HEALTH AND ENVIRONMENTAL AFFAIRS DEPARTMENT

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Comparison of Screening Values from Selected Hydrocarbon Screening Instruments

STEP Strategies for Today's Environmental Partnership

American Petroleum Institute

Strategies for Today's Environmental Partnership

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Comparison of Screening Values from Selected Hydrocarbon Screening Instruments

Health and Environmental Affairs Department

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ABSTRACT

Fugitive emissions from leaking equipment are being monitored by refineries, chemical plants, petroleum marketing terminals and oil and gas production operations. Different instruments, each capable of measuring the fugitive hydrocarbon emissions, or screening values, are being utilized by different studies. The measurement distance to hold the screening instrument from the point of maximum leak also differs for different facilities.

This study evaluated the differences in screening values for the following four different screening instruments*:

- Foxboro Organic Vapor Analyzer (OVA) 108;
- Bacharach Threshold Limit Value Sniffer (TLV Sniffer®);
- HNU® PI-101; and
- Foxboro Total Vapor Analyzer (TVA) 1000, both flame ionization detector (FID) and photo ionization detector (PID).

This study showed that there were differences in screening values for a particular component based on using the different screening instruments. Adjustment factors, or correlation equations, were developed to allow screening values from the TLV Sniffer®, and the TVA FID to be converted to comparable OVA screening values. Adjustment factors were not developed relating HNU® or TVA PID screening values to OVA screening values because inadequate correlations were found between these screening values.

This study also evaluated the differences in screening values for these screening instruments based on screening as close as possible to the surface of a component at the point of maximum leak versus screening 1 cm away from the component at the point of maximum leak. This study showed that there are differences in screening values if the screening instrument is held at 1 cm away compared to holding the instrument as close as possible to the surface. An adjustment factor, or correlation equation, was developed to convert screening values from the OVA screening instrument using a 1 cm spacer basis to an "at the surface" basis.

* Please note that other screening instruments, not studied in this report, may be available.

A 1979 study on screening distance effects and screening instrument effects was compared to the results of this study. Both studies show comparable differences between the OVA and TLV Sniffer® screening values; however, the screening distance differences were more pronounced in the 1979 study than in this study. The reason for the differences in screening distance results is unknown. These differences could be due to screening techniques, in ambient conditions, or in differences in instrument sensitivities.

An analysis was performed to determine other factors that may affect the relationship between screening values. Insignificant, or minimally significant effects were observed for windspeed, component type and service type.

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EXECUTIVE SUMMARY

Fugitive emissions from leaking equipment are being monitored by refineries, chemical companies, and petroleum marketing terminals. Several different instruments, each capable of measuring the fugitive hydrocarbon emissions, or screening values, are being utilized by these facilities. Furthermore, the distance that the screening instrument is held from the surface of the component at the point where the primary leak is measured can vary depending on local practices, the potential for probe-tip contamination, and/or the prescence of rotating parts. To investigate these differences, the Western States Petroleum Association (WSPA) and the American Petroleum Institute (API) commissioned this study.

Specifically, this study's objectives were to:

- Develop a correlation equation for converting screening instrument measurements from other analyzers* to the Foxboro Organic Vapor Analyzer (OVA) 108 measurements by collecting side by side screening measurements from four different screening instruments:
  - Foxboro OVA 108,
  - Bacharach Threshold Limit Value Sniffer (TLV Sniffer®),
  - HNU® PI-101, and
  - Foxboro Total Vapor Analyzer (TVA) 1000, both flame ionization detector (FID) and photo ionization detector (PID).
- Develop a correlation equation converting screening measurements made at a distance of 1 cm to screening done as close as possible to the surface.

These correlation equations enable facilities that collect data with different instruments and different screening distances to convert their data to screening values that can be applied to mass emission correlation equations (i.e., that relate the mass in lb/hr to a particular screening value). However, other comparisons between instruments and screening distances may also prove beneficial to facilities monitoring fugitive emissions. Some of these additional comparisons were also evaluated in this study.

* Please note that other screening instruments, not studied in this report, may be available.

For this study, equipment leaks screening data were collected from two refineries, one located in southern California and one in northern California. The testing at one refinery occurred in December, 1993. The testing at the second refinery took place in January, 1994. Of the approximately 400,000 valves and connectors available in both refineries, less than 300 components were selected for this intercomparison. The statistical sampling used was designed to provide information on the sensitivity of various portable instruments throughout the range of potential screening values. Therefore, the hydrocarbon concentrations measured when screening these components are not representative of routine data collected during leak detection and repair programs at petroleum refineries. Although not every component selected for this study was screened with each of the four portable instruments, all components were screened at least with the OVA 108. Fewer measurements were made with the other instruments because of instrument difficulties. Screening took place over a one week period at each of the two refineries.

Of the 271 components tested, 227 were valves and 44 were connectors. The majority of the components to screen were identified by refinery inspection and maintenance (I/M) teams as part of their routine I/M program. The remainder were found by Radian field staff. Because of the deliberate focus on higher leaking components identified by the I/M teams, the screening value distribution of the data is certainly biased toward higher percentages of high screening value components than would be found with a random screening program at either refinery.

RESULTS FROM DIFFERENT SCREENING INSTRUMENTS

The four instruments use three unique methods to detect the hydrocarbon concentration. The OVA 108 and the TVA 1000 (FID) are both flame ionization detectors. The HNU® and the TVA 1000 (PID) are both photo ionization detectors. The TLV Sniffer® uses a combustion gas detector. The different hydrocarbon detection systems are believed to be the primary reason for the different results between instruments. The two FID instrument results and the two PID instrument results were much more comparable to each other than to instruments using different detection systems (FID vs. PID vs. combustion gas).

Recently completed studies by WSPA and API for refineries, petroleum marketing terminals and the oil and gas production industry have all used the OVA 108 as the screening instrument. For facilities that use other screening instruments that would like to apply results of these recent studies to their facilities, an adjustment factor needs to be applied. A set of adjustment factors, or correlation equations, have been developed as part of this study to convert screening values from the TLV Sniffer® and TVA FID instruments to screening values measured with an OVA. These correlation equations are shown on Table ES-1. Plots showing the data comparing the different instrument results to each other are found in Section 3 of this report.

Table ES-1. Equations Relating Screening Values From Different Instruments[a]

Variables Correlated	Screening Distance	Number of Data Pairs	Correlation Equation	Correlation Coefficient
OVA versus TLV Sniffer®	@ Surface	174	OVA@ = $(6.09 \times 10^{-1}) \times (TLV@)^{1.216}$	0.85
	1 cm	164	OVA1 = $(4.58 \times 10^{-1}) \times (TLV1)^{1.222}$	0.75
OVA versus TVA FID	@ Surface	54	OVA@ = $(1.54) \times (TVAF@)^{0.935}$	0.90
	1 cm	52	OVA1 = $(1.02) \times (TVAF1)^{1.013}$	0.83

[a] For maximum sustainable screening values.

Key

OVA@ = OVA screening value at the surface of a component.
OVA1 = OVA screening value obtained with a 1 cm spacer.
TLV@ = TLV Sniffer® screening value at the surface of a component.
TLV1 = TLV Sniffer® screening value obtained with a 1 cm spacer.
TVAF@ = TVA screening value at the surface of a component.
TVAF1 = TVA screening value obtained with a 1 cm spacer.

No correlations were developed to relate HNU® or TVA PID screening values to OVA screening values because an adequate correlation was not found between these screening values. Therefore, it is not advisable to use mass emission correlation equations that were developed with an OVA when HNU® or TVA PID screening measurements are obtained.

Study results indicate that the differences between peak screening values (i.e., the highest observed screening value) and the maximum sustainable screening values (i.e., the maximum screening value observed for two to three seconds or which was repeated multiple times in 30–60 seconds) were not statistically significant.

RESULTS FROM DIFFERENT SCREENING DISTANCES

Most facilities that routinely screen for fugitive emissions from leaking equipment screen as close to the surface as possible but not so closely that it causes hydrocarbon contamination of the probe tip, thereby causing erroneous screening measurements. The instrument probe is normally held from the point of the highest leak on the component and the probe distance from the surface can vary from less than 1 mm to as much as 1 cm. If a 1 cm standoff basis is used, a spacer that maintains this distance can be applied to the end of the probe tip. In other cases, the inspector uses his or her experience and judgment to maintain this distance of approximately 1 cm.

For testing purposes in this study, a 1 cm spacer was applied to the probe tip to maintain a standardized distance for the 1 cm measurements. The surface measurements were made as closely as possible to the surface, recognizing that because of the instrument probe dimensions and component geometry, the actual probe distance from the surface could vary from one component type to another. The actual probe distance from the surface of the component could be some immeasurable distance which is less than 1 cm.

The recent refinery and petroleum marketing terminals studies were performed by screening components as close as possible to the surface. For facilities that use a 1 cm spacer that would like to apply results of these recent studies to their facilities, an adjustment factor needs to be applied. The adjustment factor for an OVA at the surface (OVA@) versus an OVA at 1 cm (OVA1) is given in the equation below:

$$\text{OVA@} = (3.60) \times (\text{OVA1})^{0.962} \qquad \text{(Equation ES-1)}$$

The recommended approach for converting screening values from the TLV Sniffer® and the TVA FID, when these instruments use a 1 cm spacer, to comparable OVA screening values at the surface is to first convert to comparable OVA values at 1 cm by using the correlations in Table ES-1 and then apply the above equation. Because of the lack of correlation for the HNU® and TVA PID to OVA screening values it is not recommended to convert any screening values from these instruments to OVA screening values.

Each of the instruments had screening values compared with that instrument at the surface to those with that same instrument at 1 cm. The effects of screening at the surface versus screening at 1 cm appears to have roughly the same impact for each instrument type. The screening values are two to three times lower, on the average, when obtained at a 1 cm screening distance. Plots showing the data comparing results for the different instruments are found in Section 3 of this report.

COMPARISON OF STUDY RESULTS TO EARLIER STUDY

A previous study, entitled *Valve Screening Study at Six San Francisco Bay Area Petroleum Refineries*, or the "1979 Screening Study," reported on results for similar analysis of the TLV Sniffer® and the OVA 108. The current study, or "1994 Screening Study", evaluated more components, included connectors in the analysis, included additional screening instruments, and looked at additional factors that could influence test results such as windspeed, component type and service type.

Both studies show comparable differences between OVA vs. TLV Sniffer® screening values; however, the screening distance differences were more pronounced in the 1979 Screening Study than in the 1994 Screening Study. The reason for the differences in screening distance results is unknown. These differences could be due to differences in screening techniques, in ambient conditions, or in instrument sensitivities.

COMPARISON OF OTHER FACTORS THAT MAY AFFECT THE CORRELATION EQUATIONS

An analysis was performed to determine other factors that may affect the relationship between screening values. Windspeed was found to have a statistically significant effect for some of the inter-instrument comparison correlation equations. However, the impact of windspeed on the correlation equations was minor. Only marginal improvements in the correlation coefficients were found by including windspeed in the equations for which windspeed was significant. For example, the correlation coefficient for the OVA at the surface versus OVA at 1 cm correlation equation improves from 0.929 to only 0.930 by including windspeed.

Component type and service type were shown to have a significant effect for a few of the screening value correlations developed; however, these may either be anomalous occurrences or questionable due to limited data for a specific factor. Investigations to determine any other reasons for the significant effects are beyond the scope of this project. Future research might investigate whether or not different component types with different geometries could effect the actual distance the instrument probe is away from the surface and quantify the variation effect on screening values. In addition, future research could investigate whether service type (low vapor pressure, high vapor pressure, low viscosity liquid, high viscosity liquid, etc.) could have a similar effect on measured screening values.

Section 1
INTRODUCTION

Fugitive emissions from leaking equipment such as valves and connectors are being monitored by refineries, chemical companies, and petroleum marketing terminals. Several different instruments, each capable of measuring the fugitive hydrocarbon emissions, called "screening values," are being utilized by these facilities. Furthermore, the distance that the screening instrument is held from the surface of the component at the point where the primary leak is measured can vary depending on local practices, the potential for probe-tip contamination, and/or the presence of rotating parts. To investigate these differences, the Western States Petroleum Association (WSPA) and the American Petroleum Institute (API) commissioned this study, entitled "Comparison of Screening Values from Selected Hydrocarbon Screening Instruments and Different Screening Distances" and is referred to here as the "1994 Screening Study."

STUDY OBJECTIVES

This study's objectives were to:

- Develop a correlation equation for converting screening instrument measurements from other analyzers to the Foxboro Organic Vapor Analyzer (OVA) 108 measurements by collecting side by side screening measurements from four different screening instruments* including:

  —Foxboro OVA 108,

  —Bacharach Threshold Limit Value Sniffer (TLV Sniffer®),

  —HNU® PI-101, and

  — Foxboro Total Vapor Analyzer (TVA) 1000, both flame ionization detector (FID) and photo ionization detector (PID).

- Develop a correlation equation converting screening measurements made at a distance of 1 cm to screening done as close as possible to the surface.

* Please note that other screening instruments, not studied in this report, may be available.

The correlation equations convert screening values from one instrument to those with an OVA. The reason that the reference point was an OVA was because that was the basis for the recently completed studies from WSPA and API for refineries (API, 1994) and petroleum marketing terminals (API, 1993). Another desired product of the study was an adjustment factor, or correlation equation, that could convert screening values for an OVA at one screening distance to comparable values at a different screening distance, since in the two API studies, components were screened as close to the surface as possible.

A previous study, entitled *Valve Screening Study at Six San Francisco Bay Area Petroleum Refineries* (Radian, 1979), referred to as the "1979 Screening Study" in this report, reported on results for similar analysis of the TLV Sniffer® and the OVA 108. The 1994 Screening Study evaluated more components, included connectors in the analysis, included additional screening instruments, and looked at additional factors that could influence test results (windspeed, component type and service type). The 1994 Screening Study results have been compared to the 1979 Screening Study results in this report.

PROJECT DESCRIPTION

For this study, equipment leaks screening data were collected from two refineries, one located in southern California and one in northern California. The testing at one refinery occurred in December, 1993. The testing at the second refinery took place in January, 1994. A total of 271 components were screened. Although not every component was screened with each of the four screening instruments, all components were screened at least with the OVA 108. Instrument difficulties resulted in fewer measurements with the other instruments. Screening took place over a one week period at each of the two refineries. A total of 227 valves and 44 connectors (9 flanged connectors and 35 non-flange connectors) were screened. The majority of the components to screen were identified by refinery inspection and maintenance (I/M) teams as part of their routine I/M program. The remainder were found by Radian field staff. Because of the deliberate focus on higher leaking components identified by the I/M teams, the screening value distribution of the data is biased toward higher percentages of high screening value components than would be found with a random screening program at either refinery.

REPORT ORGANIZATION

This report is organized as follows:

- Section 2 documents the test procedures including a description of the equipment, QA/QC, and sampling procedures;
- Section 3 discusses the data analysis, including comparison of the screening instrument screening values, comparison of screening values as a function of screening distance, comparison of 1994 Screening Study results to 1979 Screening Study results, and analysis of other factors that may affect the correlation equations;
- Section 4 presents the conclusions and recommendations; and
- Section 5 includes the references.

Section 2
TEST PROCEDURES

This section describes the test procedures, including a description of the equipment, quality assurance/quality control (QA/QC), and sampling procedures.

EQUIPMENT

Four different screening instruments were used in this study:

- Foxboro Organic Vapor Analyzer (OVA) 108;
- Bacharach Threshold Limit Value (TLV) Sniffer®;
- HNU® PI-101; and
- Foxboro Total Vapor Analyzer (TVA) 1000, both flame ionization detector (FID) and photo ionization detector (PID).

The first three instruments have been heavily used in past studies and in I/M programs. The final instrument is new and represents a potentially popular instrument for future studies and I/M. Please note that other screening instruments, not studied in this report, may be available. Each of the four screening instruments is briefly described:

<u>OVA 108</u>

The Foxboro OVA 108 was used for screening every component in this study. The OVA 108 is a portable FID, powered by a refillable hydrogen tank. The OVA 108 internal vacuum pump is powered by a rechargeable battery. The pump continuously draws sampled hydrocarbons and air from the probe tip to the analyzer at a flow rate of approximately one liter per minute. The hydrocarbons are analyzed by the FID. The detector output is read on a hand-held logarithmic meter scale which is graduated from 1 to 10,000 ppmv. The OVA 108 was calibrated with methane. Hydrocarbon concentrations greater than 10,000 ppmv can be measured by use of a dilution probe. The dilution probe mixes charcoal scrubbed ambient air with the sample. The charcoal was used in an attempt to remove hydrocarbons from the background dilution air. In general, a dilution ratio of 10:1 was used in this study, allowing hydrocarbon concentrations up to 100,000 ppmv to be measured.

TLV Sniffer®

The Bacharach TLV Sniffer® is a portable hydrocarbon detector that uses a catalytic combustion cell to determine hydrocarbon concentrations. A rechargeable battery provides the power for the internal sample pump which draws the sample through the detector chamber at a flow rate of approximately two liters per minute. The detector element catalytically oxidizes the hydrocarbon in the sample in order to determine the heat of combustion. This heat of combustion is expressed as an equivalent concentration. The TLV Sniffer® was calibrated with hexane. The TLV Sniffer® measures hydrocarbons from 1 to 10,000 ppmv. A dilution probe can extend the range of the TLV Sniffer® to 100,000 ppmv. However, a dilution probe was not used in this particular study for the TLV Sniffer®.

HNU®

The HNU® Systems Inc. PI-101 detector (HNU®) used was a 10.2 eV lamp PID. Similar to the previously mentioned instruments, the HNU® uses a rechargeable battery to power the internal sample pump to draw the sample through the detector chamber at a flow rate of approximately 0.10–0.18 liters per minute. The PID ionizes the sample by an ultraviolet (UV) light. The detector output is displayed on a scale with three settings: 0-20 ppmv, 0-200 ppmv, and 0-2000 ppmv. The HNU® was calibrated with isobutylene. The PID measures halogenated hydrocarbons, aldehydes, ketones, aromatics, and any other compound with an ionization potential of 10.2 eV or less, including several that cannot be measured by an FID. The PID, however, does not respond well to many alkanes, particularly in the lower carbon number ranges. There are dilution probes available for many PID instruments, but none was available for use on this study.

TVA 1000

Foxboro has recently introduced into the market an instrument that has both FID and PID capabilities, called the TVA 1000. The FID operates in nearly exactly the same manner as the OVA 108 FID. The PID operates with the same basic principles as the HNU® PID. The TVA PID uses a 10.6 eV lamp, which is relatively close to the 10.2 eV used in the HNU® The flow rate into the PID and FID combined is approximately one liter per minute. The sample stream is split into two paths within the TVA 1000 to allow for simultaneous analysis by the FID and PID. The TVA 1000 FID was calibrated with methane. The PID was calibrated with isobutylene. The range of the TVA 1000 without the dilution probe is from 1 to 50,000 ppmv for the FID and from 1 to 2,000 ppmv for the PID. A dilution probe can be attached to the TVA 1000 to extend the range. A dilution probe was used in this study to extend the range by approximately a factor of 10. The hydrocarbon concentrations were displayed in digital readouts on the hand-held sample probe and also on the body of the analyzer. The TVA 1000 also allows data to be logged internally for data collection purposes; however, this feature was not used for this study.

QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

Each screening instrument was calibrated at least once each day. If batteries needed to be replaced, the instrument was recalibrated.

The OVA 108 was calibrated using a 100 ppm methane standard (certified at plus or minus 2%). To ensure that the OVA 108 was responding adequately over the entire range of hydrocarbon concentrations, the OVA 108's response was also checked with a certified zero air standard and with 10 ppm, 1000 ppm, and 10,000 ppm methane in zero air standards (each hydrocarbon standard certified at plus or minus 2%). The OVA 108 response to all of the hydrocarbon concentrations was checked by a linear regression. A correlation coefficient (r) of 0.995 or greater was required or the instrument was repaired. The OVA 108 dilution probe was set to a dilution ratio of approximately 10:1 based on using the 10,000 ppm methane standard. The reading of the OVA 108 with the dilution probe at 26,900 ppm was also checked and recorded.

