# ANALYSIS OF REFINERY SCREENING DATA

Health and Environmental Affairs Department
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STEP
Strategies for Today's Environmental Partnership

American Petroleum Institute

American Petroleum Institute

STEP Strategies for Today's Environmental Partnership

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# Analysis of Refinery Screening Data

**Health and Environmental Affairs Department**

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# ABSTRACT

This report presents the findings and recommendations of a study of fugitive emissions from piping components (valves, flanges, etc.) at seven Los Angeles California refineries over a period of five and one-half years. These screening measurements, taken to determine the estimated fugitive emissions of volatile organic compounds (VOC) from those refineries, were collected and analyzed. These screening measurements comprise the detection portion of a leak detection and repair (LDAR) program designed to reduce fugitive emissions from components in process unit piping. The study was conducted to determine whether a more cost effective LDAR protocol could be developed. The study was expected to clarify the cause(s) of leaks by identifying the repeat leakers and high-rate leakers and by investigating the design and operational characteristics of those leaking components. High leakers (components screening $\geq$10,000 ppmv) were found to occur randomly and repeat leakers (components screening $\geq$ 1,000 ppmv more than once within a year) were negligible. *This finding indicates that there is not an easily identifiable cohort of leakers within the population of refinery components subject to LDAR.* Overall, *only 0.13 percent of the components were high leakers, but they accounted for 92 percent of the reducible VOC emissions.* Based on the current findings, a leak detection protocol that would concentrate on locating high rate leakers may be more cost effective than the current practice of monitoring all components.

TABLE OF CONTENTS

# LIST OF FIGURES

LIST OF FIGURES (Continued)

## LIST OF FIGURES (Continued)



## LIST OF TABLES

# EXECUTIVE SUMMARY

This report presents the findings and recommendations of a study of fugitive emissions from piping components (valves, flanges, etc.) at seven Los Angeles California refineries over a period of five and one-half years. Screening measurements, taken to determine the estimated fugitive emissions of volatile organic compounds (VOC) from those refineries, were collected and analyzed. These screening measurements comprise the detection portion of a leak detection and repair (LDAR) program designed to reduce those fugitive emissions from components in process unit piping. The study was conducted to determine whether or not a more cost effective LDAR protocol could be developed. Data were analyzed to determine if certain component designs or component applications (e.g., gate valves vs. globe valves, different process units, or different frequencies of actuation) tend to produce more high leakers (i.e., screening $\geq$ 10,000 ppmv) or repeat leakers (i.e., screening $\geq$ 1,000 ppmv more than once in a four-quarter period). The data were analyzed to identify the repeat leakers and high leakers by component type, generic process unit, and refinery, as well as on an aggregated basis for all refineries.

## BACKGROUND

Since the early 1980s, the U. S. Environmental Protection Agency (USEPA) has supported the development and eventually required the implementation of LDAR programs under its New Source Performance Standards. Also, many states have adopted LDAR as part of their State Implementation Plan. As the result of the adoption of the National Emission Standards for Hazardous Air Pollutants from Petroleum Refineries (40 CFR Part 63 Subpart CC), known more commonly as "Refinery MACT Rule" (MACT is an acronym for Maximum Available Control Technology), every U.S. refinery is required to implement LDAR for the processes and streams described in this rule.

The LDAR procedure (EPA Method 21) involves placing an instrument probe at the surface of a component seal and measuring the VOC concentration as the probe is moved over the surface of the seal. A correlation has been established relating the mass rate of VOC leaking from the component to the maximum concentration measured by the instrument. EPA and some state agencies have established the level of VOC concentration which determines a *leak*. If the concentration of a component is above the level defining a leak, the component must be repaired or replaced to reduce the concentration to an acceptable level. The leak definition can vary from a VOC concentration as high as 10,000 ppmv to as low as 100 ppmv depending on the type of component and the specific regulation.

The screening measurement data used in this study came from the LDAR program required by South Coast Air Quality Management District (SCAQMD), the local air agency in the Los Angeles California area. There is a SCAQMD requirement to screen all accessible components (valves, flanges, etc.) quarterly. The leak definition in the SCAQMD regulation is 1,000 ppmv. Five and a half years of screening data, comprising 11.5 million values, were analyzed in this study.

## OBJECTIVE

The objective of this study was to provide guidance for conducting LDAR programs in a more cost effective manner. Information was obtained to help determine (1) the design and operational characteristics that influence emissions and (2) whether a focused LDAR program could be more cost effective while reducing emissions than the current method of monitoring all system components.

## TECHNICAL APPROACH

All available screening data, compiled under SCAQMD Rule 1173, were obtained for the ARCO, Chevron, Mobil, Shell[1], Texaco, Ultramar, and Unocal[1] refineries. The data were processed to standardize the file formats and entered into a Microsoft®Access™ database. Queries were run to find:

- Repeat Leakers - Screening $\geq$ 1,000 ppmv more than once in a four-quarter period.
- High Leakers - Screening $\geq$ 10,000 ppmv.
- Process-by-Process Variations.
- Refinery-by-Refinery Variations.
- Mean Time Between Failures - a failure was defined as screening $\geq$ 500 ppmv.

Finally, by analyzing the above results, recommendations were made regarding a more cost effective approach to LDAR than the current practice of monitoring all components.

## RESULTS

It was found that 84 percent of the estimated refinery hourly emissions were from high leakers (screening $\geq$ 10,000 ppmv) which were only 0.13 percent of the total number of components. The average emission rate for these high leakers was approximately 1,000 times higher than the overall average for all components. Of the remaining 16 percent of the estimated emissions, 9.5 percent were from non-leakers

[1] Shell refinery was acquired by Unocal in 1994. The Unocal refinery and the former Shell refinery were acquired by Tosco in 1997 prior to the completion of this report.

(screening ≤ 100 ppmv), which constitute 99 percent of the components, and whose estimated emissions are based primarily upon an EPA specified, zero default, value for components that screen at the background concentration. This leaves approximately 6.5 percent of the total emissions due to leakers in the range of 100 ppmv to 9,999 ppmv. Thus, the high leakers account for 92 percent of the controllable (i.e., non-default zero) emissions. In comparison, in 1980 an EPA refinery investigation found that, on an equivalent basis, 4 percent of the components were high leakers, *30 times higher than the percentage observed in this study* (Radian 1980).

Relatively few components were found to be repeat leakers. Only 5.4 percent of all emissions were from repeat leakers. It was suspected that there would be certain chronic leakers, for reasons of design, operation, or maintenance, which would repeatedly exceed the leak definition. This was not observed. Instead, the high leakers were found to occur randomly. No systematic explanation for their occurrence was apparent.

There were noticeable differences when comparing the data from the different refineries. However, the overall percentage of high leakers (screening ≥ 10,000) in any refinery was less than 0.2 percent.

The three processes with the highest mass emissions were (1) catalytic reforming, emitting 13 percent of total emissions; (2) alkylation, emitting 10 percent; and (3) crude distillation, 7.5 percent. When normalized, based on the number of components in the process, isomerization units had the highest emissions per component. On the other hand, thermal crackers, sulfur plants, vacuum distillation towers, polymerization units, sour water strippers, MTBE plants, and flare systems had negligible emissions.

Data from one refinery indicated that components in liquefied petroleum gas (LPG) service tend to account for more than half of the high leakers and most of the repeat leakers. This refinery was the only one that provided a description of the stream fluid in the component. Therefore, this observation could not be confirmed for other locations.

## CONCLUSIONS

For practical purposes, this study indicates that there is no easily identifiable cohort of leakers within the population of refinery components subject to LDAR. The percentage of repeat leakers is small in absolute terms and the percentage of components, with more than two leaks within a year, is negligible.

A more cost effective LDAR program may be one that emphasizes the location and repair of high leakers rather than screening all components. Currently, LDAR programs involve extensive screening inspections of what are found to be non-leaking components. Considering that high leakers account for 92 percent of the controllable hourly emissions and that the average hourly emission rate is a thousand times greater for high leakers than that for the average component, a focus on the detection and repair of only the high leakers would reduce emissions more cost effectively than an inspection of all components.

# Section 1
# INTRODUCTION

This report presents the findings and recommendations of a study of fugitive emissions from piping components (valves, flanges, etc.) at seven Los Angeles California refineries over a period of five and one-half years. Screening measurements, taken to determine the estimated fugitive emissions of volatile organic compounds (VOC) from those refineries, were collected and analyzed. These screening measurements comprise the "detection" portion of a leak detection and repair (LDAR) program designed to reduce fugitive emissions from components in process unit piping. The study was conducted to determine whether a more cost effective LDAR protocol could be developed.

## BACKGROUND

Since the early 1980s, the U.S. Environmental Protection Administration (EPA) has supported the development, and eventually required the implementation, of LDAR programs as part of it New Source Performance Standards. As the result of the adoption of the National Emission Standards for Hazardous Air Pollutants from Petroleum Refineries (40 CFR Part 63 Subpart CC), known more commonly as "Refinery MACT Rule" (MACT is an acronym for Maximum Available Control Technology), every U.S. refinery is required to implement LDAR for the processes and streams described in this rule.

The LDAR procedure, known as EPA Method 21, involves placing a screening instrument probe on the surface of a joint seal in the component (or within 1 cm of the seal for rotating equipment) and measuring the VOC concentration, expressed in parts per million by volume (ppmv), as the probe is moved over the entire exterior surface of the component joint. Through many tests, a correlation has been established relating the mass rate of VOC leaking from the component to the ppmv value measured by the screening instrument. EPA, state and local environmental agencies have established levels of VOC concentration which determine that the component has a *leak*. If the measured ppmv level of a component is above the level defined as indicating a leak, the component must be repaired or replaced to reduce the leak to below the acceptable level. The leak definition level of VOC concentration can vary from a high of 10,000 ppmv, as specified in EPA's New Source Performance Standards (NSPS) to as low as 100 ppmv required by some state and local agencies.

The screening measurement data, used in this study, came from the LDAR program required by South Coast Air Quality Management District (SCAQMD), the local air agency in the Los Angeles California area. SCAQMD has a regulation requiring an LDAR program (Rule 1173 - adopted in 1989) which was implemented in 1991. At that time, refineries began recording their screening data and submitting them to SCAQMD each quarter. There is a general requirement to screen all accessible components (valves, flanges, screwed connections, pumps, compressors, and other components with sealed joints) quarterly. The leak definition adopted by SCAQMD is 1,000 ppmv. Approximately 70 percent of the screening data for 22 quarters, over 11 million values, were compiled for this study. Over one million components are screened each quarter in the seven major Los Angeles refineries included in this study.

Because of the great expense involved in performing this screening effort, the American Petroleum Institute (API) was interested in learning whether a more cost effective approach to LDAR could be developed rather than screening every component each quarter. Past experience shows that in these LDAR programs, approximately 99 percent of the components are already in compliance. If efforts could be redirected to only those components that leak more frequently or at higher rates, greater emission reductions may be achieved at lower costs.

## OBJECTIVE

The objective of this program, then, was to provide guidance for conducting LDAR programs in a more cost effective manner. Information was obtained to characterize the leak rate distribution among various components, processes and refineries to help determine

(1) the design and operational characteristics that influence emissions and

(2) whether a focused LDAR program could be more cost effective at reducing emissions than the current method of monitoring all system components.

## APPROACH

All available screening data, compiled under SCAQMD Rule 1173, were obtained for the ARCO, Chevron, Mobil, Shell[2], Texaco, Ultramar, and Unocal[2] refineries. The data were processed to standardize the file formats and entered into a Microsoft® Access™ database allowing the following queries to be run:

[2] Shell refinery was taken over by Unocal. The Unocal refinery and the former Shell refinery were acquired by Tosco in 1997 prior to the completion of this report in 1994.

- Repeat Leakers, by quarter, for components leaking 2, 3, and 4 times in the preceding four quarters (i.e., chronic leakers). Runs were made for "leak" definitions of greater than 500, 1,000, 10,000, 50,000, and 100,000 ppmv respectively. Total number of components, percent of total components and percent of total emissions were determined for each category.

- High Leakers, by quarter, for components screening ≥ 10,000 ppmv. Total count by component type, percent of total components and percent of total emissions were determined.

- Process-by-Process Variation, average for all quarters, comparing repeat (≥ 1,000 ppmv) and high (≥ 10,000 ppmv) leakers for valves, connectors, pumps and an aggregate of all components.

- Refinery Specific Data, by quarter, comparing overall average emissions and comparing percentage of components that were high leakers (≥ 10,000 ppmv), repeat leakers (≥ 1,000 ppmv) and all leakers (≥ 1,000 ppmv). (Over 99 percent of the components do not leak; i.e., screen below 1,000 ppmv.)

- Finally, determine a more cost-effective approach to LDAR than the current practice of monitoring all components.

## REPORT ORGANIZATION

Section 2 presents the data collection and processing effort; Section 3 presents the data summaries and the findings those data reveal. Section 4 presents a discussion of those findings with regard to more cost effective LDAR concepts and presents some suggestions for further work.

# Section 2
# DATA FROM THE LOS ANGELES REFINERIES

The screening data were obtained for seven Los Angeles refineries; ARCO, Chevron, Mobil, Shell, Texaco, Ultramar, and Unocal. As the data were collected and processed, several preliminary analyses were conducted to determine whether the data were sufficient to reach a valid conclusion or whether additional data would be needed. This section discusses the quantity and quality of those data. Ultimately, 11.5 million screening runs were entered into the program database.

## ACQUISITION

Initially, permission was obtained from the seven refineries to acquire their screening data from SCAQMD. The data requested were for the first quarter of 1992 through the second quarter of 1995. Approximately 50 percent of the requested data were obtained from SCAQMD. The refineries were then requested to provide as much of the missing data as possible. The results of the initial data collection effort are summarized in Table 2-1. It was apparent that the data collection and reporting by the refineries and the data storage by the agency improved with time. Therefore, after SCAQMD received the next annual data submittal from the refineries, another request for data was made. As shown in Table 2-1, the data collection for the last two quarters of 1995 and the first two quarters of 1996 were complete. The total count of components in each category increased each quarter. For example, in the third quarter of 1994 (the first quarter for which data were available for all seven refineries) approximately 780,000 component screening events were reported. In the second quarter of 1996, there were just over one million screening events reported. It was not apparent whether this growth in reported screenings reflected more thoroughness in the screening process or whether there was indeed an increase in the number of components in the plants. This study was conducted over a period when these refineries were undergoing modifications to produce *clean* fuels. Therefore, it is likely that an actual growth of components occurred although more specific information is not available.

The early data had many refinery-to-refinery differences in their file formats. Generally, the data included were component identification number, component type (valve, connector, etc.), service type (gas or light liquid), date of testing and screening value in ppmv. Some refineries had a process code which was interpreted for the project by the refinery staff. One refinery even had a word description of the product in the stream (e.g., gas oil, propane, crude oil). However, as SCAQMD worked to achieve a more uniform format for the data submittal, less information was submitted, although in more readily

processible form. The last four quarters of data had no process or stream identification. However, in many cases, it was possible to recover the process information by comparing the component ID numbers from previous years.

Table 2-1. Summary of the Screening Data Collection Effort
*(Overall - 108 Quarters of good data of 154 possible = 70%)*

| Yr | Qtr | REFINERY DESIGNATION | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | G |
| 91 | 1 | X | X | ♎ | ♦ | ■ | ■ | ■ |
| 91 | 2 | X | X | ♎ | ♦ | X | ■ | X |
| 91 | 3 | X | X | ♎ | ♦ | X | X | X |
| 91 | 4 | X | X | ♎ | ♦ | ■ | ■ | ■ |
| 92 | 1 | X | X | ♎ | ♦ | ■ | X | ■ |
| 92 | 2 | X | X | ♎ | ♦ | ■ | X | ■ |
| 92 | 3 | X | X | ♎ | ♦ | ■ | X | ■ |
| 92 | 4 | X | X | ♎ | ♦ | X | ■ | ■ |
| 93 | 1 | ■ | X | X | X | ■ | X | ⌘ |
| 93 | 2 | ■ | X | X | X | ■ | X | ⌘ |
| 93 | 3 | ■ | X | X | X | ■ | X | ⌘ |
| 93 | 4 | ■ | X | X | X | X | X | ⌘ |
| 94 | 1 | X | X | X | X | ■ | X | ■ |
| 94 | 2 | X | X | X | X | ■ | X | ■ |
| 94 | 3 | X | X | X | X | X | X | X |
| 94 | 4 | X | X | X | X | X | X | X |
| 95 | 1 | X | X | X | X | X | X | X |
| 95 | 2 | X | X | X | X | X | X | X |
| 95 | 3 | X | X | X | X | X | X | X |
| 95 | 4 | X | X | X | X | X | X | X |
| 96 | 1 | X | X | X | X | X | X | X |
| 96 | 2 | X | X | X | X | X | X | X |

X --- Screening data available in Microsoft®Access™ database
■ --- Indicates that data were not available at the refinery or the SCAQMD
♎ --- Refinery indicated that its data were not reliable, therefore were not used.
♦ --- Data received but corrupted. Refinery indicated that they had no other data.
⌘ --- Data received had an ID system different from the that for other data. Data were not used because of the extensive effort to convert the ID code.

## PROCESSING

The first step in data processing was to separate the data into two parts, (1) data with screening values < 100 ppmv (referred to as non-leakers) and (2) those with values ≥ 100 ppmv. There were 11.5 million screening values to process. By lumping together all screening values < 100 ppmv, the database to be processed was reduced to one percent of that number, approximately 100,000 screening values. It was not considered cost effective to process the screening values in this low range since they contributed little to the estimated emissions. They could be accurately estimated as a lump sum using the zero default value for those listed as screening at zero ppmv, and by using an average emission factor for those screening between 1 and 99 ppmv. The 1 to 99 ppmv emission factor was determined by summing all the emissions for each component type (using the screening values and correlation equations) and dividing by the number of component screening values for the respective component type. The zeros were 87.5 percent of the screening values and the 1-to-99s were 11.6 percent, a total of 99 percent (Section 3, Figure 3-13). From this non-leaker part of the database, only the count and the ppmv screening values were used. This information was needed to compute the total emissions and component counts for later use in developing percentages of components leaking and emissions attributed to various categories of equipment and service.

To standardize the file formats, the files were screened to ensure uniformly expressed units, and to assure that format changes had not affected the values. Component ID numbers were not changed. A problem arose when one refinery instituted a new ID numbering system. That system provided more information about the component (e.g., size, operating temperature, etc.) Since it came at the end of the study and could provide no useful information without additional investigation and analysis, a conversion code from the old to the new system was requested but could not be obtained. Therefore, data from that refinery could not be used for the repeat-leaker analysis and the process unit analysis. However, the data were used for the large leaker and overall emissions and leak rate distribution calculations.

# Section 3
# DATA ANALYSIS

The data collected were examined to determine the frequency of repeat leakers and large leakers and their contribution to the total fugitive VOC emissions from the aggregate of the seven refineries as well as the individual refineries and for individual process unit types. Figures 3-1 through 3-35, clearly depicting the trends, are the primary means of presenting the results of this study. A few summary tables, such as Table 3-1, are included in the main text. Appendix A contains a comprehensive table of values for the reader interested in more precise values than can be read from the graphs.

## HIGH LEAKERS AND REPEAT LEAKERS

The results of the high and repeat leakers are summarized in Table 3-1 and Figures 3-1 through 3-12. Table 3-1 presents the total leakers and repeat leakers (repeating within any four-quarter period) for five leak definitions. In the first six lines of data in the table, a leaking component is defined as one screening at $\geq$ 500 ppmv. The fourth and fifth columns show the total number and percentage of leaking components out of the total number screened, shown in the second column. There are 14,453 valves in gas service screening at or above 500 ppmv out of 1.45 million gas-service valves screened. Out of the 1.45 million gas valves, there are 2,503 that leaked two times (2X) which is 0.172 percent, 511 that leaked three times (3X), etc. In the second set of six lines, the leak definition is 1,000 ppmv; in the third, 10,000 ppmv. In aggregate (all components and services combined), only 0.06 percent of the components had single repeat leaks, even at a 500 ppmv leak definition. A repeat leak is a component that screened at or above the leak definition more than once over the preceding four quarters. When a screening value, above the leak definition, was found, the computer went back four quarters to determine if that component had screened above the same leak definition. If it had, the number of excessive screening values were recorded.

Figures 3-1 through 3-6 present the average emission factors (lb/hr) by quarter for high leakers ($\geq$ 10,000 ppmv), repeat leakers ($\geq$ 1,000) and the overall average emissions of all components in the category shown including the non-leakers. Included with each plot is a horizontal line representing the overall average emissions for the 22 quarters of data shown. In Figure 3-1, note that the large leakers have an overall emission factor that is three orders of magnitude (approximately 1,000 times) greater than the overall average for all components and services.

Table 3-1. Screening Results for Seven Refineries (5.5 years)

| Components | Total Components Screened | Leak Definition (ppmv) | Total Leaking | | Total Leaking 2 X † | | Total Leaking 3X † | | Total Leaking 4X † | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | No. | % ‡ | No. | % ‡ | No. | % ‡ | No. | % ‡ |
| Valves in Gas Service | $1.45x10^6$ | 500 | 14,453 | 0.997 | 2,503 | 0.172 | 511 | 0.035 | 81 | 0.006 |
| Valves in Light Liquid Service | $1.34x10^6$ | 500 | 13,817 | 1.031 | 2,567 | 0.192 | 569 | 0.045 | 94 | 0.007 |
| Pumps (LL) | $3.11x10^4$ | 500 | 1,102 | 3.543 | 303 | 0.974 | 83 | 0.267 | 16 | 0.051 |
| Connectors in Gas Service | $4.54x10^6$ | 500 | 12,330 | 0.272 | 1,281 | 0.028 | 210 | 0.005 | 40 | 0.001 |
| Connectors in LL Service | $4.19x10^6$ | 500 | 7,547 | 0.180 | 890 | 0.021 | 1680 | 0.004 | 34 | 0.001 |
| **TOTAL** | **$11.5 x10^6$** | | **49,249** | | **7,544** | | **3053** | | **265** | |
| | | | | | | | | | | |
| Valves in Gas Service | $1.45x10^6$ | 1,000 | 12,731 | 0.878 | 1,962 | 0.135 | 392 | 0.025 | 48 | 0.003 |
| Valves in Light Liquid Service | $1.34x10^6$ | 1,000 | 11,472 | 0.856 | 1,777 | 0.133 | 349 | 0.026 | 45 | 0.003 |
| Pumps (LL) | $3.11x10^4$ | 1,000 | 861 | 2.768 | 207 | 0.666 | 45 | 0.145 | 12 | 0.039 |
| Connectors in Gas Service | $4.54x10^6$ | 1,000 | 10,722 | 0.236 | 1,014 | 0.022 | 144 | 0.003 | 29 | 0.001 |
| Connectors in LL Service | $4.19x10^6$ | 1,000 | 6,174 | 0.147 | 653 | 0.016 | 114 | 0.003 | 23 | 0.001 |
| **TOTAL** | **$11.5 x10^6$** | | **41,960** | | **5,613** | | **1044** | | **157** | |
| | | | | | | | | | | |
| Valves in Gas Service | $1.45x10^6$ | 10,000 | 4,123 | 0.248 | 389 | 0.027 | 52 | 0.004 | 1 | 0.000 |
| Valves in Light Liquid Service | $1.34x10^6$ | 10,000 | 3,872 | 0.289 | 316 | 0.024 | 44 | 0.003 | 9 | 0.001 |
| Pumps (LL) | $3.11x10^4$ | 10,000 | 310 | 0.997 | 39 | 0.125 | 7 | 0.023 | 3 | 0.010 |
| Connectors in Gas Service | $4.54x10^6$ | 10,000 | 4,210 | 0.093 | 283 | 0.006 | 32 | 0.001 | 3 | 0.000 |
| Connectors in LL Service | $4.19x10^6$ | 10,000 | 2,247 | 0.054 | 172 | 0.004 | 40 | 0.001 | 10 | 0.000 |
| **TOTAL** | **$11.5 x10^6$** | | **14,762** | | **1199** | | **175** | | **26** | |

† Repeat leakers within any consecutive four quarter period

‡ i.e., % of Total Components Screened

Table 3-1. Screening Results for Seven Refineries (5.5 years)(Continued)

| Components | Total Components Screened | Leak Definition (ppmv) | Total Leaking | | Total Leaking 2 X † | | Total Leaking 3X † | | Total Leaking 4X † | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | No. | % ‡ | No. | % ‡ | No. | % ‡ | No. | % ‡ |
| | | | | | | | | | | |
| Valves in Gas Service | $1.45x10^6$ | 50,000 | 1,563 | 0.108 | 116 | 0.008 | 15 | 0.001 | 2 | 0.000 |
| Valves in Light Liquid Service | $1.34x10^6$ | 50,000 | 1,379 | 0.103 | 90 | 0.007 | 6 | 0.000 | 0 | 0.000 |
| Pumps (LL) | $3.11x10^4$ | 50,000 | 89 | 0.286 | 5 | 0.016 | 0 | 0.000 | 0 | 0.000 |
| Connectors in Gas Service | $4.54x10^6$ | 50,000 | 1,913 | 0.046 | 93 | 0.002 | 6 | 0.000 | 0 | 0.000 |
| Connectors in LL Service | $4.19x10^6$ | 50,000 | 858 | 0.020 | 49 | 0.001 | 8 | 0.000 | 1 | 0.000 |
| **TOTAL** | **$11.5 x10^6$** | | **5,802** | | **353** | | **35** | | **3** | |
| | | | | | | | | | | |
| Valves in Gas Service | $1.45x10^6$ | 100,000 | 1,174 | 0.081 | 83 | 0.006 | 12 | 0.001 | 1 | 0.000 |
| Valves in Light Liquid Service | $1.34x10^6$ | 100,000 | 1,058 | 0.079 | 64 | 0.005 | 0 | 0.000 | 0 | 0.000 |
| Pumps (LL) | $3.11x10^4$ | 100,000 | 58 | 0.186 | 2 | 0.006 | 0 | 0.000 | 0 | 0.000 |
| Connectors in Gas Service | $4.54x10^6$ | 100,000 | 1,456 | 0.032 | 59 | 0.001 | 4 | 0.000 | 0 | 0.000 |
| Connectors in LL Service | $4.19x10^6$ | 100,000 | 639 | 0.015 | 25 | 0.001 | 3 | 0.000 | 0 | 0.000 |
| **TOTAL** | **$11.5 x10^6$** | | **4,385** | | **233** | | **19** | | **1** | |

