbon Bond Mechanism

CEC The California Energy Commission

D&B Dun and Bradstreet - a business data base organization

DMV The Department of Motor Vehicles

FSC Freeman, Sullivan and Company

LPG Liquid Petroleum Gas

NPGA National Petroleum Gas Association

RASS Residential Appliance Saturation Survey - an energy usage survey of households in California.

SAI Systems Applications International

WLGA Western Liquid Gas Association

The following symbols are appear in the Use-Category Tables (Tables 3a-3f)

A Model assumption

AN Model assumption using NPGA data

AS Model assumption based on survey data

AW Model assumption based on input from the WLGA

DN Distribution of urban/rural SIC code used to dis-aggregate NPGA data

ES Engineering factor using survey data

EW Engineering factor using information supplied by the WLGA

M Mathematical calculation based on other information in the table

MW Mathematical calculation based on information supplied by the WLGA

S Statistic taken directly from the survey data.

APPENDIX A
NPGA Use-Categories and Descriptions

The following is a summary of the categories that the National Propane Gas Association uses to dis-aggregate state-wide usage data.

Agricultural Uses: Includes liquefied petroleum gases used in tractors, irrigation engines, space heating of buildings, cooking, crop drying, tobacco curing, flame cultivation, poultry breeding, and other agricultural applications.

Residential and Commercial Uses: Includes liquefied petroleum gases sold for use in private households and commercial establishments such as motels, restaurants, retail stores, laundries, etc. Primarily used in space heating, water heating and cooking.

Internal-Combustion Engine Fuel Uses: Includes liquefied gases for use in highway vehicles, forklifts, oil-field drilling and production equipment, etc.

Industrial Uses: Includes liquefied gases sold to manufacturing plants for such uses as standby fuel, space heating, flame cutting, metallurgical furnaces etc. Includes sales to petroleum refineries for fuel use. Other uses which include natural gas liquids and liquified refinery gas sold or used for any other purpose not described here.

Please Note: Though these categories contain more information than just LPG use, state-wide use of LPG is given by the NPGA. Category totals used in this study are based on the statewide usage figure, but remain in the same proportion as those totals originally reported by the NPGA.

APPENDIX B

URBAN AND RURAL COUNTIES IN CALIFORNIA

URBAN COUNTIES	RURAL COUNTIES
Alameda	Alpine
Contra Costa	Amador
Los Angeles	Butte
Marin	Calaveras
Orange	Colusa
Riverside	Del Norte
Sacramento	El Dorado
San Diego	Fresno
San Francisco	Glenn
San Joaquin	Humboldt
San Mateo	Imperial
Santa Clara	Inyo
Santa Cruz	Kern
Solano	Kings
Sonoma	Lake
Stanislaus	Lassen
Ventura	Madera
	Mariposa
	Mendocino
	Merced
	Modoc
	Mono
	Monterey
	Napa
	Nevada
	Placer
	Plumas
	San Benito
	San Bernardino
	San Luis Obispo
	Santa Barbara
	Shasta
	Sierra
	Siskiyou
	Sutter
	Tehama
	Trinity
	Tulare
	Tuolumne
	Yolo
	Yuba

APPENDIX C
Weights for Urban Data

NOVEMBER 6 — Dun & Bradstreet

FINAL WEIGHTS — Primary SIC Code Distribution

SIC	UNIVERSE AVAILABLE	PROPOR-TION	ACTUAL SAMPLE	WEIGHT	WEIGHTED VALUE	WEIGHTED DISTRIB.
AGRICULTURE:						
0711	87	0.12050	48.00000	0.50208	24.09972	0.12050
072X	635	0.87950	152.00000	1.15724	175.90028	0.87950
Sub-total	722	1.00000	200.00000		200.00000	1.00000
INDUSTRIAL:						
2911	23	0.00583	16.00000	0.04735	0.75754	0.00583
1761	2536	0.64251	79.00000	1.05730	83.52673	0.64251
3312	153	0.03876	3.00000	1.67976	5.03927	0.03876
3441	300	0.07601	10.00000	0.98809	9.88092	0.07601
3443	195	0.04940	10.00000	0.64226	6.42260	0.04940
3444	740	0.18748	12.00000	2.03108	24.37294	0.18748
Sub-total	3947	1.00000	130.00000		130.00000	1.00000
DISTRIBUTORS:						
5171	110	0.14013	32.00000	0.67436	21.57962	0.14013
5172	515	0.65605	90.00000	1.12258	101.03185	0.65605
5984	160	0.20382	32.00000	0.98089	31.38854	0.20382
Sub-total	785	1.00000	154.00000		154.00000	1.00000
FLEETS:						
4225	2287	0.86563	151.00000	0.98029	148.02309	0.86563
4226	355	0.13437	20.00000	1.14885	22.97691	0.13437
Sub-total	2642	1.00000	171.00000		171.00000	1.00000
TOTAL	8096	4.00000	655.00000		655.00000	4.00000

Weights for Rural Data

SIC	UNIVERSE AVAILABLE	PROPOR-TION	ACTUAL SAMPLE	WEIGHT	WEIGHTED VALUE	WEIGHTED DISTRIB.
AGRICULTURE:						
0711	93	0.05326	43.00000	0.25022	10.75945	0.05326
072X	1653	0.94674	159.00000	1.20277	191.24055	0.94674
Sub-total	1746	1.00000	202.00000		202.00000	1.00000
INDUSTRIAL:						
2911	8	0.00849	7.00000	0.16742	1.17197	0.00849
1761	651	0.69108	101.00000	0.94425	95.36943	0.69108
3312	39	0.04140	2.00000	2.85669	5.71338	0.04140
3441	96	0.10191	10.00000	1.40637	14.06369	0.10191
3443	46	0.04883	8.00000	0.84236	6.73885	0.04883
3444	102	0.10828	10.00000	1.49427	14.94268	0.10828
Sub-total	942	1.00000	138.00000		138.00000	1.00000
DISTRIBUTORS:						
5171	160	0.26756	40.00000	1.05686	42.27425	0.26756
5172	267	0.44649	90.00000	0.78384	70.54515	0.44649
5984	171	0.28595	28.00000	1.61359	45.18060	0.28595
Sub-total	598	1.00000	158.00000		158.00000	1.00000
FLEETS:						
4225	551	0.87184	121.00000	1.04476	126.41614	0.87184
4226	81	0.12816	24.00000	0.77433	18.58386	0.12816
Sub-total	632	1.00000	145.00000		145.00000	1.00000
TOTAL	3918	4.00000	643.00000		643.00000	4.00000

APPENDIX D
ARB LPG Usage Study Questionnaire

Q10 Hello, I'm ____________ calling on behalf of the California Air Resources Board. I'm trying to locate the person in your company who would know the most about the volume of your propane shipments and transfers. Who would that person be?

Could you transfer me please?

Q20 Hello, I'm ____________ calling on behalf of the California Air Resources Board. We're conducting a study to determine the usage patterns of propane Gas in California. Are you the person in your company who would know the most about the volume of your propane shipments and transfers?

(IF YES, CONTINUE. IF NO, KEEP TRYING TO LOCATE CORRECT PERSON)

The Air Resources Board is doing a survey of propane refineries, wholesalers and users throughout the state in order to determine current usage patterns and transfer procedures of propane. The survey should only take a few minutes. Your responses will grouped together with others participating in the survey and your answers will remain completely anonymous and confidential.

Q30 First, I have a few questions to determine how you use propane.

Does your company refine propane or transport propane from refineries?

1 YES - REFINE PROPANE (SKIP TO Q70)
2 YES - TRANSPORT PROPANE (SKIP TO Q80)
3 NO

Q40 Is your company considered either a propane marketer or supplier?

1 YES (SKIP TO Q125)
2 NO

Q50 Does your company buy propane from either a propane dealer or wholesaler?

1 YES (SKIP TO Q125)
2 NO

Q60 When I ask you about the volume or frequency of your transfers or shipments, please tell me if that amount is per day, per week, per month or per year.

Q70 How many gallons of propane do you use at your facility?

1 DAILY:
2 WEEKLY:
3 MONTHLY:
4 YEARLY:
5 NONE
9 DON'T KNOW

Q80 How many gallons of propane are transferred onto transport trucks?