The TLV Sniffer® was calibrated with a 500 ppm hexane standard and a 4000 ppm hexane standard. The HNU® was calibrated with a 95 ppm isobutylene standard at the first refinery and with a 102 ppm isobutylene standard at the second refinery. The TVA 1000 FID was calibrated in the same manner as the OVA 108 with the exception that the automatic calibrating mode was generally used for the TVA 1000. The automatic calibrating mode of the TVA 1000 allows for the instrument to calibrate itself when a known concentration of a calibration gas is examined. The TVA 1000 PID was calibrated in the same manner as the HNU® with the same exception that the automatic calibrating mode was generally used for the TVA 1000.

Calibration gases were carried into the field in Tedlar™ bags during all field testing. Each instrument was checked for accuracy after approximately every five samples. If an instrument failed this QA/QC check then the previous readings until the last verified QA/QC check were excluded or retested with a recalibrated instrument. In practice, very few samples needed to be excluded. The excluded samples, along with all of the raw sampling data, are shown in Appendix A.

SAMPLING PROCEDURES

In general, the screening measurements were made in accordance with the latest version of the United States Environmental Protection Agency's (U.S. EPA) Reference Method 21. U.S. EPA Method 21 instrument specifications are summarized in Table 2-1. The requirements that were followed in this study exceeded the requirements of U.S. EPA Method 21. Table 2-2 outlines the general screening procedures that were followed for all four of the screening instruments.

Table 2-1. Summary of EPA Method 21 Requirements

Determination of Volatile Organic Compound Leaks
1. Analyzer response factor <10
2. Analyzer response time ≤30 seconds
3. Calibration precision ≤10% of calibration gas
4. Internal pump capable of pulling 0.1 to 3.0 L/min
5. Intrinsically safe
6. Single hole probe with maximum ¼-inch OD
7. Linear and measuring ranges must include leak definition value (may include dilution probe)
8. Instrument readable to ±2.5% of leak definition
9. No detectable emissions (NDE) value defined as ±2.5% of leak definition (i.e., ±500 ppm)

Data collected from screening were recorded on forms like the one shown as Figure 2-1. Five different readings were made with each screening instrument for each component. The first reading was a background reading measured in an area close to the component. Once the point of maximum leakage was found on the component as close as possible to the component's surface, then the maximum sustainable leak rate and the peak leak rate were recorded. The maximum sustainable leak rate was the screening value that stabilized for two to three seconds, or was repeated multiple times in 30-60 seconds. The peak leak rate was the highest observed screening value on the instrument, even if the screening value were only a fleeting spike.

Table 2-2. Summary of Screening Procedures

General Screening Procedures
1. Prepare analyzer for sampling.
2. Calibrate analyzer.
3. Check analyzer for leaks.
4. Without fouling the tip, and without restricting flow into the analyzer probe, place probe as close as possible and approximately perpendicular to the component surface or seam where leakage could occur.
5. Move the probe slowly along the line of potential leakage to obtain the maximum reading.
6. Leave the probe tip at the maximum reading location for approximately two times the instrument response time.
7. Record the maximum sustainable screening value and the peak screening value on the data form.
8. If the reading exceeds full scale, use the dilution probe, if the instrument has a dilution probe.
9. Add 1 cm spacer to the probe tip.
10. Repeat steps 5 through 8.
11. Repeat steps 1 through 10 for the remaining screening instruments.

The next two readings (maximum sustainable and peak) were taken at a 1 cm standoff from the surface of the component. The readings at 1 cm were generally, but not always, 1 cm away from the point of highest leak at the surface of the component. The component was always rescreened to determine, independent of the surface readings, where the point of highest leak at 1 cm was found. A 1 cm spacer, supplied by Foxboro, was provided for screening at 1 cm with the OVA 108 and the TVA 1000. A different 1 cm spacer was constructed for use with the TLV Sniffer® and the HNU®.

Valves screened for this study were usually identified by the refinery inspection and maintenance (I/M) teams. The remaining valves were found by Radian staff when insufficient numbers of valves for Radian to test were located by the I/M teams on the day of Radian's testing, or if there was a need to obtain more diversity in screening values tested. In order to strengthen the statistical significance of the desired correlations, Radian attempted to obtain screening values from the whole leak range from 1 ppmv to 100,000 ppmv for the OVA 108, from 1ppmv to 10,000 ppmv for the TLV Sniffer®, from 1 to 2000 ppmv for the HNU® and from 1 to over 500,000 ppmv for the TVA 1000. Components that tested beyond the range of the analyzers (pegged components) were also screened with the pegged value recorded.

The majority of the connectors that were tested for this study were located by Radian. This was primarily because these connectors were not tagged and locating leaking connectors from the records of the I/M team was significantly more difficult than searching for these leaks independently. Furthermore, fewer leaking connectors than valves, at least on a percentage basis, are found in these refineries.

After the screening values were all recorded for a particular component, then the ambient temperature was recorded from a digital thermometer and the windspeed was recorded from an anemometer. The temperature and the windspeed were measured as close as possible to the highest leaking point on the component. As shown in Figure 2-1, also recorded was the component tag ID, the component subtype (i.e. gate, glove, plug or other type of valve), the component actuation if a valve (either control or manual), the size of the component, and the service category (light liquid, heavy liquid or gas). For this study, light liquids are defined as any liquid with vapor pressure greater than kerosene.

Duplicate measurements were taken, on the average, for every twentieth component screened. For the duplicate tests, all instrument readings were retaken exactly as on the first measurement, both for the different instruments and the different screening distances.

Plant ID: ____________ Date: ____________ Screening Team: ____________

Unit: ____________ Page: ______ of ______ Instrument ID: (OVA 108: ____) (TLV Sniffer®: ____) (HNu: ____) (TVA 1000: ____)

Seq #	Component ID	Type	Sub Cat	Act.	Size (in.)	Service	Amb. Temp.	Amb. Wind	Instrument Type	Background	Maximum Sustainable Screening at Surface	Peak Screening at Surface	Maximum Sustainable Screening at 1 cm	Peak Screening at 1 cm	Comments
									OVA 108						
									TLV Sniffer®						
									HNu						
									TVA 1000 (FID)						
									TVA 1000 (PID)						
									OVA 108						
									TLV Sniffer®						
									HNu						
									TVA 1000 (FID)						
									TVA 1000 (PID)						
									OVA 108						
									TLV Sniffer®						
									HNu						
									TVA 1000 (FID)						
									TVA 1000 (PID)						
									OVA 108						
									TLV Sniffer®						
									HNu						
									TVA 1000 (FID)						
									TVA 1000 (PID)						
									OVA 108						
									TLV Sniffer®						
									HNu						
									TVA 1000 (FID)						
									TVA 1000 (PID)						

Type: valve, con-fl (connection-flange), con-non (connection-nonflange)
Sub Cat: valves: gate, globe, plug, ball, b-fly (butterfly), bellows, other
connections: flange, screw (screwed connection), union, other
Service: H (heavy liquid), L (light liquid), G (gas)
Act: (only for valves): M (manual actuation), C (control valve)
Amb Temp.: Ambient temperature in °F.
Amb. Wind: Ambient wind velocity in mph.

QC Check
Time = ________
Standard = ________ ppm
OVA 108 = ________ ppm
TLV Sniffer® = ________ ppm
HNu = ________ ppm
TVA 1000 (FID) = ________ ppm
TVA 1000 (PID) = ________ ppm

Figure 2-1 Screening Value Data Collection Sheet

Section 3

DATA ANALYSIS

Throughout this section the following notation will be used to refer to the screening instrument and distance:

OVA@/OVA1 — Screening values obtained using the OVA at the surface and at 1 cm, respectively;

TLV@/TLVA1 — Screening values obtained using the TLV Sniffer® at the surface and at 1 cm, respectively;

HNU@/HNU1 — Screening values obtained using the HNU® at the surface and at 1 cm, respectively;

TVAF@/TVAF1 — Screening values obtained using the TVA FID at the surface and at 1 cm, respectively; and

TVAP@/TVAP1 — Screening values obtained using the TVA PID at the surface and at 1 cm, respectively.

In general, no appreciable differences were noted between the maximum sustainable screening values versus the peak screening values. Plots of both types of screening value measurements are included in this section. Correlation equations were developed using only the maximum sustainable screening value measurements, however, because it is believed that this is the type of screening value measurement typically collected by refineries.

Pegged values were obtained during the 1994 Screening Study; however, these pegged values were not included in any of the emission correlation equations and were therefore excluded from any of the statistical analysis in this report.

Statistical analyses were performed on the screening data to examine the following:

- Correlation between screening values obtained from different instrument types (OVA, TLV Sniffer®, HNU®, and TVA);
- Correlation between screening values at different screening distances (screening at the surface versus a 1 cm screening distance) for a given instrument;

- Differences between the 1979 Valve Screening Study (1979 Screening Study) results and the current 1994 Screening Study results; and

- Other variables that may affect screening results (e.g., component type, component service, windspeed).

The analyses performed for each of the aforementioned areas are discussed in detail and briefly summarized in the following sections.

The factor which could potentially cause the largest differences between the measured screening values is the type of screening instrument used. Two sets of the instruments tested during this study employ similar analytical methods in determining a screening value. The OVA and the TVA FID are both flame ionization detectors (FIDs); and the HNU® and the TVA PID are both photo ionization detectors (PID). The TLV Sniffer® instrument is neither an FID nor a PID, but uses a combustible gas detector to determine hydrocarbon concentrations. Although screening values from similar instrument types tended to be highly correlated, screening values from non-similar instrument types tended to show very low correlations. In fact, screening measurements from the OVA and TVA FID, and from the HNU® and TVA PID provided virtually a one-to-one correlation; whereas for dissimilar instrument types (i.e., the OVA and HNU®, and the OVA and the TVA PID) the correlation between screening value measurements was virtually zero in some instances (i.e., the correlation coefficient was very small and not statistically different from zero). When comparing OVA screening values to the TLV Sniffer® screening values, the differences between screening measurements tended to increase as the screening values increased. Thus, for example, an OVA screening value at 100 ppm may differ from a TLV Sniffer® screening value by only a factor of 1.5 to 2.0, whereas an OVA screening value at 10,000 ppm may differ from a TLV Sniffer® screening value by a factor of 4 to 7.

For every instrument type, screening distance (at the surface versus 1 cm) was found to have a significant effect on the measured screening value. In general, screening values obtained at a 1 cm screening distance were found to be about 2 to 3 times smaller than screening values obtained at the surface for every instrument type. This factor of 2 to 3 was found to be fairly consistent throughout the range of screening values obtained. For example, on the average, an OVA screening value of 3 ppm obtained at the surface would screen at roughly 1 ppm when screened at 1 cm screening distance; and an OVA screening value of 30,000 ppm at the surface would screen at roughly 10,000 ppm when screened at 1 cm screening distance.

Screening measurements obtained using the OVA and TLV Sniffer® screening instruments were compared to the same types of screening measurements obtained during the 1979 Screening Study. During the 1979 Screening Study a number of valves were screened using both an OVA and a TLV Sniffer® instrument. Measurements were collected at the component surface and at a 1 cm screening distance. When comparing the OVA screening values at the surface versus the TLV Sniffer® screening values at the surface, and the OVA screening values at 1 cm versus the TLV Sniffer® screening values at 1 cm, no statistically significant differences were found between the correlation equations obtained using the 1979 Screening Study data and the 1994 Screening Study data. However, when comparing the OVA screening values at the surface versus the OVA screening values at 1 cm, and the TLV Sniffer® screening values at the surface versus the TLV Sniffer® screening values at 1 cm, statistically significant differences were found between the correlation equations obtained using the 1979 Screening Study data and the 1994 Screening Study data. In summary, both studies show comparable results between OVA vs. TLV Sniffer® screening values; however, the screening distance differences are more pronounced in the 1979 Screening Study than in the 1994 Screening Study. The cause of these significant effects is unknown. However, they could be due to differences in screening techniques used during the two studies, in ambient conditions, or in instrument sensitivities.

Lastly, an analysis was performed to determine other factors that may affect the relationship between screening values. The results of this analysis showed that windspeed had a statistically significant effect on the OVA@ to OVA1 equation (that is, windspeed accounted for a significant portion of the variability in the OVA@ to OVA1 equation). Windspeed was also found to have a significant effect on the OVA@ versus TVAF@ correlation equation, the TVAP@ versus HNU®@ correlation equation, and the TVAP1 versus HNU®1 correlation equation. Investigations to determine the degree of variability of measured screening values as a function of windspeed is beyond the scope of this project. Future research might investigate the degree of screening value variability as a function of windspeed, instrument probe sampling velocity, and equipment component emission velocity. The impact of windspeed on the correlation equations, however, is minor. For example, the correlation coefficient for the OVA at the surface versus OVA at 1 cm correlation equation improves from 0.929 to only 0.930 by including windspeed. Windspeed was not found to have a significant effect on the other correlation equations developed. Component type and service type were shown to have a significant effect for a few of the screening value correlation equations developed; however, these were thought to be either anomalous occurrences or questionable due to limited data for a specific factor.

COMPARISON OF SCREENING INSTRUMENT SCREENING VALUES AT MAXIMUM SUSTAINABLE RATE AND PEAK RATE

Comparisons were performed between the OVA instrument screening values and screening values obtained using the other three instrument types. Recently published emission correlation equations (e.g., marketing terminals study and 1993 Refinery Study) were developed using an OVA instrument. Thus, it was of primary interest to compare the OVA screening values to screening values from every other instrument type rather than comparing screening values from every combination of instrument types. However, screening value measurements obtained from the HNU® and the TVA PID were also compared, because these are similar instrument types (both are photo ionization detectors). In summary, screening values from the following instruments were compared:

- OVA versus the TLV Sniffer®;
- OVA versus the HNU®;
- OVA versus the TVA FID;
- OVA versus the TVA PID; and
- HNU® versus the TVA PID.

Screening measurements collected at the component surface as well as screening measurements collected at 1 cm from the component surface were compared for different instrument types. In addition, the maximum sustainable screening values and the peak screening values were compared for different instrument types, resulting in a total of four sets of correlation equations that were evaluated for each inter-instrument comparison.
Figures 3-1 through 3-5 show the comparisons that were performed for each of the five inter-instrument categories listed above. The upper left corner of each of these figures (labeled "a")

shows a plot of the maximum sustainable screening values at the surface. The upper right corner of each of these figures (labeled "b") show plots of the peak screening values at the surface. The lower left corner of each of these figures (labeled "c") show plots of the maximum sustainable screening values at 1 cm and the lower right corner of each of these figures (labeled "d") show plots of the peak screening values at 1 cm. Each of the figures shows the corrected screening data (after subtracting the background screening value).

Correlation equations were developed using measurement error methods in which the errors in x were assumed to be equal to the errors in y, as discussed in Appendix B. Predictive correlation equations are presented only for the following inter-instrument comparisons:

- OVA versus the TLV Sniffer®;
- OVA versus the TVA FID; and
- HNU® versus the TVA PID.

Although there was a positive correlation between the OVA and the HNU®, and the OVA and the TVA PID, there was not a strong correlation. The models evaluated for these two inter-instrument relationships were not sufficiently adequate for predictive purposes. Therefore, no predictive correlation equations were developed for these two inter-instrument comparisons.

The primary objective of this study was to develop correlation equations between screening values collected using instruments other than an OVA screening instrument (e.g., a TLV Sniffer®, an HNU®, etc.) to those with an OVA instrument to use in emission correlation equations that relate lbs/hr emission rates to OVA screening values. OVA screening values were found to be highly correlated to TLV Sniffer® screening values and TVA FID screening values. Equations or adjustment factors were developed for these sets of correlation equations. OVA screening values were found to not be highly correlated with HNU® screening values or TVA PID screening values. Thus, using HNU® or TVA PID screening values to predict mass emissions based on emission correlation equations developed for OVA screening instruments is questionable.

Table 3-1 gives the correlation equations that were developed relating screening values from the different instrument types. As stated previously, correlation equations are only given for the maximum sustainable screening values (instead of the peak screening values).

Table 3-1. Equations Relating Screening Values From Different Instruments[a]

Variables Correlated	Screening Distance	Number of Data Pairs	Correlation Equation	Correlation Coefficient
OVA versus TLV Sniffer®	@ Surface	174	$OVA@ = (6.09 \times 10^{-1}) \times (TLV@)^{1.216}$	0.85
	1 cm	164	$OVA1 = (4.58 \times 10^{-1}) \times (TLV1)^{1.222}$	0.75
OVA versus TVA FID	@ Surface	54	$OVA@ = (1.54) \times (TVAF@)^{0.935}$	0.90
	1 cm	52	$OVA1 = (1.02) \times (TVAF1)^{1.013}$	0.83
TVA PID versus HNU®	@ Surface	21	$TVAP@ = (5.88 \times 10^{-1}) \times (HNU@)^{0.950}$	0.88
	1 cm	21	$TVAP1 = (1.69 \times 10^{-1}) \times (HNU1)^{1.186}$	0.59

[a] For maximum sustainable screening values.

Key

OVA@	=	OVA screening value at the surface of a component.
OVA1	=	OVA screening value obtained with a 1 cm spacer.
TLV@	=	TLV Sniffer® screening value at the surface of a component.
TLV1	=	TLV Sniffer® screening value obtained with a 1 cm spacer.
TVAF@	=	TVA FID screening value at the surface of a component.
TVAF1	=	TVA FID screening value obtained with a 1 cm spacer.
HNU@	=	HNU® screening value at the surface of a component.
HNU1	=	HNU® screening value obtained with a 1 cm spacer.
TVAP@	=	TVA PID screening value at the surface of a component.
TVAP1	=	TVA PID screening value obtained with a 1 cm spacer.

Figure 3-1 shows the correlation equations that were developed between the OVA and the TLV Sniffer®. Currently, all published emission correlation equations (i.e., relating mass emissions to screening value measurements) were developed using either an OVA or a TLV Sniffer® instrument. As shown by the predictive correlation equation in the figure, for low screening value ranges the OVA and TLV Sniffer® show similar screening value measurements, on the average. The difference between screening value measurements increases, however, as the magnitude of the screening values increases, with the OVA resulting in consistently higher screening value measurements. Thus, for example, on the average, an OVA screening value at 100 ppm may differ from a TLV Sniffer® screening value by only a factor of 1.5 to 2.0, whereas an OVA screening value at 10,000 ppm may differ from a TLV Sniffer® screening value by a factor of 4 to 7.

Figure 3-2 shows plots of the OVA screening value data versus the HNU® screening value data. As shown in the plots there is a lot of scatter in the data and the correlation coefficient is less than 0.40 for every type of correlation equation evaluated (i.e., for the maximum sustainable screening value at the surface and at 1 cm; and peak screening value at the surface and at 1 cm). In addition, the OVA screening instrument provides screening values that are typically an order of magnitude higher than the HNU® screening values. As discussed, however, the OVA and HNU® are different types of analytical instruments (the OVA is a flame ionization detector and the HNU® is a photo ionization detector).

Plots of the OVA screening values versus the TVA FID screening values are given in Figure 3-3. Note that the predictive correlation equation shows virtually a one-to-one correspondence between the OVA screening values and the TVA FID screening values for every type of screening measurement collected (i.e., maximum sustainable screening values and peak screening values at the surface and at 1 cm). That is, there appears to be no bias, but there is scatter about the regression line. As shown in the figures, the correlation equations form almost a perfect 45° line from (1,1) to (100000,100000).

Figure 3-4 shows plots of the OVA screening value data versus the TVA PID screening value data which look very similar to the plots obtained for the OVA versus the HNU® screening values. The correlation coefficients between screening values from the OVA and the TVA PID are very low (usually less than 0.40), and for figures (a) and (c) the correlation coefficients were not statistically different from zero ($\alpha = 0.05$).