† Repeat leakers within any consecutive four quarter period

‡ i.e., % of Total Components Screened

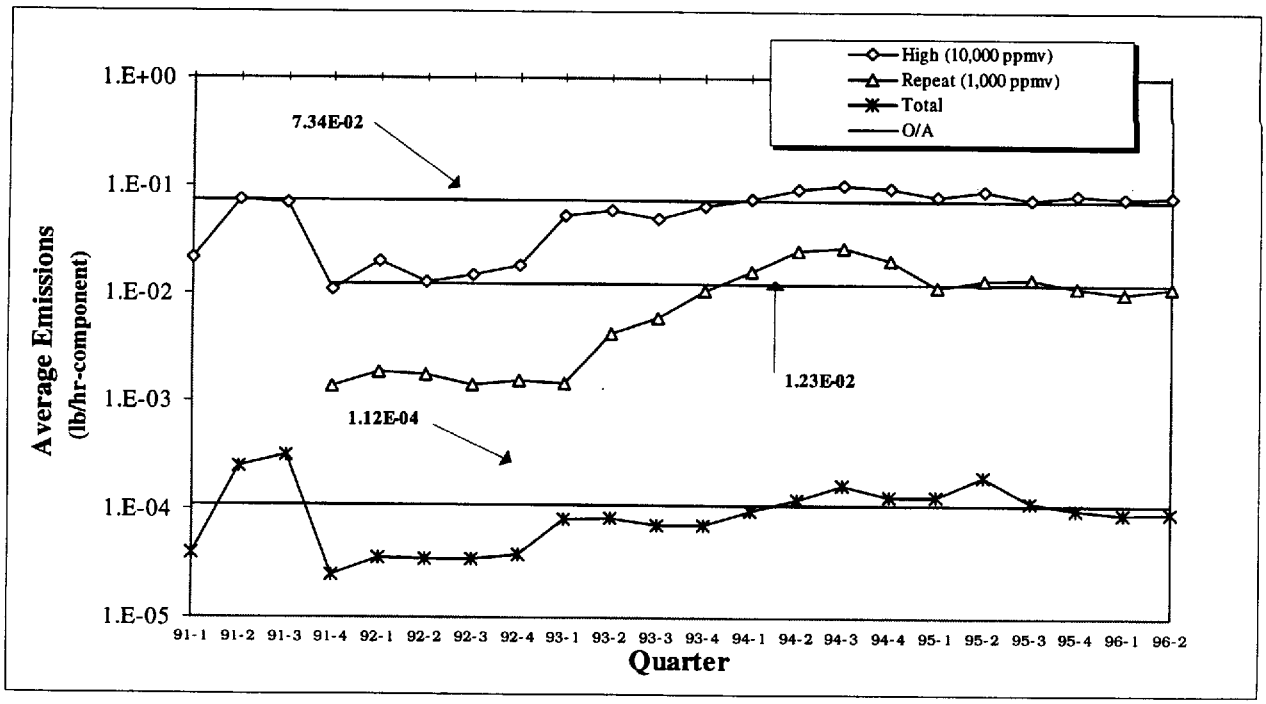


Figure 3-1. Average Per Component Emissions for High Leakers, Repeat Leakers and Total Components for **Aggregate of All Components and Services**

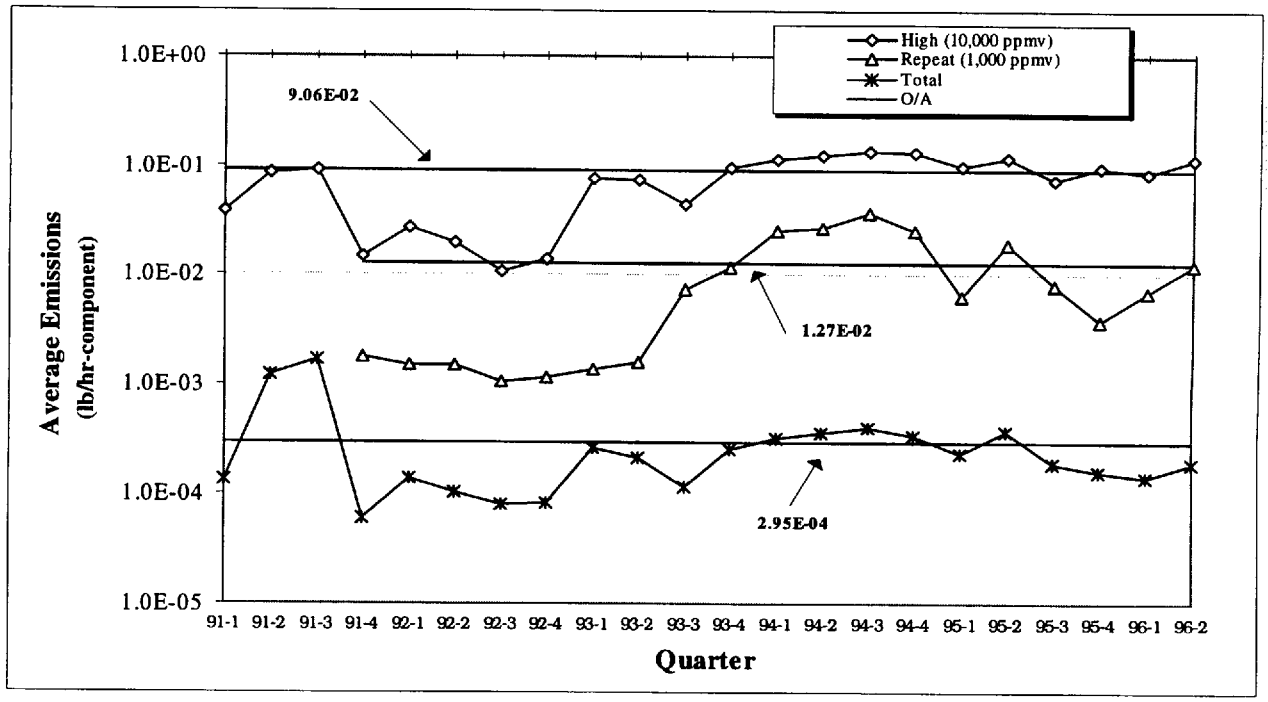


Figure 3-2. Average Per Component Emissions for High Leakers, Repeat Leakers and Total Components for **Valves in Light Liquid Service**

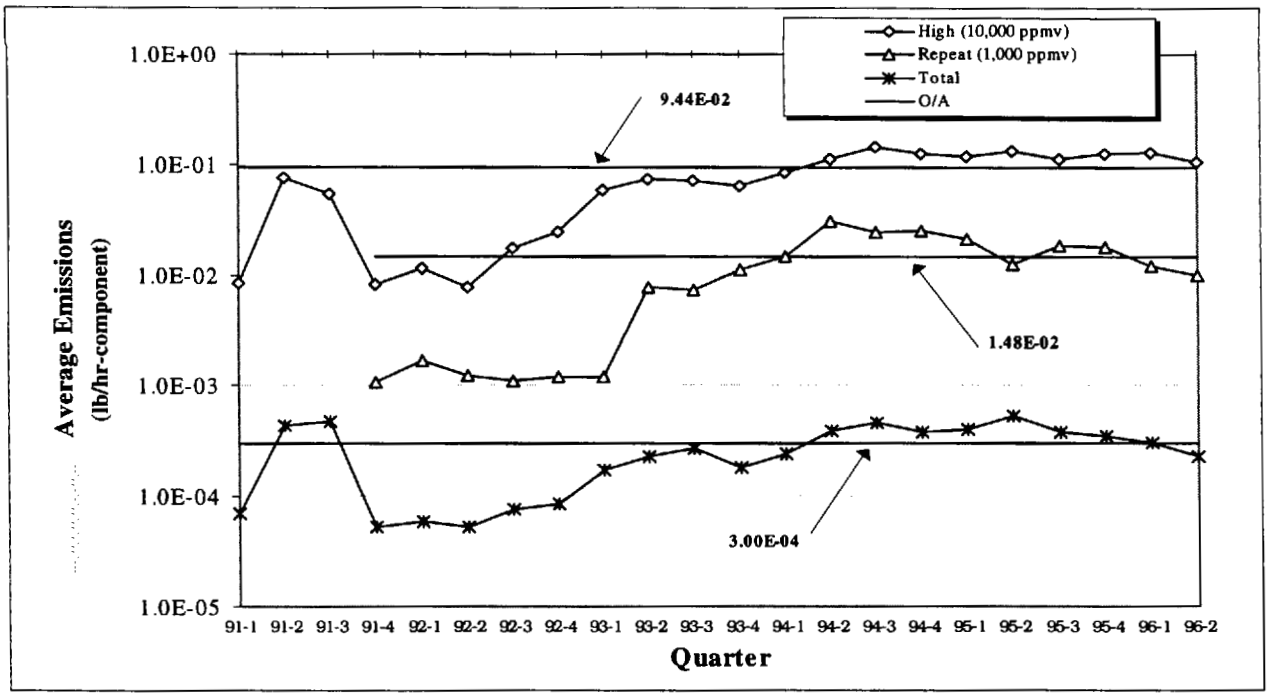


Figure 3-3. Average Per Component Emissions for High Leakers, Repeat Leakers and Total Components for **Valves in Gas Service**

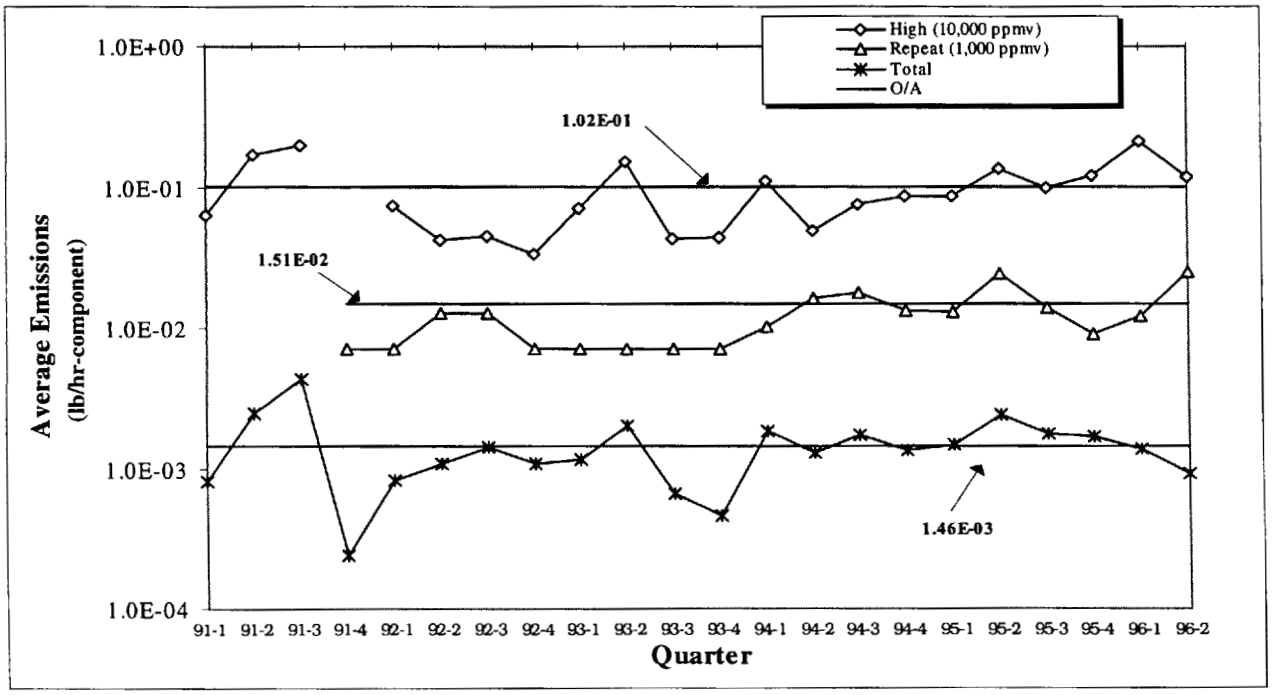


Figure 3-4. Average Per Component Emissions for High Leakers, Repeat Leakers and Total Components for **Pumps in Light Liquid Service**

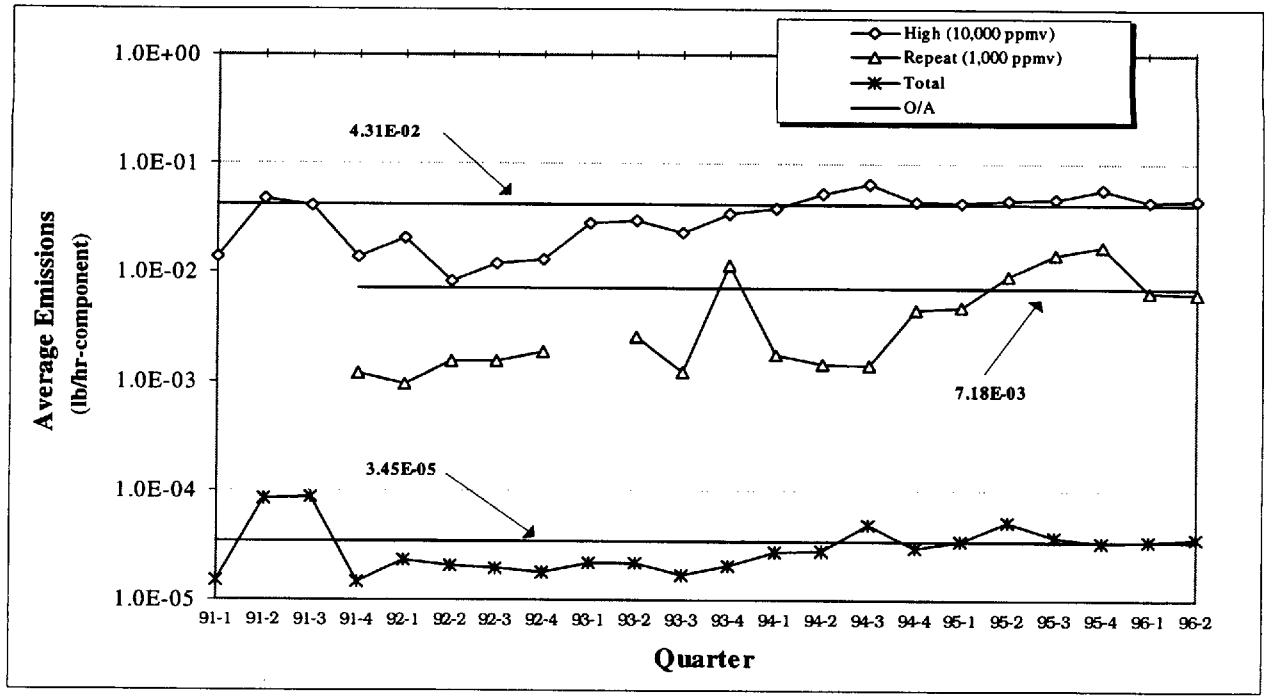


Figure 3-5. Average Per Component Emissions for High Leakers, Repeat Leakers and Total Components for **Connectors in Light Liquid Service**

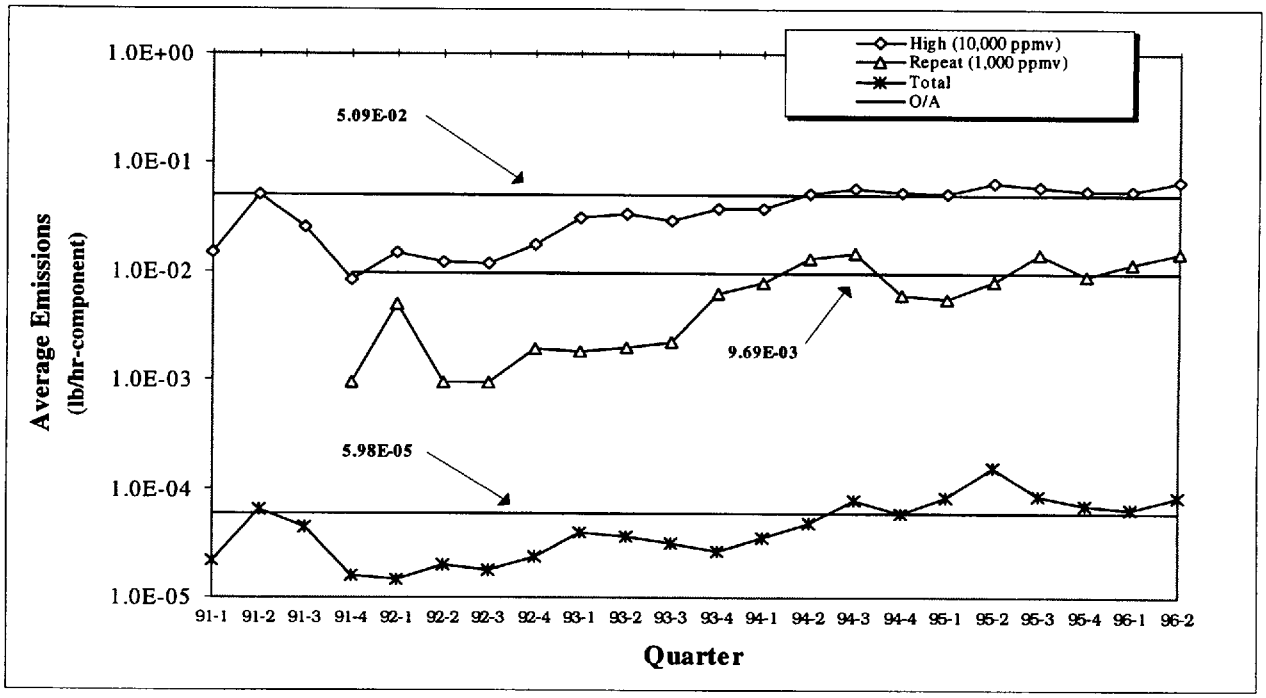


Figure 3-6. Average Per Component Emissions for High Leakers, Repeat Leakers and Total Components for **Connectors in Gas Service**

For repeat leakers, a leak definition of ≥1,000 ppmv screening value was selected for these and subsequent graphs, because there are so few repeat leaks at the higher ppmv leak definitions. If a higher value were used, the sample size would be too small to reveal trends.

The average component emission factor for the repeat leakers is almost an order of magnitude lower than that for the large leakers, but still two orders (approximately 100 times) greater than the overall average values. Although it appears that the average per component emissions increases as time goes on, inconsistencies and incomplete data may be the cause. The more recent data, at the right ends of the graphs where the curves are nearly horizontal, are more complete and reliable. The graphs for the individual components and service types are generally identical in magnitude and plot shape except for pump seals (Figure 3-4). For pumps, the overall average emission factor is higher and the large leaker emission factor is only two orders of magnitude higher. Because there are comparatively few pumps compared to valves and connectors, pumps contribute an essentially negligible amount of emissions.

Figures 3-7 through 3-12 present the percent of total emissions, for the components shown, contributed by high leakers, repeat leakers and other components over the 22 quarters of data. On each of these figures, high leakers and others for each quarter will total 100 percent. For valves, as shown in both Figures 3-8 and 3-9, respectively, for the light liquid and gas services, the high leakers contribute 89 percent. The connector emission distributions, Figures 3-11 and 3-12, are different. For connectors, the high leakers account for 67 percent for light liquid service and 79 percent for gas service. Repeat leaker emissions are negligible. The "other" emissions account for 33 and 21 percent respectively for light-liquid and gas service. "Other" emissions on these graphs are the emissions from components screening below 10,000 ppmv. To better understand these results, refer to Table 3-2 which was derived from values in Table 3-1.

The repeat leaker data in Table 3-1 confirm that there is no easily identifiable cohort of repeat leakers within the population of refinery components subject to LDAR. The percentage of repeat leakers is small

Table 3-2. Valve and Connector Leak Rate Distribution

| *Component* | *Total Screened* $10^6$ | *Leaking @ 500 ppmv* | | *Leaking @ 1,000 ppmv* | | *Leaking @ 10,000 ppmv* | |
|---|---|---|---|---|---|---|---|
| *Gas & Light Liquid* | | $10^3$ | % | $10^3$ | % | $10^3$ | % |
| **Valves** | 2.8 | 28.2 | 1.0 | 24.2 | 0.86 | 8.0 | 0.29 |
| **Connectors** | 8.7 | 19.8 | 0.2 | 16.9 | 0.2 | 6.4 | 0.07 |

in absolute terms, and the percentage of components with more than two leaks within a year, is negligible. Within any four-quarter period, and at a leak definition of 10,000 ppmv, no more than nine percent (1 in 11) of leaking valves were repeat leakers. The repeat leakers within four quarters at the emissions-dominant screening range of ≥100,000 ppmv were found to be no more than seven percent (1 in 14) of the leaking valves. Similar results were obtained for fittings (eight percent at 10,000 ppmv and four percent at 100,000 ppmv). A sharp drop in repeat leaker percentages was also found in going from double leakers to triple and quadruple leakers. This suggests there is no significant number of chronic leaking valves.

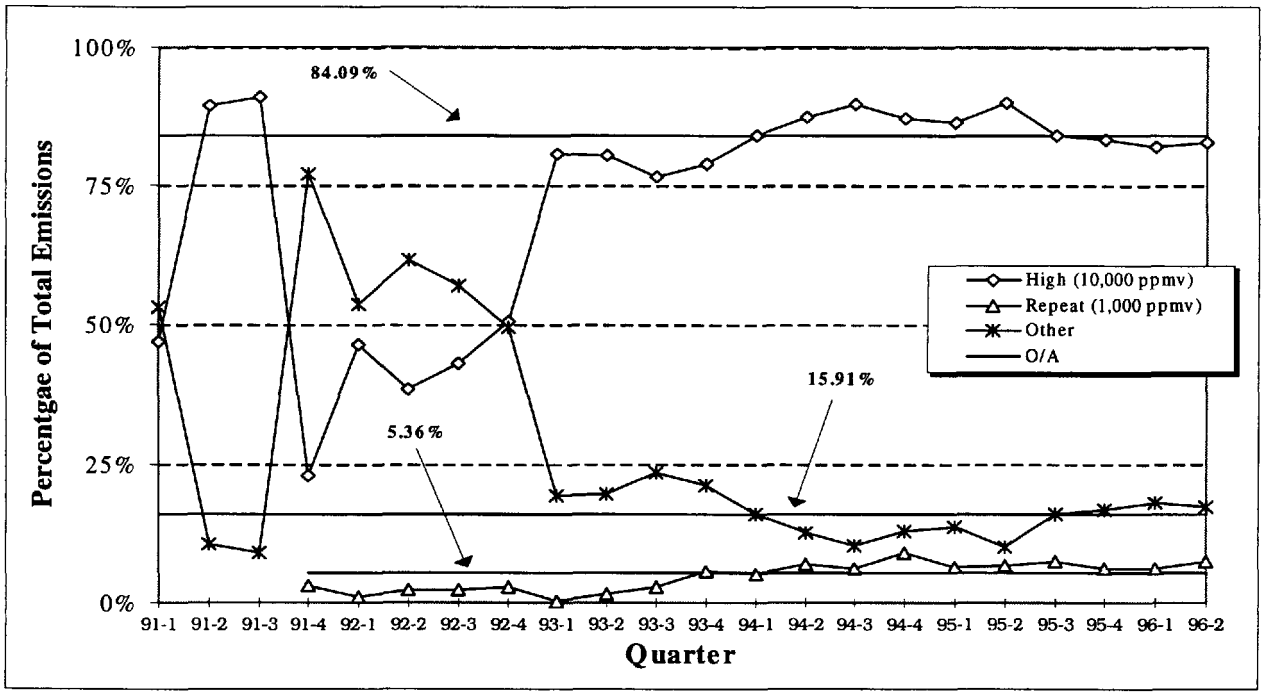


Figure 3-7. Percentage of Total Emissions for High Leakers, Repeat Leakers, and Other Leakers for **Aggregate of All Components and Services**

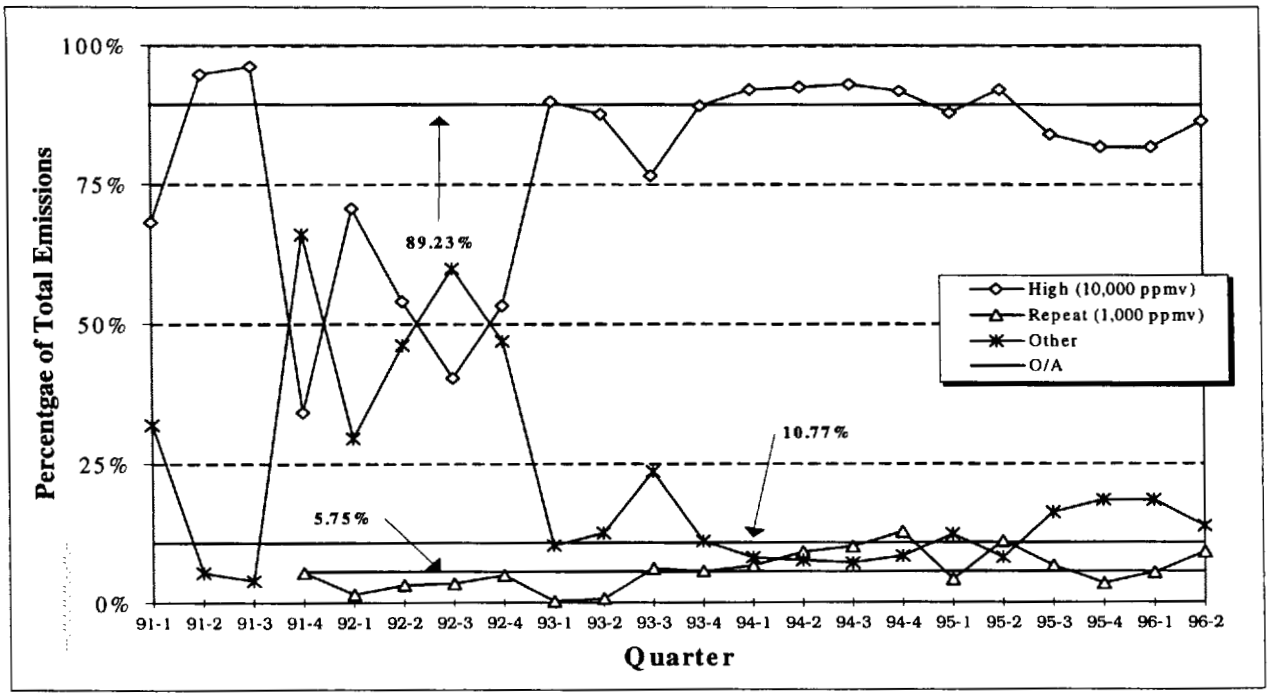


Figure 3-8. Percentage of Total Emissions for High Leakers, Repeat Leakers, and Other Leakers for **Valves in Light Liquid Service**

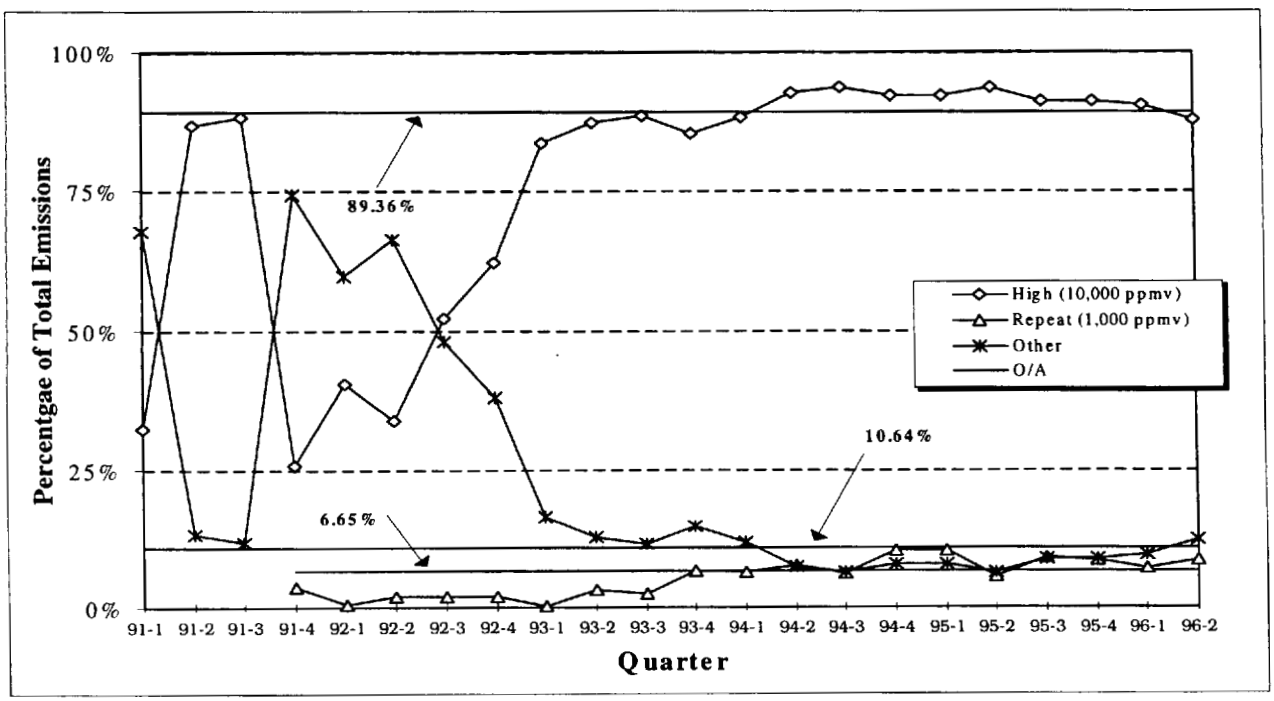


Figure 3-9. Percentage of Total Emissions for High Leakers, Repeat Leakers, and Other Leakers for **Valves in Gas Service**