1 DAILY:
2 WEEKLY:
3 MONTHLY:
4 YEARLY:
8 DON'T SHIP VIA TRUCK
9 DON'T KNOW

Q93 How many gallons are filled [ ] using a bleeder valve?

1 ENTER # OF GALLONS:
2 PERCENTAGE:
9 DON'T KNOW

Q100 How many gallons of propane are transferred onto railcars?

1 DAILY:
2 WEEKLY:
3 MONTHLY:
4 YEARLY:
8 DON'T SHIP VIA RAIL
9 DON'T KNOW

Q113 And how many gallons are filled [ ] using a bleeder valve?

1 ENTER # OF GALLONS
2 PERCENTAGE:
9 DON'T KNOW

Q120 How many rail containers are loaded [ ] ?

1 NUMBER OF CONTAINERS:
9 DON'T KNOW

Q122 Besides transporting (and refining) propane, is your site involved in other areas of distribution? For instance, do you transfer propane to Bobtail trucks, or do you fill cylinders for customers?

1 YES
2 NO (SKIP TO 575)

Q125 Do you have any large on-site storage tanks of 1,500 gallons or more?

1 YES
2 NO (SKIP TO Q165)
9 DON'T KNOW

Q140 What is the water capacity of your large on-site storage tanks?

(ENTER AS MANY AS APPLY)
1 10,000 GALLONS
2 20,000 GALLONS
3 30,000 GALLONS
4 OTHER
5 DON'T KNOW
6 NO OTHER CHOICES

Q146 ENTER OTHER SIZES:

1.
2.
3.
4.
5.

Q151 When I ask you about the volume or frequency of your transfers or shipments, please tell me if that amount if per day, per week, per month or per year.

Q155 How many gallons of propane are transported to you?

1 DAILY:
2 WEEKLY:
3 MONTHLY:
4 YEARLY:
9 DONT KNOW

Q165 Are Bobtail trucks filled at your bulk plant?

1 YES
2 NO (SKIP TO 610)
9 DONT KNOW

Q170 Do you operate the same number of Bobtails year round?

1 YES
2 NO (SKIP TO Q190)
9 DON'T KNOW

Q180 And how many Bobtail trucks do you operate?

1 ENTER # OF BOBTAILS:
9 DON'T KNOW

Q190 How many Bobtail trucks do you normally operate, that is, during non-peak seasons?

1 ENTER #:
9 DON'T KNOW

Q200 How many trucks do you ADD during the peak season?

1 ENTER #:
9 DON'T KNOW

Q210 What is the water capacity of the Bobtail trucks loaded at your bulk plant? How many do you have of each?

ENTER #:
1 1,600 GALLONS:
2 1,800 GALLONS:
3 2,400 GALLONS:
4 2,600 GALLONS:
5 2,800 GALLONS:
6 3,000 GALLONS:
7 3,200 GALLONS:
8 OTHER
9 DON'T KNOW
A NO OTHER CHOICES
OTHER SIZE:

Q242 Are any of these Bobtails filled using a bleeder valve?

1 YES
2 NO
9 DON'T KNOW

Q243 What percentage of all your Bobtails are filled using a bleeder valve?

1 PERCENTAGE:
9 DON'T KNOW
(ASK IF Q170 = YES)

Q250 Do your average number of deliveries remain the same year round, or do you have a peak season?

1 # DELIVERIES REMAINS THE SAME
2 HAS PEAK SEASON (SKIP TO Q400)
9 DON'T KNOW

Q255 The next few questions are about the water capacity of your Bobtail trucks, and the average number of deliveries per day from each size Bobtail. Since your fleet is fairly large, it might be more convenient for you if we faxed you those particular questions. But, we would need you to fax the questionnaire back to us today.

We can, however, also do those questions over the phone. Which would you prefer? Have those questions faxed, or do them now over the phone?

1 FAX (SKIP TO Q276)
2 PHONE

Q256 INTERVIEWER: PLEASE USE ARB-LPG SURVEY FORM B. BE SURE THAT ALL BOBTAILS ARE ACCOUNTED FOR. DON'T FORGET TO ASK ABOUT PEAK AND NON-PEAK SEASON, IF APPLICABLE.

WHEN YOU HAVE COMPLETED THAT PART OF THE SURVEY ON PAPER, CONTINUE WITH THE CATI QUESTIONNAIRE.

ONCE YOU ARE OFF THE PHONE, BE SURE TO NOT THE OPEN NUMBER, RECORD NUMBER, COMPANY NAME AND LOCATION ON THE FORM.

Q257 In order to fax this part of the questionnaire to you, I need your name and fax number.

INTERVIEWER: ENTER FAX INFORMATION ON FAX COVER SHEET. PLEASE CONFIRM COMPANY NAME AND SPELLING OF RESPONDENT'S NAME.

I would like to ask you just a few more questions about other ways you may transfer propane.

ONCE YOU ARE OFF THE PHONE, MAKE SURE YOU GET THE OPEN NUMBER AND FILL OUT THE TOP PART OF THE FORM COMPLETELY.

GIVE THE COMPLETED FORM TO YOUR SUPERVISOR AS SOON AS YOU FINISH IT.

Q260 On an average day, how many times is each Bobtail loaded with propane and what is the average number of deliveries for each truck per day?

RELOADS: # DELIVERIES:
RELOADS: # DELIVERIES:
RELOADS: # DELIVERIES:
RELOADS: # DELIVERIES:
RELOADS: # DELIVERIES:

Q400 On an average day during your PEAK SEASON, how many times is each Bobtail loaded with propane and what is the average number of deliveries for each truck per day?

RELOADS: # DELIVERIES:
RELOADS: # DELIVERIES:
RELOADS: # DELIVERIES:
RELOADS: # DELIVERIES:
RELOADS: # DELIVERIES:

Q475 For how many months does your peak season last?

1 ENTER # OF MONTHS:
9 DON'T KNOW

Q500 On an average NON-PEAK SEASON day, how many times is each Bobtail loaded with propane and what is the average number of deliveries for each truck per day?

RELOADS: # DELIVERIES:
RELOADS: # DELIVERIES:
RELOADS: # DELIVERIES:
RELOADS: # DELIVERIES:
RELOADS: # DELIVERIES:

Q575 How many days a week does your business operate?

1 FIVE DAYS
2 SIX DAYS (REFINERIES ONLY)
3 SEVEN DAYS
9 DON'T KNOW

Q580 Do you have any storage tanks of less than 1,500 gallons?

1 YES
2 NO
9 DON'T KNOW

Q582 Do you use these tanks to fill other containers or vehicles?

1 YES
2 NO (SKIP TO 850)

Q585 What is the size of your propane storage tank or tanks? (ENTER AS MANY AS APPLY)

1 1-150 GALLONS
2 151-300 GALLONS
3 301-600 GALLONS
4 601-900 GALLONS
5 901-1500 GALLONS
6 DON'T KNOW
7 NO OTHER CHOICES

Q591 Does your company fill cylinders for customers, either on-site for delivery, or at the customer's site?

1 YES
2 NO (SKIP TO 630)
9 DON'T KNOW

Q595 How many cylinders are filled for customers?

1 DAILY:
2 WEEKLY:
3 MONTHLY:
4 YEARLY:
9 DON'T KNOW

Q625 How many gallons are used [ ] to fill these cylinders?

1 NUMBER OF GALLONS:
9 DON'T KNOW

Q630 Does your company operate propane fueled vehicles?

1 YES
2 NO (SKIP TO 670)
3 DON'T KNOW

Q631 Please give the type and number of propane vehicles you operate. (ENTER AS MANY AS APPLY)

1 # FORKLIFT VEHICLES:
2 # HIGHWAY VEHICLES:
3 # OTHER VEHICLES:
4 DONT KNOW
5 NO OTHER CHOICES

Q650 For your fleet of vehicles, how many gallons of propane are used?

1 DAILY:
2 WEEKLY:
3 MONTHLY:
4 YEARLY:
9 DONT KNOW

Q660 For your fleet of vehicles, how many transfers are made [ ]?

1 NUMBER OF TRANSFERS:
9 DONT KNOW

Q670 Do other users, besides your company, fill their propane vehicles and/or cylinders from your storage tank(s)?

1 YES
2 NO (SKIP TO 685)
9 DON'T KNOW

Q671 How many gallons of propane are transferred to other users' propane vehicles and/or cylinders?