Because the HNU® and the TVA PID are similar instrument types (i.e., both are photo ionization detectors) it was of interest to compare the screening measurements from these two instruments. In practice, an equation relating these two instrument types would probably be of little use because none of the published emission correlation equations (i.e., relating mass emissions to screening values) were developed using an HNU® or TVA PID instrument. As would be expected, however, screening value measurements from these two instruments are highly correlated. Figure 3-5 shows plots of the data and the predictive correlation that would be obtained based on the limited data available for these two instruments. Although both of these instruments are capable of measuring concentrations greater than 2,000 ppm with the

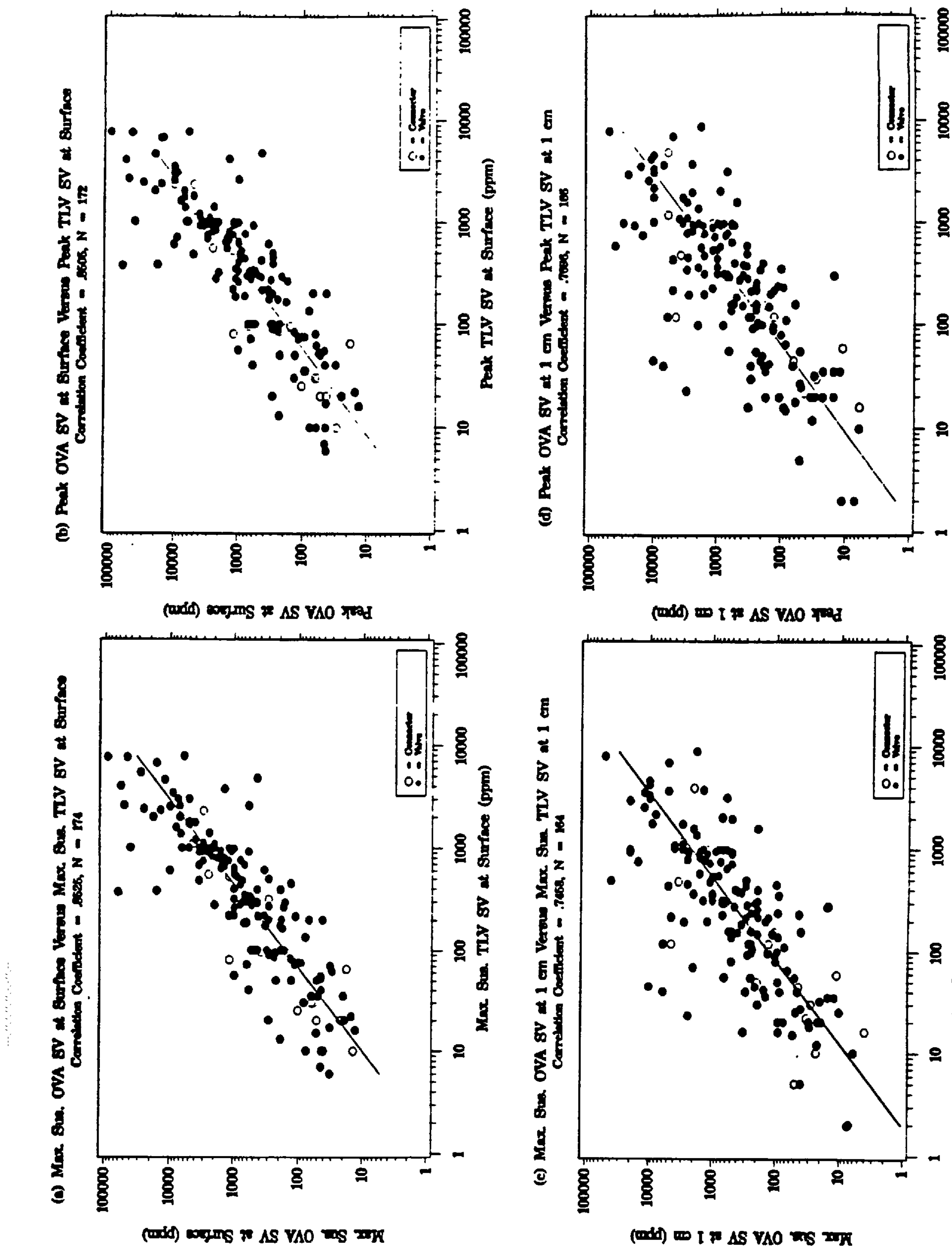


Figure 3-1 OVA vs. TLV Sniffer® Screening Instrument

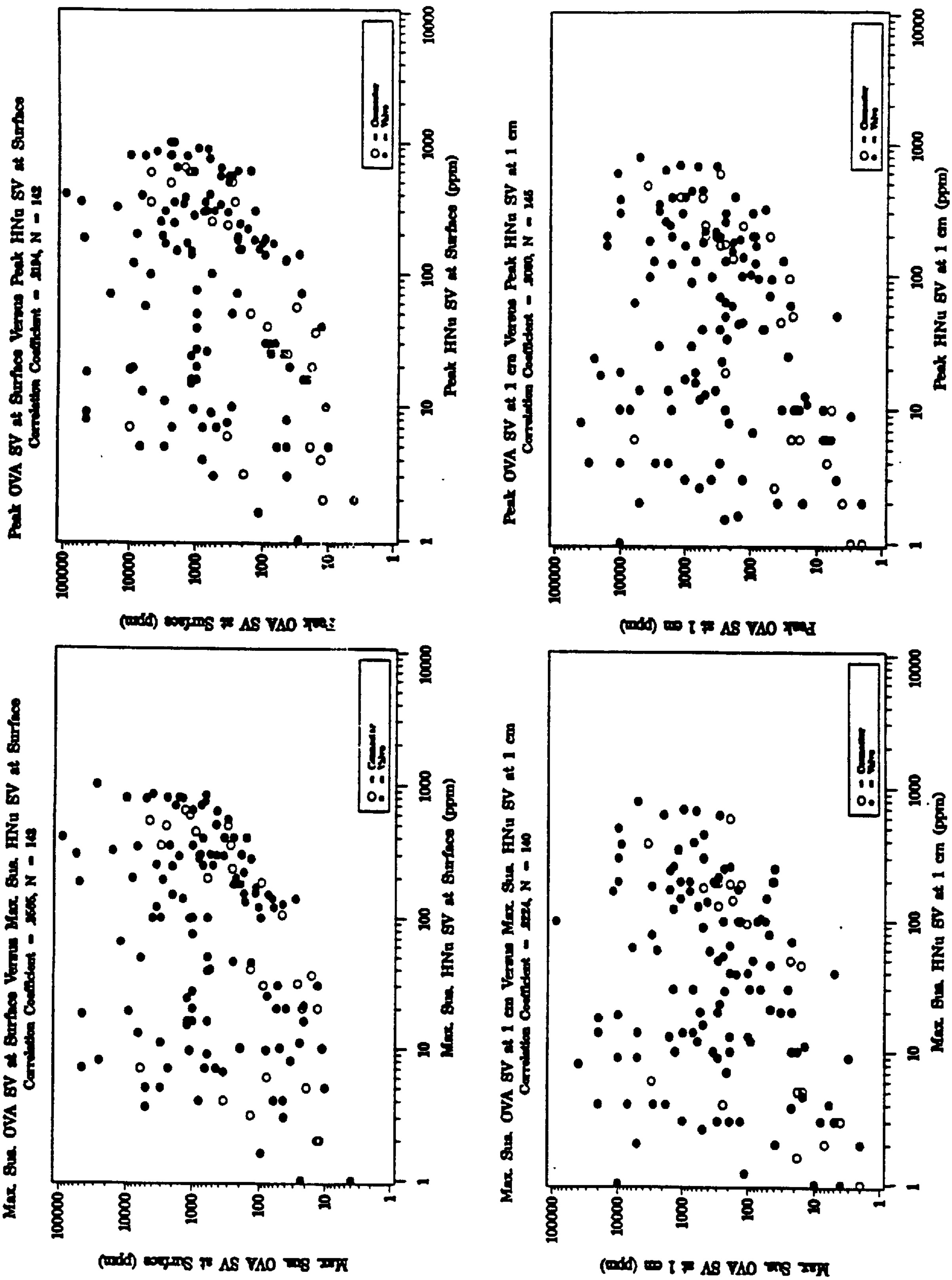


Figure 3-2 OVA vs. HNU® Screening Instrument

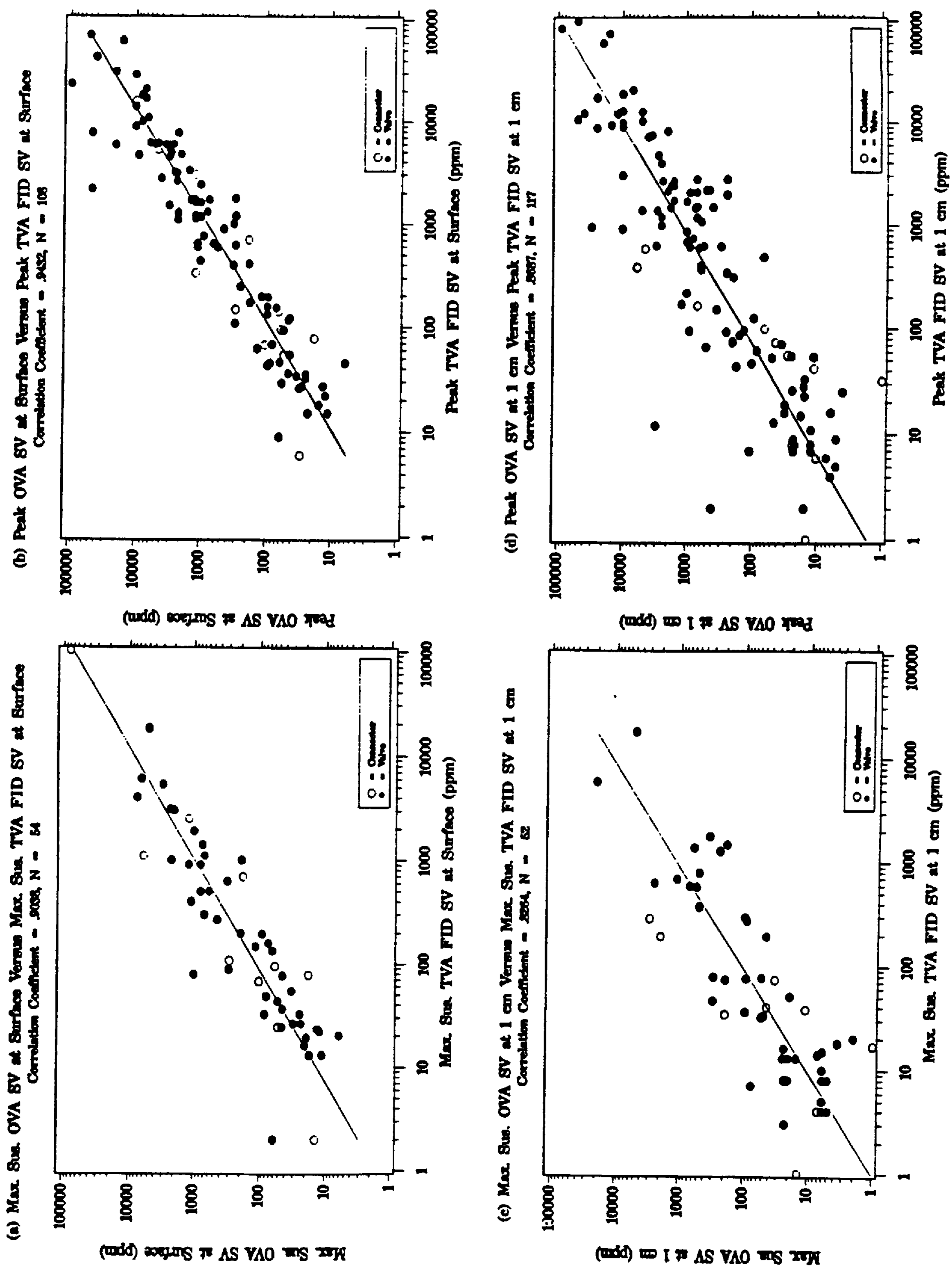


Figure 3-3 OVA vs. TVA FID Screening Instrument

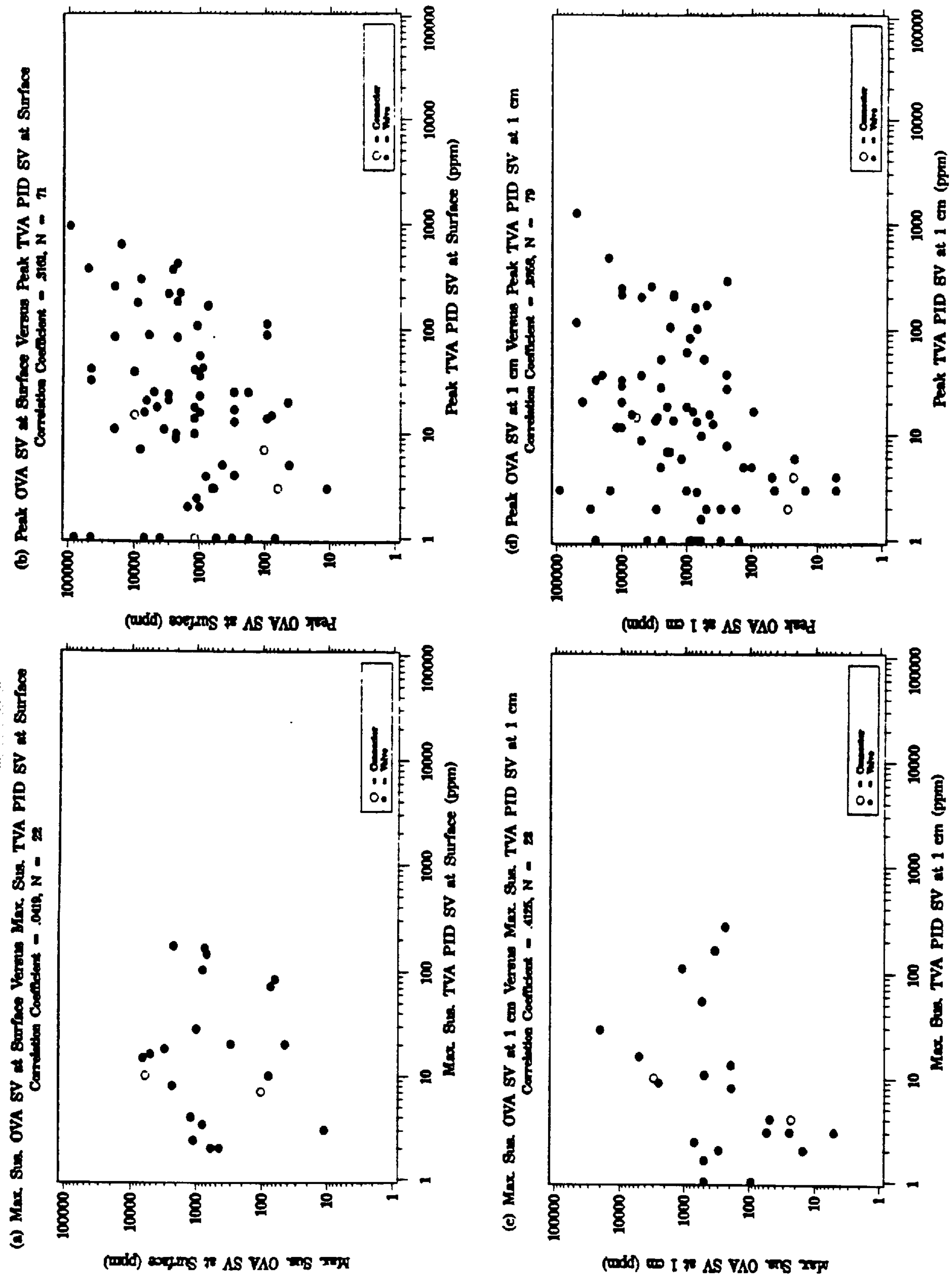


Figure 3-4 OVA vs. TVA PID Screening Instrument

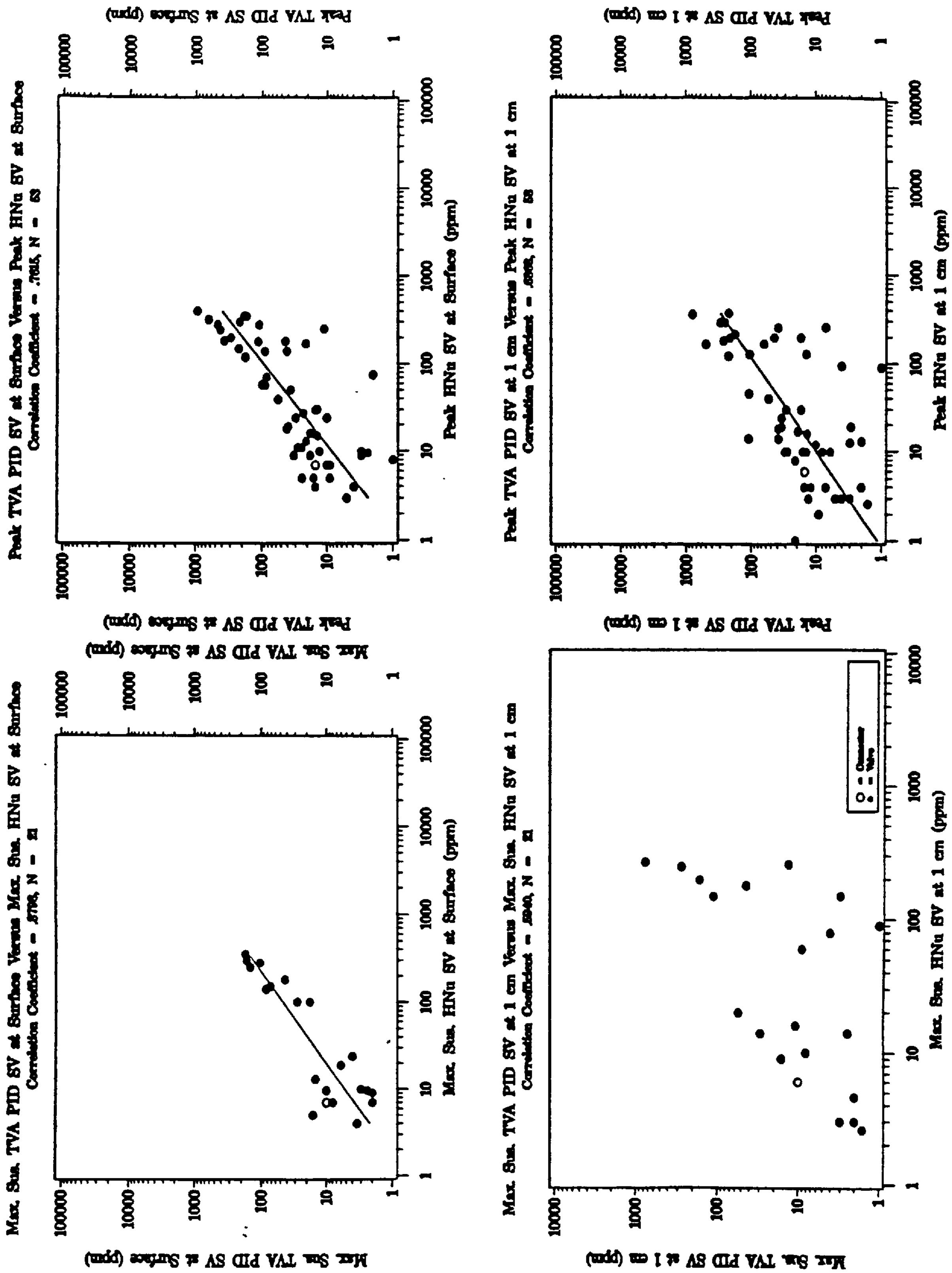


Figure 3-5 TVA PID vs. HNU® Screening Instrument

use of a dilution probe, a dilution probe was not used for this study for the HNU®. Thus, no HNU® measurements greater than 2,000 ppm are plotted (because these were recorded as "pegged at >2,000 ppm").