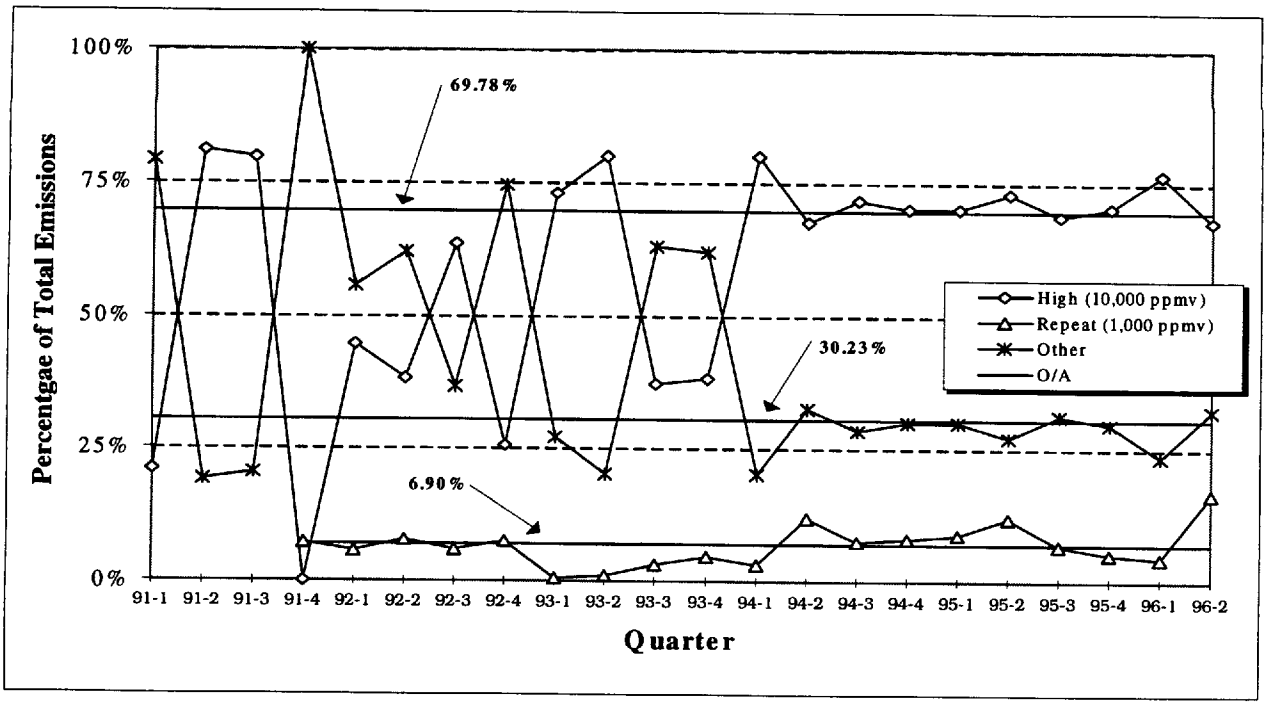


Figure 3-10. Percentage of Total Emissions for High Leakers, Repeat Leakers, and Other Leakers for **Pumps in Light Liquid Service**

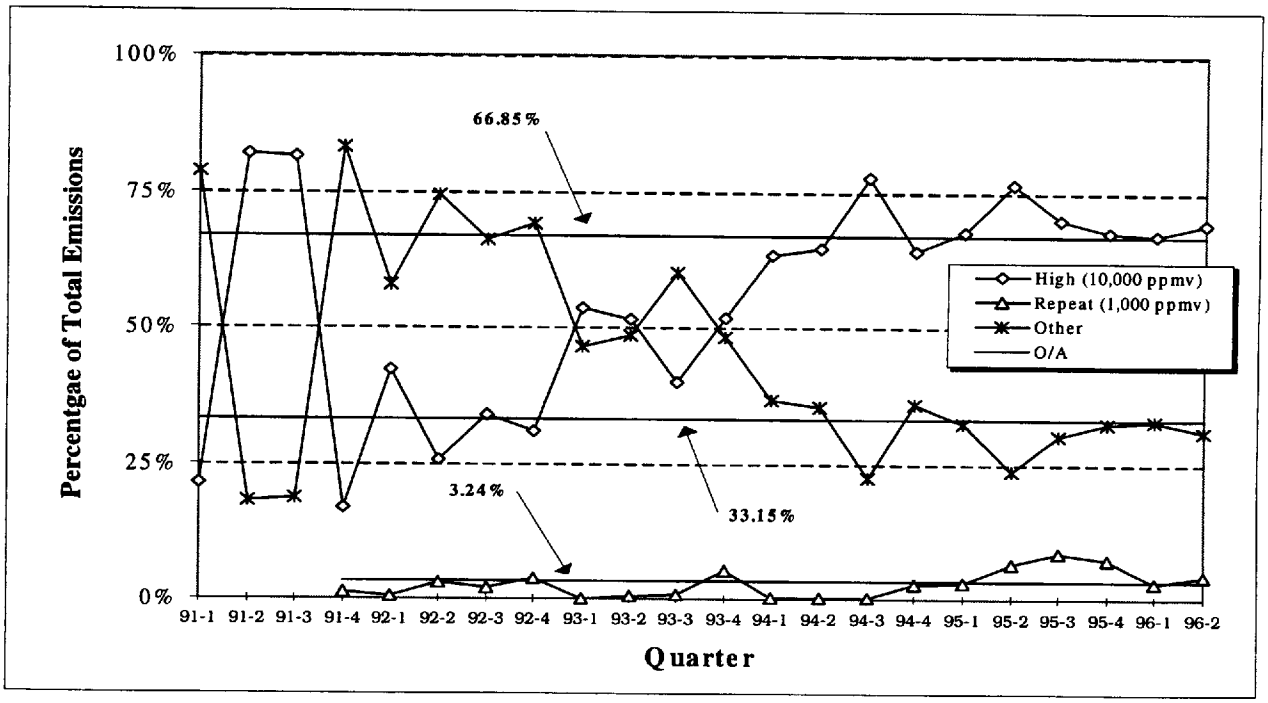


Figure 3-11. Percentage of Total Emissions for High Leakers, Repeat Leakers, and Other Leakers for **Connectors in Light Liquid Service**

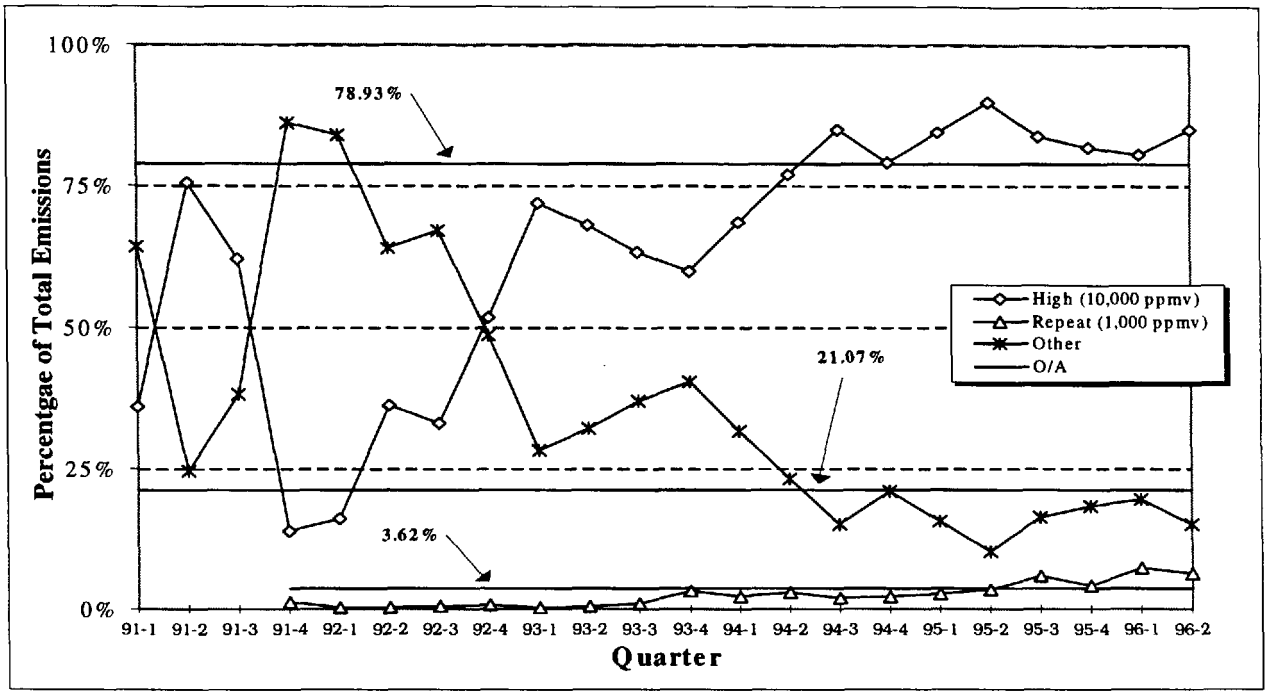


Figure 3-12. Percentage of Total Emissions for High Leakers, Repeat Leakers, and Other Leakers for **Connectors in Gas Service**

While there are three times as many connectors as valves, the number of leaking valves is greater than leaking connectors for the three leak definitions shown. Also, the percentages of connectors leaking, for the three leak definitions in Table 3-2, are less than one fourth of comparable values for valves. Thus, the lower contribution of high leakers in Figures 3-11 and 3-12 can be explained by the observation that connectors have relatively few high leakers, apparently because the connector is static where a valve stem is moved each time the valve is actuated.

## DISTRIBUTION OF EMISSIONS BY SCREENING RANGES

The distribution of emissions and component count over various ranges of screening values is shown in Figure 3-13. This figure shows that 84 percent of the total emissions are attributed to the high leakers (≥10,000 ppmv), 16 percent to other components. Half of this other 16 percent of the emissions are attributed to the components screening at zero. Only 0.07 percent of all components are repeat leakers.

## DISTRIBUTION OF EMISSIONS BY COMPONENT CATEGORY

The distribution of total emissions by component category is summarized in Table 3-3. These data show that over 68 percent of the total emissions are from valves. The connectors only account for about a third of that amount even though there are nearly three times the number of connectors as there are valves.

This ratio is consistent with the number of leaking connectors to valves. Although the contribution from pumps is very small, it is high considering the very low number of pumps in this study. (Pressure relief valves, compressors, open ended lines, drains, etc. were not included in this study.)

| Screening Interval | Total Screening Events in Interval | Total Count Distribution % | Emissions lb/hr | Emission Distribution % |
|---|---|---|---|---|
| **0** | 10,114,633 | 87.51 | 19.79 | 8.43 |
| **1 - 99** | 1,342,550 | 11.62 | 2.63 | 1.12 |
| **100 - 499** | 51,894 | 0.449 | 2.78 | 1.18 |
| **500 - 999** | 7,289 | 0.063 | 1.04 | 0.44 |
| **1,000 - 9,999** | 27,198 | 0.235 | 11.52 | 4.91 |
| **10,000 - 49,999** | 8,960 | 0.078 | 12.53 | 5.34 |
| **50,000 - 99,999** | 1,417 | 0.012 | 5.37 | 2.29 |
| **>=100,000** | 4,385 | 0.038 | 179.01 | 76.28 |
| **Total** | 11,558,326 | 100.00 | 234.67 | 100.00 |

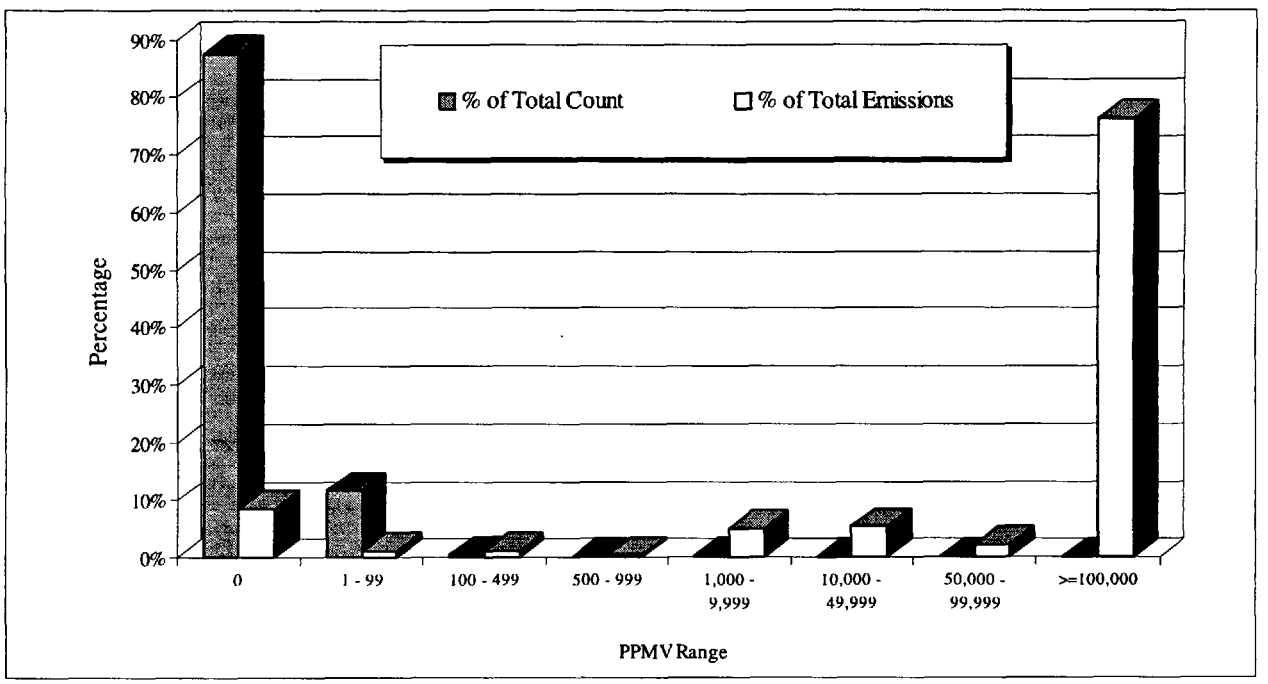


Figure 3-13. Distribution of Component Count and Estimated Emissions by Screening Range
*Average of All Component Types, Service Types for 5.5 Years*

Table 3-3. Distribution of Emissions by Component Category

| Component Category | Service | Total Emissions for Category, lb/hr | Percent of Total Emissions for Category |
|---|---|---|---|
| Valves | G | 79.22 | 33.76 |
| Valves | LL | 80.58 | 34.34 |
| Pumps | LL | 8.25 | 3.51 |
| Connectors | G | 40.31 | 17.18 |
| Connectors | LL | 26.32 | 11.21 |
| | Total | 234.67 | 100.00 |

PROCESS UNIT VARIATIONS

Figures 3-14 through 3-26 reveal the distribution of emissions and leaking components over the various process-unit categories shown in Table 3-4.

Table 3-4. Process Unit Description

| API Code | Process Unit |
|---|---|
| A | Crude distillation unit |
| B | Alkylation (HF, sulfuric acid) unit |
| C | Catalytic reforming unit |
| D | Hydrocracking unit |
| E | Hydrotreating/hydrorefining unit |
| F | Catalytic cracking (fluid and other ) and CO boiler |
| G | Thermal cracking (visbreaking and other) |
| H | Thermal cracking (coking) |
| I | Hydrogen Plant |
| J | Asphalt Plant |
| K | Product (liquid and gas) blending and treating units |
| L | Sulfur plant |
| M | Vacuum distillation towers |
| N | Full-range distillation units (light ends, naphtha, solvent, etc.) |
| O | Isomerization unit |
| P | Polymerization unit |
| Q | MEK dewaxing unit |
| R | Other lube oil and specialties processing |
| S | Interunit pipeline system |
| T | Sour and other water strippers |
| U | MTBE unit |
| V | Flare System |
| Z | Other (specify) |

*Note: Components associated with tanks are identified with the process that the tanks feed*

These are the same generic process unit descriptions used by API in discussions with EPA during the development of the National Emissions Standards for Hazardous Air Pollutants from Petroleum Refineries (i.e., "Refinery MACT"). The API code letters (Table 3-4) are used in Figures 3-14 through 3-25.

Figures 3-14 through 3-19 present plots of the percentage of total quarterly emissions contributed by the component identified on the graph at the process indicated by code letter. *Total quarterly emissions* means the emissions from all components, services and process categories. Thus, the emission percentages are comparatively low for individual component types and process unit categories. The values for each process in Figure 3-14 are the summation of the corresponding values in Figures 3-15 through 3-19.

It is apparent from the respective graphs, that valves are the primary contributor to the aggregated emissions. In order of their contribution to the total and considering only the high rate leakers ($\geq$ 10,000 ppmv) and repeat leakers (at $\geq$1,000 ppmv), the processes rank as shown in Table 3-5. Emissions were significantly lower than average for processes G, L, M, P, T and U. This was consistent independent of the type of component.

The results in Table 3-5 are taken from Figures 3-15 through 3-19. These data indicate that reformers have the highest proportion of fugitive emissions accounting for 13 percent of all emissions from all components, refineries, and quarters for which there are data. Of those 13 percent, 11 percent is from valves (Figures 3-2 and 3-3) and 2 percent from connectors (Figures 3-5 and 3-6). Reformer emissions are followed closely by those from alkylation units at 9.4 percent. Each of the next seven processes, listed above, contribute 4 to 8 percent of the emissions. It should not be overlooked that thermal cracking, sulfur plants, vacuum distillation towers, polymerization units, sour and other water strippers, MTBE units, have very low fugitive emissions.

Table 3-5. Contribution to Total Emissions by Process Unit High and Repeat Leakers

| Rank | Process Unit and Letter Designation | % of Emissions from High & Repeat Leakers |
|---|---|---|
| 1 | Catalytic Reforming Unit - C | 13.2 |
| 2 | Alkylation Unit - B | 9.4 |
| 3 | Crude Distillation Unit - A | 7.3 |
| 4 | Product Blending Unit - K | 6.2 |
| 5 | Hydrogen Plant - I | 5.9 |
| 6 | Interunit Pipelines - S | 5.3 |
| 7 | Catalytic Cracking Unit - F | 5.0 |
| 8 | Hydrotreating Unit- E | 4.9 |
| 9 | Thermal Cracking (Coker) Unit - H | 4.6 |
| 10 | Full-range Distillation Unit - N | 3.6 |
| 11 | Isomerization Unit - O | 2.8 |
| 12 | Hydrocracking Unit -D | 2.1 |
| | *Processes G,L,M,P,T,U,&V all <1%* | 2.6 (collectively) |
| | Other - Z *(Includes processes not identified)* | 15.5 |
| | Total | 88.7 |

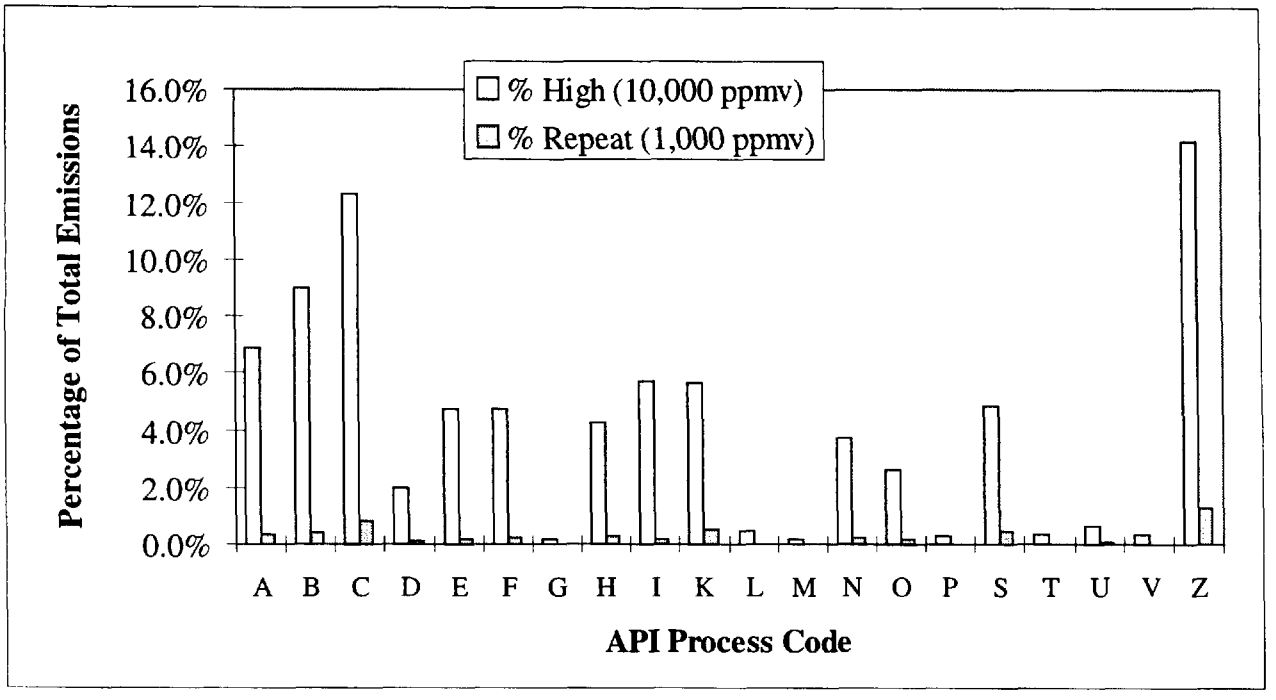


Figure 3-14. Percentage of Total Emissions for High Leakers and Repeat Leakers in Refinery Processes for **Aggregate of All Components and Services**

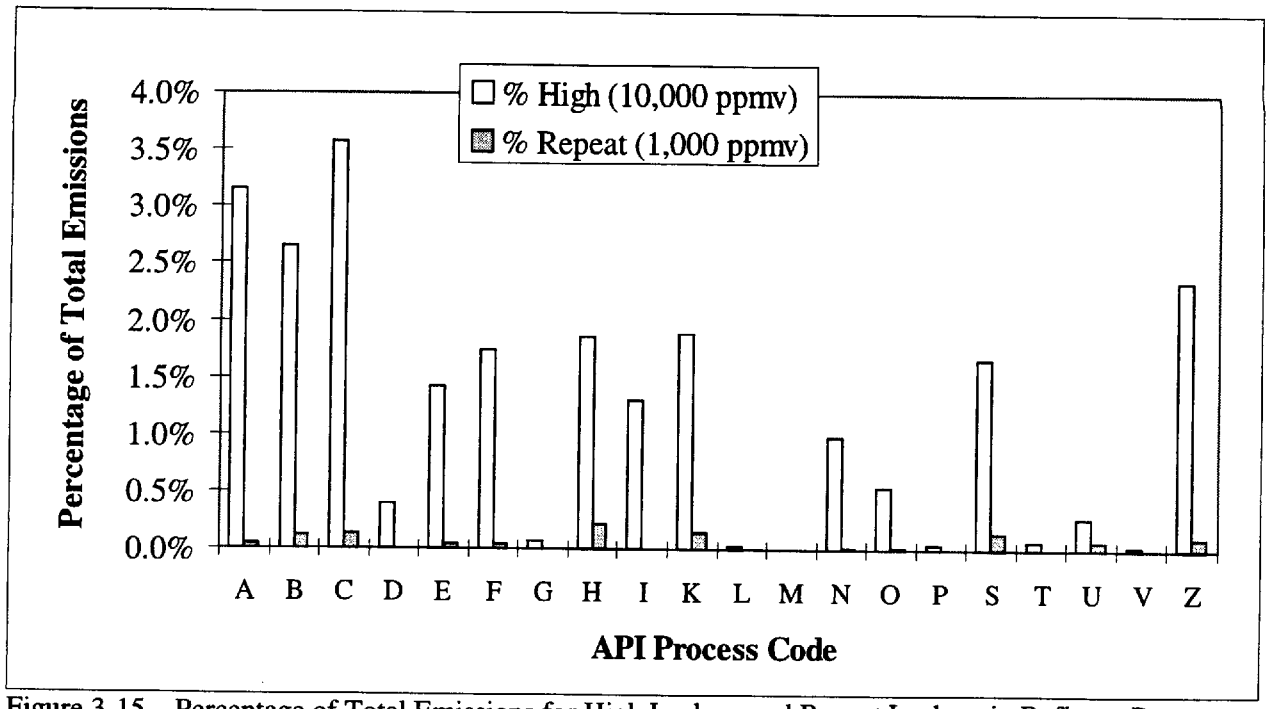


Figure 3-15. Percentage of Total Emissions for High Leakers and Repeat Leakers in Refinery Processes for **Valves in Light Liquid Service**

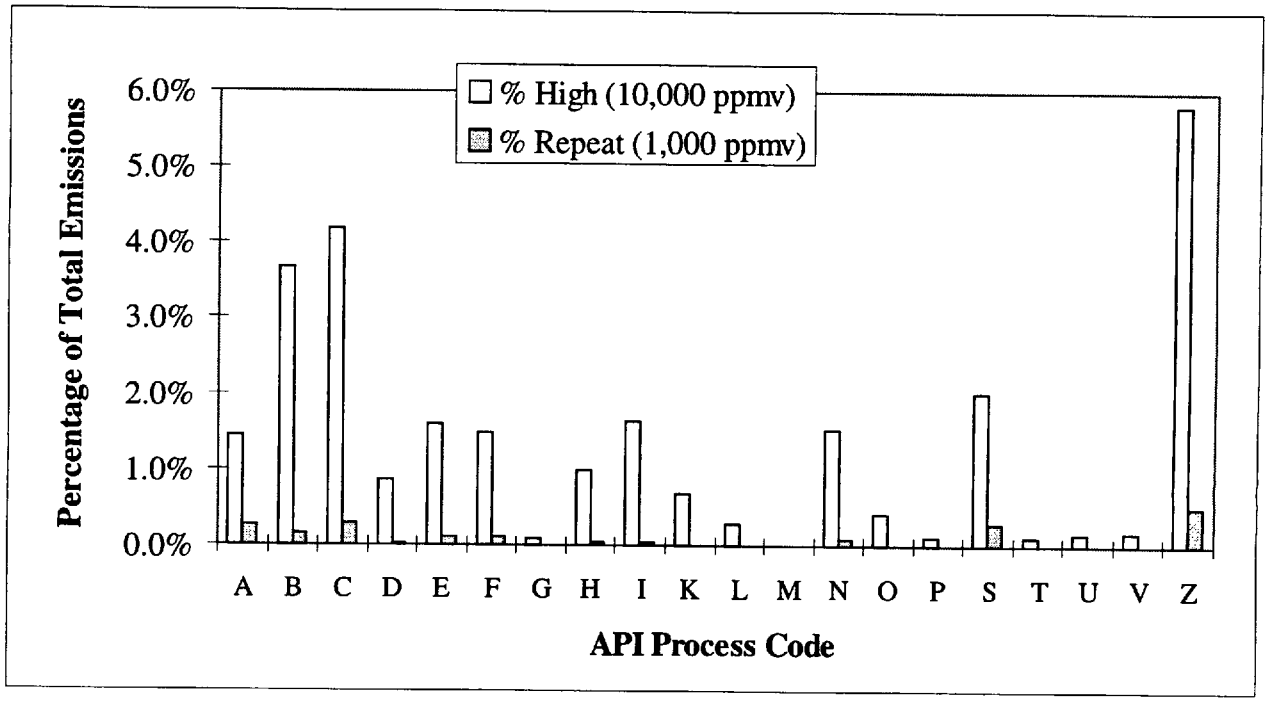


Figure 3-16. Percentage of Total Emissions for High Leakers and Repeat Leakers in Refinery Processes for **Valves in Gas Service**