1 DAILY:
2 WEEKLY:
3 MONTHLY:
4 YEARLY:
9 DONT KNOW

Q680 How many transfers do you make [ ] to these propane fueled vehicles and/or cylinders?

1 NUMBER OF TRANSFERS:
9 DONT KNOW

Q685 Besides propane vehicles, does your company fill cylinders or transfer propane for any use not described?

1 YES
2 NO (SKIP TO 800)
9 DON'T KNOW

Q686 For these uses, how many gallons are transferred?

1 DAILY:
2 WEEKLY:
3 MONTHLY:
4 YEARLY:
9 DON'T KNOW

Q699 For these uses, how many transfers are made [ ]?

1 ENTER # OF TRANSFERS:
9 DON'T KNOW

Q710 How many days a week does your business operate?

1 FIVE DAYS
2 SIX DAYS
3 SEVEN DAYS
9 DON'T KNOW

Q800 Next, I would like to ask some questions about the types of equipment and procedures your company uses to transfer propane Are you also the person in your company who would know about the equipment and procedures?

1 YES
2 NO

Q801 Who would be the person in your company who knows about your propane transfer equipment and procedures?

I would like to thank you for your cooperation. You've been very helpful. Could you transfer me to (REFERRAL NAME) please?

IF UNABLE TO REACH EQUIPMENT/PROCEDURES REFERRAL, PLEASE NOTE THE NAME ON CALLBACK SCREEN.

Q802 Hello, I'm _____________ calling on behalf of the Air Resources Board. We're conducting a study to determine the usage patterns of propane in California. Are you the person in your company who would know the most about the type of equipment and procedures that your company uses to transfer propane?

The Air Resources Board is doing a survey of propane refineries,wholesalers and users throughout the state in order to determine current usage patterns and transfer procedures of propane. The survey should only take a few minutes. Your responses will be grouped together with others participating in the survey and will remain completely anonymous and your answers confidential.

Q820 When filling cylinders, do you use a . . .

1 7141 MALE & FEMALE QUICK DISCONNECT FITTING
2 QUICK ACTING SHUT-OFF NOZZLE
3 A COMPACT ACME FILLER COUPLING
4 EXTENDED SAFETY FILLER COUPLING
5 SOMETHING ELSE
9 DON'T KNOW

Q821 Is an adapter used most of the time for this operation?

1 YES
2 NO
9 DON'T KNOW

Q822 What type of adapter is most commonly used? PLEASE DESCRIBE:

Q823 Of all the cylinders you fill, what percentage of those are filled using a bleeder valve?

1 PERCENTAGE:
9 DON'T KNOW

Q830 When transferring fuel on-site to propane fueled vehicles do you use a . . .

1 A COMPACT ACME FILLER COUPLING
2 A QUICK ACTING SHUT-OFF NOZZLE
3 A COMPACT ACME FILLER COUPLING
4 7141 MALE AND FEMALE QUICK DISCONNECT FITTING
5 SOMETHING ELSE
9 DON'T KNOW

SPECIFY:

Q832 Is an adapter used most of the time for this operation?

1 YES
2 NO
9 DON'T KNOW

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Q834 What type of adapter is most commonly used?

PLEASE DESCRIBE:

Q840 When transferring fuel for any other application, do you most often use a . . .

1 COMPACT ACME FILLER COUPLING
2 A QUICK ACTING SHUT-OFF NOZZLE
3 7141 MALE AND FEMALE QUICK DISCONNECT FITTING
4 EXTENDED SAFETY FILLER COUPLING
5 SOMETHING ELSE
9 DON'T KNOW

SPECIFY:

Q842 Is an adapter most of the time for this operation?

1 YES
2 NO
9 DON'T KNOW

Q844 What type of adapter is most commonly used?

PLEASE DESCRIBE:

Q845 For delivering propane from a Bobtail do you use a. . .
(READ LIST)

1 A QUICK ACTING SHUT-OFF NOZZLE
2 A COMPACT ACME FILLER COUPLING
3 EXTENDED SAFETY FILLER COUPLING
4 SOMETHING ELSE
9 DON'T KNOW

SPECIFY:

Q846 Is an adapter used most of the time for this operation?

1 YES
2 NO
9 DON'T KNOW

Q848 What type of adapter is most commonly used? PLEASE DESCRIBE:

Q820 Those are all of the questions that I have. I want to thank you very much for your time and cooperation.

APPENDIX E
LPG Residential Data Results

ESTIMATED MARKET PENETRATION OF
LIQUID PROPANE GAS FOR HOUSEHOLD HEATING
STATE OF CALIFORNIA BY COUNTY

COUNTY	ESTIMATED PERCENT DWELLINGS USING ANY LP GAS FOR HEATING	ESTIMATED # OF 1990 DWELLING UNITS	ESTIMATED DWELLING # OF UNITS USING ANY LP GAS
ALAMEDA	10.70	504109	53940
ALPINE	38.82	1319	512
AMADOR	27.78	12814	3560
BUTTE	15.51	76115	11805
CALAVERAS	45.45	19153	8705
COLUSA	17.60	6295	1108
CONTRA COSTA	9.97	316170	31522
DEL NORTE	7.70	9091	700
EL DORADO	30.73	61451	18884
FRESNO	18.87	235563	44451
GLENN	10.00	9329	933
HUMBOLDT	7.70	51134	3937
IMPERIAL	8.20	36559	2998
INYO	18.48	8712	1610
KERN	9.18	198636	18235
KINGS	33.33	30843	10280
LAKE	31.94	28822	9206
LASSEN	27.87	10358	2887
LOS ANGELES	4.90	3163343	155004
MADERA	30.60	30831	9434
MARIN	5.35	99757	5337
MARIPOSA	54.76	7700	4217
MENDOCINO	5.71	33649	1921
MERCED	17.48	58410	10210
MODESTO	9.28	4672	434
MONO	27.22	10664	2902
MONTEREY	13.60	121224	16486
NAPA	5.13	44199	2267
NEVADA	35.29	37352	13182
ORANGE	1.60	875072	14001
PLACER	10.73	77879	8356
PLUMAS	27.87	11942	3328
RIVERSIDE	8.20	483847	39675
SACRAMENTO	9.33	417574	39168
SAN BENITO	11.59	12230	1417
SAN BERNARDINO	8.20	542332	44471
SAN DIEGO	4.90	946240	46366
SAN FRANCISCO	9.70	328471	31862
SAN JOAQUIN	13.50	166274	22447
SAN LUIS OBISPO	9.29	90200	8380
SAN MATEO	9.80	251782	24675

ESTIMATED MARKET PENETRATION OF
LIQUID PROPANE GAS FOR HOUSEHOLD HEATING
STATE OF CALIFORNIA BY COUNTY

COUNTY	ESTIMATED PERCENT DWELLINGS USING ANY LP GAS FOR HEATING	ESTIMATED # OF 1990 DWELLING UNITS	ESTIMATED DWELLING # OF UNITS USING ANY LP GAS
SANTA BARBARA	10.33	138149	14271
SANTA CLARA	9.88	540240	53376
SANTA CRUZ	8.55	91878	7856
SHASTA	27.87	60552	16876
SIERRA	31.58	2166	684
SISKIYOU	27.87	20141	5613
SOLANO	11.81	119533	14117
SONOMA	9.07	161062	14608
STANISLAUS	11.24	132027	14840
SUTTER	16.55	24163	4000
TEHAMA	12.76	20403	2602
TRINITY	7.70	7540	581
TULARE	28.38	105013	29803
TUOLUMNE	32.18	25175	8101
VENTURA	1.10	228478	2513
YOLO	10.85	53000	5751
YUBA	15.51	21245	3295
TOTAL		11182882	929700

Globe and Angle Valves

Because of their sturdy maintenance-free design and construction, RegO globe and angle valves are preferred for LP-Gas and NH_3 service. Ductile iron bodies and stainless steel stems to resist corrosion. Spring loaded TFE V-type stem seals and BUNA N seats for long-lived leakproof service.

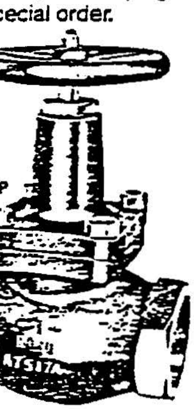
Ideal for all plant piping. Equipped with a ¼" NPT plug to facilitate use of vent valve or hydrostatic relief valve. Suitable for use up to 400 psig. T Series with teflon seats available on special order.