The correlation equations given in Table 3-1 are shown in Figure 3-6 along with the 95% confidence intervals for the mean. The plots labeled "a", "b", and "c" in Figure 3-6 show the correlation equations for the:

- OVA versus the TLV Sniffer®;
- OVA versus the TVA FID; and
- TVA PID versus the HNU®, respectively.

The equations and the confidence intervals are given for screening values obtained at the surface (the solid lines) and screening values obtained at 1 cm from the surface (the dashed lines). In each case, the center line is the correlation equation and the outer lines are the 95% confidence intervals for the mean. As stated previously, the correlation equations were developed using measurement error method (MEM) techniques. The MEM technique is discussed in Appendix B.

COMPARISON OF SCREENING DISTANCES AT MAXIMUM SUSTAINABLE RATE AND PEAK SUSTAINABLE RATE

Figures 3-7 through 3-11 show plots of the screening values obtained at the surface versus screening values obtained at 1 cm, for the OVA, TLV Sniffer®, HNU®, TVA FID, and TVA PID screening instruments, respectively. The first plot on each of these figures (labelled "a") shows the data obtained for the maximum sustainable screening values and the second plot (labelled "b") shows the data obtained for the peak screening values. The solid line overlaid on each plot indicates the correlation equations obtained. These correlation equations were developed using measurement error methods in which the relative variability in the y-axis was assumed equal to the relative variability in the x-axis. A discussion of this method and a justification of the assumptions for this method can be found in Appendix B.

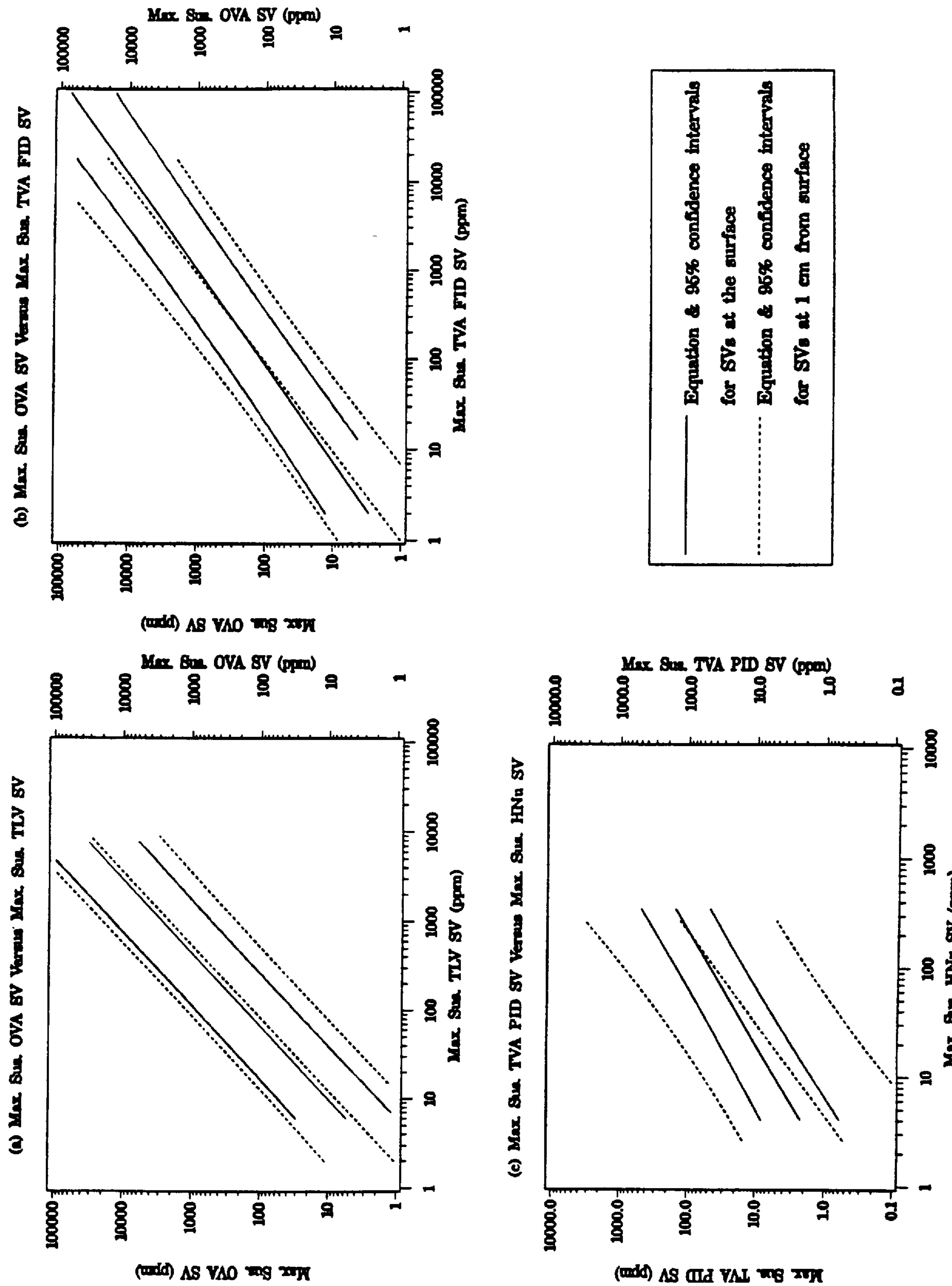


Figure 3-6. Equations Relating Screening Values from Different Instruments

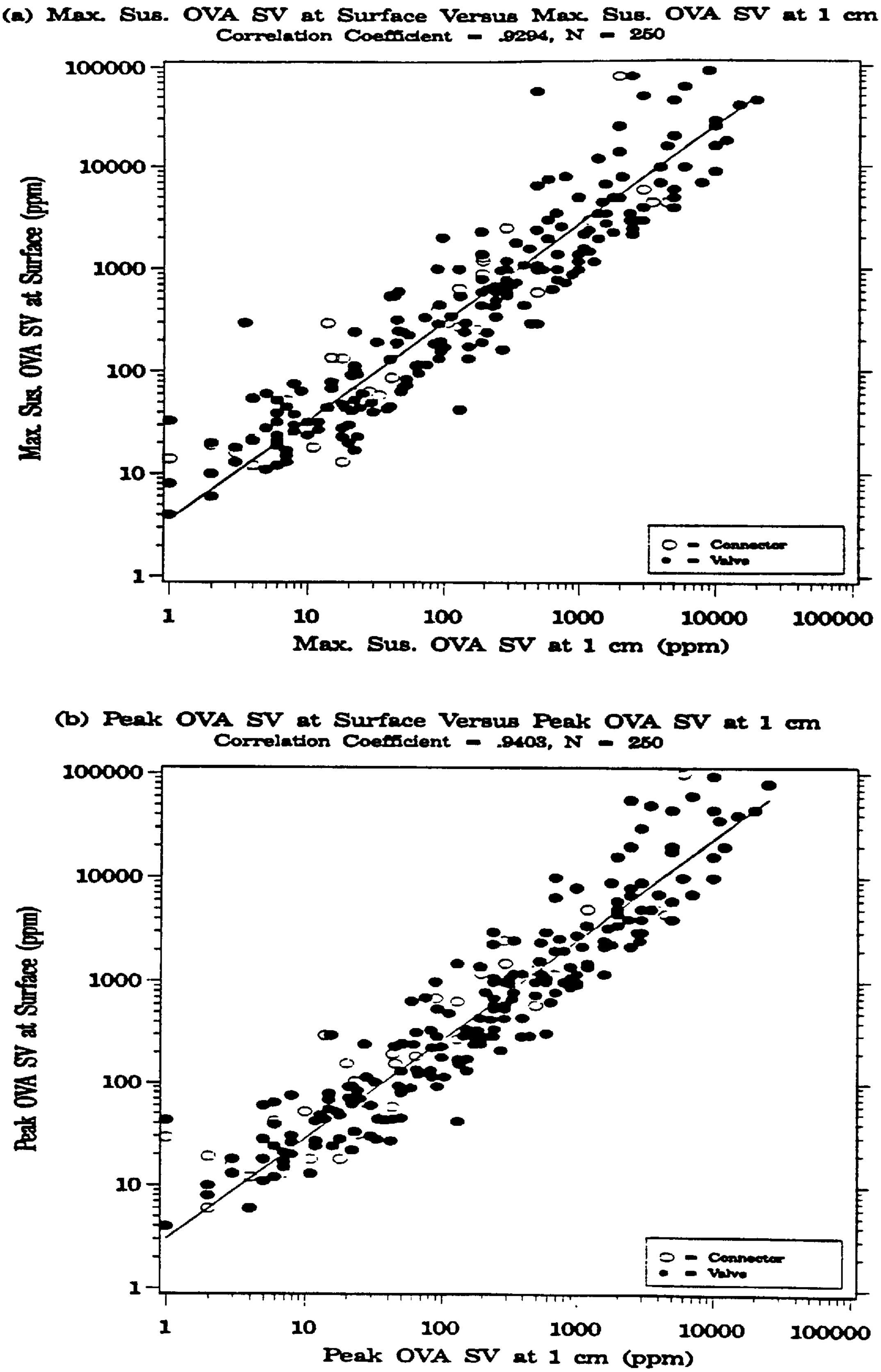
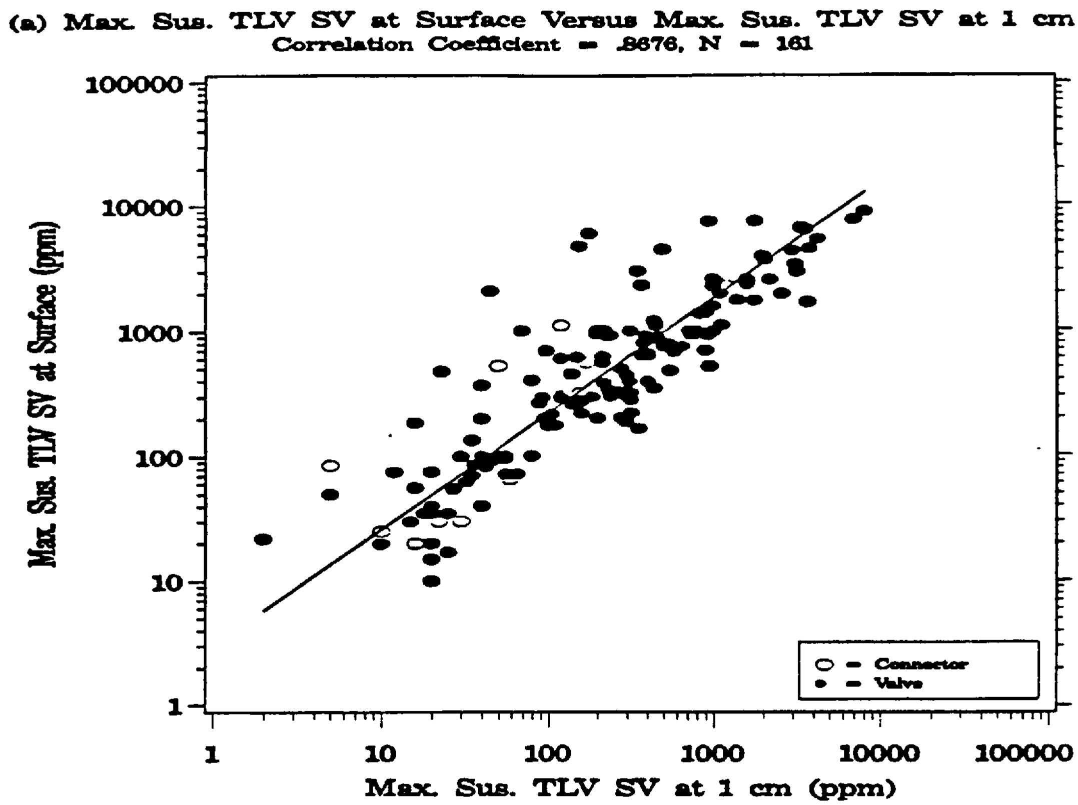


Figure 3-7 OVA at Surface vs. OVA at 1 cm



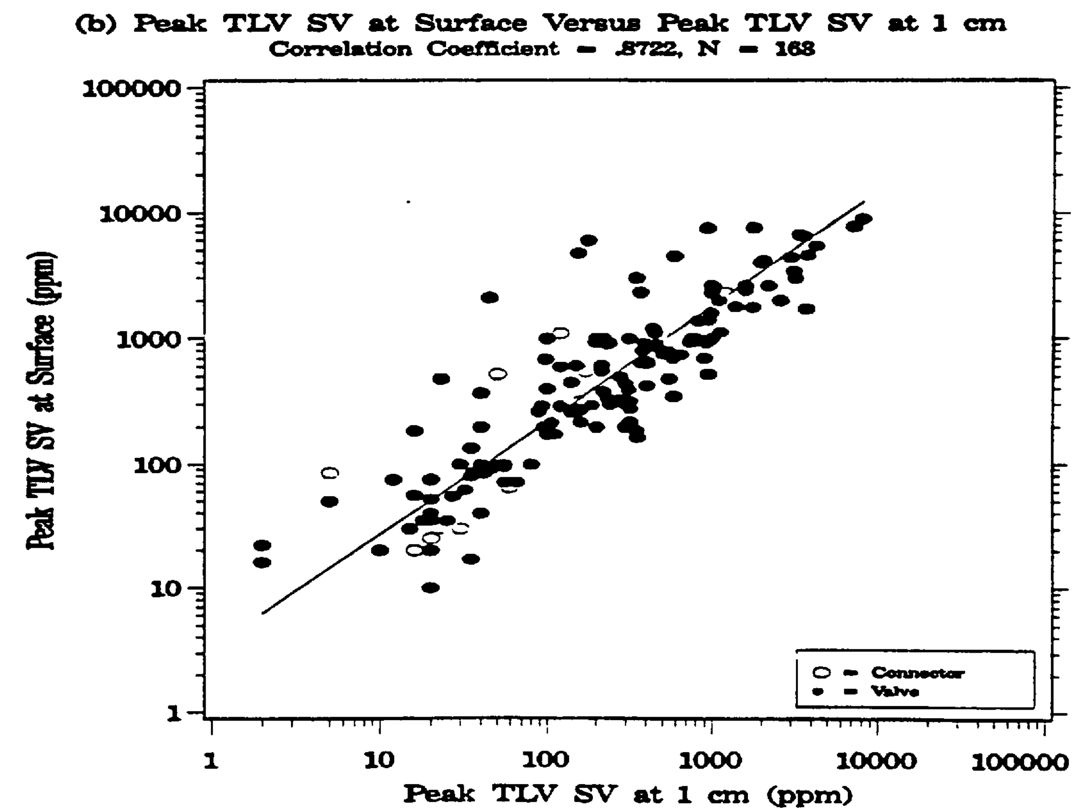
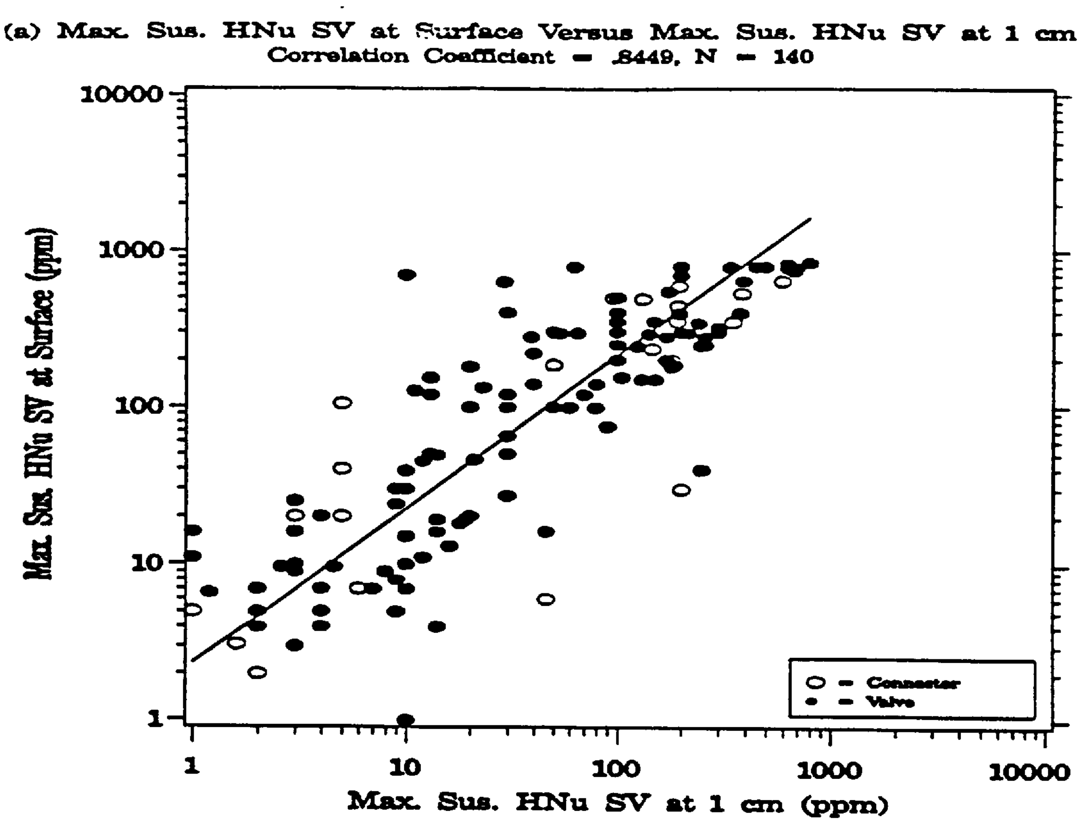