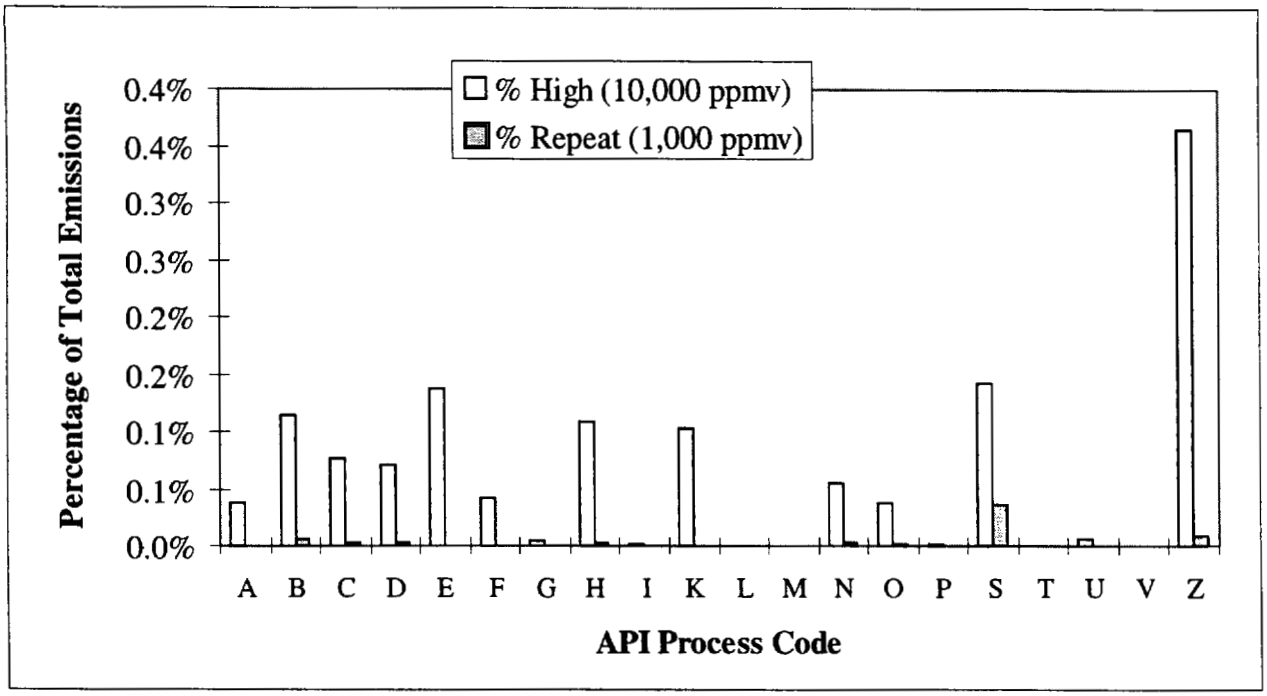


Figure 3-17. Percentage of Total Emissions for High Leakers and Repeat Leakers in Refinery Processes for **Pumps in Light Liquid Service**

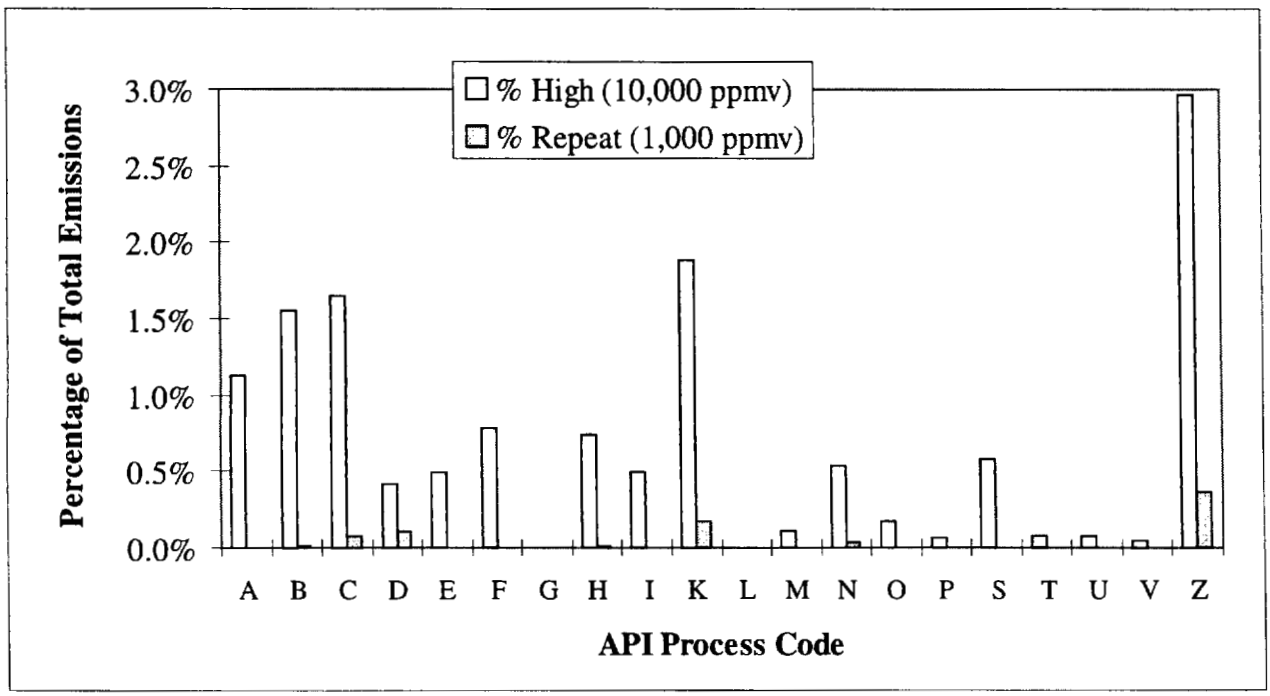


Figure 3-18. Percentage of Total Emissions for High Leakers and Repeat Leakers in Refinery Processes for **Connectors in Light Liquid Service**

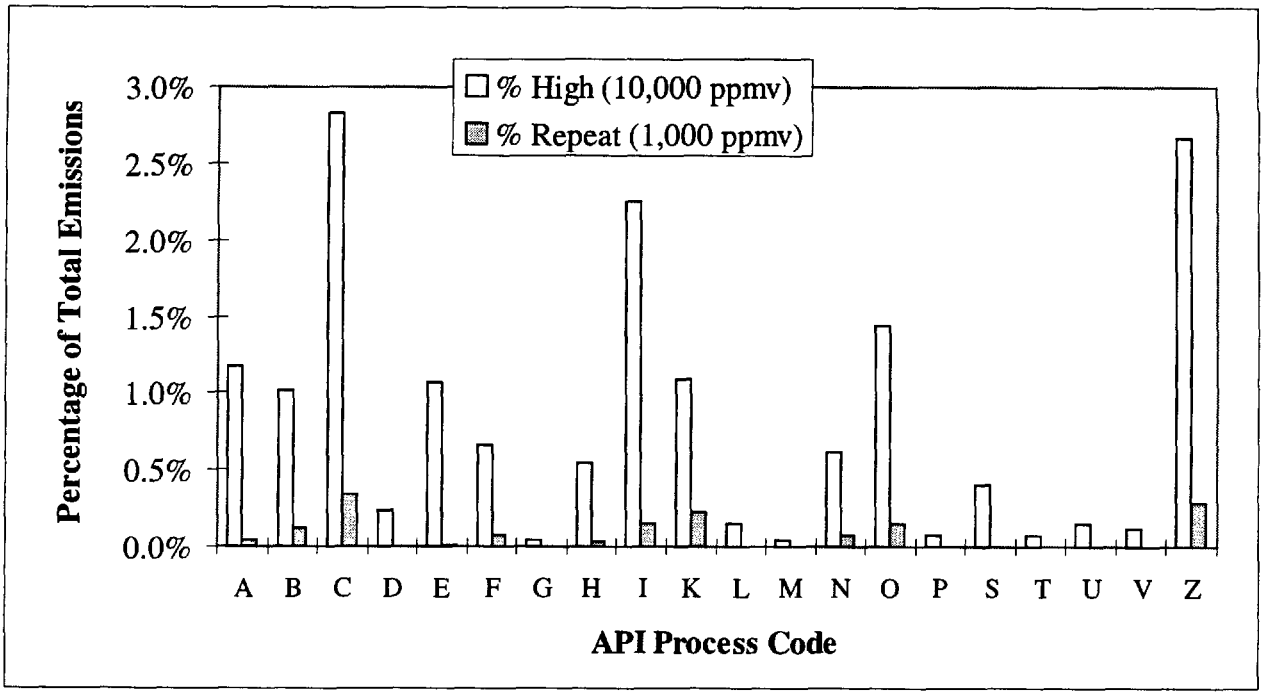


Figure 3-19. Percentage of Total Emissions for High Leakers and Repeat Leakers in Refinery Processes for **Connectors in Gas Service**

Figures 3-20 through 3-25 present the percent of leaking components in respective processes. Figure 3-20 shows that Process O, Isomerization, has the largest percent of high and repeat leakers but Figure 3-14 shows that the total emissions from Process O are relatively low. However, process category C, Reformers, has the second highest percentage of leakers, both high and repeat, and also have the highest relative emissions.

Figure 3-26 gives another perspective on which process categories are likely to have components which have higher emissions. Since process units characteristically have varying numbers of components, Figure 3-26 was prepared to normalize this effect by dividing the total emissions for each category by the number of components in the category to produce, in effect, an emission factor (lb/hr-component). From this figure, it apparent that Process Category O, Isomerization, has an emission factor an order of magnitude higher than that for the other process categories. Process B, Alkylation, has the next highest emissions and percent leakers.

Reformers have been considered to be one of the higher emitting processes due to their motor-operated valves. Unfortunately, the database contained no indication as to the types of valves screened. Alkylation units use stirred reactors with dynamic seals; however, it is likely that the refineries might

categorize these dynamic seals as other components, not valves. The total emissions from the other category was so small that it was ignored in this study.

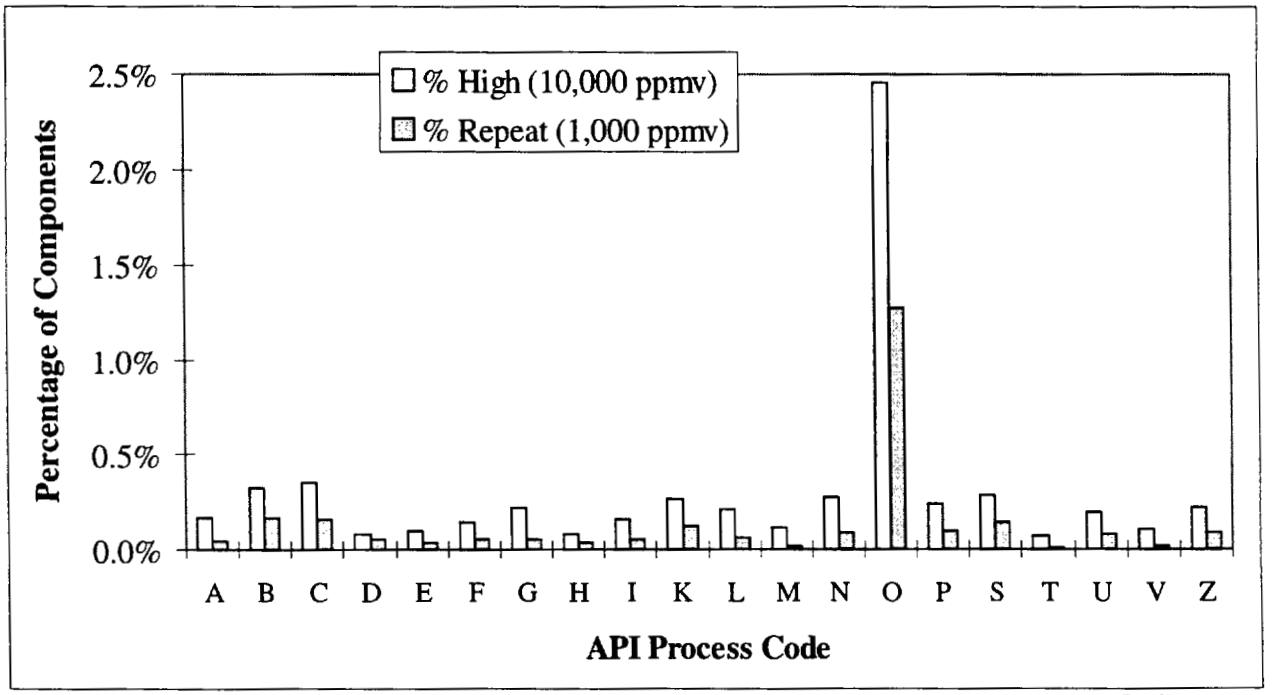


Figure 3-20. Percentage of Total Component Count for High Leakers and Repeat Leakers in Refinery Processes for **Aggregate of All Components and Services**

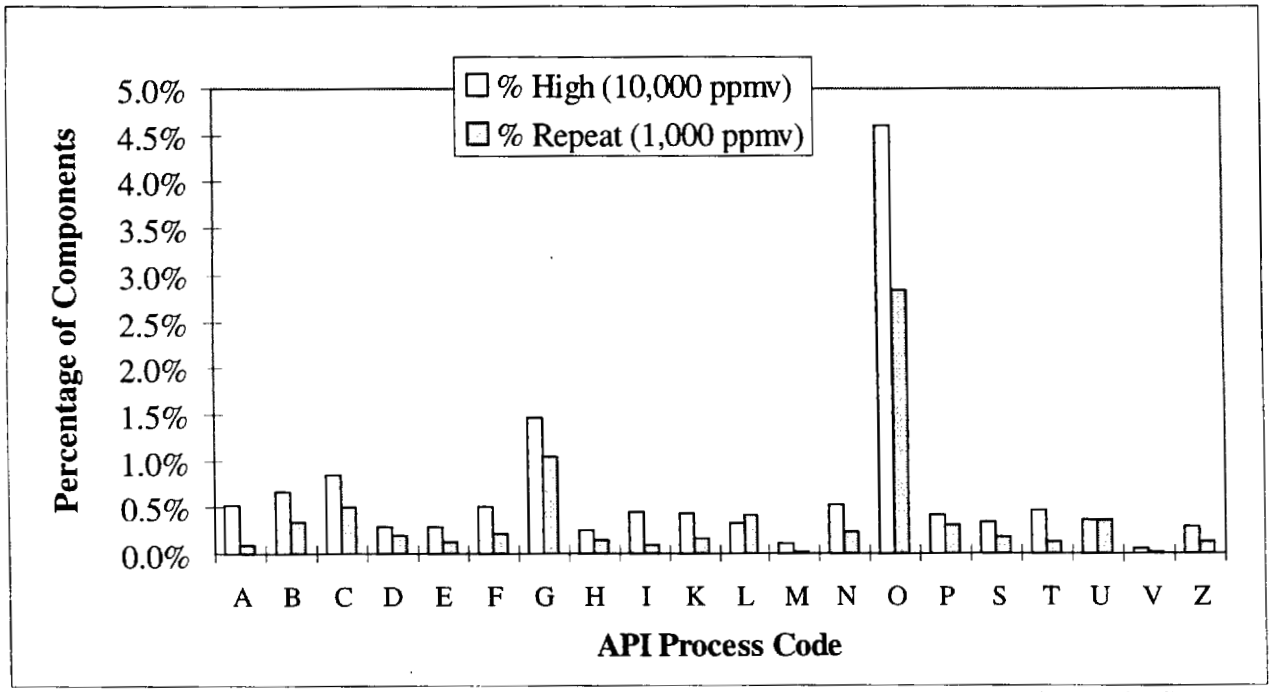


Figure 3-21. Percentage of Total Component Count for High Leakers and Repeat Leakers in Refinery Processes for **Valves in Light Liquid Service**

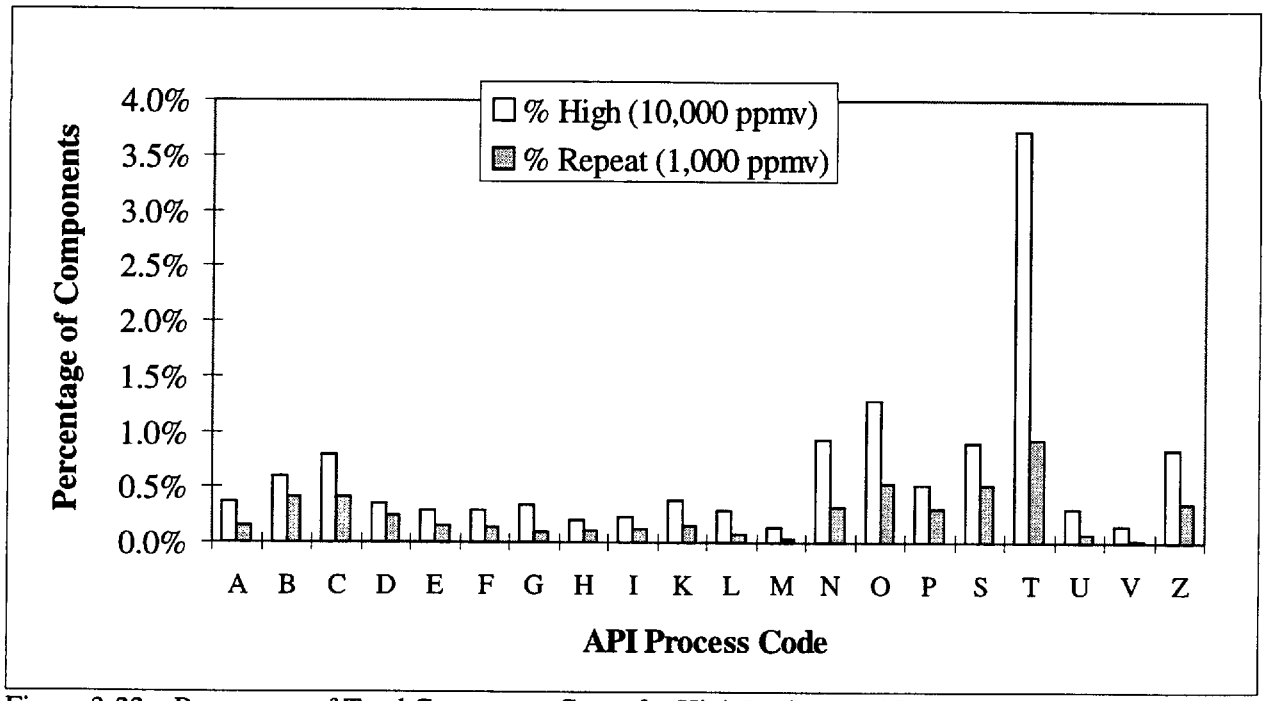


Figure 3-22. Percentage of Total Component Count for High Leakers and Repeat Leakers in Refinery Processes for **Valves in Gas Service**

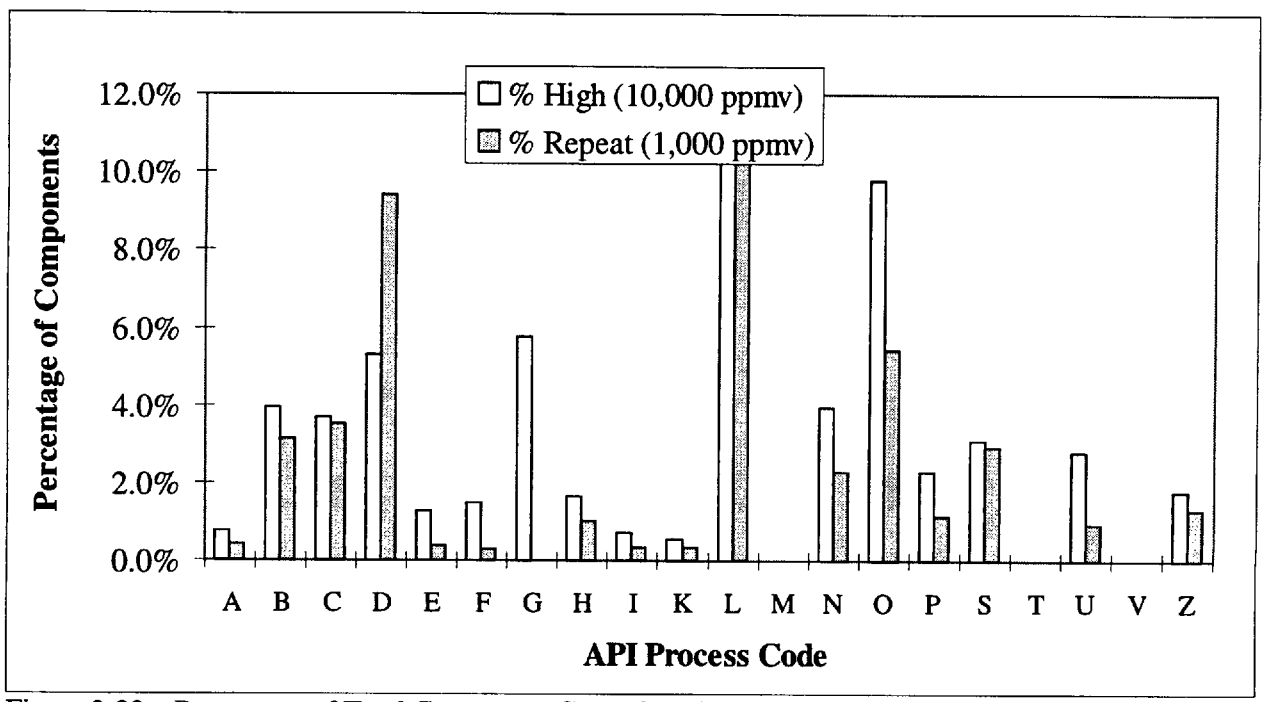


Figure 3-23. Percentage of Total Component Count for High Leakers and Repeat Leakers in Refinery Processes for **Pumps in Light Liquid Service**

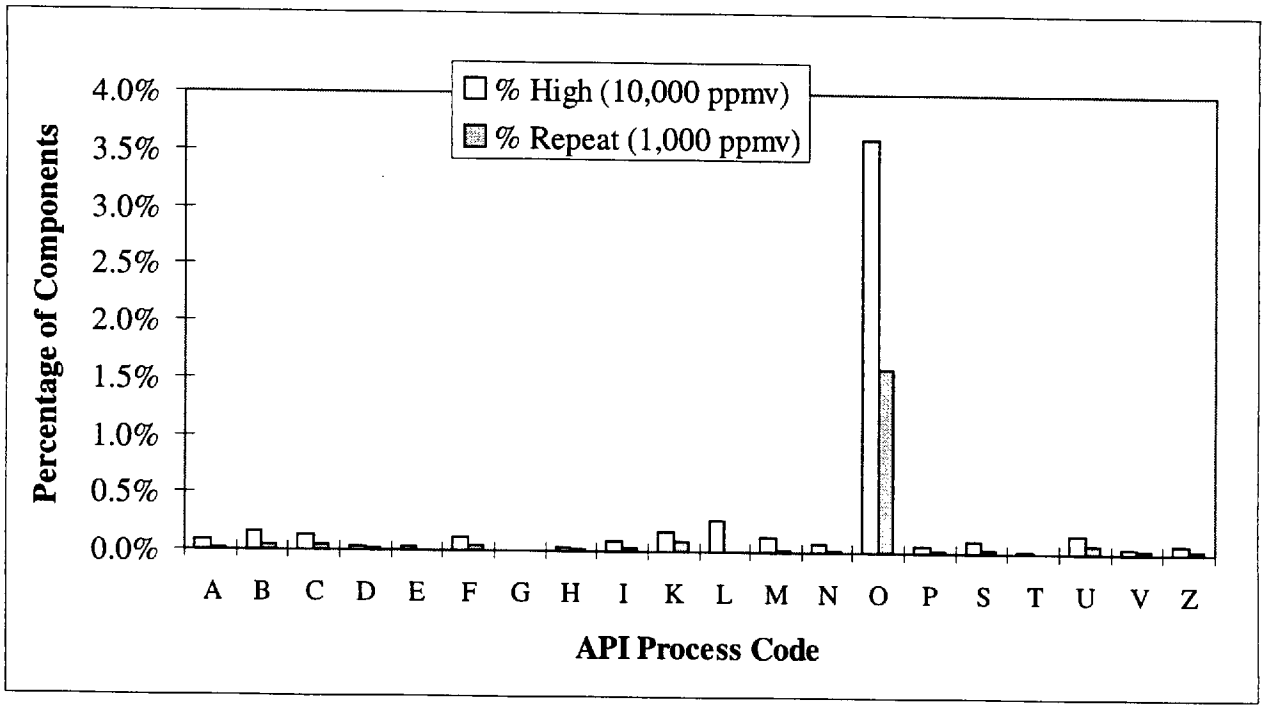


Figure 3-24. Percentage of Total Component Count for High Leakers and Repeat Leakers in Refinery Processes for **Connectors in Light Liquid Service**