A7507AP

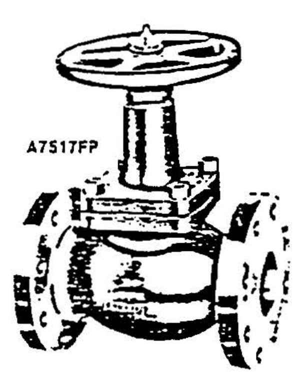
A7513AP

A7514AP

A7517AP



A7517FP

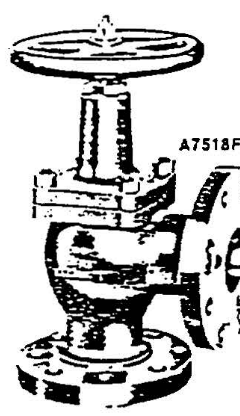


Inlet and Outlet Size	Part Number				Flow, GPM Propane @ 1 PSI Pressure Drop*	
	Buna N Seats		Teflon Seats **			
	Straight	Angle	Straight	Angle	Straight	Angle
½"FNPT	—	—	TA7034P	TA7034LP	10.0	14.8
¾"FNPT	A7505AP	A7506AP	TA7505AP	TA7506AP	12.0	17.7
1"FNPT	A7507AP	A7508AP	TA7507AP	TA7508AP	17.8	22.0
1¼"FNPT	A7509BP	A7510BP	TA7509BP	TA7510BP	36.5	54.0
1½"FNPT	A7511AP	A7512AP	TA7511AP	TA7512AP	43.0	55.5
1½" 300#ANSI R.F. Flange	A7511FP	—	—	—	46.0	—
2"FNPT	A7513AP	A7514AP	TA7513AP	TA7514AP	75.0	88.5
2" 300#ANSI R.F. Flange	A7513FP	A7514FP	TA7513FP	—	78.0	133
3"FNPT	A7517AP	A7518AP	TA7517AP	TA7518AP	197	303
3" 300#ANSI R.F. Flange	A7517FP	A7518FP	TA7517FP	—	197	303

* To obtain approximate flow at other than 1 PSI pressure drop, multiply flow in table by square root of pressure drop. Example: A7514FP @ 9 PSID = 133 x $\sqrt{9}$ = 399 GPM propane. For NH_3 flow, multiply by .90.

** Teflon seat on valves built to order.

A7518FP



Squibb-Taylor "Hi-Flo" Globe & Angle Valves

AL308 & 310 Globe
AL309 & 311 Angle
SCREWED BONNET

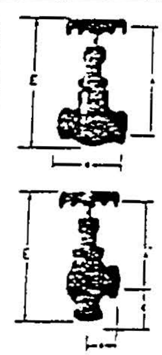
AL312, 314, 316 & 320 Globe
AL313, 316, 317 & 321 Angle
BOLTED BONNET

AL300 Series
3/4" thru 3" Sizes

AL308 through 321-"Hi-Flo" series-LP-gas or NH_3 liquid or vapor service, and other gases.

- Stainless steel stems
- Resilient swivel seats
- Ductile iron bodies
- Spring loaded chevron teflon packing

PART NO.	NPT SIZE	TYPE	PORT DIA.	APPROX. WT. LBS.	WOG WORKING PRESS.	DIMENSIONS A	B	C	D	E
AL308P	3/4"	Globe	3/4"	2-1/2 lbs.	400 lbs.	4-1/4"	—	—	3-5/8"	5-1/4"
AL309P	3/4"	Angle	3/4"	2-1/2 lbs.	400 lbs.	3-7/8"	1-11/16"	1-1/2"	—	5-9/16"
AL310P	1"	Globe	1"	3 lbs.	400 lbs.	4-3/4"	—	—	4-1/4"	6"
AL311P	1"	Angle	1"	3 lbs.	400 lbs.	3-1/2"	2"	2"	—	5-1/2"
AL312P	1-1/4"	Globe	1-1/4"	8 lbs.	400 lbs.	6-1/4"	—	—	5"	7-3/4"
AL313P	1-1/4"	Angle	1-1/4"	8 lbs.	400 lbs.	6"	2-1/2"	2-1/2"	—	8-1/2"
AL314P	1-1/2"	Globe	1-1/2"	8-3/4 lbs.	400 lbs.	6-1/4"	—	—	5-5/16"	7-7/8"
AL315P	1-1/2"	Angle	1-1/2"	8-1/2 lbs.	400 lbs.	6-1/8"	2-5/8"	2-5/8"	—	8-3/4"
AL316P	2"	Globe	2"	12-1/2 lbs.	400 lbs.	6-3/4"	—	—	6"	9"
AL317P	2"	Angle	2"	11-3/4 lbs.	400 lbs.	5-3/8"	3"	3-1/8"	—	8-1/2"
AL320P	3"	Globe	3"	41 lbs.	400 lbs.	11-5/16"	—	—	9"	14-5/16"
AL321P	3"	Angle	3"	37-1/4 lbs.	400 lbs.	10-1/4"	4"	4"	—	14-1/4"



Add to part no. for accessories desired: R — A1325 Hyd. Relief Valve—S.S. B — A1911 Bleed Valve—S.S. P — Plug (standard)

AL400
"Economy" Series
1/2" and 3/4"

PART NO.	NPT. SIZE	TYPE	DIMENSIONS A	B	C	D	E
AL410P	1/2"	Globe	3-3/8	—	—	3-1/2	—
AL411P	1/2"	Angle	3-3/8	1-1/2	1-3/4	—	5-1/8
AL412P	3/4"	Globe	3-3/8	—	—	3-1/2	—
AL413P	3/4"	Angle	3-3/8	1-1/2	1-3/4	—	5-1/8

Add to part no. for accessories desired:
R — A1325 Relief—S.S. B — A1911 Bleed—S.S. P — Plug (standard)

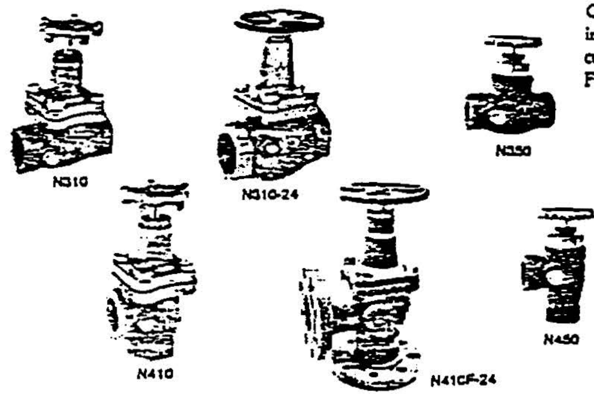
A1596R New!
Liquid Withdrawal Valve With Excess Flow Valve

Built-in hydrostatic relief valve relieves internally.

Inlet-1-1/4" M.NPT.
Outlet-1" F.NPT.
Closing Flow-49 GPM

Note: Squibb-Taylor AL407P & AL409P NH_3 Angle Valve. A1550P & A1597R NH_3 Multi-Purpose Valves are also available.
Reço SS8001 Hyd. Relief. A8016DP. A8017DLP. A8017DH. A7551P. A7550P NH_3 Valves are also available.

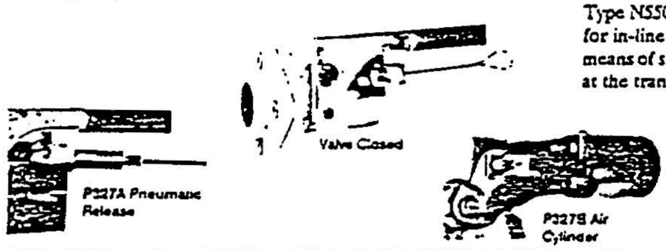
Globe and Angle Valves



Globe and angle valves are widely used at bulk plants to control gas flow in the piping system, at storage tanks, on trucks, and at pump compressors.
For TFE seat disc, add "T" to basic type number, e.g., N310T or N410T.