Figure 3-8 TLV Sniffer® at Surface vs. TLV Sniffer® at 1 cm



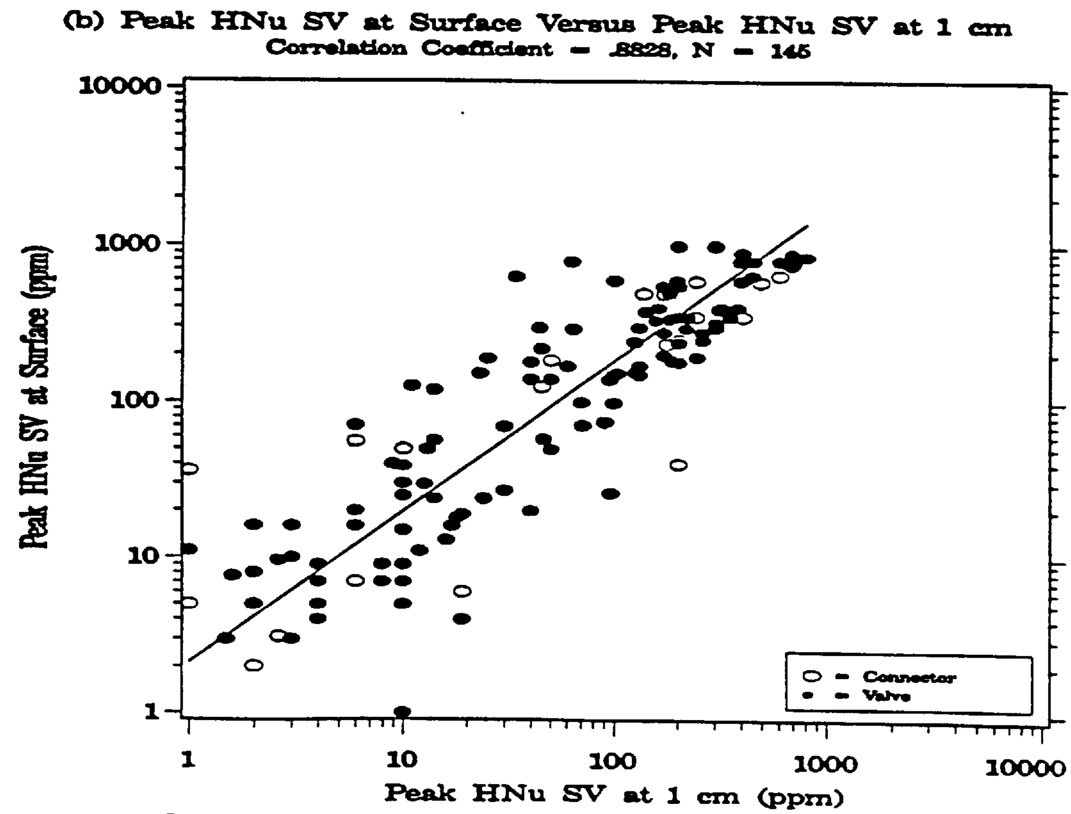
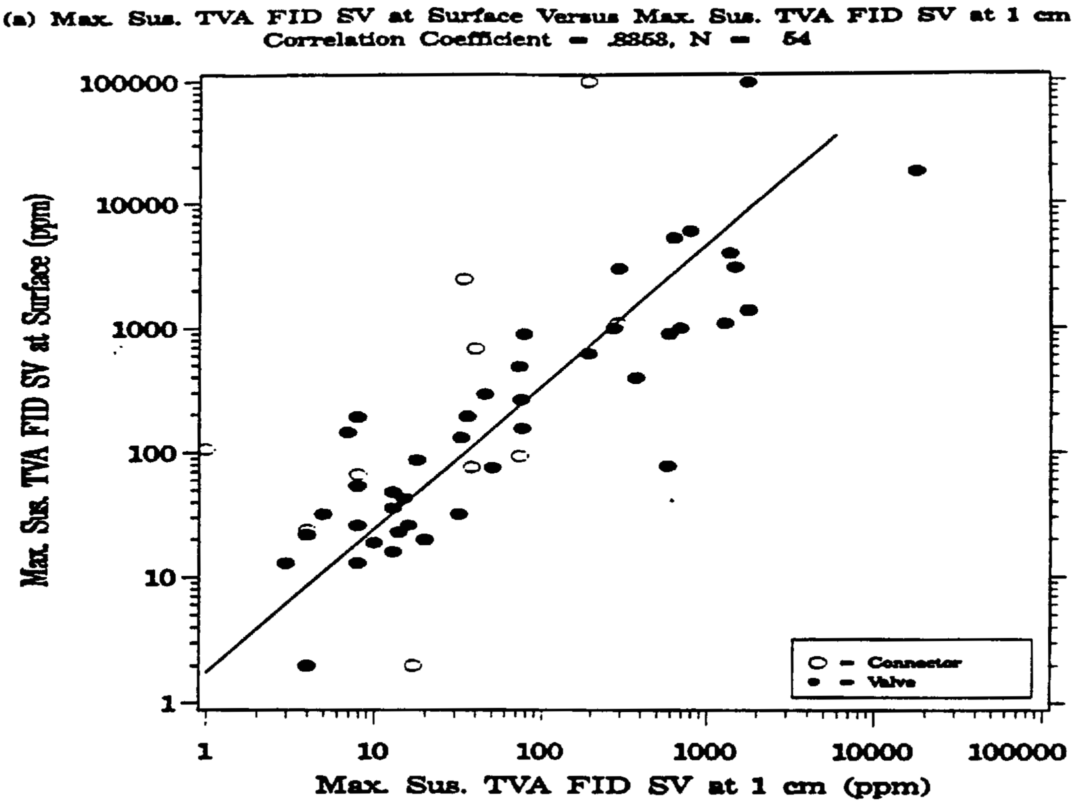


Figure 3-9 HNU® at Surface vs. HNU® at 1 cm



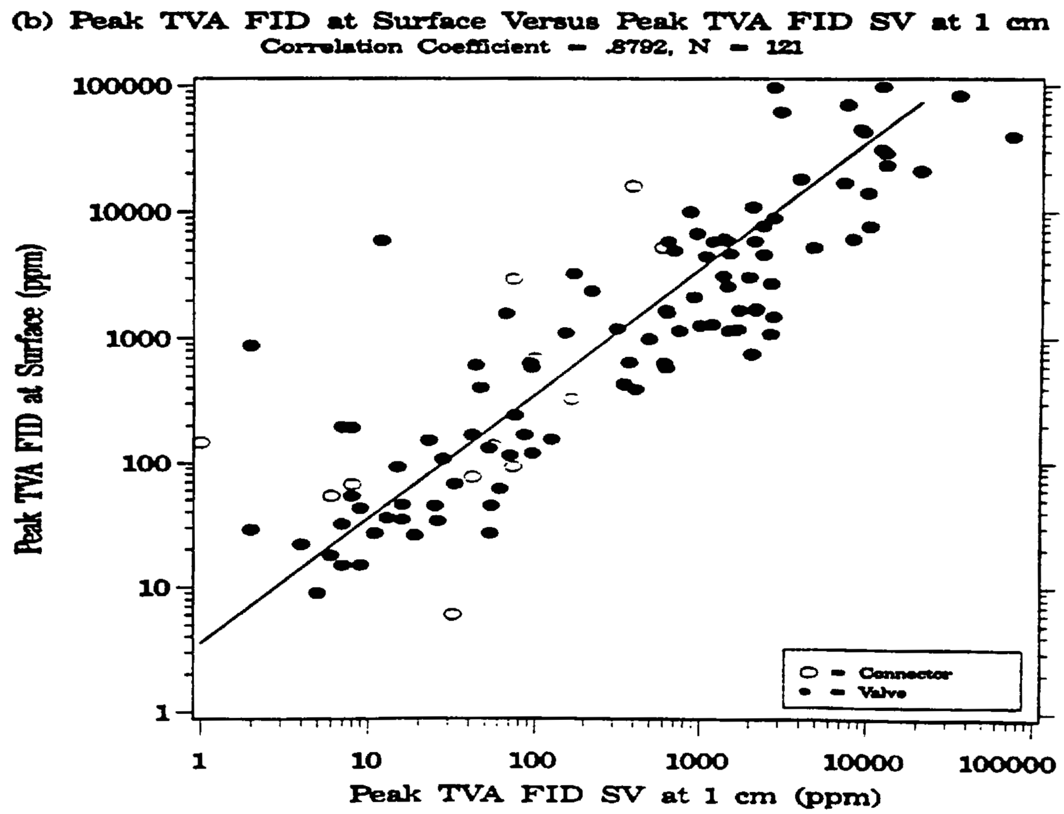


Figure 3-10 TVA FID at Surface vs. TVA FID at 1 cm

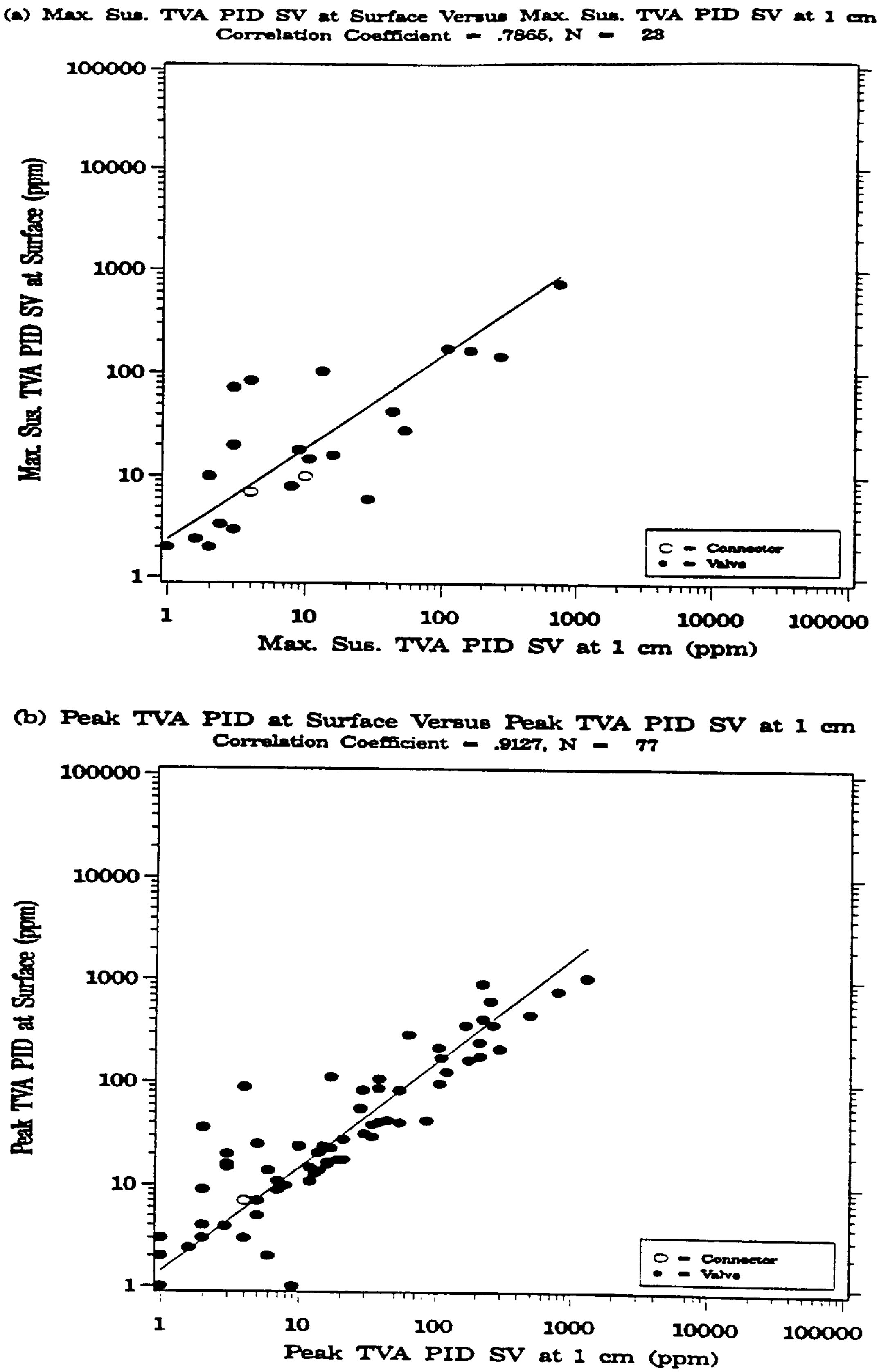


Figure 3-11 TVA PID at Surface vs. TVA PID at 1 cm

As shown by the correlation equations overlaid on each of the figures, screening measurements obtained at 1 cm are generally 2 to 3 times lower than screening measurements obtained at the component surface. [A perfect one-to-one correlation would produce a 45° line from (1,1) to (100000,100000)]. This trend appears to be fairly consistent throughout the screening value range for all instrument types.

Note that for the TLV Sniffer® instrument and the HNU® instrument, there are no screening values greater than 10,000 ppm and 2,000 ppm, respectively. Although dilution probes are available for these instruments (to increase the range of measurable screening values), the dilution probes were not used for this study. A dilution probe was used for the TVA PID instrument; however, no measurable screening values were detected at concentrations greater than 2,000 ppm using this instrument. For all of the instruments, correlation equations developed are most applicable for the range of screening values shown on the plots.

Table 3-2 gives correlation equations relating screening values at the surface to screening values at 1 cm for each of the four instrument types. Correlation equations are only given for

Table 3-2. Equations Relating Screening Values at the Surface to Screening Values at 1 cm[a]

Variables Correlated	Number of Data Pairs	Correlation Equation	Correlation Coefficient
OVA @ Surface vs. OVA at 1 cm	250	$OVA@ = (3.60) \times (OVA1)^{0.962}$	0.93
TLV Sniffer® @ Surface vs. TLV Sniffer® at 1 cm	161	$TLV@ = (3.07) \times (TLV1)^{0.927}$	0.87
HNU® @ Surface vs. HNU® at 1 cm	140	$HNU@ = (2.34) \times (HNU1)^{0.981}$	0.84
TVA FID @ Surface vs. TVA FID at 1 cm	54	$TVAF@ = (1.77) \times (TVAF1)^{1.139}$	0.84
TVA PID @ Surface vs. TVA PID at 1 cm	23	$TVAP@ = (2.39) \times (TVAP1)^{0.891}$	0.79

[a] For maximum sustainable screening values.

Key

OVA@ = OVA screening value at the surface of a component.
OVA1 = OVA screening value obtained with a 1 cm spacer.
TLV@ = TLV Sniffer® screening value at the surface of a component.
TLV1 = TLV Sniffer® screening value obtained with a 1 cm spacer.
TVAF@ = TVA FID screening value at the surface of a component.
TVAF1 = TVA FID screening value obtained with a 1 cm spacer.
HNU@ = HNU® screening value at the surface of a component.
HNU1 = HNU® screening value obtained with a 1 cm spacer.
TVAP@ = TVA PID screening value at the surface of a component.
TVAP1 = TVA PID screening value obtained with a 1 cm spacer.

the maximum sustainable screening values (instead of the peak screening values). It is believed that the maximum sustainable screening values are the screening measurements refineries typically collect. As shown in the figures, however, there was very little visible difference between the equations obtained for the maximum sustainable screening value correlation equations and the peak screening value correlation equations. Table 3-2 also shows the number of data pairs used to develop the correlation equations and the correlation coefficient for each of the equations. As shown in the table, the correlation coefficients ranged from 0.79 to 0.93.

Figure 3-12 shows plots of the correlation equations given in Table 3-2. The 95% confidence intervals for the mean are also overlaid on these figures. The solid lines in the figures indicates the regression equations and the dashed lines indicate the 95% confidence intervals for the mean. The plots labeled "a" through "e" show the correlation equations for the:

- OVA screening values at the surface versus OVA screening values at 1 cm;
- TLV screening values at the surface versus TLV screening values at 1 cm;
- HNU® screening values at the surface versus HNU® screening values at 1 cm;
- TVA FID screening values at the surface versus TVA FID screening values at 1 cm; and
- TVA PID screening values at the surface versus TVA PID screening values at 1 cm.

The equations given in Table 3-2 and shown in Figure 3-12 were developed using a measurement error method (MEM) as discussed in Appendix B of this report.

COMPARISON OF CURRENT STUDY DATA TO 1979 SCREENING STUDY DATA

A screening value study was conducted for several west coast refineries in 1979. The results of this study are published in a report, entitled *Valve Screening Study of Six San Francisco Bay Area Petroleum Refineries* (Radian, 1979), also referred to as the "1979 Screening Study" for this report. During the 1979 Screening Study, over 100 valves were screened using both an OVA and a TLV Sniffer® screening instrument. In addition, screening measurements were

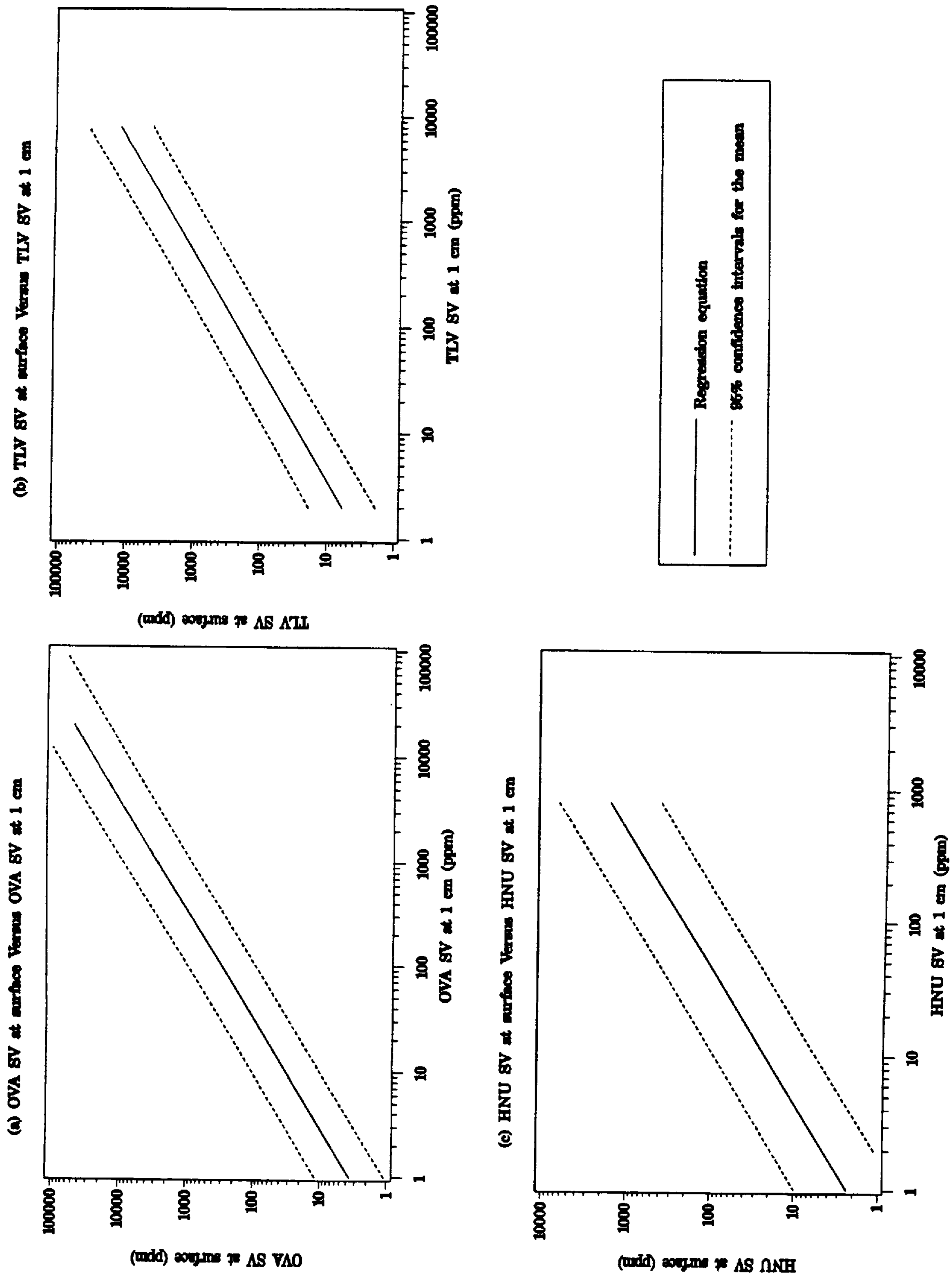


Figure 3-12 Equations Relating Screening Values at the Surface to Screening Values at 1 cm

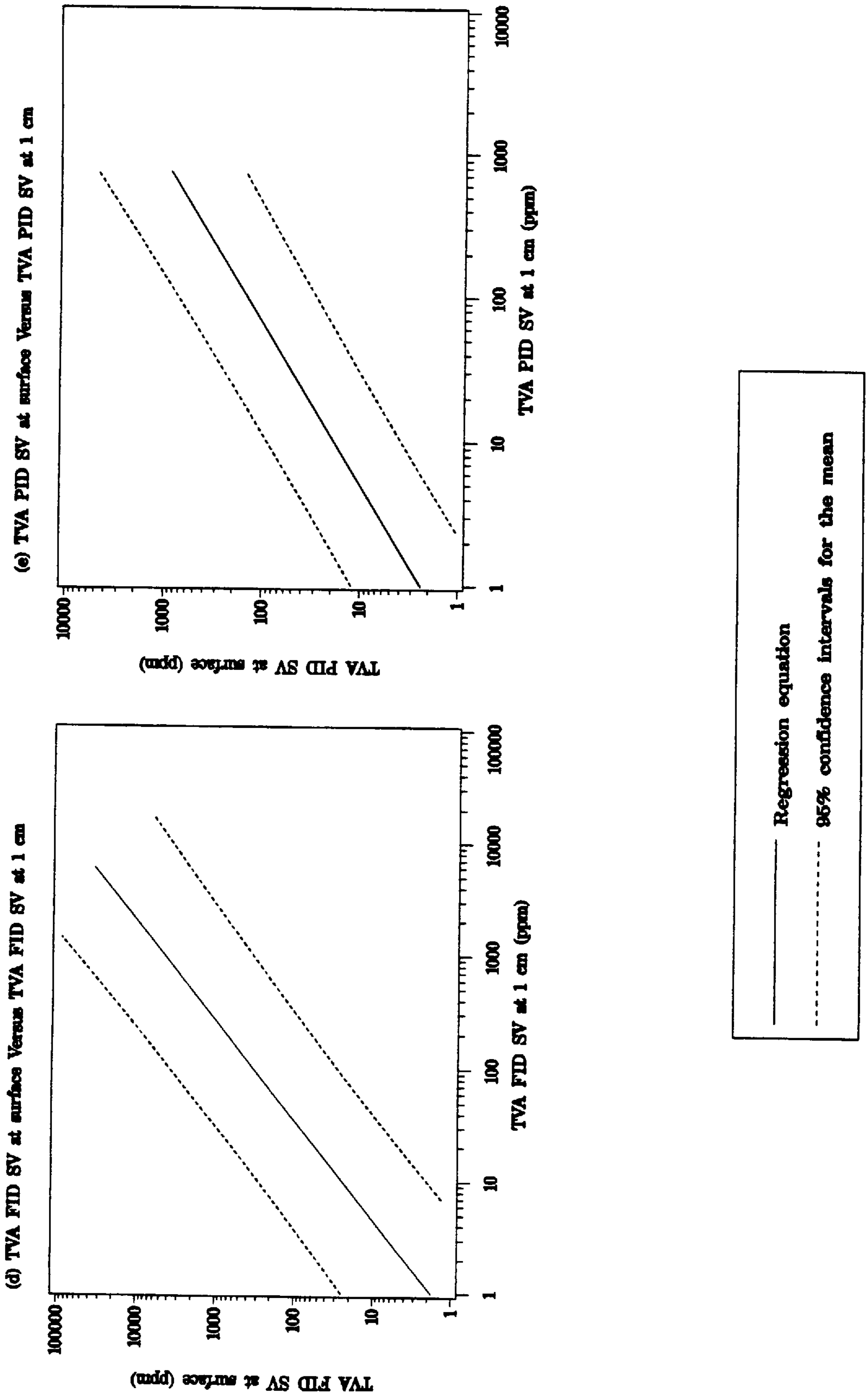


Figure 3-12 Equations Relating Screening Values at the Surface to Screening Values at 1 cm (Continued)

obtained at the component surface and at 1 cm from the component surface. Data collected for the 1979 Screening Study (as given in Appendix B of the 1979 Screening Study report) were compared to data collected for the 1994 Screening Study. It should be noted, however, that it is not known whether background measurements were taken for the 1979 Screening Study and subtracted from the component screening values, which was the procedure used for the 1994 Screening Study. In addition, the 1979 Screening Study data included pegged screening measurements (i.e., those screened beyond the range) which were removed before comparing them to the 1994 Screening Study data. As mentioned previously, pegged screening values were also obtained during the 1994 Screening Study; however, these values were not included in any of the analysis.