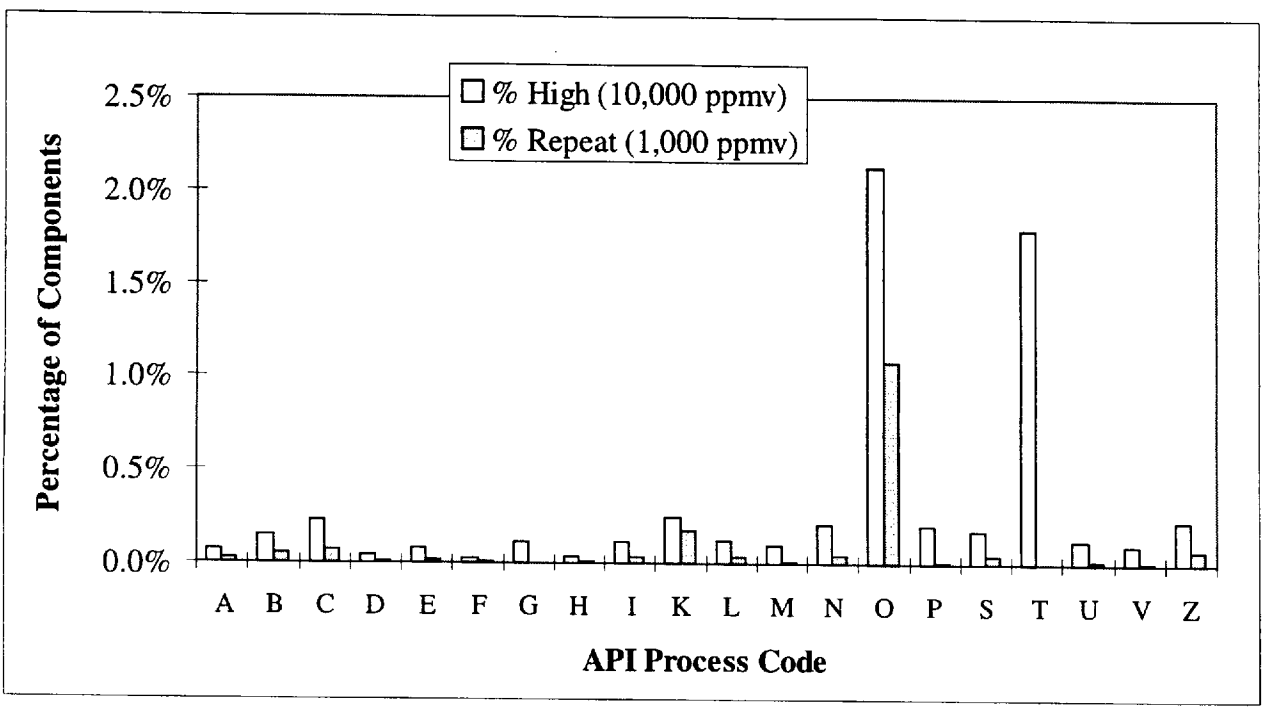


Figure 3-25. Percentage of Total Component Count for High Leakers and Repeat Leakers in Refinery Processes for **Connectors in Gas Service**

| Process Code | Emission Factor, $10^{-5}$ lb/hr | Process Code | Emission Factor, $10^{-5}$ lb/hr | Process Code | Emission Factor, $10^{-5}$ lb/hr | Process Code | Emission Factor, $10^{-5}$ lb/hr |
|---|---|---|---|---|---|---|---|
| A | 3.3094 | F | 2.9775 | L | 2.6612 | S | 4.8524 |
| B | 6.3392 | G | 2.3703 | M | 1.1905 | T | 1.0229 |
| C | 5.5898 | H | 1.6302 | N | 2.6694 | U | 2.6561 |
| D | 1.6492 | I | 3.6246 | O | 26.2551 | V | 1.3232 |
| E | 1.8670 | K | 4.8430 | P | 2.3781 | Z | 3.3888 |

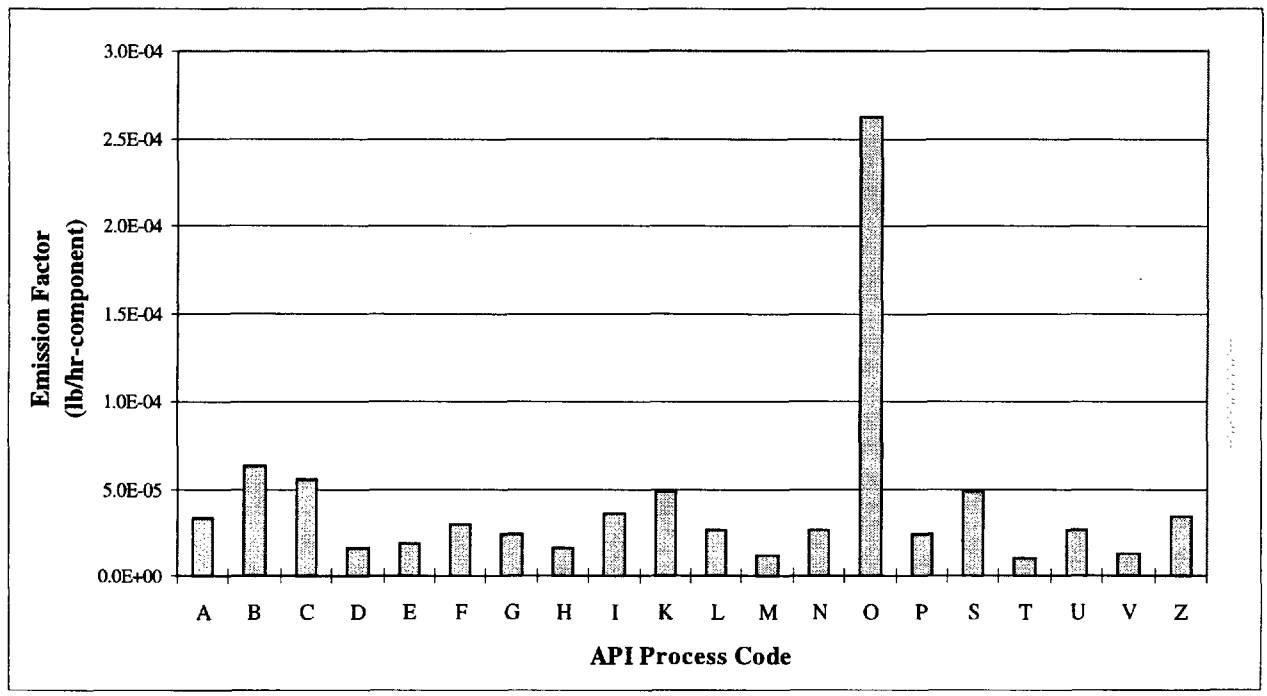


Figure 3-26. Emission Factors By Processes for **Aggregate of All Components and Services**

REFINERY-TO-REFINERY VARIATIONS

The aggregated quarterly average emissions for all components and services, from high, repeat and other leaking components, for each refinery (A through G), are presented in Figures 3-27 through 3-33. For comparison purposes, the aggregate of all refineries is shown in Figure 3-1. A comparison of the overall performance of the individual refineries is presented in Table 3-6 and Figure 3-34. In addition to the comparison on an emissions basis, Figure 3-35 shows a comparison of the percentage of the components that are high leakers (≥ 10,000 ppmv), repeat leakers (≥ 1,000 ppmv) and the others (non-repeaters

screening < 10,000 ppmv). Refinery D has consistently more leaking components and Refinery C has consistently fewer components. However, the overall range of percent leaking is low compared to other standards. For example, from *Improving Air Quality: Guidance for Estimating Fugitive Emissions from Equipment*, Table G-2, p. 153, (CMA, 1989), which extracts sections of data from the 1980 EPA refinery study, the percent of components expected to screen ≥ 10,000 ppmv is as follows:

| | | | |
|---|---|---|---|
| Valves - Gas Service - | 11.4% | Valves - Light Liquid Service - | 6.9% |
| Pumps - Light Liquid Service - | 9.6% | Connectors - All Services - | 2.0% |

Table 3-6. Comparison of Various Refinery Performance; Average Emissions, lb/hr-component

| Leak Category | 7-Refinery Aggregate | Refinery A | Refinery B | Refinery C | Refinery D | Refinery E | Refinery F | Refinery G |
|---|---|---|---|---|---|---|---|---|
| **High** | 7.34E-02 | 3.07E-02 | 4.42E-02 | 6.51E-02 | 1.10E-01 | 9.29E-02 | 7.38E-02 | 7.45E-02 |
| **Repeat** | 1.23E-02 | 4.46E-03 | 8.06E-03 | 1.28E-02 | 3.28E-02 | 1.29E-02 | 1.16E-02 | 1.43E-02 |
| **Other** | 1.12E-04 | 5.67E-05 | 6.32E-05 | 5.77E-05 | 3.51E-04 | 2.88E-04 | 1.15E-04 | 9.58E-05 |
| **Ref. Fig.** | 3-1 | 3-25 | 3-26 | 3-27 | 3-28 | 3-29 | 3-30 | 3-31 |

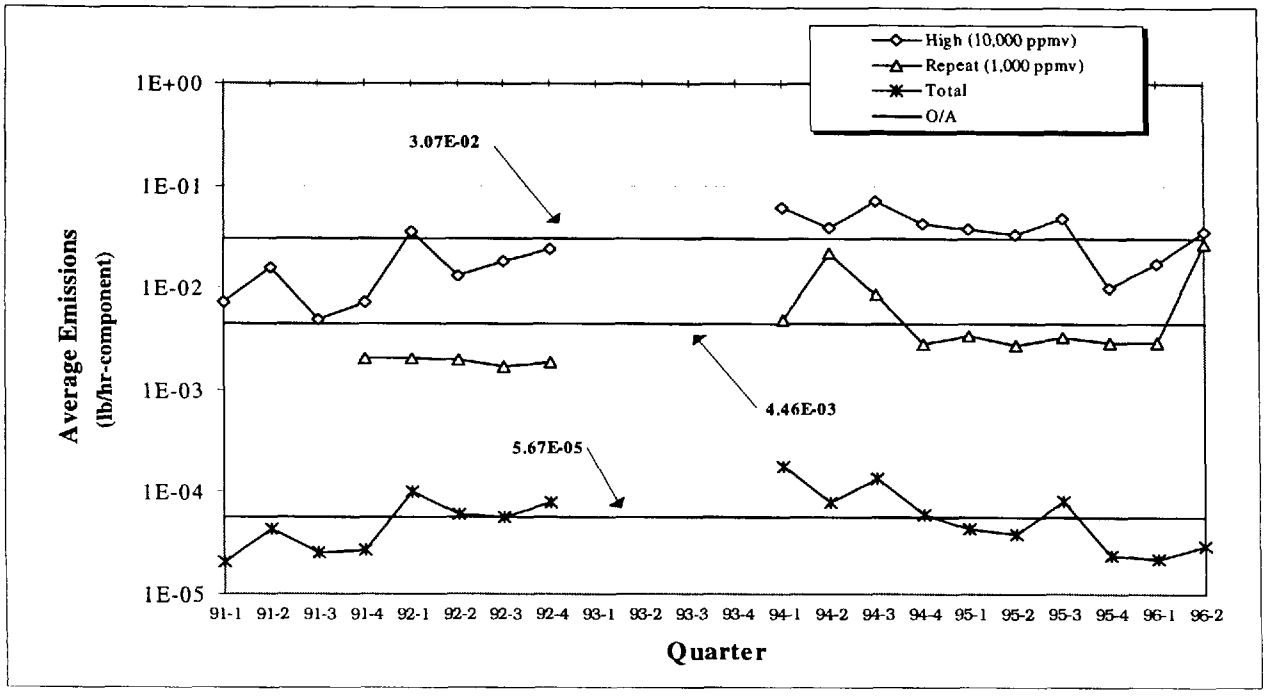


Figure 3-27. Aggregated Quarterly Emissions from High Leakers Repeat Leakers, and Total Components for **Refinery A**

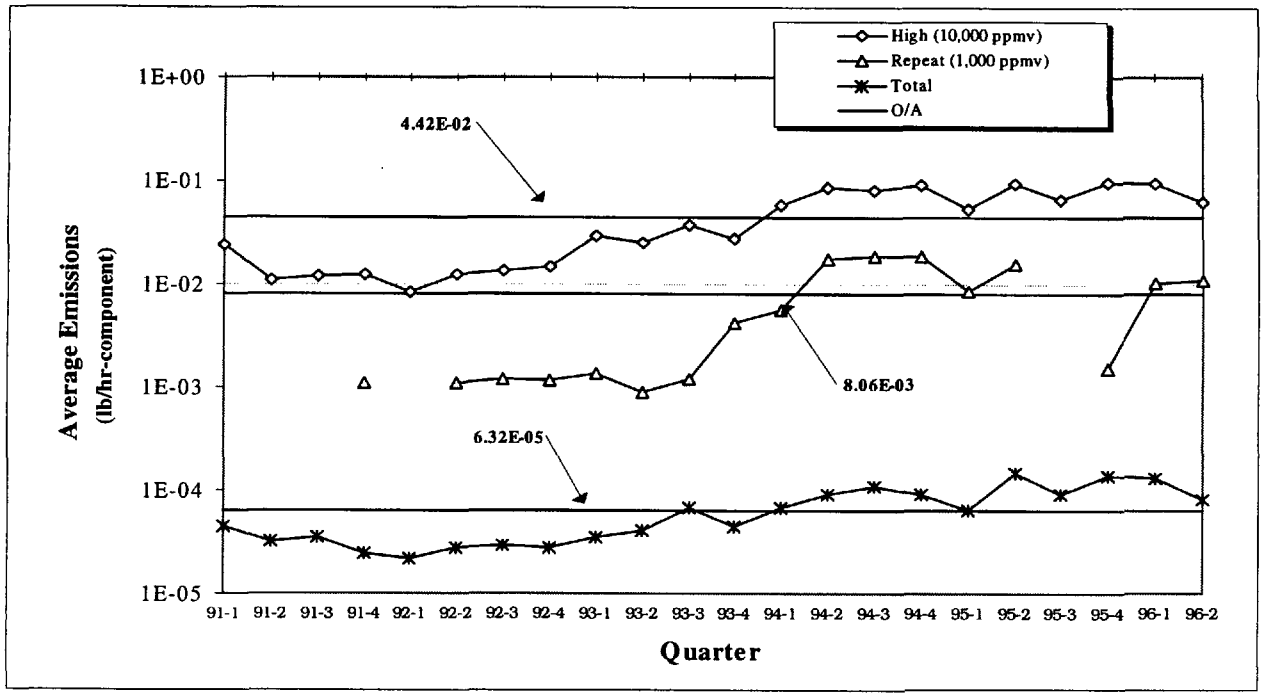


Figure 3-28. Aggregated Quarterly Emissions from High Leakers, Repeat Leakers, and Total Components for **Refinery B**

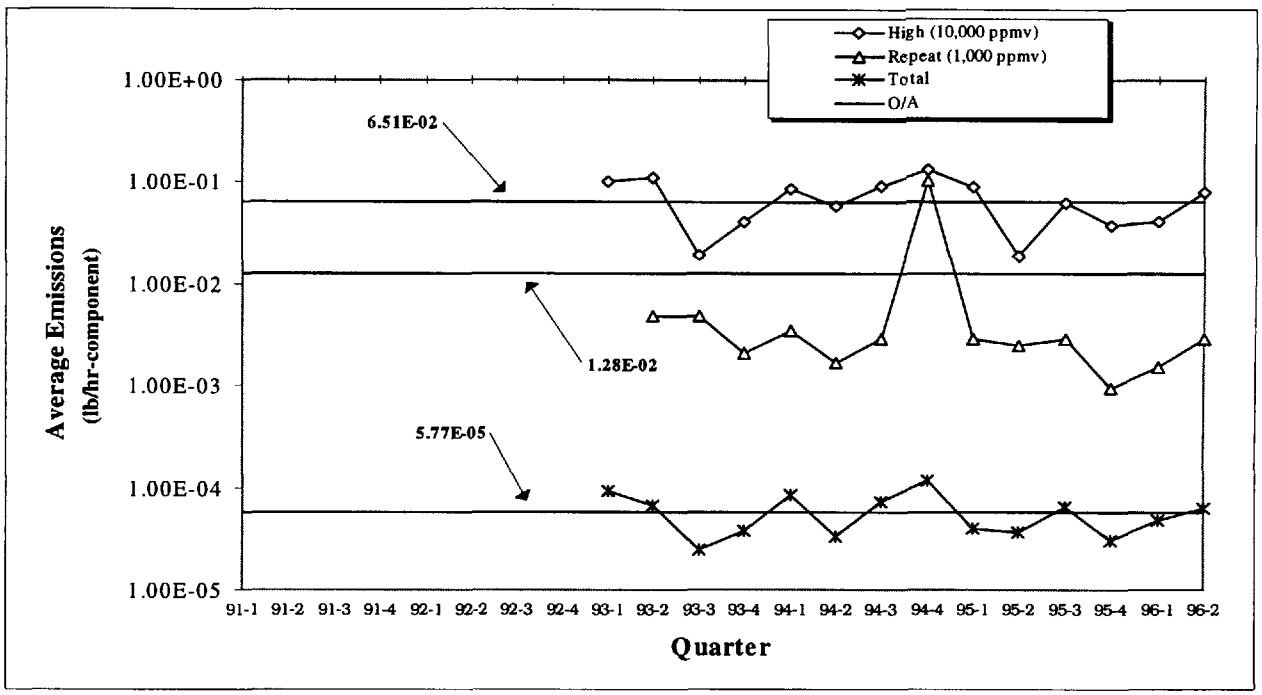


Figure 3-29. Aggregated Quarterly Emissions from High Leakers, Repeat Leakers, and Total Components for **Refinery C**

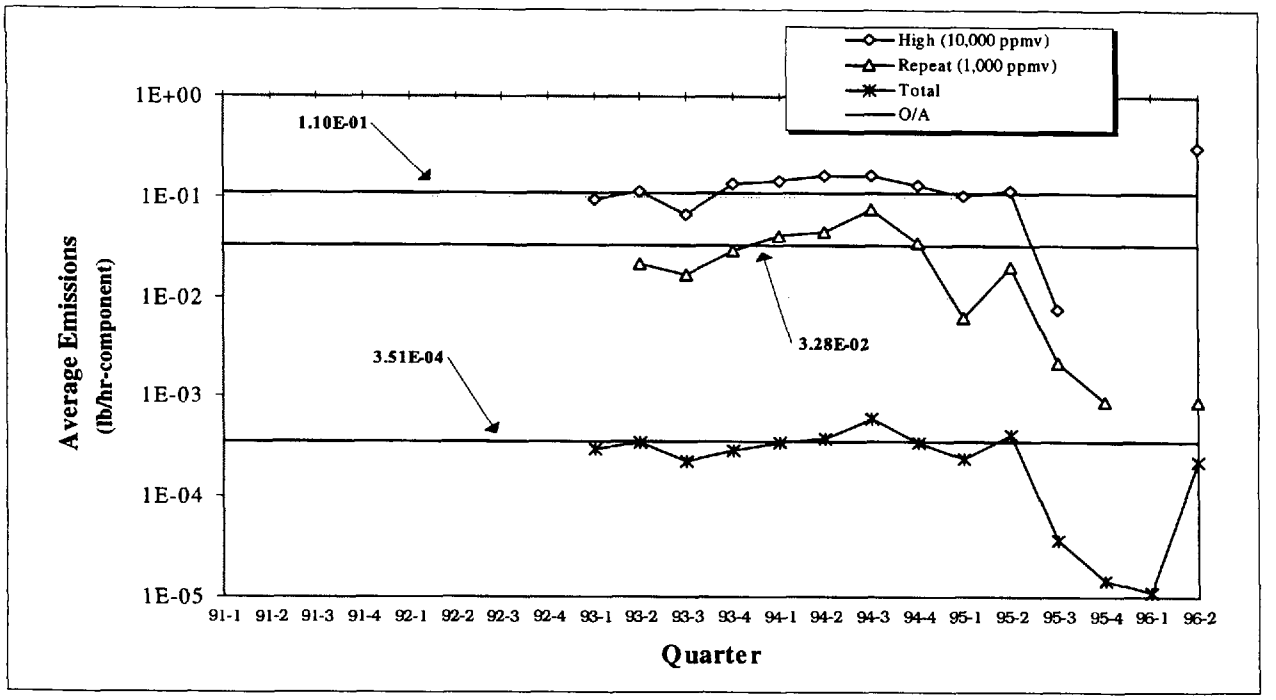


Figure 3-30. Aggregated Quarterly Emissions from High Leakers, Repeat Leakers, and Total Components for **Refinery D**

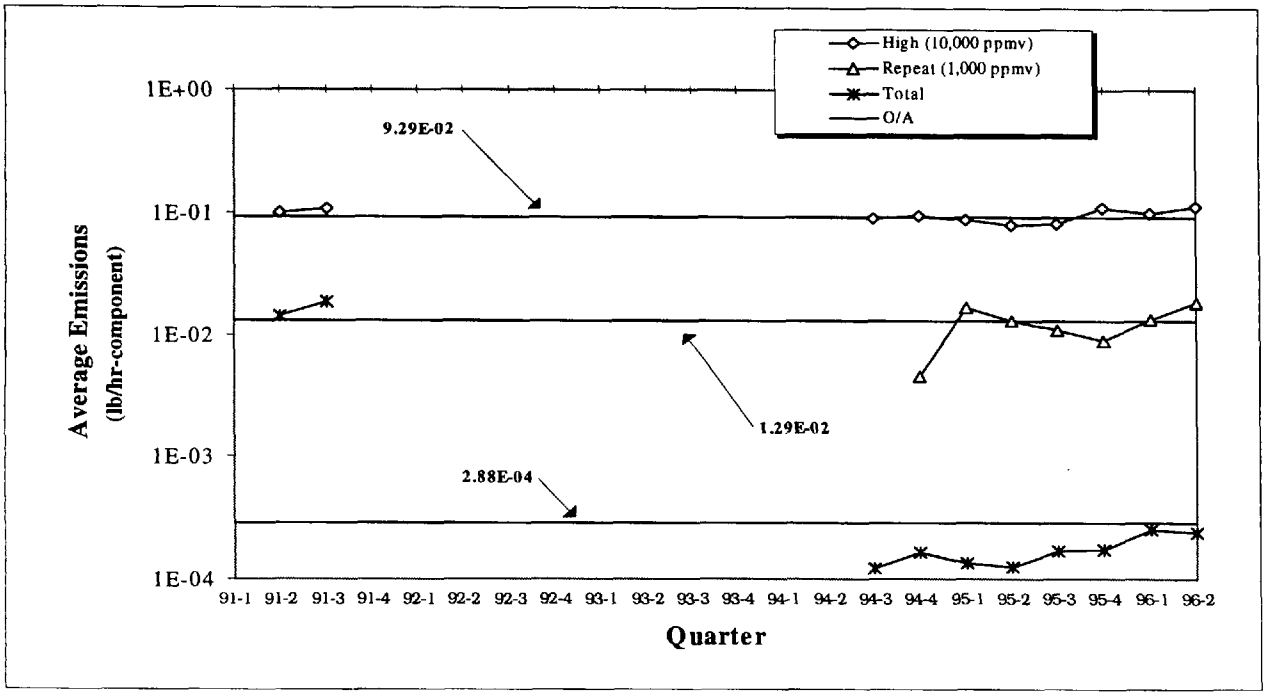


Figure 3-31. Aggregated Quarterly Emissions from High Leakers, Repeat Leakers, and Total Components for **Refinery E**

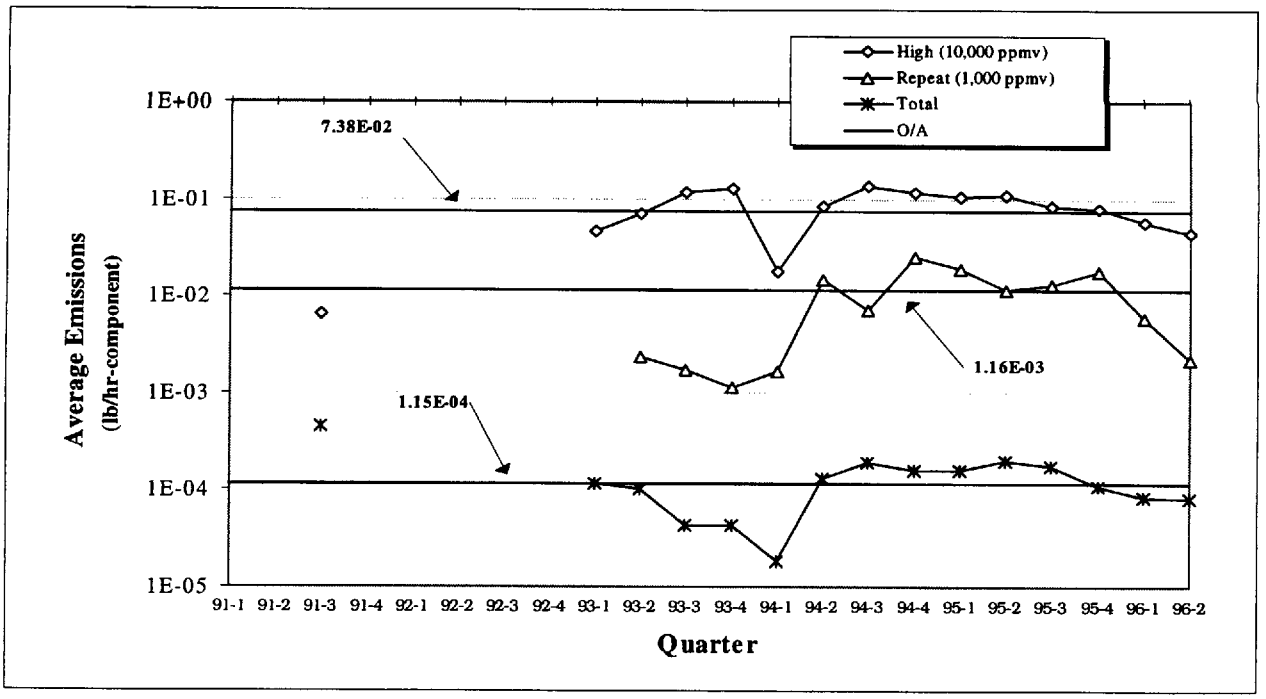


Figure 3-32. Aggregated Quarterly Emissions from High Leakers, Repeat Leakers, and Total Components for **Refinery F**

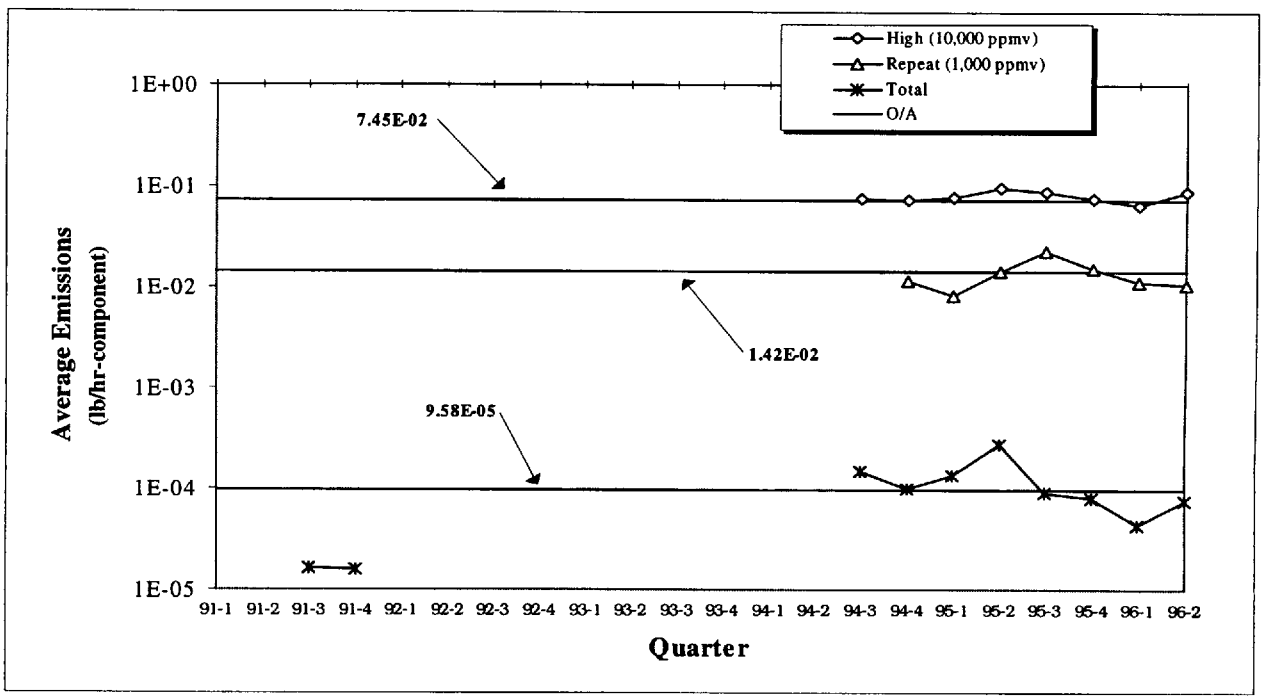


Figure 3-33. Aggregated Quarterly Emissions from High Leakers, Repeat Leakers, and Total Components for **Refinery G**