SERVICE	INLET & OUTLET CONNECTIONS	TYPE NUMBER				
		Heavy-Duty Version		Economy Version		
		Globe	Angle	Globe	Angle	
LP-Gas and NH3	1/2" FNPT	N301-04	N401-04	—	—	113.58
	3/4" FNPT	N301-06	N401-06	—	—	113.58
	1" FNPT	N301-08	N401-08	—	—	118.78
	1-1/4" FNPT	N310-10	N410-10	—	—	222.10
	1-1/2" FNPT	N310-12	N410-12	—	—	222.10
	2" FNPT	N310-16	N410-16	—	—	256.91
	3" FNPT	N310-24	N410-24	—	—	1000.12
	3" ANSI Flange	N310F-24	N410F-24	—	—	1581.48
LP-Gas	1/2" FNPT	—	—	N350-04	N450-04	72.72
	3/4" FNPT	—	—	N350-06	N450-06	72.72

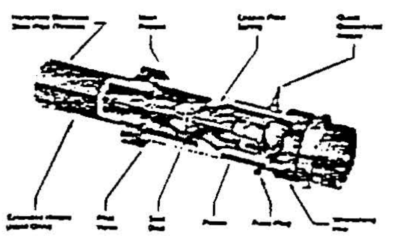
Emergency Shutoff Valves for Bulk Plants



Type N550 Snappy Joe emergency shutoff valves (ESVs) are designed for in-line installation, usually near a bulkhead. The valves provide a means of shutting off gas in the event of a hose rupture or piping breaks at the transfer area.

BODY SIZE	FLOW @ 1 PSIG DIFFERENTIAL	ACCESSORIES	TYPE NUMBER	
1-1/4" FNPT	125 gpm	P164B Cable Release P327A Pneumatic Release P327B Air Cylinder T11395 Control Valve	N550-10	407.41
2" FNPT	150 gpm		N550-16	746.91
3" FNPT	250 gpm		N550-24	1104.07

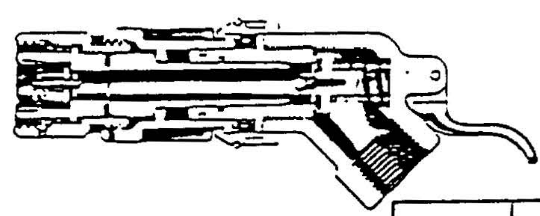
Emergency Shutoff Valves for Railroad Tank Cars



Series N560 Snappy Joe ESVs are designed expressly for attachment to the shutoff valves on railroad tank cars. Usually three N560s will be used, two on the liquid line and one on the vapor line.

NIPPLE LENGTH	SHUTOFF VALVE CONNECTION	HOSE CONNECTION	ACCESSORIES	TYPE NUMBER	
5.15"	2" MNPT	3-1/4" M. Acme	Type P560 Extension Coupling	N560-26	1560.62
1.30"				N561-26	1358.07

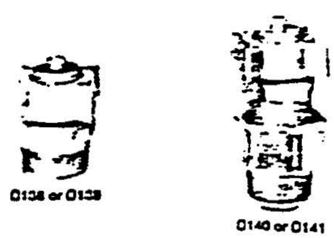
Hose End



Type N480 hose end valves are intended for quick opening and closing during bobtail truck deliveries of LP-gas or NH3.

INLET CONNECTION	OUTLET CONNECTION	TYPE NUMBER		
		LP-gas Service	NH3 Service	
1" FNPT	1-3/4" F. Acme	N480	—	338.15
1" FNPT	1-3/4" F. Acme	—	N481	327.55

Large Filler Valves

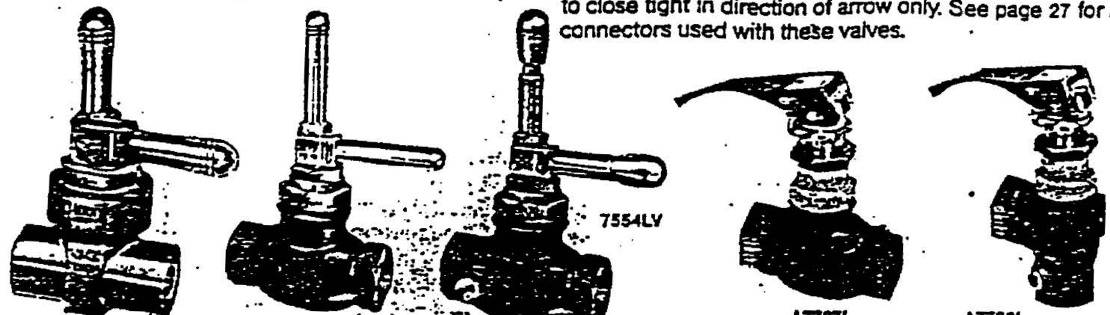


Type D138-D141 filler valves are used on ASME tanks found at bulk plants, as well as tanks used on bobtail and transport trucks.
For ring and chain assembly, order P167.

CONTAINER CONNECTION	LINE CONNECTION	BACK CHECK	FILLING CAP. (@ 10 psig diff. press.)	USE WITH BACK CHECK VALVE	TYPE NUMBER	
2" MNPT	2-1/4" M. Acme	Double	100 gpm	—	D140	236.42
2" MNPT	2-1/4" M. Acme	Single	105 gpm	G112 or G107	D138	145.58
3" MNPT	3-1/4" M. Acme	Double	225 gpm	—	D141	613.43
3" MNPT	3-1/4" M. Acme	Single	275 gpm	G104	D139	278.88

Quick-Acting Shut-Off Valves

Lever operation, for liquid transfer, especially hose end service. Designed to close tight in direction of arrow only. See page 27 for ACME connectors used with these valves.



7553T 7554S 7554LV A7707L A7708L

Hose Connection	Outlet Connection	Part Number Straight	Part Number Angle	Stem Seal Type	Locking Handle	Body Material	Flow GPM Propane @ 1 PSI Pressure Drop*
¼"F.NPT	¼"F.NPT	7553T	–	O-Ring	No	Forged Brass	1.95
¼"F.NPT	¼"F.NPT	A7553A	–	O-Ring	No	Ductile Iron	1.95
⅜"F.NPT	⅜"F.NPT	7553TA	–	O-Ring	No	Forged Brass	1.95
½"F.NPT	½"F.NPT	7553TB	–	O-Ring	No	Forged Brass	1.95
½"F.NPT	½"F.NPT	7553TC	–	O-Ring	No	Forged Brass	1.95
½"F.NPT	½"F.NPT	7554SA	–	Flange Ring	No	Ductile Iron	7.3
½"F.NPT	½"F.NPT	7554LAV**	–	Flange Ring	Yes	Ductile Iron	7.3
¾"F.NPT	¾"F.NPT	7554S	–	Flange Ring	No	Ductile Iron	11.5
¾"F.NPT	¾"F.NPT	7554LV**	–	Flange Ring	Yes	Ductile Iron	11.5
1"F.NPT	1"F.NPT	A7707L**	A7708L**	TFE V-Ring	Yes	Ductile Iron	A7707L 18.0 A7708L 22.0
1"F.NPT	1¾"F.ACME	–	A7797***	TFE V-Ring	Yes	Ductile Iron	16.0

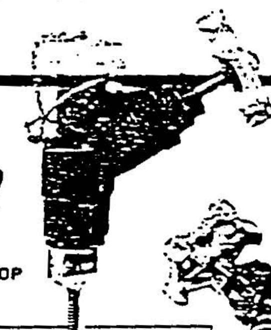
*To obtain approximate flow at other than 1 PSI pressure drop, multiply flow in table by square root of pressure drop. Example: 7554S @ 9 PSID = 11.5 x $\sqrt{9}$ = 34.5 GPM propane. For NH_3 flow, multiply by .90.
**Built in vent valve.
***Special hose end valve with built-in ACME adapter and minimum bleed.

A7797

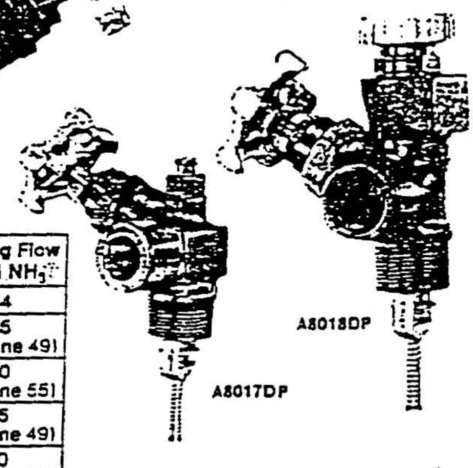
NH_3 Multipurpose Valves

A8017 series also used for liquid withdrawal in LP-Gas tanks. All include ¼" plugged (P suffix on part number) opening for attachment of pressure gauge or hydrostatic relief valve.