Differences between the following screening value comparisons were examined for the 1979 Screening Study data and the 1994 Screening Study data:

- OVA screening values at the surface versus OVA screening values at 1 cm;
- TLV Sniffer® screening values at the surface versus TLV Sniffer® screening values at 1 cm;
- OVA screening values at the surface versus TLV Sniffer® screening values at the surface; and
- OVA screening values at 1 cm versus TLV Sniffer® screening values at 1 cm.

Figure 3-13 shows plots of the 1979 Screening Study data and the 1994 Screening Study data for the four relationships listed above. The 1979 Screening Study data are indicated by an asterisk (*) in the figures and the 1994 Screening Study data are indicated by a dot. Correlation equations were developed for each of the studies, separately, and are overlaid on these plots. The dashed line indicates the correlation equation obtained using the 1979 Screening Study data and the solid line indicates the correlation equation obtained using the 1994 Screening Study data. Both sets of correlation equations were developed using measurement error methods in which the variability in the x value was assumed equal to the variability in the y value, as discussed in Appendix B of this report.

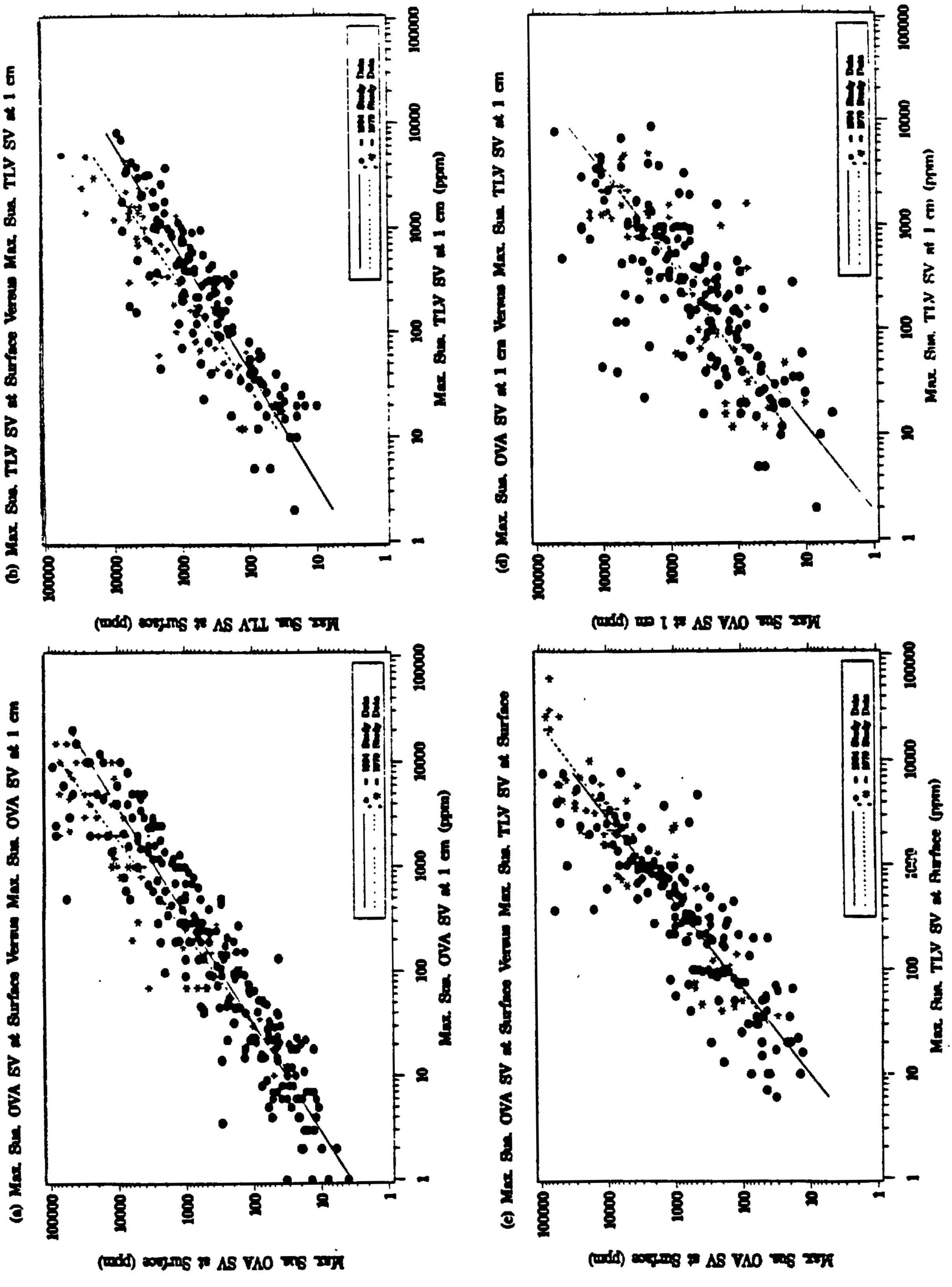


Figure 3-13 Comparison of 1979 Study Data to 1994 Study Data

Analysis of covariances (ANCOVAs) performed on the 1979 and 1994 data indicated that there were significant differences between the studies when comparing the OVA screening values at the surface to the OVA screening values at 1 cm, and when comparing the TLV Sniffer® screening values at the surface to the TLV Sniffer® screening values at 1 cm. The equations developed for each of these correlation equations are shown in plots (a) and (b) of Figure 3-13. As shown in the plots, the 1979 Screening Study equation results in screening values that are roughly 2 to 3 times different, on the average, for high screening value ranges. Differences between the studies were not as apparent for the lower screening value ranges. These differences between studies are fairly consistent for both the OVA and the TLV Sniffer® correlation equations. The cause for this difference between studies is not known. However, differences between studies could be attributable to different screening techniques, different ambient conditions, or different instrument sensitivities. It is also noted, that although statistically significant differences between the correlation equations for the two studies were found, the data are fairly well interspersed for low screening value ranges (i.e., < 1,000 ppm).

Plots (c) and (d) of Figure 3-13 show the correlation equations obtained for the two studies for the OVA versus the TLV Sniffer® screening measurements at the surface, and the OVA versus the TLV Sniffer® screening measurements at 1 cm, respectively. The ANCOVA results showed that there were no statistically significant differences between the studies for these two sets of correlation equations. In fact, the correlation equations shown in plot (c) are nearly identical.

ANALYSIS OF OTHER FACTORS THAT MAY AFFECT THE CORRELATION EQUATIONS

Analysis was performed to evaluate whether or not other factors, such as component type (connector or valve), service (light liquid, heavy liquid, or gas) or windspeed, may affect the correlation results. This analysis was performed only for those cases where a correlation equation was developed.

Analyses of covariance (ANCOVAs) were performed to determine if any other measured factors (i.e., component type, service, or windspeed) had a significant effect on the relationship between the logarithm of the y variable and the logarithm of the x variable. One of the assumptions in performing ANCOVAs is that the errors are normally distributed and that the variances are constant for different factors or ranges. These assumptions were met by taking the natural logarithms of the x and y values.

Testing for the significance of main effects (or factors) and the factor multiplied by log(x) (the interaction term) in an ANCOVA is analogous to testing whether separate regression equations developed for those factors will have intercepts and slopes, respectively, that are statistically different.

Table 3-3 shows the results of the ANCOVAs performed for the five sets of correlation equations developed which relate screening values at the surface to screening values obtained at 1 cm, and Table 3-4 shows the results of the ANCOVAs performed for the three sets of correlation equations developed relating screening values from different instrument types. The p-values for the main effect (i.e., the intercept) and the interaction term (i.e., the slope) are given in parenthesis for each of the factors. Those factors that have a statistically significant main effect (i.e., the intercepts of the different equations are significantly different) or have a statistically significant interaction term (i.e., the slopes of the different equations are significantly different) at the 0.10 level are noted with an "S" (significant) in the tables. Those factors for which the main effect and the interaction terms were not statistically significant at the 0.10 level are noted with an"NS" (not significant) in the table.

As shown in Tables 3-3 and 3-4, component type was found to have a significant effect only for the TVAF@ versus the TVAF1 correlation equations. Component type was not found to have a significant effect for the other correlation equations developed. This is consistent with the visual evidence shown in Figures 3-1 through 3-9 and 3-11. In each of these figures, different symbols were used to indicate the different component types (i.e., connector or valve). As shown in the figures, screening value measurements obtained for these two different component types were fairly well interspersed. The data shown in Figure 3-10 (i.e., for the TVAF@ versus the TVAF1) is redrawn in Figure 3-14 and overlaid with correlation equations developed for the different component types. Figure 3-14(a) did not have sufficient data for connectors to develop an adequate correlation equation. Although the differences in correlation equations for connectors and valves is apparent in Figure 3-14(b), the large differences could be attributable to the fact that there were insufficient data to adequately

Table 3-3. Results of Multivariate Analysis for Correlations Between Screening Distances

Equation Group	Equation (Y vs X)	Screening Type	Factor Tested (After accounting for variation in the X-variable)		
			Component Type (connector, valve)	Component Phase (LL, HL, Gas)	Windspeed
1	OVA@ vs OVA1	Maximum Sustainable SV	NS (0.39, 0.88)	S (0.02, 0.65)	S (0.08, 0.91)
		Peak Screening Value	NS (0.21, 0.50)	S (0.02, 0.54)	S (0.04, 0.86)
2	TLV@ vs TLV1	Maximum Sustainable SV	NS (0.72, 0.46)	NS (0.32, 0.12)	NS (0.77, 0.95)
		Peak Screening Value	NS (0.89, 0.34)	NS (0.40. 0.17)	NS (0.65, 0.83)
3	HNU@ vs HNU1	Maximum Sustainable SV	NS (0.57, 0.77)	NS (0.49, 0.57)	NS (0.44, 0.95)
		Peak Screening Value	NS (0.65, 0.27)	NS (0.32, 0.74)	NS (0.46, 0.99)
4	TVAF@ vs TVAF1	Maximum Sustainable	S (0.05, 0.98)	NS (0.36)[a]	NS (0.65, 0.32)
		Peak Screening Value	S (0.07, 0.64)	NS (0.75, 0.18)	NS (0.70, 0.46)
5	TVAP@ vs TVAP1	Maximum Sustainable SV	NS (0.57, 0.85)	NS (0.83)[a]	NS (0.51, 0.97)
		Peak Screening Value	NS (0.46, 0.89)	NS (0.53, 0.32)	NS (0.40, 0.11)

Key:

HL	=	Heavy liquid
HNU@	=	HNU® screening value at the surface of a component.
HNU1	=	HNU® screening value obtained with a 1 cm spacer.
LL	=	Light liquid
NS	=	Not statistically significant at the 0.10 significance level (p-values for intercept and slope, respectively, given in parenthesis).
OVA@	=	OVA screening value at the surface of a component.
OVA1	=	OVA screening value obtained with a 1 cm spacer.
S	=	Statistically significant at the 0.10 significance level (p-values for intercept and slope, respectively, given in parenthesis).
SV	=	Screening value
TLV@	=	TLV Sniffer® screening value at the surface of a component.
TLV1	=	TLV Sniffer® screening value obtained with a 1 cm spacer.
TVAF@	=	TVA FID screening value at the surface of a component.
TVAF1	=	TVA FID screening value obtained with a 1 cm spacer.
TVAP@	=	TVA PID screening value at the surface of a component.
TVAP1	=	TVA PID screening value obtained with a 1 cm spacer.

[a] Insufficient data to test both slope and intercept terms.

Table 3-4. Results of Multivariate Analysis for Correlations between Instrument Types

Equation Group	Equation (Y vs X)	Screening Type	Factor Tested (After accounting for variation in the X-variable)		
			Component Type (connector, valve)	Component Phase (LL, HL, Gas)	Windspeed
1	OVA@ vs TLV@	Maximum Sustainable SV	NS (0.83, 0.94)	S (0.43, 0.08)	NS (0.63, 0.90)
		Peak Screening Value	NS (0.86, 1.00)	S (0.36. 0.10)	NS (0.52, 0.97)
	OVA1 vs TLV1	Maximum Sustainable SV	NS (0.39, 0.60)	NS (0.28, 0.73)	NS (0.25, 0.51)
		Peak Screening Value	NS (0.33, 0.29)	NS (0.36, 0.74)	NS (0.31, 0.74)
2	OVA@ vs TVAF@	Maximum Sustainable SV	NS (0.61, 0.95)	NS (0.66)[a]	NS (0.40, 0.19)
		Peak Screening Value	NS (0.99, 0.62)	S (0.04, 0.87)	NS (0.24, 0.07)
	OVA1 vs TVAF1	Maximum Sustainable SV	NS (0.29, 0.52)	NS (0.34)[a]	NS (0.69, 0.18)
		Peak Screening Value	NS (0.80, 0.13)	S (0.13, 0.07)	NS (0.19, 0.63)
3	TVAP@ vs HNU@	Maximum Sustainable	NS (0.25)[a]	NS (0.51)[a]	S (0.03, 0.36)
		Peak Screening Value	NS (0.61)[a]	NS (0.50, 0.59)	S (0.05, 0.70)
	TVAP1 vs HNU1	Maximum Sustainable	NS (0.59)[a]	NS (0.37)[a]	NS (0.54, 0.19)
		Peak Screening Value	NS (0.70)[a]	NS (0.64, 0.75)	S (0.27, 0.10)

S = Statistically significant at the 0.10 significance level (p-values for intercept and slope, respectively, given in parenthesis).
NS = Not statistically significant at the 0.10 significance level (p-values for intercept and slope, respectively, given in parenthesis).

[a] Insufficient data to test both intercept and slope terms.

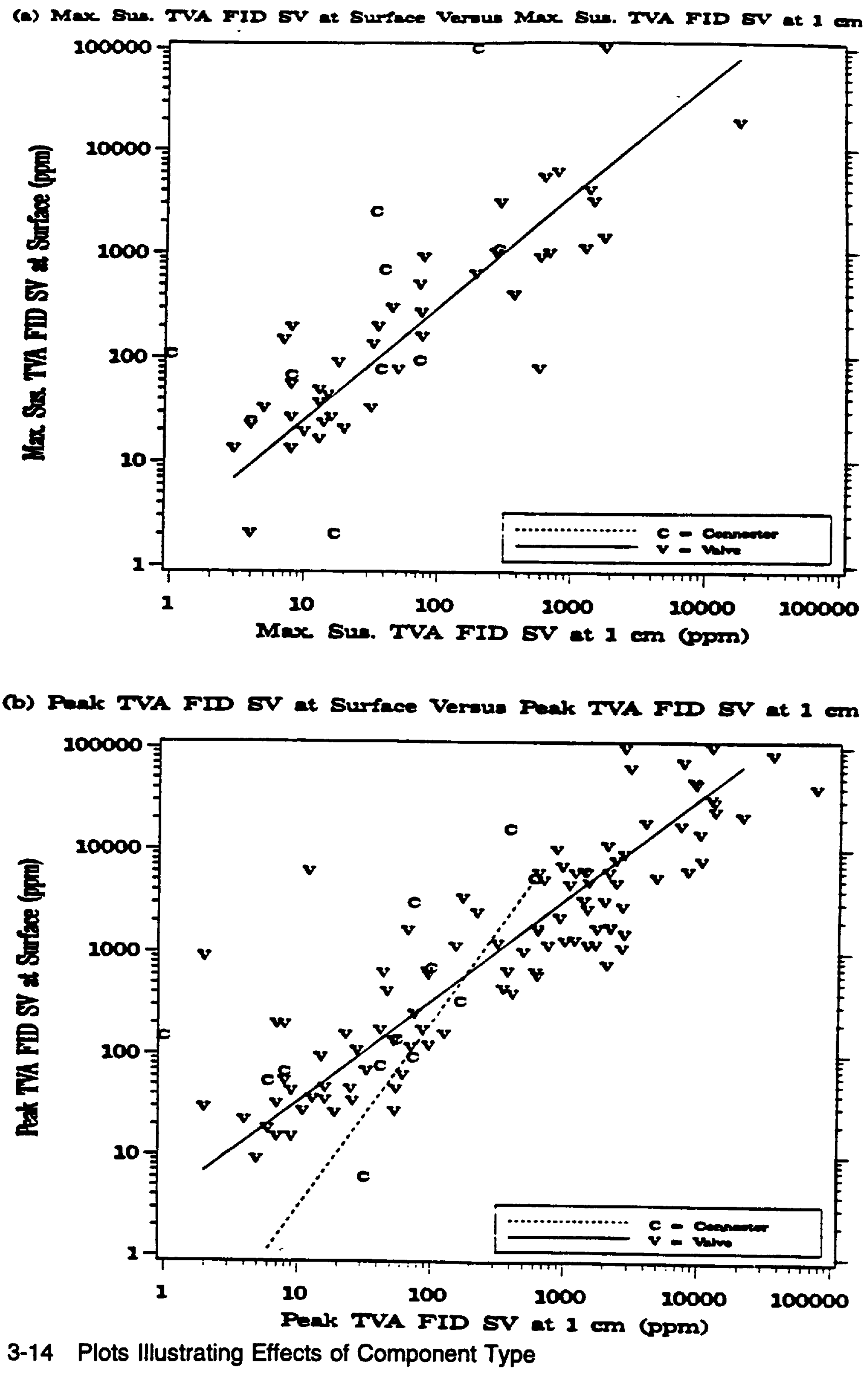


Figure 3-14 Plots Illustrating Effects of Component Type

represent connectors, especially for the larger screening value ranges. Thus, the significant effect found for component type for the TVAF@ versus the TVAF1 correlation equations may be an anomaly.