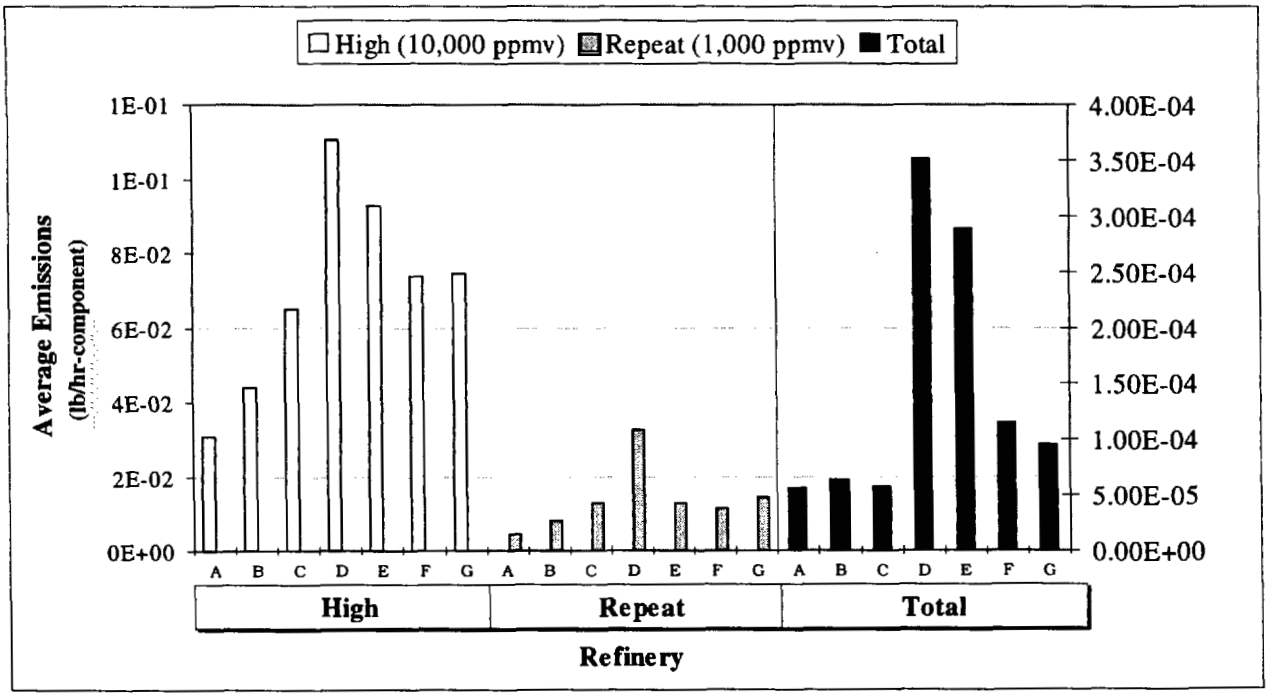


Figure 3-34. Refinery by Refinery Comparison of Average Emissions of High Leakers, Repeat Leakers and Total Components for **Aggregate of All Components and Services**

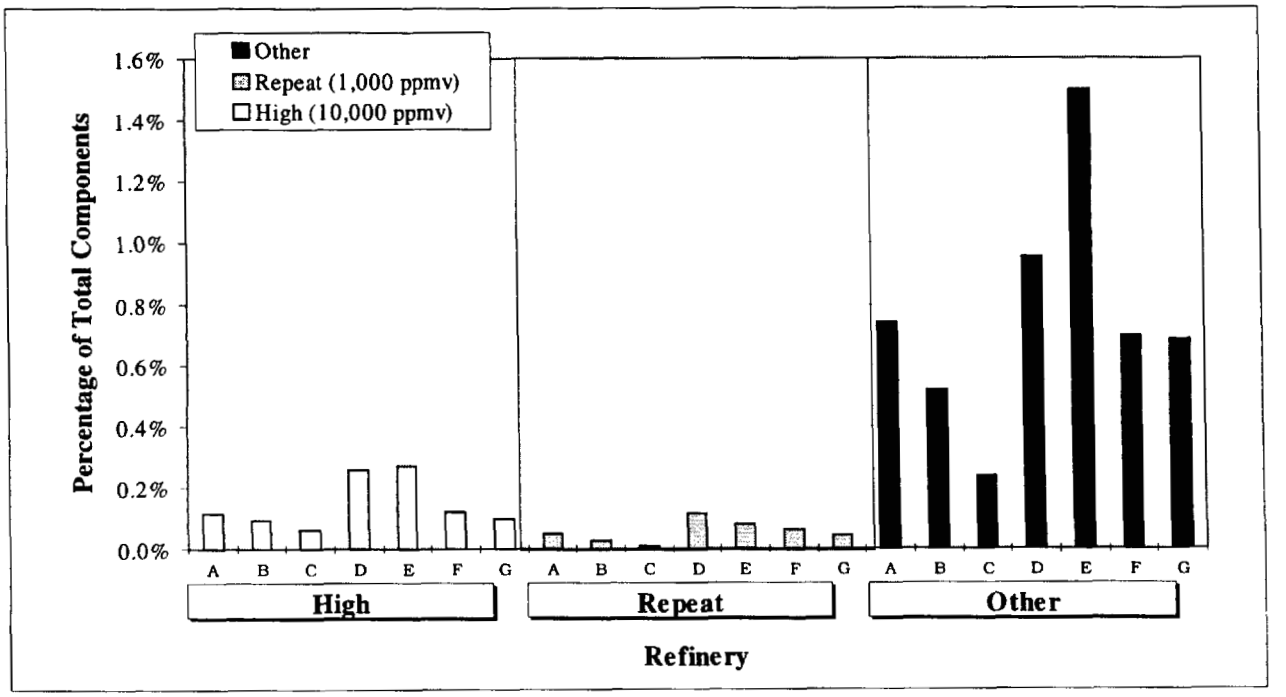


Figure 3-35. Refinery by Refinery Comparison of Percentage of Components That Are High Leakers, Repeat Leakers, and Other Components for **Aggregate of All Components and Services**

GREATER LEAK TENDENCY OF COMPONENTS IN LPG STREAMS

In investigating the individual refinery data, it was found that one refinery had reported its stream identifications. For that refinery, as shown in Table 3-7, it was found that 57 percent of the high leakers, 68 percent of the two-time high leakers (screening ≥ 10,000 ppmv) and 81 percent of the three and four times high leakers were located on specific process streams, those categorized as liquefied petroleum gas (LPG) or fuel gas streams. For the leakers over 50,000 ppmv, the LPG lines account for 62 percent. While this tendency of the LPG sections of a refinery to have disproportionately large number of high leakers was observed, it was not possible to check for these tendencies in other refineries.

Table 3-7. Proportion of High Leakers in Low Pressure Gas Line Components for Refinery A

| **Components Screening at Level Shown →** | **≥10,000 ppmv** | | **≥ 10,000 ppmv - 2X** | | **≥ 10,000 ppmv - 3X** | | **≥10,000 ppmv - 4X** | | **≥ 50,000 ppmv** | | **≥ 100,000 ppmv** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Product in Stream ↓** | **No.** | **%** | **No.** | **%** | **No.** | **%** | **No.** | **%** | **No.** | **%** | **No.** | **%** |
| Total - All Products | 1319 | 100 | 264 | 100 | 64 | 100 | 16 | 100 | 245 | 100 | 201 | 100 |
| Butane | 280 | 21.2 | 78 | 29.6 | 29 | 45.3 | 8 | 50.0 | 57 | 23.3 | 45 | 22.4 |
| Propane | 104 | 7.9 | 29 | 11.0 | 7 | 10.9 | 3 | 18.8 | 24 | 9.8 | 22 | 10.9 |
| LPG | 96 | 7.3 | 24 | 9.1 | 4 | 6.3 | 0 | 0.0 | 23 | 9.4 | 19 | 9.5 |
| Fuel Gas/ Nat'l Gas | 161 | 12.2 | 27 | 10.2 | 6 | 9.4 | 1 | 6.3 | 31 | 12.7 | 25 | 12.4 |
| Hydrogen | 106 | 8.0 | 22 | 8.3 | 6 | 9.4 | 1 | 6.3 | 19 | 7.8 | 14 | 7.0 |
| **Total LPG** | **747** | **56.6** | **180** | **68.2** | **52** | **81.3** | **13** | **81.3** | **154** | **62.9** | **125** | **62.2** |

# Section 4
# RECOMMENDATION FOR COST EFFECTIVE LDAR

Currently, LDAR programs involve screening all components and repairing and re-screening of leaking components. These programs involve extensive screening inspections of non-leaking components. From the preceding data presentation, high leakers (screening $\geq$ 10,000 ppmv) account for 92 percent of the controllable emissions from the Los Angeles refineries included in the study. Furthermore, of that 92 percent, 83 percent of the emissions are from the pegged sources (i.e., components screening $\geq$ 100,000 ppmv). Clearly, a more cost effective LDAR program would be one that does not require the monitoring of all components, but one that finds and repairs the high leakers. The perception is that the current program wastes at least 98 percent of its effort monitoring non-leakers.

Section 5

# REFERENCES

CMA, 1989. *Improving Air Quality: Guidance for Estimating Fugitive Emissions from Equipment,* Chemical Manufacturers Association, Washington, D.C.

Radian Corp., 1980, *Assessment of Atmospheric Emissions from Petroleum Refining, Vol. I, Technical Report,* Environmental Protection Agency Report EPA-600/2-80-075a, Research Triangle Park, NC.

# Appendix A
# MATRIX TABLE OF RESULTS

The following tables are intended for those interested in the exact numbers used during the study. There are five sets of tables. Each table is a summary of the information for a specific leak definition. The first table is at 500 ppmv, the second at 1,000 ppmv, and so on, as indicated by the title. Each table is divided into two pages due to the large amount of information. The first page of the table is for the first quarter of 1991 through the fourth quarter of 1993. The second page of the table is for the first quarter of 1994 through the second quarter of 1996. The quarters are listed at the top of each table (the last two numbers of the year, a dash, and the quarter). For example, 91-1 means the first quarter of 1991. Each table is divided into five sections, one section for each component type.

Each row is labeled as to the information it holds and each column is the number for that quarter of the year. The first column, however, is the aggregated total for all the quarters. This number is repeated on the second page of the table as well so that it can be referenced without having to look back to the first page. Here is an explanation of each of the row headings.

Total Components - The count of the total number of components screened.

Total Leakers - The number of components having a screening value at or above the level set in the title.

Leaked 2 or More - The number of components that were found to be leaking at least twice within the past four quarters. This represents the number of repeat leakers.

% of Leakers - The percentage of repeat leakers from total leakers.

% of Total Comp - The percentage of repeat leakers out of the total components.

The last three rows repeat but with components that leaked at least three times and with four times. Then the entire section of rows is repeated for the next component type.

Table A-1. Combined Matrix for Leakers with Values >= 500

| Fitting - Gas | Total | 91-1 | 91-2 | 91-3 | 91-4 | 92-1 | 92-2 | 92-3 | 92-4 | 93-1 | 93-2 | 93-3 | 93-4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Components | 4657771 | 86316 | 95679 | 88992 | 94185 | 128462 | 128506 | 128815 | 130269 | 177789 | 179582 | 185707 | 189235 |
| Total Leakers | 12330 | 175 | 357 | 404 | 202 | 181 | 280 | 236 | 231 | 361 | 392 | 378 | 266 |
| Leaked 2 or More | 1281 | N/A | N/A | N/A | 23 | 2 | 8 | 16 | 13 | 9 | 15 | 24 | 29 |
| % of Leakers | 10.389% | N/A | N/A | N/A | 11.386% | 1.105% | 2.857% | 6.780% | 5.628% | 2.493% | 3.827% | 6.349% | 10.902% |
| % of Total Comp | 0.028% | N/A | N/A | N/A | 0.024% | 0.002% | 0.006% | 0.012% | 0.010% | 0.005% | 0.008% | 0.013% | 0.015% |
| Leaked 3 or More | 210 | N/A | N/A | N/A | 3 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 2 |
| % of Leakers | 1.703% | N/A | N/A | N/A | 1.485% | 0.000% | 0.000% | 0.424% | 0.433% | 0.277% | 0.255% | 0.265% | 0.752% |
| % of Total Comp | 0.005% | N/A | N/A | N/A | 0.003% | 0.000% | 0.000% | 0.001% | 0.001% | 0.001% | 0.001% | 0.001% | 0.001% |
| Leaked 4 Times | 40 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.324% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.433% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.001% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.001% | 0.000% | 0.000% | 0.000% | 0.000% |
| **Fitting - Liquid** | | | | | | | | | | | | | |
| Total Components | 4310233 | 114068 | 113203 | 112949 | 112568 | 81147 | 85476 | 82158 | 84480 | 130828 | 134987 | 141000 | 146482 |
| Total Leakers | 7547 | 157 | 471 | 488 | 194 | 213 | 319 | 215 | 189 | 128 | 153 | 127 | 132 |
| Leaked 2 or More | 890 | N/A | N/A | N/A | 24 | 26 | 50 | 44 | 57 | 0 | 6 | 15 | 16 |
| % of Leakers | 11.793% | N/A | N/A | N/A | 12.371% | 12.207% | 15.674% | 20.465% | 30.159% | 0.000% | 3.922% | 11.811% | 12.121% |
| % of Total Comp | 0.021% | N/A | N/A | N/A | 0.021% | 0.032% | 0.058% | 0.054% | 0.067% | 0.000% | 0.004% | 0.011% | 0.011% |
| Leaked 3 or More | 168 | N/A | N/A | N/A | 4 | 3 | 9 | 7 | 13 | 0 | 1 | 0 | 4 |
| % of Leakers | 2.226% | N/A | N/A | N/A | 2.062% | 1.408% | 2.821% | 3.256% | 6.878% | 0.000% | 0.654% | 0.000% | 3.030% |
| % of Total Comp | 0.004% | N/A | N/A | N/A | 0.004% | 0.004% | 0.011% | 0.009% | 0.015% | 0.000% | 0.001% | 0.000% | 0.003% |
| Leaked 4 Times | 34 | N/A | N/A | N/A | 1 | 2 | 0 | 1 | 2 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.451% | N/A | N/A | N/A | 0.515% | 0.939% | 0.000% | 0.465% | 1.058% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.001% | N/A | N/A | N/A | 0.001% | 0.002% | 0.000% | 0.001% | 0.002% | 0.000% | 0.000% | 0.000% | 0.000% |
| **Pump - Liquid** | | | | | | | | | | | | | |
| Total Components | 34431 | 374 | 417 | 461 | 410 | 604 | 606 | 604 | 607 | 1010 | 1010 | 1057 | 1001 |
| Total Leakers | 1102 | 15 | 17 | 34 | 4 | 24 | 32 | 32 | 39 | 27 | 32 | 27 | 19 |
| Leaked 2 or More | 303 | N/A | N/A | N/A | 3 | 7 | 10 | 6 | 15 | 2 | 4 | 5 | 3 |
| % of Leakers | 27.495% | N/A | N/A | N/A | 75.000% | 29.167% | 31.250% | 18.750% | 38.462% | 7.407% | 12.500% | 18.519% | 15.789% |
| % of Total Comp | 0.880% | N/A | N/A | N/A | 0.732% | 1.159% | 1.650% | 0.993% | 2.471% | 0.198% | 0.396% | 0.473% | 0.300% |
| Leaked 3 or More | 83 | N/A | N/A | N/A | 0 | 1 | 5 | 3 | 4 | 0 | 0 | 1 | 1 |
| % of Leakers | 7.532% | N/A | N/A | N/A | 0.000% | 4.167% | 15.625% | 9.375% | 10.256% | 0.000% | 0.000% | 3.704% | 5.263% |
| % of Total Comp | 0.241% | N/A | N/A | N/A | 0.000% | 0.166% | 0.825% | 0.497% | 0.659% | 0.000% | 0.000% | 0.095% | 0.100% |
| Leaked 4 Times | 16 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 1.452% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.046% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| **Valve - Gas** | | | | | | | | | | | | | |
| Total Components | 1494303 | 27036 | 34048 | 32225 | 31231 | 37455 | 37515 | 37696 | 37607 | 57576 | 57546 | 61249 | 57949 |
| Total Leakers | 14453 | 410 | 702 | 709 | 348 | 367 | 372 | 430 | 336 | 407 | 475 | 578 | 433 |
| Leaked 2 or More | 2503 | N/A | N/A | N/A | 67 | 6 | 43 | 74 | 69 | 28 | 56 | 67 | 82 |
| % of Leakers | 17.318% | N/A | N/A | N/A | 19.253% | 1.635% | 11.559% | 17.209% | 20.536% | 6.880% | 11.789% | 11.592% | 18.938% |
| % of Total Comp | 0.168% | N/A | N/A | N/A | 0.215% | 0.016% | 0.115% | 0.196% | 0.183% | 0.049% | 0.097% | 0.109% | 0.142% |
| Leaked 3 or More | 511 | N/A | N/A | N/A | 12 | 1 | 1 | 7 | 16 | 5 | 6 | 10 | 13 |
| % of Leakers | 3.536% | N/A | N/A | N/A | 3.448% | 0.272% | 0.269% | 1.628% | 4.762% | 1.229% | 1.263% | 1.730% | 3.002% |
| % of Total Comp | 0.034% | N/A | N/A | N/A | 0.038% | 0.003% | 0.003% | 0.019% | 0.043% | 0.009% | 0.010% | 0.016% | 0.022% |
| Leaked 4 Times | 81 | N/A | N/A | N/A | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| % of Leakers | 0.560% | N/A | N/A | N/A | 0.862% | 0.000% | 0.000% | 0.000% | 0.298% | 0.000% | 0.000% | 0.000% | 0.231% |
| % of Total Comp | 0.005% | N/A | N/A | N/A | 0.010% | 0.000% | 0.000% | 0.000% | 0.003% | 0.000% | 0.000% | 0.000% | 0.002% |
| **Valve - Liquid** | | | | | | | | | | | | | |
| Total Components | 1364399 | 34781 | 32115 | 33199 | 31624 | 23645 | 23676 | 23956 | 23871 | 50728 | 50807 | 54166 | 50760 |
| Total Leakers | 13817 | 458 | 1163 | 1335 | 386 | 406 | 477 | 451 | 354 | 361 | 361 | 386 | 394 |
| Leaked 2 or More | 2567 | N/A | N/A | N/A | 92 | 83 | 130 | 150 | 149 | 18 | 60 | 64 | 84 |
| % of Leakers | 18.579% | N/A | N/A | N/A | 23.834% | 20.443% | 27.254% | 33.259% | 42.090% | 4.986% | 16.620% | 16.580% | 21.320% |
| % of Total Comp | 0.188% | N/A | N/A | N/A | 0.291% | 0.351% | 0.549% | 0.626% | 0.624% | 0.035% | 0.118% | 0.118% | 0.165% |
| Leaked 3 or More | 596 | N/A | N/A | N/A | 24 | 17 | 26 | 31 | 43 | 6 | 4 | 7 | 18 |
| % of Leakers | 4.314% | N/A | N/A | N/A | 6.218% | 4.187% | 5.451% | 6.874% | 12.147% | 1.662% | 1.108% | 1.813% | 4.569% |
| % of Total Comp | 0.044% | N/A | N/A | N/A | 0.076% | 0.072% | 0.110% | 0.129% | 0.180% | 0.012% | 0.008% | 0.013% | 0.035% |
| Leaked 4 Times | 94 | N/A | N/A | N/A | 1 | 5 | 2 | 3 | 8 | 1 | 1 | 1 | 1 |
| % of Leakers | 0.680% | N/A | N/A | N/A | 0.259% | 1.232% | 0.419% | 0.665% | 2.260% | 0.277% | 0.277% | 0.259% | 0.254% |
| % of Total Comp | 0.007% | N/A | N/A | N/A | 0.003% | 0.021% | 0.008% | 0.013% | 0.034% | 0.002% | 0.002% | 0.002% | 0.002% |
| Total Components | 11861137 | 262575 | 275462 | 267826 | 270018 | 271313 | 275779 | 273229 | 276834 | 417931 | 423932 | 443179 | 445427 |

Table A-1. Combined Matrix for Leakers with Values >= 500 (continued)

| Fitting - Gas | Total | 94-1 | 94-2 | 94-3 | 94-4 | 95-1 | 95-2 | 95-3 | 95-4 | 96-1 | 96-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Components | 4657771 | 207828 | 212462 | 300659 | 302539 | 275600 | 287896 | 347880 | 362524 | 367645 | 379201 |
| Total Leakers | 12330 | 364 | 424 | 800 | 771 | 769 | 1308 | 1232 | 1101 | 977 | 1121 |
| Leaked 2 or More | 1281 | 24 | 26 | 39 | 81 | 106 | 184 | 158 | 159 | 178 | 187 |
| % of Leakers | 10.389% | 6.593% | 6.132% | 4.875% | 10.506% | 13.784% | 14.067% | 12.825% | 14.441% | 18.219% | 16.682% |
| % of Total Comp | 0.028% | 0.012% | 0.012% | 0.013% | 0.027% | 0.038% | 0.064% | 0.045% | 0.044% | 0.048% | 0.049% |
| Leaked 3 or More | 210 | 3 | 0 | 6 | 9 | 18 | 36 | 31 | 30 | 30 | 37 |
| % of Leakers | 1.703% | 0.824% | 0.000% | 0.750% | 1.167% | 2.341% | 2.752% | 2.516% | 2.725% | 3.071% | 3.301% |
| % of Total Comp | 0.005% | 0.001% | 0.000% | 0.002% | 0.003% | 0.007% | 0.013% | 0.009% | 0.008% | 0.008% | 0.010% |
| Leaked 4 Times | 40 | 1 | 0 | 0 | 3 | 2 | 8 | 10 | 9 | 3 | 3 |
| % of Leakers | 0.324% | 0.275% | 0.000% | 0.000% | 0.389% | 0.260% | 0.612% | 0.812% | 0.817% | 0.307% | 0.268% |
| % of Total Comp | 0.001% | 0.000% | 0.000% | 0.000% | 0.001% | 0.001% | 0.003% | 0.003% | 0.002% | 0.001% | 0.001% |
| **Fitting - Liquid** | | | | | | | | | | | |
| Total Components | 4310233 | 170644 | 178590 | 267999 | 278592 | 284082 | 288115 | 354230 | 351719 | 390172 | 406744 |
| Total Leakers | 7547 | 209 | 184 | 417 | 404 | 411 | 582 | 631 | 488 | 686 | 749 |
| Leaked 2 or More | 890 | 12 | 13 | 26 | 56 | 58 | 95 | 95 | 65 | 95 | 137 |
| % of Leakers | 11.793% | 5.742% | 7.065% | 6.235% | 13.861% | 14.112% | 16.323% | 15.055% | 13.320% | 13.848% | 18.291% |
| % of Total Comp | 0.021% | 0.007% | 0.007% | 0.010% | 0.020% | 0.020% | 0.033% | 0.027% | 0.018% | 0.024% | 0.034% |
| Leaked 3 or More | 168 | 3 | 0 | 2 | 3 | 12 | 27 | 25 | 13 | 12 | 30 |
| % of Leakers | 2.226% | 1.435% | 0.000% | 0.480% | 0.743% | 2.920% | 4.639% | 3.962% | 2.664% | 1.749% | 4.005% |
| % of Total Comp | 0.004% | 0.002% | 0.000% | 0.001% | 0.001% | 0.004% | 0.009% | 0.007% | 0.004% | 0.003% | 0.007% |
| Leaked 4 Times | 34 | 0 | 0 | 0 | 0 | 0 | 7 | 10 | 4 | 2 | 5 |
| % of Leakers | 0.451% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 1.203% | 1.585% | 0.820% | 0.292% | 0.668% |
| % of Total Comp | 0.001% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.002% | 0.003% | 0.001% | 0.001% | 0.001% |
| **Pump - Liquid** | | | | | | | | | | | |
| Total Components | 34431 | 1271 | 1289 | 2061 | 2188 | 2160 | 2177 | 3791 | 3686 | 3653 | 3994 |
| Total Leakers | 1102 | 41 | 56 | 94 | 77 | 77 | 100 | 105 | 85 | 82 | 83 |
| Leaked 2 or More | 303 | 10 | 17 | 21 | 29 | 27 | 30 | 23 | 31 | 28 | 32 |
| % of Leakers | 27.495% | 24.390% | 30.357% | 22.340% | 37.662% | 35.065% | 30.000% | 21.905% | 36.471% | 34.146% | 38.554% |
| % of Total Comp | 0.880% | 0.787% | 1.319% | 1.019% | 1.325% | 1.250% | 1.378% | 0.607% | 0.841% | 0.766% | 0.801% |
| Leaked 3 or More | 83 | 1 | 3 | 6 | 5 | 10 | 7 | 11 | 4 | 10 | 11 |
| % of Leakers | 7.532% | 2.439% | 5.357% | 6.383% | 6.494% | 12.987% | 7.000% | 10.476% | 4.706% | 12.195% | 13.253% |
| % of Total Comp | 0.241% | 0.079% | 0.233% | 0.291% | 0.229% | 0.463% | 0.322% | 0.290% | 0.109% | 0.274% | 0.275% |
| Leaked 4 Times | 16 | 0 | 0 | 0 | 1 | 3 | 2 | 4 | 2 | 0 | 4 |
| % of Leakers | 1.452% | 0.000% | 0.000% | 0.000% | 1.299% | 3.896% | 2.000% | 3.810% | 2.353% | 0.000% | 4.819% |
| % of Total Comp | 0.046% | 0.000% | 0.000% | 0.000% | 0.046% | 0.139% | 0.092% | 0.106% | 0.054% | 0.000% | 0.100% |
| **Valve - Gas** | | | | | | | | | | | |
| Total Components | 1494303 | 68268 | 68756 | 108119 | 110670 | 101227 | 106169 | 103955 | 101357 | 102736 | 113913 |
| Total Leakers | 14453 | 542 | 651 | 1010 | 1044 | 860 | 1018 | 1175 | 996 | 768 | 822 |
| Leaked 2 or More | 2503 | 87 | 90 | 146 | 219 | 204 | 263 | 253 | 241 | 232 | 276 |
| % of Leakers | 17.318% | 16.052% | 13.825% | 14.455% | 20.977% | 23.721% | 25.835% | 21.532% | 24.197% | 30.208% | 33.577% |
| % of Total Comp | 0.168% | 0.127% | 0.131% | 0.135% | 0.198% | 0.202% | 0.248% | 0.243% | 0.238% | 0.226% | 0.242% |
| Leaked 3 or More | 511 | 18 | 22 | 23 | 37 | 34 | 54 | 53 | 55 | 52 | 92 |
| % of Leakers | 3.536% | 3.321% | 3.379% | 2.277% | 3.544% | 3.953% | 5.305% | 4.511% | 5.522% | 6.771% | 11.192% |
| % of Total Comp | 0.034% | 0.026% | 0.032% | 0.021% | 0.033% | 0.034% | 0.051% | 0.051% | 0.054% | 0.051% | 0.081% |
| Leaked 4 Times | 81 | 2 | 7 | 2 | 6 | 2 | 6 | 8 | 10 | 15 | 18 |
| % of Leakers | 0.560% | 0.369% | 1.075% | 0.198% | 0.575% | 0.233% | 0.589% | 0.681% | 1.004% | 1.953% | 2.190% |
| % of Total Comp | 0.005% | 0.003% | 0.010% | 0.002% | 0.005% | 0.002% | 0.006% | 0.008% | 0.010% | 0.015% | 0.016% |
| **Valve - Liquid** | | | | | | | | | | | |
| Total Components | 1364399 | 60176 | 60910 | 101800 | 105120 | 102263 | 104926 | 97831 | 93627 | 101419 | 102999 |
| Total Leakers | 13817 | 451 | 482 | 917 | 934 | 732 | 910 | 905 | 716 | 585 | 653 |
| Leaked 2 or More | 2567 | 66 | 90 | 130 | 236 | 187 | 255 | 222 | 186 | 165 | 200 |
| % of Leakers | 18.579% | 14.634% | 18.672% | 14.177% | 25.268% | 25.546% | 28.022% | 24.530% | 25.978% | 28.205% | 30.628% |
| % of Total Comp | 0.188% | 0.110% | 0.148% | 0.128% | 0.225% | 0.183% | 0.243% | 0.227% | 0.199% | 0.163% | 0.194% |
| Leaked 3 or More | 596 | 10 | 12 | 23 | 37 | 41 | 62 | 69 | 52 | 46 | 68 |
| % of Leakers | 4.314% | 2.217% | 2.490% | 2.508% | 3.961% | 5.601% | 6.813% | 7.624% | 7.263% | 7.863% | 10.413% |
| % of Total Comp | 0.044% | 0.017% | 0.020% | 0.023% | 0.035% | 0.040% | 0.059% | 0.071% | 0.056% | 0.045% | 0.066% |
| Leaked 4 Times | 94 | 0 | 0 | 0 | 3 | 2 | 10 | 15 | 15 | 14 | 12 |
| % of Leakers | 0.680% | 0.000% | 0.000% | 0.000% | 0.321% | 0.273% | 1.099% | 1.657% | 2.095% | 2.393% | 1.838% |
| % of Total Comp | 0.007% | 0.000% | 0.000% | 0.000% | 0.003% | 0.002% | 0.010% | 0.015% | 0.016% | 0.014% | 0.012% |
| Total Components | 11861137 | 508187 | 522007 | 780638 | 799109 | 765332 | 789283 | 907687 | 912913 | 965625 | 1006851 |