REGO



A8016DP



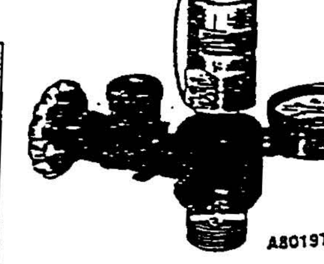
A8018DP A8017DP

Application	Part Number	Tank Connection	Outlet Connection	Hose Connection	Equalizer Valve	Closing Flow GPM NH_3
Filling*	A8016DP	1¼"M.NPT	–	1¾"M.ACME	N/A	44
Withdrawal	A8017DH**	1¼"M.NPT	1"F.NPT	–	Yes	45 (propane 49)
	A8017DP	1¼"M.NPT	1"F.NPT	–	No	50 (propane 55)
	A8017DLP	1¼"M.NPT	¾"F.NPT	–	No	45 (propane 49)
Filling/ Withdrawal	A8018DP	1¼"M.NPT	1"F.NPT	1¾"M.ACME	No	50 (propane 55)

*Also used for vapor equalization.
**Automatic back pressure check valve built into shut-off valve, designed to relieve hydrostatic pressure back to tank, eliminating need for separate hydrostatic relief valve.

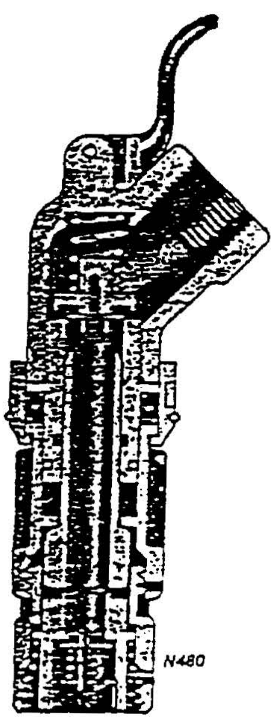
Application	Part Number	Tank Connection	Vapor Bleed Connection	Pressure Gauge* Order Separately	Pressure Relief Valve
Vapor bleed, fixed liquid level vent valve, pressure gauge and pressure relief valve	A8019T12.0 Cut dip tube to required length	1¼"M.NPT	¼"F.NPT	A8400	AA3130UA250 (Included)

*Not installed. Order separately.



A8019T

FISHER



N480

Type N480 & N481 Hose End Valves

Type N480 hose end valves are intended for quick opening and closing during bobtail truck deliveries of LP-gas or NH_3. The N480's unique design prevents it from being opened unless attached to a 1¾-inch acme filler valve at the tank. The 45° angle body configuration gives maximum handling ease during the transfer operation.

Increased Safety – Even with the operating lever in the open position, the N480 is designed to not open unless connected. This prevents accidental opening during hose reel-up or at other times.

Operational Ease – The fluted coupler permits quick attachment to the filler valve, and the operating lever is easy to reach for opening or closing.

Filler Hose Adaptor – Type N480 includes a filler hose adaptor (Type M570, page 33) which permits the hose end valve and hose to be removed from filler valves that fail to close. In such cases the M570 adaptor forms a seal on the filler valve by means of a back check valve.

Caution: Other brands of filler hose adaptors should not be used with the N480 because they could allow accidental opening of the valve while it is being carried.

NH_3 Service – Type N481 hose end valves (without the Type M570 filler hose adaptor) can be supplied for NH_3 applications.

Specifications

Weight: 5.3 lbs. (N480); 4.2 lbs. (N481)

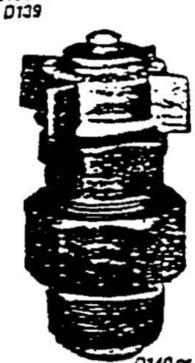
Body: Ductile iron

Coupling & Operating Lever: Stainless steel

Flow Tube: Carbon steel, TFE coated

INLET CONNECTION	OUTLET CONNECTION	TYPE NUMBER	
		LP-gas Service	NH_3 Service
1-in. FNPT	1¾-in. F. Acme	N480	N481

D138 or D139



D140 or D141

Large Filler Valves

Type D138-D141 filler valves are used on ASME tanks found at bulk plants, as well as tanks used on bobtail and transport trucks. Heavy-duty construction throughout gives extra strength for safe, rapid filling.

Thick walled bodies, along with formed seat retainers, provide top performance. Generous wrenching flats on both upper and lower body sections make installation easier and prevent damage to internal parts. The efficiently designed flow channel offers low resistance to flow for best pump and hose life.

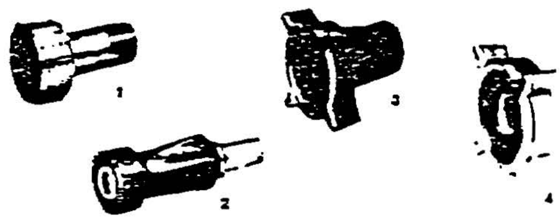
Leakage from the upper and lower body connection (D140 and D141) is prevented by a resilient gasket that is retained within a specially machined groove in the lower body. Internal parts are of stress relieved brass bar stock with the exception of stainless steel springs and stems.

Type D138 & D139 – Single-back check valves for use with either a supplementary back check valve (see "G" series above) or a manual shutoff valve (see page 17).

Type D140 & D141 – Conventional two-piece design valves with both an upper and lower back check. The bubble tight upper back check has a resilient seat for maximum service life. A metal-to-metal lower back check protects against loss of tank contents in the event of an accident and also permits removal of the upper body with the tank under pressure.

CONTAINER CONNECTION	LINE CONNECTION*	BACK CHECK	TYPE NUMBER	FILLING CAPACITY (At 10 psig differential pressure)	USE WITH BACK CHECK VALVE
2-in. MNPT	2¼-in. M. Acme	Double	D140	100 gpm	—
		Single	D138	105 gpm	G112 or G107
3-in. MNPT	3¼-in. M. Acme	Double	D141	225 gpm	—
		Single	D139	275 gpm	G104

Female Acme Filler Couplings



FEMALE ACME	OTHER CONNECTION	LENGTH	REF. NO.	TYPE NUMBER Brass	Steel	
1-1/4"	3/8" MNPT	3"	1	M100	—	25.41
1-1/4"	1/2" MNPT	2-1/2"	1	M101	—	23.66
1-3/4"	1/2" MNPT	3"	1	M110	—	27.53
1-3/4"	3/4" MNPT	3"	1	M111	—	18.88
1-3/4"	3/4" MNPT	3"	1	—	M631-6	51.96
1-3/4"	3/4" MNPT	6-1/8"	2	—	M635-6	73.26
1-3/4"	1" MNPT	3"	1	M112	—	23.83
1-3/4"	1" MNPT	3"	1	—	M631-8	34.40
1-3/4"	1" MNPT	7"	2	—	M635-8	58.14
2-1/4"	1-1/4" MNPT	3-1/4"	3	M120	—	73.58
2-1/4"	1-1/4" MNPT	3-1/4"	3	—	M121	89.29
3-1/4"	1-1/4" FNPT	1-1/2"	4	M442	—	92.98
3-1/4"	2" MNPT	3-3/4"	3	M130	—	100.49
3-1/4"	2" MNPT	3-3/4"	3	—	M133	82.47
4-1/4"	3" MNPT	4-1/2"	4	M664-24	—	282.17
4-1/4"	3" MNPT	4-1/2"	4	—	M634-24	225.88

Male Acme x Female NPT Adaptors

MALE ACME	FEMALE NPT	WASHER DWNG NO.	TYPE NUMBER Brass	Steel	
1-1/4"	1/4"	IE8122	M498-4/2	—	22.22
1-1/4"	3/8"		M498-4/3	—	27.20
1-1/4"	1/2"		M192	—	28.37
1-1/4"	3/4"		M193	—	48.37
1-3/4"	1/4"	IE8124	M210	—	12.35
1-3/4"	3/8"		M211	—	14.20
1-3/4"	1/2"		M212	—	15.31
1-3/4"	3/4"		M213	—	13.58
1-3/4"	3/4"		—	M526-6	31.85
1-3/4"	1"		M214	—	30.12
1-3/4"	1"		—	M526-8	63.46
2-1/4"	1"	IE8126	M502-12/8	—	57.28
2-1/4"	1-1/4"		M502-16/10	—	52.58
2-1/4"	1-1/4"		—	M522-16/10	66.58
2-1/4"	1-1/2"		M502-16/12	—	80.37
3-1/4"	1-1/4"	IE8128	M250	—	70.02
3-1/4"	2"		M252	—	60.48
3-1/4"	2"		—	M528-16	94.22
3-1/4"	3"		M508-24	—	172.96
3-1/4"	3"		—	M528-24	119.23
4-1/4"	3"	T10948	M509-24	—	228.52
4-1/4"	3"		—	M529-24	167.16