Component service (i.e., light liquid, heavy liquid, or gas) was found to have a significant effect for six of the correlation equations evaluated. These were for the OVA@ versus OVA1 correlation equations (maximum sustainable and peak screening values), the OVA@ versus TLV@ correlation equations (maximum sustainable and peak screening values), the OVA@ versus TVAF@ correlation equation (peak screening values), and the OVA1 versus TVAF1 correlation equation (peak screening values). Figure 3-15 shows the data for each of these correlation equations overlaid with the service specific correlation equation. Although the ANCOVA results indicated that these equations were statistically different, the differences between the equations in plots (a), (b), and (e) of Figure 3-15 do not seem to be very large and may not be of practical significance. Plots (c), (d), and (f) of Figure 3-15 show larger differences between the correlation equations developed; however, these large differences may be due, in part, to the lack of data available to define some of the service types.

The last factor evaluated was windspeed. It was hypothesized that windspeed could potentially have a significant effect, especially for screening value readings obtained at 1 cm. Windspeed was found to have a significant effect for six of the correlation equations developed - the OVA@ versus OVA1 correlation equations (maximum sustainable and peak screening values), the OVA@ versus TVAF@ correlation equation (peak screening values), the TVAP@ versus HNU®@ correlation equations (maximum sustainable and peak screening values), and the TVAP1 versus HNU1 correlation equation (peak screening value). Thus, windspeed was found to account for a significant portion of the variability in the correlation equations developed for these six cases. The degree of variability of measured screening values as a function of windspeed is beyond the scope of this project, although, it could be investigated in future related work. However, the impact of windspeed on the correlation equations was minor. Only marginal improvements in the correlation coefficients were found for the equations for which windspeed was significant. For example, the correlation coefficient for the OVA@ versus OVA1 correlation equation improves from 0.929 to only 0.930 by including windspeed.

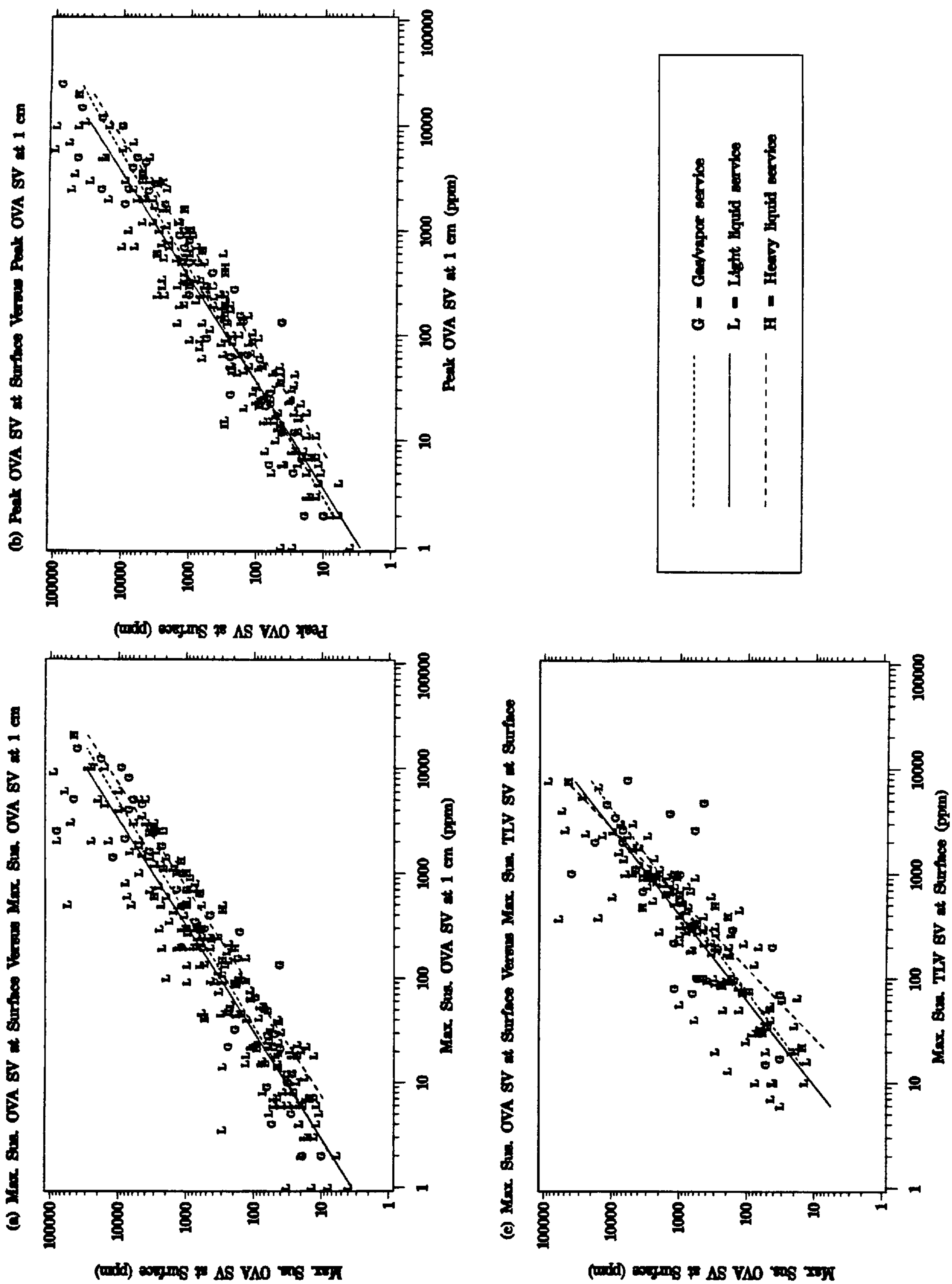


Figure 3-15 Plots Illustrating Service Type Effects

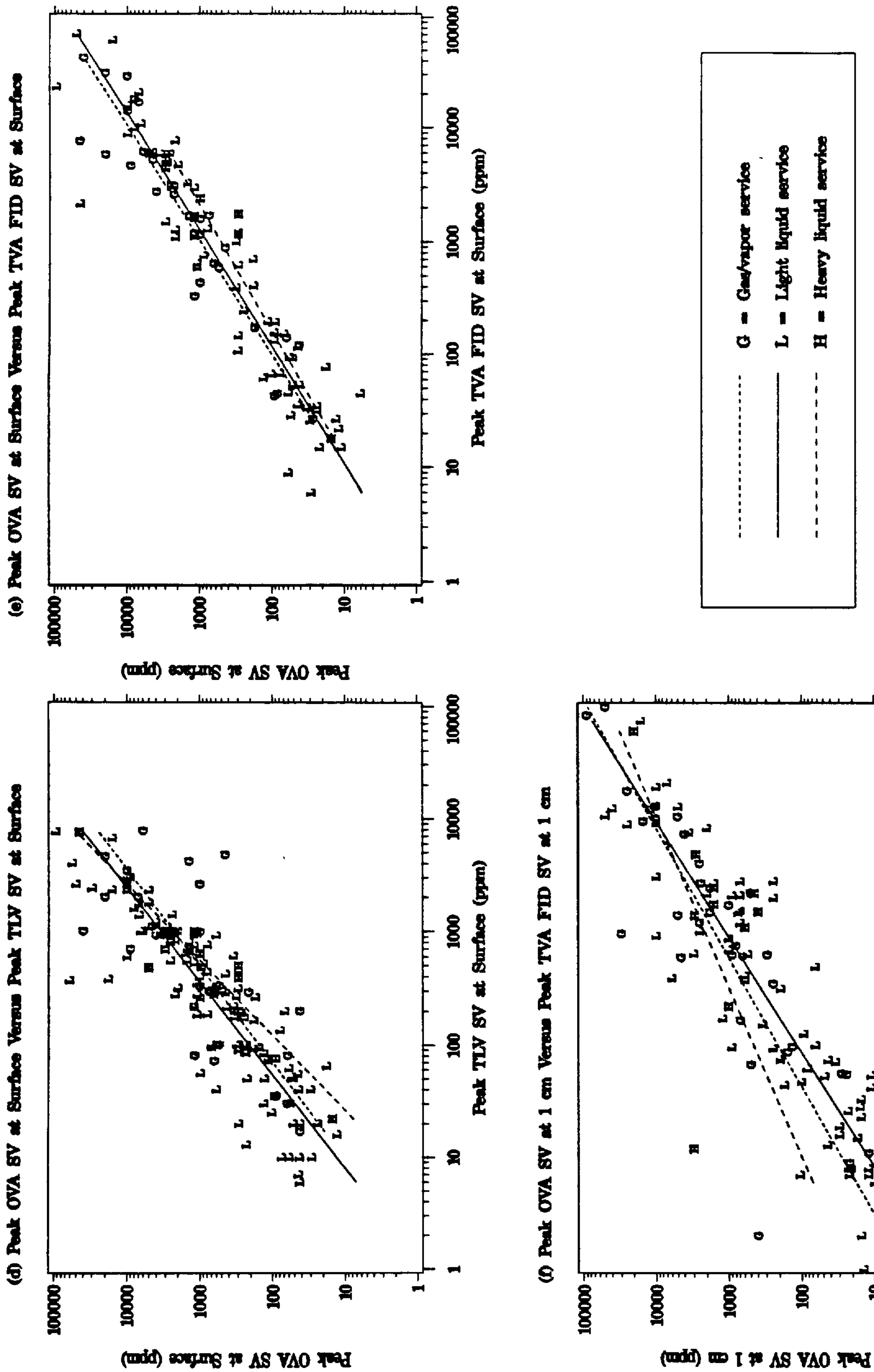


Figure 3-15 Plots Illustrating Service Type Effects (Continued)

Section 4

CONCLUSIONS AND RECOMMENDATIONS

RESULTS FROM DIFFERENT SCREENING INSTRUMENTS

The four instruments use three unique methods to detect hydrocarbon concentrations. The OVA 108 and the TVA 1000 (FID) are both flame ionization detectors. The HNU® and the TVA 1000 (PID) are both photo ionization detectors. The TLV Sniffer® uses a combustible gas detector. The different hydrocarbon detection systems are believed to be the primary reason for the different results between instruments. The two FID instrument results and the two PID instrument results were much more comparable to each other than to instruments using different detection systems (FID vs. PID vs. combustible gas).

Results from this study indicate that measured screening values from different instruments are different for the same component. A set of adjustment factors, or correlation equations, have been developed as part of this study to convert screening values from the TLV Sniffer® and TVA FID instruments to those measured with an OVA. These correlation equations are shown on Table 4-1.

Table 4-1. Equations Relating Screening Values From Different Instruments[a]

Variables Correlated	Screening Distance	Number of Data Pairs	Correlation Equation	Correlation Coefficient
OVA versus TLV Sniffer®	@ Surface	174	$OVA@ = (6.09 \times 10^{-1}) \times (TLV@)^{1.216}$	0.85
	1 cm	164	$OVA1 = (4.58 \times 10^{-1}) \times (TLV1)^{1.222}$	0.75
OVA versus TVA FID	@ Surface	54	$OVA@ = (1.54) \times (TVAF@)^{0.935}$	0.90
	1 cm	52	$OVA1 = (1.02) \times (TVAF1)^{1.013}$	0.83

[a] For maximum sustainable screening values.

Key

OVA@ = OVA screening value at the surface of a component.
OVA1 = OVA screening value obtained with a 1 cm spacer.
TLV@ = TLV Sniffer® screening value at the surface of a component.
TLV1 = TLV Sniffer® screening value obtained with a 1 cm spacer.
TVAF@ = TVA screening value at the surface of a component.
TVAF1 = TVA screening value obtained with a 1 cm spacer.

No correlations were developed to relate HNU® or TVA PID screening values to OVA screening values because an adequate correlation was not found between these screening values. Therefore, it is <u>not</u> advisable to use mass emission correlation equations that were developed with an OVA when HNU® or TVA PID screening measurements are obtained.

Study results indicate that the differences between peak screening values and the maximum sustainable screening values were not significant.

RESULTS FROM DIFFERENT SCREENING DISTANCES

The recent refinery and petroleum marketing terminals studies were performed by screening components as close as possible to the surface. For facilities having data obtained using a 1 cm spacer, that would like to apply results of these recent studies to their facilities, an adjustment factor needs to be applied. The adjustment factor for an OVA at the surface (OVA@) versus an OVA at 1 cm (OVA1) is given in the equation below:

$$OVA@ = (3.60) \times (OVA1)^{0.962} \qquad \text{(Equation 4-1)}$$

The recommended approach for converting TLV Sniffer® and the TVA FID screening values to comparable OVA screening values at the surface, when a 1 cm spacer is used with these instruments, is to first convert to comparable OVA values at 1 cm by using the correlations in Table 4-1 and then apply the above equation. Because of the lack of correlation for the HNU® and TVA PID to OVA screening values it is not recommended to convert any screening values from these instruments to OVA screening values. It should be noted that if a mass emission rate-screening value correlation line is plotted on log-log scale graph paper, based upon OVA screening measurements 1 cm away from the surface, and then Equation 4-1 is used to convert the 1 cm screening values (OVA1) to at the surface values (OVA@) and the straight line is replotted with the converted values on the same graph, the new line will be shifted to the right and will be lower than the original 1 cm mass emission rate-screening value correlation line.

Each of the instruments had screening values compared with that instrument at the surface to those with that same instrument at 1 cm. The effects of screening at the surface versus screening at 1 cm appears to have roughly the same impact for each instrument type. The screening values are two to three times lower, on the average, when obtained at a 1 cm screening distance.

COMPARISON OF STUDY RESULTS TO EARLIER STUDY

A previous study, entitled *Valve Screening Study at Six San Francisco Bay Area Petroleum Refineries*, or the "1979 Screening Study," reported on results for similar analysis of the TLV Sniffer® and the OVA 108. The current study, or "1994 Screening Study", evaluated more components, included connectors in the analysis, included additional screening instruments, and looked at additional factors that could influence test results such as windspeed, component type and service type.

Both studies show comparable differences between OVA and TLV Sniffer® screening values; however, the screening distance differences were more pronounced in the 1979 Screening Study than in the 1994 Screening Study. The reason for the differences in screening distance results is unknown. These differences could be due to differences in screening techniques, in ambient conditions, or in instrument sensitivities.

COMPARISON OF OTHER FACTORS THAT MAY AFFECT THE CORRELATION EQUATIONS

An analysis was performed to determine other factors that may affect the relationship between screening values. Windspeed was found to have a statistically significant effect for some of the inter-instrument comparison correlation equations. However, the impact of windspeed on the correlation equations was minor. Only marginal improvements in the correlation coefficients were found for the equations for which windspeed was significant. For example, the correlation coefficient for the OVA at the surface versus OVA at 1 cm correlation equation improves from 0.929 to only 0.930 by including windspeed.

Component type and service type were shown to have a significant effect for a few of the screening value correlations developed; however, these are thought to either be anomalous occurrences or questionable due to limited data for a specific factor.

Section 5

REFERENCES

1. American Petroleum Institute, 1993. *Development of Fugitive Emission Factors and Emission Profiles for Petroleum Marketing Terminals.* API Publication Number 4588. Prepared by Radian Corporation. May 1993.

2. American Petroleum Institute, 1994. *1993 Study of Refinery Fugitive Emission from Equipment Leaks.* API Publication Numbers 4612 and 4613. Prepared by Radian Corporation. Glendale, CA. February 1994.

3. Radian Corporation, 1979. *Valve Screening Study at Six San Francisco Bay Area Petroleum Refineries.* Prepared for six refineries. Austin, TX. February 1979.

APPENDIX A

Screening Value Data

API / WSPA Screening Study Data

Refinery L Sequence Number*	Component Information: Component Type	Subcategory	Actuation	Size (in.)	Service	Ambient Conditions: Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft/min)	Screening Data: Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
1	valve	Gate	M	--	LL	55	4	OVA 108	10	>100,000	>100,000	>100,000	>100,000	OVA 108 Instr. Id #20143
1	valve	Gate	M	--	LL	55	4	TLV Sniffer	0	>10,000	>10,000	>10,000	>10,000	TLV Sniffer Instr. Id #WO0546
1	valve	Gate	M	--	LL	55	4	HNu	0	180	180	180	200	HNu Instr. Id #870125
1	valve	Gate	M	--	LL	55	4	TVA 1000 (FID)	4	98,000	98,000	1,800	2,800	TVA 1000 (FID) Instr. Id #A1585 Without dilute at 1cm
1	valve	Gate	M	--	LL	55	4	TVA 1000 (PID)	1	44	44	45	45	TVA 1000 (PID) Instr. Id #A1585 Without dilute at 1cm
2	valve	Gate	M	--	LL	62	86	OVA 108	10	>100,000	>100,000	20,000	25,000	
2	valve	Gate	M	--	LL	62	86	TLV Sniffer	0	4,400	4,400	3,000	3,000	
2	valve	Gate	M	--	LL	62	86	HNu	<1	20	25	15	25	
2	valve	Gate	M	--	LL	62	86	TVA 1000 (FID)	4	178,400	178,400	6,000	9,000	Erratic readings
2	valve	Gate	M	--	LL	62	86	TVA 1000 (PID)	1	7	31	30	35	
3	valve	Gate	M	1	LL	58	2	OVA 108	8	1,200	1,200	300	350	
3	valve	Gate	M	1	LL	58	2	TLV Sniffer	0	750	750	500	600	
3	valve	Gate	M	1	LL	58	2	HNu	<1	25	25	10	15	
3	valve	Gate	M	1	LL	58	2	TVA 1000 (FID)	1	900	1,117	80	155	
3	valve	Gate	M	1	LL	58	2	TVA 1000 (PID)	3	7	13	1.5	2	
4	valve	Gate	M	1/2	LL	64	64	OVA 108	8	1,100	1,100	500	800	
4	valve	Gate	M	1/2	LL	64	64	TLV Sniffer	0	950	950	950	950	
4	valve	Gate	M	1/2	LL	64	64	HNu	0.4	10	10	3	3	
4	valve	Gate	M	1/2	LL	64	64	TVA 1000 (FID)	3	400	650	380	380	
4	valve	Gate	M	1/2	LL	64	64	TVA 1000 (PID)	0.6	3	3	2.2	2.2	
5	valve	Gate	M	3	LL	63	150	OVA 108	7	100	120	30	35	
5	valve	Gate	M	3	LL	63	150	TLV Sniffer	0	0	0	0	0	
5	valve	Gate	M	3	LL	63	150	HNu	0.4	2	2	1	1	
5	valve	Gate	M	3	LL	63	150	TVA 1000 (FID)						Flame out.
5	valve	Gate	M	3	LL	63	150	TVA 1000 (PID)	2	2	2	2	2	
6	valve	Ball	M	8	LL	61	120	OVA 108	7	5,000	9,000	1,000	3,000	
6	valve	Ball	M	8	LL	61	120	TLV Sniffer	0	3,000	3,000	350	350	
6	valve	Ball	M	8	LL	61	120	HNu	0.4	4	20	0	0.4	
6	valve	Ball	M	8	LL	61	120	TVA 1000 (FID)						
6	valve	Ball	M	8	LL	61	120	TVA 1000 (PID)						
7	con-fl	F	---	3	LL	64	190	OVA 108	7	140	200	25	50	
7	con-fl	F	---	3	LL	64	190	TLV Sniffer	>100*					* Need to recalibrate
7	con-fl	F	---	3	LL	64	190	HNu	0.4	3.5	3.5	2	3	
7	con-fl	F	---	3	LL	64	190	TVA 1000 (FID)						
7	con-fl	F	---	3	LL	64	190	TVA 1000 (PID)						
8	valve	Gate	M	3	LL	68	16	OVA 108	8	35	35	20	50	
8	valve	Gate	M	3	LL	68	16	TLV Sniffer	35					
8	valve	Gate	M	3	LL	68	16	HNu	0.4	0.4	0.4	0.4	0.4	
8	valve	Gate	M	3	LL	68	16	TVA 1000 (FID)						
8	valve	Gate	M	3	LL	68	16	TVA 1000 (PID)						
9	con-non	Th	---	1	LL	58	187	OVA 108	8	350	350	250	250	Connector left side
9	con-non	Th	---	1	LL	58	187	TLV Sniffer						
9	con-non	Th	---	1	LL	58	187	HNu	1	5	7	5	20	