Table A-2. Combined Matrix for Leakers with Values >= 1,000

| Fitting - Gas | Total | 91-1 | 91-2 | 91-3 | 91-4 | 92-1 | 92-2 | 92-3 | 92-4 | 93-1 | 93-2 | 93-3 | 93-4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Components | 4657771 | 86316 | 95679 | 88992 | 94185 | 128462 | 128506 | 128815 | 130269 | 177789 | 179582 | 185707 | 189235 |
| Total Leakers | 10722 | 164 | 315 | 294 | 171 | 161 | 259 | 203 | 219 | 352 | 379 | 323 | 240 |
| Leaked 2 or More | 1014 | N/A | N/A | N/A | 20 | 1 | 7 | 14 | 12 | 9 | 15 | 24 | 26 |
| % of Leakers | 9.457% | N/A | N/A | N/A | 11.696% | 0.621% | 2.703% | 6.897% | 5.479% | 2.557% | 3.958% | 7.430% | 10.833% |
| % of Total Comp | 0.022% | N/A | N/A | N/A | 0.021% | 0.001% | 0.005% | 0.011% | 0.009% | 0.005% | 0.008% | 0.013% | 0.014% |
| Leaked 3 or More | 144 | N/A | N/A | N/A | 3 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 2 |
| % of Leakers | 1.343% | N/A | N/A | N/A | 1.754% | 0.000% | 0.000% | 0.000% | 0.000% | 0.284% | 0.264% | 0.310% | 0.833% |
| % of Total Comp | 0.003% | N/A | N/A | N/A | 0.003% | 0.000% | 0.000% | 0.000% | 0.000% | 0.001% | 0.001% | 0.001% | 0.001% |
| Leaked 4 Times | 29 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| % of Leakers | 0.270% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.310% | 0.000% |
| % of Total Comp | 0.001% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.001% | 0.000% |
| **Fitting - Liquid** | | | | | | | | | | | | | |
| Total Components | 4310233 | 114068 | 113203 | 112949 | 112568 | 81147 | 85476 | 82158 | 84480 | 130828 | 134987 | 141000 | 146482 |
| Total Leakers | 6174 | 139 | 374 | 410 | 122 | 146 | 267 | 155 | 137 | 122 | 142 | 112 | 115 |
| Leaked 2 or More | 653 | N/A | N/A | N/A | 16 | 12 | 34 | 21 | 31 | 0 | 5 | 15 | 14 |
| % of Leakers | 10.577% | N/A | N/A | N/A | 13.115% | 8.219% | 12.734% | 13.548% | 22.628% | 0.000% | 3.521% | 13.393% | 12.174% |
| % of Total Comp | 0.015% | N/A | N/A | N/A | 0.014% | 0.015% | 0.040% | 0.026% | 0.037% | 0.000% | 0.004% | 0.011% | 0.010% |
| Leaked 3 or More | 114 | N/A | N/A | N/A | 3 | 1 | 3 | 4 | 2 | 0 | 1 | 0 | 4 |
| % of Leakers | 1.846% | N/A | N/A | N/A | 2.459% | 0.685% | 1.124% | 2.581% | 1.460% | 0.000% | 0.704% | 0.000% | 3.478% |
| % of Total Comp | 0.003% | N/A | N/A | N/A | 0.003% | 0.001% | 0.004% | 0.005% | 0.002% | 0.000% | 0.001% | 0.000% | 0.003% |
| Leaked 4 Times | 23 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.373% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.001% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| **Pump - Liquid** | | | | | | | | | | | | | |
| Total Components | 34431 | 374 | 417 | 461 | 410 | 604 | 606 | 604 | 607 | 1010 | 1010 | 1057 | 1001 |
| Total Leakers | 861 | 12 | 10 | 23 | 2 | 12 | 23 | 23 | 25 | 26 | 29 | 19 | 14 |
| Leaked 2 or More | 207 | N/A | N/A | N/A | 1 | 4 | 4 | 4 | 7 | 1 | 3 | 3 | 3 |
| % of Leakers | 24.042% | N/A | N/A | N/A | 50.000% | 33.333% | 17.391% | 17.391% | 28.000% | 3.846% | 10.345% | 15.789% | 21.429% |
| % of Total Comp | 0.601% | N/A | N/A | N/A | 0.244% | 0.662% | 0.660% | 0.662% | 1.153% | 0.099% | 0.297% | 0.284% | 0.300% |
| Leaked 3 or More | 45 | N/A | N/A | N/A | 0 | 0 | 1 | 2 | 1 | 0 | 0 | 1 | 0 |
| % of Leakers | 5.226% | N/A | N/A | N/A | 0.000% | 0.000% | 4.348% | 8.696% | 4.000% | 0.000% | 0.000% | 5.263% | 0.000% |
| % of Total Comp | 0.131% | N/A | N/A | N/A | 0.000% | 0.000% | 0.165% | 0.331% | 0.165% | 0.000% | 0.000% | 0.095% | 0.000% |
| Leaked 4 Times | 12 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 1.394% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.035% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| **Valve - Gas** | | | | | | | | | | | | | |
| Total Components | 1494303 | 27036 | 34048 | 32225 | 31231 | 37455 | 37515 | 37696 | 37607 | 57576 | 57546 | 61249 | 57949 |
| Total Leakers | 12731 | 389 | 633 | 632 | 305 | 341 | 334 | 381 | 297 | 394 | 461 | 516 | 402 |
| Leaked 2 or More | 1962 | N/A | N/A | N/A | 58 | 5 | 32 | 54 | 51 | 25 | 52 | 58 | 64 |
| % of Leakers | 15.411% | N/A | N/A | N/A | 19.016% | 1.466% | 9.581% | 14.173% | 17.172% | 6.345% | 11.280% | 11.240% | 15.920% |
| % of Total Comp | 0.131% | N/A | N/A | N/A | 0.186% | 0.013% | 0.085% | 0.143% | 0.136% | 0.043% | 0.090% | 0.095% | 0.110% |
| Leaked 3 or More | 362 | N/A | N/A | N/A | 11 | 0 | 0 | 4 | 9 | 4 | 6 | 6 | 10 |
| % of Leakers | 2.843% | N/A | N/A | N/A | 3.607% | 0.000% | 0.000% | 1.050% | 3.030% | 1.015% | 1.302% | 1.163% | 2.488% |
| % of Total Comp | 0.024% | N/A | N/A | N/A | 0.035% | 0.000% | 0.000% | 0.011% | 0.024% | 0.007% | 0.010% | 0.010% | 0.017% |
| Leaked 4 Times | 48 | N/A | N/A | N/A | 3 | 0 | 1 | 0 | 0 | 0 | 1 | 2 | 7 |
| % of Leakers | 0.377% | N/A | N/A | N/A | 0.984% | 0.000% | 0.299% | 0.000% | 0.000% | 0.000% | 0.217% | 0.388% | 1.741% |
| % of Total Comp | 0.003% | N/A | N/A | N/A | 0.010% | 0.000% | 0.003% | 0.000% | 0.000% | 0.000% | 0.002% | 0.003% | 0.012% |
| **Valve - Liquid** | | | | | | | | | | | | | |
| Total Components | 1364399 | 34781 | 32115 | 33199 | 31624 | 23645 | 23676 | 23956 | 23871 | 50728 | 50807 | 54166 | 50760 |
| Total Leakers | 11472 | 415 | 963 | 1119 | 284 | 296 | 363 | 342 | 274 | 347 | 342 | 331 | 339 |
| Leaked 2 or More | 1777 | N/A | N/A | N/A | 58 | 32 | 51 | 64 | 83 | 16 | 57 | 54 | 64 |
| % of Leakers | 15.490% | N/A | N/A | N/A | 20.423% | 10.811% | 14.050% | 18.713% | 30.292% | 4.611% | 16.667% | 16.314% | 18.879% |
| % of Total Comp | 0.130% | N/A | N/A | N/A | 0.183% | 0.135% | 0.215% | 0.267% | 0.348% | 0.032% | 0.112% | 0.100% | 0.126% |
| Leaked 3 or More | 349 | N/A | N/A | N/A | 14 | 7 | 4 | 8 | 15 | 6 | 3 | 7 | 17 |
| % of Leakers | 3.042% | N/A | N/A | N/A | 4.930% | 2.365% | 1.102% | 2.339% | 5.474% | 1.729% | 0.877% | 2.115% | 5.015% |
| % of Total Comp | 0.026% | N/A | N/A | N/A | 0.044% | 0.030% | 0.017% | 0.033% | 0.063% | 0.012% | 0.006% | 0.013% | 0.033% |
| Leaked 4 Times | 45 | N/A | N/A | N/A | 0 | 3 | 2 | 1 | 1 | 1 | 1 | 0 | 0 |
| % of Leakers | 0.392% | N/A | N/A | N/A | 0.000% | 1.014% | 0.551% | 0.292% | 0.365% | 0.288% | 0.292% | 0.000% | 0.000% |
| % of Total Comp | 0.003% | N/A | N/A | N/A | 0.000% | 0.013% | 0.008% | 0.004% | 0.004% | 0.002% | 0.002% | 0.000% | 0.000% |
| Total Components | 11861137 | 262575 | 275462 | 267826 | 270018 | 271313 | 275779 | 273229 | 276834 | 417931 | 423932 | 443179 | 445427 |

Table A-2. Combined Matrix for Leakers with Values >= 1,000 (continued)

| Fitting - Gas | Total | 94-1 | 94-2 | 94-3 | 94-4 | 95-1 | 95-2 | 95-3 | 95-4 | 96-1 | 96-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Components | 4657771 | 207828 | 212462 | 300659 | 302539 | 275600 | 287896 | 347880 | 362524 | 367645 | 379201 |
| Total Leakers | 10722 | 338 | 397 | 707 | 660 | 679 | 1143 | 1032 | 884 | 859 | 943 |
| Leaked 2 or More | 1014 | 19 | 22 | 29 | 63 | 87 | 152 | 117 | 117 | 149 | 131 |
| % of Leakers | 9.457% | 5.621% | 5.542% | 4.102% | 9.545% | 12.813% | 13.298% | 11.337% | 13.235% | 17.346% | 13.892% |
| % of Total Comp | 0.022% | 0.009% | 0.010% | 0.010% | 0.021% | 0.032% | 0.053% | 0.034% | 0.032% | 0.041% | 0.035% |
| Leaked 3 or More | 144 | 1 | 0 | 6 | 6 | 11 | 24 | 26 | 19 | 20 | 23 |
| % of Leakers | 1.343% | 0.296% | 0.000% | 0.849% | 0.909% | 1.620% | 2.100% | 2.519% | 2.149% | 2.328% | 2.439% |
| % of Total Comp | 0.003% | 0.000% | 0.000% | 0.002% | 0.002% | 0.004% | 0.008% | 0.007% | 0.005% | 0.005% | 0.006% |
| Leaked 4 Times | 29 | 0 | 3 | 2 | 5 | 8 | 7 | 2 | 1 | 0 | 0 |
| % of Leakers | 0.270% | 0.000% | 0.756% | 0.283% | 0.758% | 1.178% | 0.612% | 0.194% | 0.113% | 0.000% | 0.000% |
| % of Total Comp | 0.001% | 0.000% | 0.001% | 0.001% | 0.002% | 0.003% | 0.002% | 0.001% | 0.000% | 0.000% | 0.000% |
| **Fitting - Liquid** | | | | | | | | | | | |
| Total Components | 4310233 | 170644 | 178590 | 267999 | 278592 | 284082 | 288115 | 354230 | 351719 | 390172 | 406744 |
| Total Leakers | 6174 | 174 | 162 | 355 | 356 | 354 | 500 | 490 | 397 | 557 | 588 |
| Leaked 2 or More | 653 | 10 | 8 | 17 | 49 | 51 | 82 | 75 | 49 | 63 | 101 |
| % of Leakers | 10.577% | 5.747% | 4.938% | 4.789% | 13.764% | 14.407% | 16.400% | 15.306% | 12.343% | 11.311% | 17.177% |
| % of Total Comp | 0.015% | 0.006% | 0.004% | 0.006% | 0.018% | 0.018% | 0.028% | 0.021% | 0.014% | 0.016% | 0.025% |
| Leaked 3 or More | 114 | 3 | 0 | 1 | 3 | 12 | 22 | 22 | 8 | 7 | 18 |
| % of Leakers | 1.846% | 1.724% | 0.000% | 0.282% | 0.843% | 3.390% | 4.400% | 4.490% | 2.015% | 1.257% | 3.061% |
| % of Total Comp | 0.003% | 0.002% | 0.000% | 0.000% | 0.001% | 0.004% | 0.008% | 0.006% | 0.002% | 0.002% | 0.004% |
| Leaked 4 Times | 23 | 0 | 0 | 0 | 7 | 7 | 4 | 2 | 3 | 0 | 0 |
| % of Leakers | 0.373% | 0.000% | 0.000% | 0.000% | 1.966% | 1.977% | 0.800% | 0.408% | 0.756% | 0.000% | 0.000% |
| % of Total Comp | 0.001% | 0.000% | 0.000% | 0.000% | 0.003% | 0.002% | 0.001% | 0.001% | 0.001% | 0.000% | 0.000% |
| **Pump - Liquid** | | | | | | | | | | | |
| Total Components | 34431 | 1271 | 1289 | 2061 | 2188 | 2160 | 2177 | 3791 | 3686 | 3653 | 3994 |
| Total Leakers | 861 | 32 | 46 | 83 | 55 | 60 | 80 | 85 | 71 | 63 | 68 |
| Leaked 2 or More | 207 | 7 | 12 | 15 | 18 | 19 | 22 | 20 | 22 | 18 | 24 |
| % of Leakers | 24.042% | 21.875% | 26.087% | 18.072% | 32.727% | 31.667% | 27.500% | 23.529% | 30.986% | 28.571% | 35.294% |
| % of Total Comp | 0.601% | 0.551% | 0.931% | 0.728% | 0.823% | 0.880% | 1.011% | 0.528% | 0.597% | 0.493% | 0.601% |
| Leaked 3 or More | 45 | 1 | 1 | 4 | 3 | 6 | 4 | 7 | 4 | 5 | 5 |
| % of Leakers | 5.226% | 3.125% | 2.174% | 4.819% | 5.455% | 10.000% | 5.000% | 8.235% | 5.634% | 7.937% | 7.353% |
| % of Total Comp | 0.131% | 0.079% | 0.078% | 0.194% | 0.137% | 0.278% | 0.184% | 0.185% | 0.109% | 0.137% | 0.125% |
| Leaked 4 Times | 12 | 0 | 0 | 2 | 2 | 3 | 2 | 0 | 3 | 0 | 0 |
| % of Leakers | 1.394% | 0.000% | 0.000% | 2.410% | 3.636% | 5.000% | 2.500% | 0.000% | 4.225% | 0.000% | 0.000% |
| % of Total Comp | 0.035% | 0.000% | 0.000% | 0.097% | 0.091% | 0.139% | 0.092% | 0.000% | 0.081% | 0.000% | 0.000% |
| **Valve - Gas** | | | | | | | | | | | |
| Total Components | 1494303 | 68268 | 68756 | 108119 | 110670 | 101227 | 106169 | 103955 | 101357 | 102736 | 113913 |
| Total Leakers | 12731 | 481 | 585 | 887 | 908 | 753 | 879 | 983 | 833 | 652 | 685 |
| Leaked 2 or More | 1962 | 72 | 65 | 123 | 172 | 162 | 207 | 188 | 174 | 178 | 222 |
| % of Leakers | 15.411% | 14.969% | 11.111% | 13.867% | 18.943% | 21.514% | 23.549% | 19.125% | 20.888% | 27.301% | 32.409% |
| % of Total Comp | 0.131% | 0.105% | 0.095% | 0.114% | 0.155% | 0.160% | 0.195% | 0.181% | 0.172% | 0.173% | 0.195% |
| Leaked 3 or More | 362 | 15 | 19 | 16 | 29 | 22 | 41 | 39 | 39 | 32 | 60 |
| % of Leakers | 2.843% | 3.119% | 3.248% | 1.804% | 3.194% | 2.922% | 4.664% | 3.967% | 4.682% | 4.908% | 8.759% |
| % of Total Comp | 0.024% | 0.022% | 0.028% | 0.015% | 0.026% | 0.022% | 0.039% | 0.038% | 0.038% | 0.031% | 0.053% |
| Leaked 4 Times | 48 | 2 | 5 | 2 | 2 | 4 | 2 | 5 | 12 | 0 | 0 |
| % of Leakers | 0.377% | 0.416% | 0.855% | 0.225% | 0.220% | 0.531% | 0.228% | 0.509% | 1.441% | 0.000% | 0.000% |
| % of Total Comp | 0.003% | 0.003% | 0.007% | 0.002% | 0.002% | 0.004% | 0.002% | 0.005% | 0.012% | 0.000% | 0.000% |
| **Valve - Liquid** | | | | | | | | | | | |
| Total Components | 1364399 | 60176 | 60910 | 101800 | 105120 | 102263 | 104926 | 97831 | 93627 | 101419 | 102999 |
| Total Leakers | 11472 | 382 | 438 | 800 | 806 | 604 | 760 | 723 | 565 | 472 | 507 |
| Leaked 2 or More | 1777 | 52 | 73 | 114 | 181 | 136 | 197 | 155 | 133 | 114 | 143 |
| % of Leakers | 15.490% | 13.613% | 16.667% | 14.250% | 22.457% | 22.517% | 25.921% | 21.438% | 23.540% | 24.153% | 28.205% |
| % of Total Comp | 0.130% | 0.086% | 0.120% | 0.112% | 0.172% | 0.133% | 0.188% | 0.158% | 0.142% | 0.112% | 0.139% |
| Leaked 3 or More | 349 | 8 | 8 | 17 | 26 | 27 | 34 | 47 | 33 | 25 | 43 |
| % of Leakers | 3.042% | 2.094% | 1.826% | 2.125% | 3.226% | 4.470% | 4.474% | 6.501% | 5.841% | 5.297% | 8.481% |
| % of Total Comp | 0.026% | 0.013% | 0.013% | 0.017% | 0.025% | 0.026% | 0.032% | 0.048% | 0.035% | 0.025% | 0.042% |
| Leaked 4 Times | 45 | 0 | 2 | 1 | 6 | 8 | 6 | 8 | 5 | 0 | 0 |
| % of Leakers | 0.392% | 0.000% | 0.457% | 0.125% | 0.744% | 1.325% | 0.789% | 1.107% | 0.885% | 0.000% | 0.000% |
| % of Total Comp | 0.003% | 0.000% | 0.003% | 0.001% | 0.006% | 0.008% | 0.006% | 0.008% | 0.005% | 0.000% | 0.000% |
| Total Components | 11861137 | 508187 | 522007 | 780638 | 799109 | 765332 | 789283 | 907687 | 912913 | 965625 | 1006851 |

Table A-3. Combined Matrix for Leakers with Values >= 10,000

| Fitting - Gas | Total | 91-1 | 91-2 | 91-3 | 91-4 | 92-1 | 92-2 | 92-3 | 92-4 | 93-1 | 93-2 | 93-3 | 93-4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Components | 4657771 | 86316 | 95679 | 88992 | 94185 | 128462 | 128506 | 128815 | 130269 | 177789 | 179582 | 185707 | 189235 |
| Total Leakers | 4210 | 46 | 93 | 94 | 25 | 20 | 76 | 64 | 90 | 166 | 133 | 126 | 80 |
| Leaked 2 or More | 283 | N/A | N/A | N/A | 0 | 1 | 0 | 0 | 3 | 2 | 4 | 8 | 3 |
| % of Leakers | 6.722% | N/A | N/A | N/A | 0.000% | 5.000% | 0.000% | 0.000% | 3.333% | 1.205% | 3.008% | 6.349% | 3.750% |
| % of Total Comp | 0.006% | N/A | N/A | N/A | 0.000% | 0.001% | 0.000% | 0.000% | 0.002% | 0.001% | 0.002% | 0.004% | 0.002% |
| Leaked 3 or More | 32 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.760% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.001% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| Leaked 4 Times | 3 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.071% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| **Fitting - Liquid** | | | | | | | | | | | | | |
| Total Components | 4310233 | 114068 | 113203 | 112949 | 112568 | 81147 | 85476 | 82158 | 84480 | 130828 | 134987 | 141000 | 146482 |
| Total Leakers | 2247 | 26 | 163 | 193 | 20 | 38 | 54 | 44 | 36 | 53 | 50 | 41 | 45 |
| Leaked 2 or More | 172 | N/A | N/A | N/A | 1 | 0 | 5 | 3 | 7 | 0 | 2 | 1 | 6 |
| % of Leakers | 7.655% | N/A | N/A | N/A | 5.000% | 0.000% | 9.259% | 6.818% | 19.444% | 0.000% | 4.000% | 2.439% | 13.333% |
| % of Total Comp | 0.004% | N/A | N/A | N/A | 0.001% | 0.000% | 0.006% | 0.004% | 0.008% | 0.000% | 0.001% | 0.001% | 0.004% |
| Leaked 3 or More | 40 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| % of Leakers | 1.780% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 2.222% |
| % of Total Comp | 0.001% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.001% |
| Leaked 4 Times | 10 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.445% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| **Pump - Liquid** | | | | | | | | | | | | | |
| Total Components | 34431 | 374 | 417 | 461 | 410 | 604 | 606 | 604 | 607 | 1010 | 1010 | 1057 | 1001 |
| Total Leakers | 310 | 1 | 5 | 8 | 0 | 3 | 6 | 12 | 5 | 12 | 11 | 6 | 4 |
| Leaked 2 or More | 39 | N/A | N/A | N/A | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 12.581% | N/A | N/A | N/A | 0.000% | 0.000% | 16.667% | 8.333% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.113% | N/A | N/A | N/A | 0.000% | 0.000% | 0.165% | 0.166% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| Leaked 3 or More | 7 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 2.258% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.020% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| Leaked 4 Times | 3 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.968% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.009% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| **Valve - Gas** | | | | | | | | | | | | | |
| Total Components | 1494303 | 27036 | 34048 | 32225 | 31231 | 37455 | 37515 | 37696 | 37607 | 57576 | 57546 | 61249 | 57949 |
| Total Leakers | 4123 | 73 | 167 | 238 | 53 | 78 | 87 | 88 | 81 | 141 | 158 | 203 | 142 |
| Leaked 2 or More | 389 | N/A | N/A | N/A | 3 | 1 | 3 | 3 | 4 | 2 | 10 | 13 | 9 |
| % of Leakers | 9.435% | N/A | N/A | N/A | 5.660% | 1.282% | 3.448% | 3.409% | 4.938% | 1.418% | 6.329% | 6.404% | 6.338% |
| % of Total Comp | 0.026% | N/A | N/A | N/A | 0.010% | 0.003% | 0.008% | 0.008% | 0.011% | 0.003% | 0.017% | 0.021% | 0.016% |
| Leaked 3 or More | 52 | N/A | N/A | N/A | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| % of Leakers | 1.261% | N/A | N/A | N/A | 0.000% | 0.000% | 1.149% | 0.000% | 0.000% | 0.000% | 0.000% | 0.493% | 0.704% |
| % of Total Comp | 0.003% | N/A | N/A | N/A | 0.000% | 0.000% | 0.003% | 0.000% | 0.000% | 0.000% | 0.000% | 0.002% | 0.002% |
| Leaked 4 Times | 1 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.024% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| **Valve - Liquid** | | | | | | | | | | | | | |
| Total Components | 1364399 | 34781 | 32115 | 33199 | 31624 | 23645 | 23676 | 23956 | 23871 | 50728 | 50807 | 54166 | 50760 |
| Total Leakers | 3872 | 84 | 424 | 563 | 44 | 85 | 67 | 72 | 76 | 156 | 129 | 111 | 120 |
| Leaked 2 or More | 316 | N/A | N/A | N/A | 10 | 5 | 8 | 3 | 6 | 2 | 10 | 10 | 15 |
| % of Leakers | 8.161% | N/A | N/A | N/A | 22.727% | 5.882% | 11.940% | 4.167% | 7.895% | 1.282% | 7.752% | 9.009% | 12.500% |
| % of Total Comp | 0.023% | N/A | N/A | N/A | 0.032% | 0.021% | 0.034% | 0.013% | 0.025% | 0.004% | 0.020% | 0.018% | 0.030% |
| Leaked 3 or More | 44 | N/A | N/A | N/A | 5 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 3 |
| % of Leakers | 1.136% | N/A | N/A | N/A | 11.364% | 1.176% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 1.802% | 2.500% |
| % of Total Comp | 0.003% | N/A | N/A | N/A | 0.016% | 0.004% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.004% | 0.006% |
| Leaked 4 Times | 9 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| % of Leakers | 0.232% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.833% |
| % of Total Comp | 0.001% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.002% |
| Total Components | 11861137 | 262575 | 275462 | 267826 | 270018 | 271313 | 275779 | 273229 | 276834 | 417931 | 423932 | 443179 | 445427 |