Female Acme Vapor Return Couplings

FEMALE ACME	MALE NPT	LENGTH	REF. NO.	TYPE NUMBER Brass	Steel	
1-1/4"	3/8"	2-1/2"	5	M140	—	17.16
1-1/4"	3/8"	6-1/4"	6	M394	—	125.81
1-1/4"	1/2"	2-1/2"	5	M141	—	17.16
1-1/4"	1/2"	2-1/2"	5	—	M640-4	51.58
1-3/4"	3/4"	3-3/8"	5	M150	—	49.29
1-3/4"	3/4"	7"	6	—	M646-6	129.38
1-3/4"	1"	3-1/4"	5	M151	—	40.12
1-3/4"	1"	3-1/4"	5	—	M641-8	77.53
1-3/4"	1"	7-3/8"	6	—	M646-8	129.38
2-1/4"	1-1/4"	3-3/8"	7	M160	—	98.17

Male Acme x Male NPT Adaptors

MALE ACME	MALE NPT	WASHER DWNG. NO.	TYPE NUMBER Brass	Steel	
1-1/4"	1/2"	IE8122	M498-4/2	—	22.22
1-1/4"	3/4"		M498-4/3	—	27.20
1-1/4"	1"		—	M520-8	70.00
1-3/4"	1/2"	IE8124	—	M521-4	48.27
1-3/4"	3/4"		M215	—	16.05
1-3/4"	3/4"		—	M521-6	31.80
1-3/4"	1"		M216	—	17.16
1-3/4"	1"		—	M521-8	24.07
1-3/4"	1-1/4"		M217	—	16.79
1-3/4"	1-1/4"		—	M521-10	32.98
2-1/4"	1-1/4"	IE8125	M233	—	43.70
2-1/4"	1-1/4"		—	M234	62.72
2-1/4"	1-1/2"		M502-12/8	—	57.28
2-1/4"	2"		M502-16/10	—	52.58
2-1/4"	2"		—	M522-16/10	66.58
3-1/4"	2"	IE8128	M503-16	—	88.17
3-1/4"	2"		—	M283	151.80
3-1/4"	3"		M282	—	136.91
3-1/4"	3"		—	M523-24	151.80
4-1/4"	3"	T10948	M504-24	—	222.38
4-1/4"	3"		—	M524-24	158.52

Male Acme Adaptors

MALE ACME	WASHER DWNG. NO.	TYPE NUMBER Brass	Steel	
1-1/4" x 1-1/4"	IE8122	M270	—	31.43
1-3/4" x 1-3/4"	IE8124	M273	—	37.10
1-3/4" x 1-3/4"	IE8124	—	M536-14	51.38
2-1/4" x 2-1/4"	IE8125	—	M536-18	69.36
3-1/4" x 3-1/4"	IE8125	—	M536-28	122.10
4-1/4" x 4-1/4"	T10948	—	M538-34	206.18

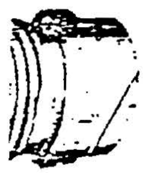
O-Rings for Male Acme Adaptors

The 2-1/4" and 3-1/4" male adaptors listed above can be supplied with replacement O-rings instead of the conventional washer type of gasket. O-rings give tighter seal in most cases than the washers.

DESCRIPTION	TYPE NUMBER	
O-ring for 2-1/4" Adaptors	T12855 T0012	3.90
O-ring for 3-1/4" Adaptors	1H2317 06562	2.08

Male Acme x Male NPT Adaptors—Brass/Steel

Part No.	Description
5763C	1-1/4" Acme x 1/2" MNPT
5763D	1-1/4" Acme x 3/4" MNPT
A215	1-3/4" Acme x 3/4" MNPT
A216	1-3/4" Acme x 1" MNPT
A217	1-3/4" Acme x 1-1/4" MNPT
A5765C	1-3/4" Acme x 1/2" MNPT (Steel)
A5765E	1-3/4" Acme x 1" MNPT (Steel)
A5765F	1-3/4" Acme x 1-1/4" MNPT (Steel)
A233	2-1/4" Acme x 1-1/4" MNPT
A502A	2-1/4" Acme x 1-1/2" MNPT
A502B	2-1/4" Acme x 2" MNPT
A503	3-1/4" Acme x 2" MNPT
A503A	3-1/4" Acme x 2-1/2" MNPT
A262	3-1/4" Acme x 3" MNPT
A5763H	3-1/4" Acme x 2" MNPT (Steel)
A5771X	4-1/4" Acme x 3" MNPT (Steel)



Male Acme x Female NPT Adaptors—Brass/Steel

Part No.	Description
5762A	1-1/4" Acme x 1/4" FNPT
A4988	1-1/4" Acme x 3/8" FNPT
5762C	1-1/4" Acme x 1/2" FNPT
5762D	1-1/4" Acme x 3/4" FNPT
A210	1-3/4" Acme x 1/4" FNPT
57648	1-3/4" Acme x 3/8" FNPT
A212	1-3/4" Acme x 1/2" FNPT
A213	1-3/4" Acme x 3/4" FNPT
A214	1-3/4" Acme x 1" FNPT
A5764W	1-3/4" Acme x 3/8" Bolt (Steel)
A5764D	1-3/4" Acme x 3/4" FNPT (Steel)
A502A	2-1/4" Acme x 1" FNPT
A502B	2-1/4" Acme x 1-1/4" FNPT
A502C	2-1/4" Acme x 1-1/2" FNPT
A252	3-1/4" Acme x 2" FNPT
A250	3-1/4" Acme x 1-1/4" FNPT
A255	3-1/4" Acme x 1-1/2" FNPT
5768J	3-1/4" Acme x 2-1/2" FNPT
M508-24	3-1/4" Acme x 3" FNPT
A5763H	3-1/4" Acme x 2" FNPT (Steel)

Male Acme Coupler

Part No.	Description
A270	1-1/4" Acme x 1-1/4" Acme
A273	1-3/4" Acme x 1-3/4" Acme
5767M	2-1/4" Acme x 2-1/4" Acme
5769M	3-1/4" Acme x 3-1/4" Acme

Acme Caps & Plugs

Female Acme Caps

Part No.	Description
1875-3A	1-1/4" Acme Cap
1850-3	1-3/4" Acme Cap
1850-10	1-3/4" Acme Cap with strap
A431	2-1/4" Acme Cap & Chain—(Brass)
M432	2-1/4" Acme Cap (Steel)
A441	3-1/4" Acme Cap & Chain—(Brass)
M443	3-1/4" Acme Cap & Chain—(Steel)

Plastic Plugs With Chains*

Part No.	Description
A178	1-1/4" M Acme
A179	1-3/4" M Acme
A180	2-1/4" M Acme
A181	3-1/4" M Acme

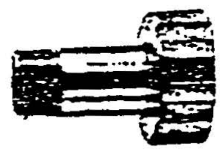
*5765PN Brass 1¼" Acme Plug & Chain is also available.