Table A-3. Combined Matrix for Leakers with Values >= 10,000 (continued)

| Fitting - Gas | Total | 94-1 | 94-2 | 94-3 | 94-4 | 95-1 | 95-2 | 95-3 | 95-4 | 96-1 | 96-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Components | 4657771 | 207828 | 212462 | 300659 | 302539 | 275600 | 287896 | 347880 | 362524 | 367645 | 379201 |
| Total Leakers | 4210 | 129 | 153 | 343 | 258 | 296 | 486 | 405 | 381 | 351 | 395 |
| Leaked 2 or More | 283 | 2 | 6 | 8 | 14 | 24 | 47 | 37 | 37 | 50 | 37 |
| % of Leakers | 6.722% | 1.550% | 3.922% | 2.332% | 5.426% | 8.108% | 9.671% | 9.136% | 9.711% | 14.245% | 9.367% |
| % of Total Comp | 0.006% | 0.001% | 0.003% | 0.003% | 0.005% | 0.009% | 0.016% | 0.011% | 0.010% | 0.014% | 0.010% |
| Leaked 3 or More | 32 | 0 | 0 | 2 | 0 | 0 | 6 | 9 | 7 | 4 | 4 |
| % of Leakers | 0.760% | 0.000% | 0.000% | 0.583% | 0.000% | 0.000% | 1.235% | 2.222% | 1.837% | 1.140% | 1.013% |
| % of Total Comp | 0.001% | 0.000% | 0.000% | 0.001% | 0.000% | 0.000% | 0.002% | 0.003% | 0.002% | 0.001% | 0.001% |
| Leaked 4 Times | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 |
| % of Leakers | 0.071% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.494% | 0.262% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.001% | 0.000% | 0.000% | 0.000% |
| **Fitting - Liquid** | | | | | | | | | | | |
| Total Components | 4310233 | 170644 | 178590 | 267999 | 278592 | 284082 | 288115 | 354230 | 351719 | 390172 | 406744 |
| Total Leakers | 2247 | 76 | 61 | 154 | 120 | 121 | 194 | 194 | 140 | 203 | 221 |
| Leaked 2 or More | 172 | 2 | 1 | 2 | 10 | 13 | 34 | 28 | 12 | 15 | 30 |
| % of Leakers | 7.655% | 2.632% | 1.639% | 1.299% | 8.333% | 10.744% | 17.526% | 14.433% | 8.571% | 7.389% | 13.575% |
| % of Total Comp | 0.004% | 0.001% | 0.001% | 0.001% | 0.004% | 0.005% | 0.012% | 0.008% | 0.003% | 0.004% | 0.007% |
| Leaked 3 or More | 40 | 0 | 0 | 0 | 0 | 1 | 12 | 14 | 6 | 2 | 4 |
| % of Leakers | 1.780% | 0.000% | 0.000% | 0.000% | 0.000% | 0.826% | 6.186% | 7.216% | 4.286% | 0.985% | 1.810% |
| % of Total Comp | 0.001% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.004% | 0.004% | 0.002% | 0.001% | 0.001% |
| Leaked 4 Times | 10 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 3 | 2 | 2 |
| % of Leakers | 0.445% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.515% | 1.031% | 2.143% | 0.985% | 0.905% |
| % of Total Comp | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.001% | 0.001% | 0.001% | 0.000% |
| **Pump - Liquid** | | | | | | | | | | | |
| Total Components | 34431 | 1271 | 1289 | 2061 | 2188 | 2160 | 2177 | 3791 | 3686 | 3653 | 3994 |
| Total Leakers | 310 | 17 | 23 | 34 | 24 | 23 | 25 | 29 | 23 | 18 | 21 |
| Leaked 2 or More | 39 | 1 | 5 | 5 | 5 | 5 | 3 | 4 | 2 | 2 | 5 |
| % of Leakers | 12.581% | 5.882% | 21.739% | 14.706% | 20.833% | 21.739% | 12.000% | 13.793% | 8.696% | 11.111% | 23.810% |
| % of Total Comp | 0.113% | 0.079% | 0.388% | 0.243% | 0.229% | 0.231% | 0.138% | 0.106% | 0.054% | 0.055% | 0.125% |
| Leaked 3 or More | 7 | 0 | 0 | 1 | 0 | 1 | 3 | 1 | 1 | 0 | 0 |
| % of Leakers | 2.258% | 0.000% | 0.000% | 2.941% | 0.000% | 4.348% | 12.000% | 3.448% | 4.348% | 0.000% | 0.000% |
| % of Total Comp | 0.020% | 0.000% | 0.000% | 0.049% | 0.000% | 0.046% | 0.138% | 0.026% | 0.027% | 0.000% | 0.000% |
| Leaked 4 Times | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |
| % of Leakers | 0.968% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 4.000% | 3.448% | 4.348% | 0.000% | 0.000% |
| % of Total Comp | 0.009% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.046% | 0.026% | 0.027% | 0.000% | 0.000% |
| **Valve - Gas** | | | | | | | | | | | |
| Total Components | 1494303 | 68268 | 68756 | 108119 | 110670 | 101227 | 106169 | 103955 | 101357 | 102736 | 113913 |
| Total Leakers | 4123 | 171 | 224 | 320 | 307 | 261 | 321 | 311 | 269 | 216 | 214 |
| Leaked 2 or More | 389 | 16 | 21 | 31 | 41 | 39 | 42 | 39 | 35 | 35 | 42 |
| % of Leakers | 9.435% | 9.357% | 9.375% | 9.688% | 13.355% | 14.943% | 13.084% | 12.540% | 13.011% | 16.204% | 19.626% |
| % of Total Comp | 0.026% | 0.023% | 0.031% | 0.029% | 0.037% | 0.039% | 0.040% | 0.038% | 0.035% | 0.034% | 0.037% |
| Leaked 3 or More | 52 | 2 | 4 | 4 | 8 | 3 | 6 | 7 | 4 | 4 | 7 |
| % of Leakers | 1.261% | 1.170% | 1.786% | 1.250% | 2.606% | 1.149% | 1.869% | 2.251% | 1.487% | 1.852% | 3.271% |
| % of Total Comp | 0.003% | 0.003% | 0.006% | 0.004% | 0.007% | 0.003% | 0.006% | 0.007% | 0.004% | 0.004% | 0.006% |
| Leaked 4 Times | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.024% | 0.000% | 0.000% | 0.000% | 0.000% | 0.383% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.001% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| **Valve - Liquid** | | | | | | | | | | | |
| Total Components | 1364399 | 60176 | 60910 | 101800 | 105120 | 102263 | 104926 | 97831 | 93627 | 101419 | 102999 |
| Total Leakers | 3872 | 159 | 160 | 284 | 255 | 184 | 269 | 212 | 130 | 139 | 149 |
| Leaked 2 or More | 316 | 12 | 21 | 26 | 39 | 28 | 40 | 31 | 15 | 14 | 21 |
| % of Leakers | 8.161% | 7.547% | 13.125% | 9.155% | 15.294% | 15.217% | 14.870% | 14.623% | 11.538% | 10.072% | 14.094% |
| % of Total Comp | 0.023% | 0.020% | 0.034% | 0.026% | 0.037% | 0.027% | 0.038% | 0.032% | 0.016% | 0.014% | 0.020% |
| Leaked 3 or More | 44 | 0 | 1 | 3 | 3 | 3 | 7 | 7 | 2 | 4 | 3 |
| % of Leakers | 1.136% | 0.000% | 0.625% | 1.056% | 1.176% | 1.630% | 2.602% | 3.302% | 1.538% | 2.878% | 2.013% |
| % of Total Comp | 0.003% | 0.000% | 0.002% | 0.003% | 0.003% | 0.003% | 0.007% | 0.007% | 0.002% | 0.004% | 0.003% |
| Leaked 4 Times | 9 | 0 | 2 | 0 | 3 | 0 | 1 | 2 | 0 | 0 | 0 |
| % of Leakers | 0.232% | 0.000% | 1.250% | 0.000% | 1.176% | 0.000% | 0.372% | 0.943% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.001% | 0.000% | 0.003% | 0.000% | 0.003% | 0.000% | 0.001% | 0.002% | 0.000% | 0.000% | 0.000% |
| Total Components | 11861137 | 508187 | 522007 | 780638 | 799109 | 765332 | 789283 | 907687 | 912913 | 965625 | 1006851 |

Table A-4. Combined Matrix for Leakers with Values >= 50,000

| Fitting - Gas | Total | 91-1 | 91-2 | 91-3 | 91-4 | 92-1 | 92-2 | 92-3 | 92-4 | 93-1 | 93-2 | 93-3 | 93-4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Components | 4657771 | 86316 | 95679 | 88992 | 94185 | 128462 | 128506 | 128815 | 130269 | 177789 | 179582 | 185707 | 189235 |
| Total Leakers | 1913 | 11 | 39 | 23 | 6 | 4 | 18 | 13 | 17 | 41 | 38 | 35 | 29 |
| Leaked 2 or More | 93 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| % of Leakers | 4.861% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 3.448% |
| % of Total Comp | 0.002% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.001% |
| Leaked 3 or More | 6 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.314% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| Leaked 4 Times | 0 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| **Fitting - Liquid** | | | | | | | | | | | | | |
| Total Components | 4310233 | 114068 | 113203 | 112949 | 112568 | 81147 | 85476 | 82158 | 84480 | 130828 | 134987 | 141000 | 146482 |
| Total Leakers | 858 | 3 | 62 | 65 | 3 | 11 | 2 | 6 | 3 | 12 | 13 | 10 | 10 |
| Leaked 2 or More | 49 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| % of Leakers | 5.711% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 10.000% |
| % of Total Comp | 0.001% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.001% |
| Leaked 3 or More | 8 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.932% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| Leaked 4 Times | 1 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.117% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| **Pump - Liquid** | | | | | | | | | | | | | |
| Total Components | 34431 | 374 | 417 | 461 | 410 | 604 | 606 | 604 | 607 | 1010 | 1010 | 1057 | 1001 |
| Total Leakers | 89 | 0 | 2 | 5 | 0 | 2 | 1 | 1 | 0 | 2 | 4 | 1 | 0 |
| Leaked 2 or More | 5 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 5.618% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.015% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| Leaked 3 or More | 0 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| Leaked 4 Times | 0 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| **Valve - Gas** | | | | | | | | | | | | | |
| Total Components | 1494303 | 27036 | 34048 | 32225 | 31231 | 37455 | 37515 | 37696 | 37607 | 57576 | 57546 | 61249 | 57949 |
| Total Leakers | 1563 | 11 | 48 | 53 | 8 | 9 | 14 | 9 | 6 | 41 | 57 | 67 | 41 |
| Leaked 2 or More | 116 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 |
| % of Leakers | 7.422% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 3.509% | 2.985% | 4.878% |
| % of Total Comp | 0.008% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.003% | 0.003% | 0.003% |
| Leaked 3 or More | 15 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| % of Leakers | 0.960% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 2.439% |
| % of Total Comp | 0.001% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.002% |
| Leaked 4 Times | 2 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.128% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| **Valve - Liquid** | | | | | | | | | | | | | |
| Total Components | 1364399 | 34781 | 32115 | 33199 | 31624 | 23645 | 23676 | 23956 | 23871 | 50728 | 50807 | 54166 | 50760 |
| Total Leakers | 1379 | 24 | 137 | 201 | 6 | 20 | 5 | 3 | 5 | 49 | 37 | 22 | 43 |
| Leaked 2 or More | 90 | N/A | N/A | N/A | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 |
| % of Leakers | 6.526% | N/A | N/A | N/A | 16.667% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 4.545% | 6.977% |
| % of Total Comp | 0.007% | N/A | N/A | N/A | 0.003% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.002% | 0.006% |
| Leaked 3 or More | 6 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.435% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| Leaked 4 Times | 0 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| Total Components | 11861137 | 262575 | 275462 | 267826 | 270018 | 271313 | 275779 | 273229 | 276834 | 417931 | 423932 | 443179 | 445427 |

Table A-4. Combined Matrix for Leakers with Values >= 50,000 (continued)

| Fitting - Gas | Total | 94-1 | 94-2 | 94-3 | 94-4 | 95-1 | 95-2 | 95-3 | 95-4 | 96-1 | 96-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Components | 4657771 | 207828 | 212462 | 300659 | 302539 | 275600 | 287896 | 347880 | 362524 | 367645 | 379201 |
| Total Leakers | 1913 | 43 | 67 | 188 | 117 | 144 | 280 | 230 | 174 | 161 | 235 |
| Leaked 2 or More | 93 | 1 | 2 | 3 | 4 | 7 | 11 | 17 | 11 | 16 | 20 |
| % of Leakers | 4.861% | 2.326% | 2.985% | 1.596% | 3.419% | 4.861% | 3.929% | 7.391% | 6.322% | 9.938% | 8.511% |
| % of Total Comp | 0.002% | 0.000% | 0.001% | 0.001% | 0.001% | 0.003% | 0.004% | 0.005% | 0.003% | 0.004% | 0.005% |
| Leaked 3 or More | 6 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 2 |
| % of Leakers | 0.314% | 0.000% | 0.000% | 0.532% | 0.000% | 0.000% | 0.357% | 0.435% | 0.575% | 0.000% | 0.851% |
| % of Total Comp | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.001% |
| Leaked 4 Times | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| **Fitting - Liquid** | | | | | | | | | | | |
| Total Components | 4310233 | 170644 | 178590 | 267999 | 278592 | 284082 | 288115 | 354230 | 351719 | 390172 | 406744 |
| Total Leakers | 858 | 22 | 24 | 84 | 49 | 44 | 92 | 90 | 73 | 83 | 97 |
| Leaked 2 or More | 49 | 0 | 0 | 0 | 2 | 3 | 9 | 12 | 8 | 6 | 8 |
| % of Leakers | 5.711% | 0.000% | 0.000% | 0.000% | 4.082% | 6.818% | 9.783% | 13.333% | 10.959% | 7.229% | 8.247% |
| % of Total Comp | 0.001% | 0.000% | 0.000% | 0.000% | 0.001% | 0.001% | 0.003% | 0.003% | 0.002% | 0.002% | 0.002% |
| Leaked 3 or More | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 2 | 1 |
| % of Leakers | 0.932% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 1.111% | 5.479% | 2.410% | 1.031% |
| % of Total Comp | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.001% | 0.001% | 0.000% |
| Leaked 4 Times | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| % of Leakers | 0.117% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 1.205% | 0.000% |
| % of Total Comp | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| **Pump - Liquid** | | | | | | | | | | | |
| Total Components | 34431 | 1271 | 1289 | 2061 | 2188 | 2160 | 2177 | 3791 | 3686 | 3653 | 3994 |
| Total Leakers | 89 | 4 | 1 | 8 | 5 | 6 | 11 | 10 | 7 | 11 | 8 |
| Leaked 2 or More | 5 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 |
| % of Leakers | 5.618% | 0.000% | 0.000% | 12.500% | 0.000% | 0.000% | 9.091% | 10.000% | 0.000% | 9.091% | 12.500% |
| % of Total Comp | 0.015% | 0.000% | 0.000% | 0.049% | 0.000% | 0.000% | 0.046% | 0.026% | 0.000% | 0.027% | 0.025% |
| Leaked 3 or More | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| Leaked 4 Times | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| **Valve - Gas** | | | | | | | | | | | |
| Total Components | 1494303 | 68268 | 68756 | 108119 | 110670 | 101227 | 106169 | 103955 | 101357 | 102736 | 113913 |
| Total Leakers | 1563 | 52 | 90 | 180 | 135 | 114 | 162 | 139 | 129 | 111 | 87 |
| Leaked 2 or More | 116 | 3 | 9 | 11 | 14 | 15 | 11 | 15 | 14 | 10 | 8 |
| % of Leakers | 7.422% | 5.769% | 10.000% | 6.111% | 10.370% | 13.158% | 6.790% | 10.791% | 10.853% | 9.009% | 9.195% |
| % of Total Comp | 0.008% | 0.004% | 0.013% | 0.010% | 0.013% | 0.015% | 0.010% | 0.014% | 0.014% | 0.010% | 0.007% |
| Leaked 3 or More | 15 | 0 | 0 | 2 | 3 | 2 | 3 | 2 | 0 | 2 | 0 |
| % of Leakers | 0.960% | 0.000% | 0.000% | 1.111% | 2.222% | 1.754% | 1.852% | 1.439% | 0.000% | 1.802% | 0.000% |
| % of Total Comp | 0.001% | 0.000% | 0.000% | 0.002% | 0.003% | 0.002% | 0.003% | 0.002% | 0.000% | 0.002% | 0.000% |
| Leaked 4 Times | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.128% | 0.000% | 0.000% | 0.000% | 1.481% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | 0.000% | 0.000% | 0.000% | 0.002% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| **Valve - Liquid** | | | | | | | | | | | |
| Total Components | 1364399 | 60176 | 60910 | 101800 | 105120 | 102263 | 104926 | 97831 | 93627 | 101419 | 102999 |
| Total Leakers | 1379 | 62 | 68 | 143 | 118 | 68 | 124 | 66 | 56 | 49 | 73 |
| Leaked 2 or More | 90 | 4 | 7 | 14 | 16 | 4 | 16 | 8 | 3 | 4 | 9 |
| % of Leakers | 6.526% | 6.452% | 10.294% | 9.790% | 13.559% | 5.882% | 12.903% | 12.121% | 5.357% | 8.163% | 12.329% |
| % of Total Comp | 0.007% | 0.007% | 0.011% | 0.014% | 0.015% | 0.004% | 0.015% | 0.008% | 0.003% | 0.004% | 0.009% |
| Leaked 3 or More | 6 | 0 | 0 | 0 | 1 | 0 | 2 | 2 | 0 | 0 | 1 |
| % of Leakers | 0.435% | 0.000% | 0.000% | 0.000% | 0.847% | 0.000% | 1.613% | 3.030% | 0.000% | 0.000% | 1.370% |
| % of Total Comp | 0.000% | 0.000% | 0.000% | 0.000% | 0.001% | 0.000% | 0.002% | 0.002% | 0.000% | 0.000% | 0.001% |
| Leaked 4 Times | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| Total Components | 11861137 | 508187 | 522007 | 780638 | 799109 | 765332 | 789283 | 907687 | 912913 | 965625 | 1006851 |

Table A-5. Combined Matrix for Leakers with Values >= 100,000

| Fitting - Gas | Total | 91-1 | 91-2 | 91-3 | 91-4 | 92-1 | 92-2 | 92-3 | 92-4 | 93-1 | 93-2 | 93-3 | 93-4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Components | 4657771 | 86316 | 95679 | 88992 | 94185 | 128462 | 128506 | 128815 | 130269 | 177789 | 179582 | 185707 | 189235 |
| Total Leakers | 1456 | 2 | 32 | 14 | 0 | 1 | 2 | 2 | 8 | 31 | 28 | 22 | 19 |
| Leaked 2 or More | 59 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| % of Leakers | 4.052% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 5.263% |
| % of Total Comp | 0.001% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.001% |
| Leaked 3 or More | 4 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.275% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| Leaked 4 Times | 0 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| **Fitting - Liquid** | | | | | | | | | | | | | |
| Total Components | 4310233 | 114068 | 113203 | 112949 | 112568 | 81147 | 85476 | 82158 | 84480 | 130828 | 134987 | 141000 | 146482 |
| Total Leakers | 639 | 1 | 55 | 53 | 1 | 3 | 1 | 2 | 2 | 9 | 9 | 5 | 10 |
| Leaked 2 or More | 25 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| % of Leakers | 3.912% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 10.000% |
| % of Total Comp | 0.001% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.001% |
| Leaked 3 or More | 3 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.469% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| Leaked 4 Times | 0 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| **Pump - Liquid** | | | | | | | | | | | | | |
| Total Components | 34431 | 374 | 417 | 461 | 410 | 604 | 606 | 604 | 607 | 1010 | 1010 | 1057 | 1001 |
| Total Leakers | 58 | 0 | 2 | 4 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 0 | 0 |
| Leaked 2 or More | 2 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 3.448% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.006% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| Leaked 3 or More | 0 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| Leaked 4 Times | 0 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| **Valve - Gas** | | | | | | | | | | | | | |
| Total Components | 1494303 | 27036 | 34048 | 32225 | 31231 | 37455 | 37515 | 37696 | 37607 | 57576 | 57546 | 61249 | 57949 |
| Total Leakers | 1174 | 0 | 37 | 37 | 0 | 1 | 0 | 3 | 5 | 23 | 33 | 42 | 26 |
| Leaked 2 or More | 83 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 |
| % of Leakers | 7.070% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 3.030% | 2.381% | 7.692% |
| % of Total Comp | 0.006% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.002% | 0.002% | 0.003% |
| Leaked 3 or More | 12 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| % of Leakers | 1.022% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 3.846% |
| % of Total Comp | 0.001% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.002% |
| Leaked 4 Times | 1 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.085% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| **Valve - Liquid** | | | | | | | | | | | | | |
| Total Components | 1364399 | 34781 | 32115 | 33199 | 31624 | 23645 | 23676 | 23956 | 23871 | 50728 | 50807 | 54166 | 50760 |
| Total Leakers | 1058 | 8 | 108 | 157 | 1 | 5 | 3 | 1 | 2 | 35 | 28 | 13 | 35 |
| Leaked 2 or More | 64 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| % of Leakers | 6.049% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 7.692% | 5.714% |
| % of Total Comp | 0.005% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.002% | 0.004% |
| Leaked 3 or More | 0 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| Leaked 4 Times | 0 | N/A | N/A | N/A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | N/A | N/A | N/A | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| Total Components | 11861137 | 262575 | 275462 | 267826 | 270018 | 271313 | 275779 | 273229 | 276834 | 417931 | 423932 | 443179 | 445427 |

Table A-5. Combined Matrix for Leakers with Values >= 100,000 (continued)

| Fitting - Gas | Total | 94-1 | 94-2 | 94-3 | 94-4 | 95-1 | 95-2 | 95-3 | 95-4 | 96-1 | 96-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Components | 4657771 | 207828 | 212462 | 300659 | 302539 | 275600 | 287896 | 347880 | 362524 | 367645 | 379201 |
| Total Leakers | 1456 | 32 | 55 | 137 | 97 | 106 | 226 | 170 | 146 | 134 | 192 |
| Leaked 2 or More | 59 | 1 | 2 | 3 | 2 | 2 | 7 | 11 | 6 | 11 | 13 |
| % of Leakers | 4.052% | 3.125% | 3.636% | 2.190% | 2.062% | 1.887% | 3.097% | 6.471% | 4.110% | 8.209% | 6.771% |
| % of Total Comp | 0.001% | 0.000% | 0.001% | 0.001% | 0.001% | 0.001% | 0.002% | 0.003% | 0.002% | 0.003% | 0.003% |
| Leaked 3 or More | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| % of Leakers | 0.275% | 0.000% | 0.000% | 0.730% | 0.000% | 0.000% | 0.000% | 0.588% | 0.685% | 0.000% | 0.521% |
| % of Total Comp | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| Leaked 4 Times | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| **Fitting - Liquid** | | | | | | | | | | | |
| Total Components | 4310233 | 170644 | 178590 | 267999 | 278592 | 284082 | 288115 | 354230 | 351719 | 390172 | 406744 |
| Total Leakers | 639 | 20 | 23 | 71 | 35 | 35 | 59 | 61 | 56 | 60 | 68 |
| Leaked 2 or More | 25 | 0 | 0 | 0 | 1 | 1 | 4 | 7 | 6 | 2 | 3 |
| % of Leakers | 3.912% | 0.000% | 0.000% | 0.000% | 2.857% | 2.857% | 6.780% | 11.475% | 10.714% | 3.333% | 4.412% |
| % of Total Comp | 0.001% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.001% | 0.002% | 0.002% | 0.001% | 0.001% |
| Leaked 3 or More | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 |
| % of Leakers | 0.469% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 1.639% | 3.571% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.001% | 0.000% | 0.000% |
| Leaked 4 Times | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| **Pump - Liquid** | | | | | | | | | | | |
| Total Components | 34431 | 1271 | 1289 | 2061 | 2188 | 2160 | 2177 | 3791 | 3686 | 3653 | 3994 |
| Total Leakers | 58 | 4 | 1 | 3 | 3 | 3 | 7 | 5 | 6 | 10 | 5 |
| Leaked 2 or More | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| % of Leakers | 3.448% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 14.286% | 0.000% | 0.000% | 0.000% | 20.000% |
| % of Total Comp | 0.006% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.046% | 0.000% | 0.000% | 0.000% | 0.025% |
| Leaked 3 or More | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| Leaked 4 Times | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| **Valve - Gas** | | | | | | | | | | | |
| Total Components | 1494303 | 68268 | 68756 | 108119 | 110670 | 101227 | 106169 | 103955 | 101357 | 102736 | 113913 |
| Total Leakers | 1174 | 43 | 76 | 143 | 119 | 93 | 132 | 105 | 102 | 85 | 69 |
| Leaked 2 or More | 83 | 3 | 6 | 9 | 13 | 10 | 7 | 10 | 9 | 6 | 6 |
| % of Leakers | 7.070% | 6.977% | 7.895% | 6.294% | 10.924% | 10.753% | 5.303% | 9.524% | 8.824% | 7.059% | 8.696% |
| % of Total Comp | 0.006% | 0.004% | 0.009% | 0.008% | 0.012% | 0.010% | 0.007% | 0.010% | 0.009% | 0.006% | 0.005% |
| Leaked 3 or More | 12 | 0 | 0 | 1 | 3 | 2 | 1 | 2 | 0 | 2 | 0 |
| % of Leakers | 1.022% | 0.000% | 0.000% | 0.699% | 2.521% | 2.151% | 0.758% | 1.905% | 0.000% | 2.353% | 0.000% |
| % of Total Comp | 0.001% | 0.000% | 0.000% | 0.001% | 0.003% | 0.002% | 0.001% | 0.002% | 0.000% | 0.002% | 0.000% |
| Leaked 4 Times | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.085% | 0.000% | 0.000% | 0.000% | 0.840% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | 0.000% | 0.000% | 0.000% | 0.001% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| **Valve - Liquid** | | | | | | | | | | | |
| Total Components | 1364399 | 60176 | 60910 | 101800 | 105120 | 102263 | 104926 | 97831 | 93627 | 101419 | 102999 |
| Total Leakers | 1058 | 56 | 63 | 119 | 103 | 55 | 96 | 46 | 37 | 35 | 52 |
| Leaked 2 or More | 64 | 4 | 6 | 13 | 14 | 2 | 11 | 3 | 1 | 2 | 5 |
| % of Leakers | 6.049% | 7.143% | 9.524% | 10.924% | 13.592% | 3.636% | 11.458% | 6.522% | 2.703% | 5.714% | 9.615% |
| % of Total Comp | 0.005% | 0.007% | 0.010% | 0.013% | 0.013% | 0.002% | 0.010% | 0.003% | 0.001% | 0.002% | 0.005% |
| Leaked 3 or More | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| Leaked 4 Times | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| % of Leakers | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| % of Total Comp | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| Total Components | 11861137 | 508187 | 522007 | 780638 | 799109 | 765332 | 789283 | 907687 | 912913 | 965625 | 1006851 |

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