Thread Adaptors

Male Acme x Female Acme Swivel

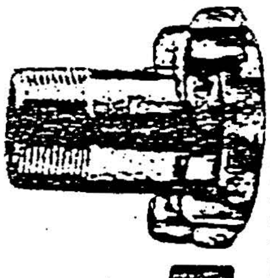
Part No.	Male Acme	Female Acme
MSA301	1-3/4"	2-1/4"
MSA302	1-3/4"	3-1/4"
M623 (Steel)	3-1/4"	4-1/4"

Acme Filler Couplings



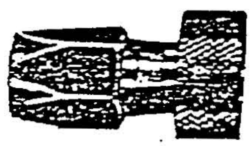
Female Acme Filler Couplings

Part No.	Description
A698A	1-3/4" Acme x 3/4" MNPT
A698B	1-3/4" Acme x 1" MNPT
A698C	1-3/4" Acme x 1/2" MNPT
A3175	1-3/4" Acme x 3/4" MNPT (Steel)
A3175A	1-3/4" Acme x 1" MNPT (Steel)
M100	1-1/4" Acme x 3/8" MNPT



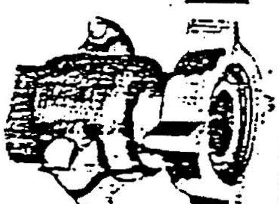
Female Acme Filler Couplings

Part No.	Description
A120	2-1/4" Acme x 1-1/4" MNPT
A130	3-1/4" Acme x 2" MNPT
A3185	2-1/4" Acme x 1-1/4" MNPT (Steel)
A3195	3-1/4" Acme x 2" MNPT (Steel)



Female Acme Filler Couplings By Reuseable Hose Couplings

Part No.	Description
101	1-3/4" Acme x 1/2" I.D. Hose
102S	1-3/4" Acme x 3/4" I.D. Hose
103S	1-3/4" Acme x 1" I.D. Hose



Female Acme Filler Couplings By Clamp Type Hose Coupling

Part No.	Description
M3162-12S	1-3/4" Acme x 3/4" I.D. Hose
M3162-32S	3-1/4" Acme x 2" I.D. Hose

Extended Safety Female Acme Filler Couplings—Steel

Part No.	Description
A1130F	1-3/4" Acme x 3/4" MNPT
A1131F	1-3/4" Acme x 1" MNPT
A7575L5	1-3/4" Acme x 1-1/4" MNPT
A7575L2	1-3/4" Acme x 1/2" MNPT

Acme Vapor Couplings

Vapor Equalizing Couplings

Part No.	Description
A798A	1-1/4" Acme x 3/8" MNPT
A798B	1-1/4" Acme x 1/2" MNPT
3181	1-3/4" Acme x 3/4" MNPT
3181A	1-3/4" Acme x 1" MNPT
A160	2-1/4" x 1-1/4" MNPT

Extended Safety Vapor Equalizing Coupling

Part No.	Description
A7571L	1-1/4" Acme x 3/8" MNPT
A7571LA	1-1/4" Acme x 1/2" MNPT
A7571LB	1-1/4" Acme x 3/4" MNPT

McTIER SUPPLY COMPANY

ACME Check Connectors for Lift Trucks

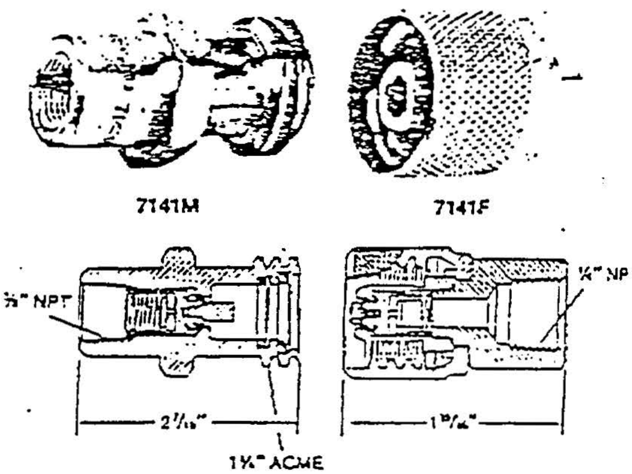
7141F and 7141M

These brass connectors are especially designed to join the carburetor fuel line to the service valve on lift truck cylinders. Sturdy, long lasting ACME threads allow quick, hand-tight assembly that provides for quick and simple cylinder replacement. Back checks automatically close in each connector when disconnected.

The 7141M couples directly to the service valve. An integral O-ring is designed to seal before the internal check opens, aiding in product loss prevention. A gasket at the ACME thread is a secondary seal when the connectors are tightened together. The connector fits RegO lift truck cylinder filling adapters for fast, convenient filling.

The 7141F accepts fuel line adapter and couples directly to the 7141M. The O-ring seal in the 7141M is designed to seal before the internal check opens to allow product to pass through the connection. The knurled coupling eases threading and the ACME threads provide rapid, effortless make-up, even against LP-Gas pressure.

NOTE: Refer to the "Cylinder and Service Valves" section of the L-500 catalog for additional information.



Ordering Information

RegO Part Number	Application	Inlet	Outlet	Accessories* Protective Cap Rubber	Brass
7141M	Service Valve	⅜" F.NPT	1¾" M. ACME	7141M-40	7141FP
7141F	Fuel Line	1¾" F.ACME	1¼" F.NPT	—	—

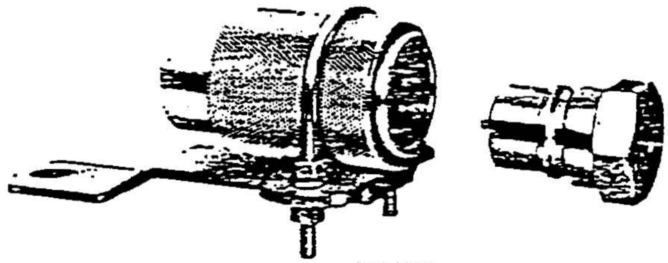
* Recommended to minimize foreign material entering valves which could result in leakage.

Pull-away Valves

Pull-away valves provide protection against gas escape at motor fuel dispensers should a vehicle pull away with the hose connected. Back checks in both halves are designed to close when a tension load of approximately 75 lbs. causes the pull-away valve to separate.

For Filling Rates*	Inlet and Outlet Size	Part Number
Up to 16 GPM	¾" F. NPT	A2141A6
Up to 30 GPM	1" F. NPT	A2141A8

*Based on 10 PSI pressure drop propane.



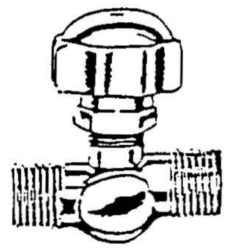
A2141A8

Needle Valves

Needle valves are used for small inexpensive shut-off and provide accurate throttling in torch and small burner applications.

Inlet Connection	Outlet Connection	Part Number
¼" M.NPT	¼" M.NPT	1224WA
9/16"-18 L.H.	⅛" M.NPT	1314WA
9/16"-18 L.H.	¼" M.NPT	1316WA
¼" M.NPT	9/16"-18 L.H.	1318WA

1224WA

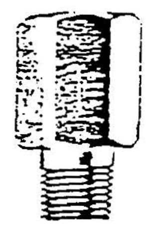


(Gritrol) Fuel Line Filters

Intended for use in liquid fuel line to trap foreign material which otherwise might damage precision parts in the carburetion system.

Inlet Connection NPT	Outlet Connection NPT	Part Number
¼" Female	¼" Male	12802
½" Male	½" Female	12804

12802



Vent Valves

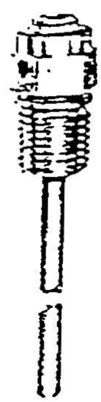
(Fixed Liquid Level Gauges)

REGO

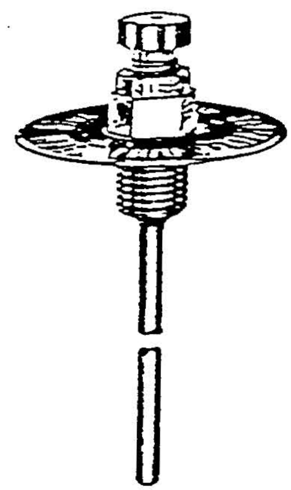
These vent type gauging devices are used in the filling operation of containers to indicate when the maximum permitted filling level has been attained. Gauges with or without tubes are available to fit the configuration of the container. All valves have 1/4" M.NPT tank connection.

Part Number	Instruction Plate	Dip Tube	Actuation	Material
3165	No	Optional*	Hex head	Brass
3165H	No		5/16" Allen	
3165P	Yes		Hex head	
TA3169F12.0	No	12"	Tee Handle	Stainless body Teflon seat disc Steel dip tube
TSS3169	No	No	Tee Handle	Stainless body Teflon seat disc

*When ordering valves with dip tube attached, add an F to the part number and specify "V" length in inches and tenths following the F. Example 3165HF05.6 for a 5.6 inch dip tube attached to a 3165H. Dip tubes are available in following inch lengths: 4.7, 5.6, 6.9 and 10.6



3165HF12.0



3165FP12.0

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