API / WSPA Screening Study Data

Refinery L Sequence Number	Component Information: Component Type	Subcategory	Actuation	Size (in.)	Service	Ambient Conditions: Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft/min)	Screening Data: Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
9	con-non	Th	---	1	LL	56	187	TVA 1000 (FID)						
9	con-non	Th	---	1	LL	56	187	TVA 1000 (PID)						
10	valve	Gate	M	3	LL	57	140	OVA 108	7	550	550	140	250	
10	valve	Gate	M	3	LL	57	140	TLV Sniffer						
10	valve	Gate	M	3	LL	57	140	HNu	2	2	5	1	3.5	
10	valve	Gate	M	3	LL	57	140	TVA 1000 (FID)						
10	valve	Gate	M	3	LL	57	140	TVA 1000 (PID)						
11	valve	Gate	M	3	LL	55	544	OVA 108	7	350	350	120	160	
11	valve	Gate	M	3	LL	55	544	TLV Sniffer	30	640	640	180	180	
11	valve	Gate	M	3	LL	55	544	HNu	0.4	7	8	1.8	2	
11	valve	Gate	M	3	LL	55	544	TVA 1000 (FID)						
11	valve	Gate	M	3	LL	55	544	TVA 1000 (PID)						
12	valve	Gate	M	6	LL	55	241	OVA 108	6	14	14	7	8	
12	valve	Gate	M	6	LL	55	241	TLV Sniffer						Background too high
12	valve	Gate	M	6	LL	55	241	HNu	0.2	0.2	0.2	0.2	0.2	
12	valve	Gate	M	6	LL	55	241	TVA 1000 (FID)						
12	valve	Gate	M	6	LL	55	241	TVA 1000 (PID)						
13	valve	Gate	M	--	LL	53	120	OVA 108	8	120	300	30	100	H2 ran out.
13	valve	Gate	M	--	LL	53	120	TLV Sniffer						
13	valve	Gate	M	--	LL	53	120	HNu	0.2	200	23	4	7	Invalid surface readings.
13	valve	Gate	M	--	LL	53	120	TVA 1000 (FID)						
13	valve	Gate	M	--	LL	53	120	TVA 1000 (PID)						
14	valve	Gate	M	2	LL	44	480	OVA 108	7	85	85	22	22	
14	valve	Gate	M	2	LL	44	480	TLV Sniffer	25	160	160	60	60	
14	valve	Gate	M	2	LL	44	480	HNu	0.4	10	30	5	13	
14	valve	Gate	M	2	LL	44	480	TVA 1000 (FID)	2	50	70	15	35	
14	valve	Gate	M	2	LL	44	480	TVA 1000 (PID)	5	15	20	7	8	
15	valve	Plug	M	8	LL	48	16	OVA 108	7	2,200	2,200	1,100	1,600	
15	valve	Plug	M	8	LL	48	16	TLV Sniffer	16	650	850	500	500	
15	valve	Plug	M	8	LL	48	16	HNu	0.4	350	350	150	200	
15	valve	Plug	M	8	LL	48	16	TVA 1000 (FID)	5	1,000	1,100	700	2,700	Variable reading
15	valve	Plug	M	8	LL	48	16	TVA 1000 (PID)	8	180	190	120	220	Variable reading
16	valve	Gate	M	8	LL	56	51	OVA 108	7	70	100	55	55	
16	valve	Gate	M	8	LL	56	51	TLV Sniffer	10	45	45	35	35	
16	valve	Gate	M	8	LL	56	51	HNu	0.4	140	140	80	95	
16	valve	Gate	M	8	LL	56	51	TVA 1000 (FID)	7	140	140	40	60	
16	valve	Gate	M	8	LL	56	51	TVA 1000 (PID)	6	90	95	10	10	
17	valve	Gate	C	16	LL	48	670	OVA 108	10	2,400	2,400	500	550	
17	valve	Gate	C	16	LL	48	670	TLV Sniffer	0	1,400	1,400	900	950	
17	valve	Gate	C	16	LL	48	670	HNu	0.4	800	800	450	450	
17	valve	Gate	C	16	LL	48	670	TVA 1000 (FID)						
17	valve	Gate	C	16	LL	48	670	TVA 1000 (PID)						
18	valve	Gate	M	6	LL	47	250	OVA 108	20	6,800	6,800	1,600	2,500	

API / WSPA Screening Study Data

Refinery L	Component Information					Ambient Conditions		Screening Data						
Sequence Number	Component Type	Subcategory	Actuation	Size (in.)	Service	Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft/min)	Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
18	valve	Gate	M	6	LL	47	250	TLV Sniffer	20	1,400	1,400	850	850	
18	valve	Gate	M	6	LL	47	250	HNu	8	350	400	250	320	
18	valve	Gate	M	6	LL	47	250	TVA 1000 (FID)						
18	valve	Gate	M	6	LL	47	250	TVA 1000 (PID)						
19	valve	Gate	M	6	LL	54	130	OVA 108	20	1,600	1,600	450	550	
19	valve	Gate	M	6	LL	54	130	TLV Sniffer	15	650	650	420	420	
19	valve	Gate	M	6	LL	54	130	HNu	9	300	350	150	190	
19	valve	Gate	M	6	LL	54	130	TVA 1000 (FID)						Flame out PID too low
19	valve	Gate	M	6	LL	54	130	TVA 1000 (PID)						Flame out PID too low.
20	valve	Gate	M	1/2	LL	62	210	OVA 108	10	800	800	300	350	
20	valve	Gate	M	1/2	LL	62	210	TLV Sniffer	20	780	780	520	520	
20	valve	Gate	M	1/2	LL	62	210	HNu	3	300	300	220	220	
20	valve	Gate	M	1/2	LL	62	210	TVA 1000 (FID)						Flame out PID too low.
20	valve	Gate	M	1/2	LL	62	210	TVA 1000 (PID)						Flame out. PID too low
21	valve	Plug	M	10	LL	58	130	OVA 108	10	550	650	50	70	
21	valve	Plug	M	10	LL	58	130	TLV Sniffer	12	290	290	170	170	
21	valve	Plug	M	10	LL	58	130	HNu	0	40	400	250	320	Variable
21	valve	Plug	M	10	LL	58	130	TVA 1000 (FID)						
21	valve	Plug	M	10	LL	58	130	TVA 1000 (PID)						
22	valve	Gate	M	1	LL	60	110	OVA 108	10	1,000	1,500	140	140	
22	valve	Gate	M	1	LL	60	110	TLV Sniffer	5	560	560	220	220	
22	valve	Gate	M	1	LL	60	110	HNu	0.4	350	380	100	140	
22	valve	Gate	M	1	LL	60	110	TVA 1000 (FID)						
22	valve	Gate	M	1	LL	60	110	TVA 1000 (PID)						
23	valve	Gate	M	6	LL	50	550	OVA 108	6	180	180	110	140	
23	valve	Gate	M	6	LL	50	550	TLV Sniffer	5	270	270	94	94	
23	valve	Gate	M	6	LL	50	550	HNu	0	220	220	40	45	
23	valve	Gate	M	6	LL	50	550	TVA 1000 (FID)						
23	valve	Gate	M	6	LL	50	550	TVA 1000 (PID)						
24	valve	Gate	M	8	LL	48	750	OVA 108	8	1,400	1,400	200	200	
24	valve	Gate	M	8	LL	48	750	TLV Sniffer	8	670	670	410	410	
24	valve	Gate	M	8	LL	48	750	HNu	0	140	170	40	60	
24	valve	Gate	M	8	LL	48	750	TVA 1000 (FID)						
24	valve	Gate	M	8	LL	48	750	TVA 1000 (PID)						
25	valve	Gate	M	1	GAS	52	210	OVA 108	11	60	100	40	70	
25	valve	Gate	M	1	GAS	52	210	TLV Sniffer	50	65	65	68	66	
25	valve	Gate	M	1	GAS	52	210	HNu	0	0	0			
25	valve	Gate	M	1	GAS	52	210	TVA 1000 (FID)						
25	valve	Gate	M	1	GAS	52	210	TVA 1000 (PID)						
26	valve	Gate	M	1	GAS	50	2	OVA 108	8	40	50	18	20	
26	valve	Gate	M	1	GAS	50	2	TLV Sniffer	5	22	22	30	40	
26	valve	Gate	M	1	GAS	50	2	HNu	0	0	0	0	0	
26	valve	Gate	M	1	GAS	50	2	TVA 1000 (FID)						TVA 1000 (FID) Instr Id #A140F

API / WSPA Screening Study Data

Refinery L Sequence Number	Component Information: Component Type	Subcategory	Actuation	Size (in.)	Service	Ambient Conditions: Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft/min)	Screening Data: Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
26	valve	Gate	M	1	GAS	50	2	TVA 1000 (PID)						
27	valve	Gate	M	1	GAS	51	40	OVA 108	8	40	70	20	30	
27	valve	Gate	M	1	GAS	51	40	TLV Sniffer	5	75	85	40	40	
27	valve	Gate	M	1	GAS	51	40	HNu	0	0	0	0	0	
27	valve	Gate	M	1	GAS	51	40	TVA 1000 (FID)						
27	valve	Gate	M	1	GAS	51	40	TVA 1000 (PID)						
28	valve	Gate	M	3	LL	59	6	OVA 108	8	58,000	58,000	500	2,500	
28	valve	Gate	M	3	LL	59	6	TLV Sniffer	10	4,000	4,000	2,000	2,000	
28	valve	Gate	M	3	LL	59	6	HNu	0	300	350	350	300	
28	valve	Gate	M	3	LL	59	6	TVA 1000 (FID)						
28	valve	Gate	M	3	LL	59	6	TVA 1000 (PID)						
29	valve	Gate	M	3	LL	61	18	OVA 108	11	>112,000	>112,000	89,600	89,600	
29	valve	Gate	M	3	LL	61	18	TLV Sniffer	10	>10,000	>10,000	>10,000	>10,000	
29	valve	Gate	M	3	LL	61	18	HNu	3	4,000	5,000	3,000	4,000	Erroneous readings (beyond range)
29	valve	Gate	M	3	LL	61	18	TVA 1000 (FID)						TVA 1000 (FID) Instr. Id #A1565
29	valve	Gate	M	3	LL	61	18	TVA 1000 (PID)						
30	valve	Gate	M	3	LL	58	110	OVA 108	10	1,100	1,200	400	400	
30	valve	Gate	M	3	LL	58	110	TLV Sniffer	30	950	950	420	420	
30	valve	Gate	M	3	LL	58	110	HNu	1	100	150	80	100	
30	valve	Gate	M	3	LL	58	110	TVA 1000 (FID)						
30	valve	Gate	M	3	LL	58	110	TVA 1000 (PID)						
31	valve	Gate	M	1	LL	61	25	OVA 108	12	4,000	5,000	3,000	3,500	
31	valve	Gate	M	1	LL	61	25	TLV Sniffer	30	1,800	1,800	1,800	1,800	
31	valve	Gate	M	1	LL	61	25	HNu	1	100	100	80	100	
31	valve	Gate	M	1	LL	61	25	TVA 1000 (FID)						
31	valve	Gate	M	1	LL	61	25	TVA 1000 (PID)						
32	valve	Gate	M	1	LL	58	94	OVA 108	10	2,800	3,300	1,600	1,700	
32	valve	Gate	M	1	LL	58	94	TLV Sniffer	0	950	950	950	950	
32	valve	Gate	M	1	LL	58	94	HNu	8	200	200	180	250	
32	valve	Gate	M	1	LL	58	94	TVA 1000 (FID)						
32	valve	Gate	M	1	LL	58	94	TVA 1000 (PID)						
33	con-non	Th	...	1	LL	58	94	OVA 108	9	95	95	50	60	
33	con-non	Th	...	1	LL	58	94	TLV Sniffer	0	0	0	0	0	
33	con-non	Th	...	1	LL	58	94	HNu	0	30	40	200	200	
33	con-non	Th	...	1	LL	58	94	TVA 1000 (FID)						
33	con-non	Th	...	1	LL	58	94	TVA 1000 (PID)						
34	valve	Gate	M	1	LL	58	94	OVA 108	8	110	110	30	40	
34	valve	Gate	M	1	LL	58	94	TLV Sniffer	0	75	75	12	12	
34	valve	Gate	M	1	LL	58	94	HNu	0	120	170	70	130	
34	valve	Gate	M	1	LL	58	94	TVA 1000 (FID)						
34	valve	Gate	M	1	LL	58	94	TVA 1000 (PID)						
35	valve	Gate	M	2	LL	58	70	OVA 108	8	>112,000	>112,000	>112,000	>112,000	
35	valve	Gate	M	2	LL	58	70	TLV Sniffer	0	>10,000	>10,000	>10,000	>10,000	

API / WSPA Screening Study Data

Refinery L Sequence Number	Component Information					Ambient Conditions		Screening Data						
	Component Type	Subcategory	Actuation	Size (in.)	Service	Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft/min)	Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
35	valve	Gate	M	2	LL	58	70	HNu	0	>2,000	>2,000	>2,000	>2,000	
35	valve	Gate	M	2	LL	58	70	TVA 1000 (FID)						
35	valve	Gate	M	2	LL	58	70	TVA 1000 (PID)						
36	valve	Gate	M	1	LL	67	38	OVA 108	8	600	600	300	300	
36	valve	Gate	M	1	LL	67	38	TLV Sniffer	0	40	40	40	40	
36	valve	Gate	M	1	LL	67	38	HNu	0	100	100	50	70	
36	valve	Gate	M	1	LL	67	38	TVA 1000 (FID)						
36	valve	Gate	M	1	LL	67	38	TVA 1000 (PID)						
37	valve	Gate	M	3	LL	57	103	OVA 108	10	28,000	35,840	10,000	11,000	
37	valve	Gate	M	3	LL	57	103	TLV Sniffer	0	5,400	5,400			
37	valve	Gate	M	3	LL	57	103	HNu	0	1,000	1,200			Variable
37	valve	Gate	M	3	LL	57	103	TVA 1000 (FID)						
37	valve	Gate	M	3	LL	57	103	TVA 1000 (PID)						
38	valve	Gate	C	30	LL	80	60	OVA 108	8	120	130	70	75	
38	valve	Gate	C	30	LL	80	60	TLV Sniffer	5	220	220			
38	valve	Gate	C	30	LL	80	60	HNu	0	170	200			
38	valve	Gate	C	30	LL	80	60	TVA 1000 (FID)						
38	valve	Gate	C	30	LL	80	60	TVA 1000 (PID)						
39	valve	Gate	C	30	LL	60	8	OVA 108	6	450	450	200	200	
39	valve	Gate	C	30	LL	60	8	TLV Sniffer	58	450	460	460	460	
39	valve	Gate	C	30	LL	60	8	HNu	5	300	340	70	160	
39	valve	Gate	C	30	LL	60	8	TVA 1000 (FID)						
39	valve	Gate	C	30	LL	60	8	TVA 1000 (PID)						
40	con-fl	F	. . .	5	LL	50	270	OVA 108	8	30	50	12	14	
40	con-fl	F	. . .	5	LL	50	270	TLV Sniffer	44	64	64	60*	60*	* Spacer too big on 60 ppm reading
40	con-fl	F	. . .	5	LL	50	270	HNu	0	20	25	3	10*	* Spacer too big on 10 ppm reading
40	con-fl	F	. . .	5	LL	50	270	TVA 1000 (FID)						
40	con-fl	F	. . .	5	LL	50	270	TVA 1000 (PID)						
41	valve	Gate	M	6	LL	58	71	OVA 108	10	112,000	112,000	89,600	100,800	
41	valve	Gate	M	6	LL	58	71	TLV Sniffer	7	>10,000	>10,000	>10,000	>10,000	
41	valve	Gate	M	6	LL	58	71	HNu	0	300	400	100	160	
41	valve	Gate	M	6	LL	58	71	TVA 1000 (FID)						
41	valve	Gate	M	6	LL	58	71	TVA 1000 (PID)						
42	valve	Plug	M	6	LL	50	30	OVA 108	12	35	40	30	45	
42	valve	Plug	M	6	LL	50	30	TLV Sniffer	200					Background too high.
42	valve	Plug	M	6	LL	50	30	HNu	0	1	1	10	10	
42	valve	Plug	M	6	LL	50	30	TVA 1000 (FID)						
42	valve	Plug	M	6	LL	50	30	TVA 1000 (PID)						
43	valve	Gate	M	2	GAS	50	250	OVA 108	9	50	80	30	30	
43	valve	Gate	M	2	GAS	50	250	TLV Sniffer						Background too high.
43	valve	Gate	M	2	GAS	50	250	HNu	0	0	0	0	0	
43	valve	Gate	M	2	GAS	50	250	TVA 1000 (FID)						
43	valve	Gate	M	2	GAS	50	250	TVA 1000 (PID)						

API / WSPA Screening Study Data

Refinery L Sequence Number	Component Information: Component Type	Subcategory	Actuation	Size (in.)	Service	Ambient Conditions: Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft/min)	Screening Data: Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
44	valve	Gate	M	4	LL	50	98	OVA 108	10	>112,000	>112,000	10,000	18,000	
44	valve	Gate	M	4	LL	50	98	TLV Sniffer						
44	valve	Gate	M	4	LL	50	98	HNu	0	>2,000	>2,000	200	200	
44	valve	Gate	M	4	LL	50	98	TVA 1000 (FID)						
44	valve	Gate	M	4	LL	50	98	TVA 1000 (PID)						
45	valve	Gate	M	8	LL	60	115	OVA 108	20	16,000	18,000	4,500	5,000	
45	valve	Gate	M	8	LL	60	115	TLV Sniffer	80	460	460	300	300	
45	valve	Gate	M	8	LL	60	115	HNu						Battery dead
45	valve	Gate	M	8	LL	60	115	TVA 1000 (FID)						
45	valve	Gate	M	8	LL	60	115	TVA 1000 (PID)						
46	valve	Gate	M	8	LL	54	190	OVA 108	30	61,600	61,600	6,000	7,000	
46	valve	Gate	M	8	LL	54	190	TLV Sniffer	80	450	450	120	120	
46	valve	Gate	M	8	LL	54	190	HNu						
46	valve	Gate	M	8	LL	54	190	TVA 1000 (FID)						
46	valve	Gate	M	8	LL	54	190	TVA 1000 (PID)						
47	valve	Gate	M	8	LL	50	155	OVA 108	35	1,000	1,000	300	350	
47	valve	Gate	M	8	LL	50	155	TLV Sniffer	100	56	56	220	220	Invalid. Failed QC check.
47	valve	Gate	M	8	LL	50	155	HNu						
47	valve	Gate	M	8	LL	50	155	TVA 1000 (FID)						
47	valve	Gate	M	8	LL	50	155	TVA 1000 (PID)						
48	valve	Gate	M	8	LL	48	360	OVA 108	10	50	70	40	40	
48	valve	Gate	M	8	LL	48	360	TLV Sniffer	70	80	80	90	90	
48	valve	Gate	M	8	LL	48	360	HNu						
48	valve	Gate	M	8	LL	48	360	TVA 1000 (FID)						
48	valve	Gate	M	8	LL	48	360	TVA 1000 (PID)						
49	valve	Btfy	C	1	LL	47	480	OVA 108	10	14,000	16,000	2,000	2,000	
49	valve	Btfy	C	1	LL	47	480	TLV Sniffer	80	2,400	2,400	450	450	
49	valve	Btfy	C	1	LL	47	480	HNu						
49	valve	Btfy	C	1	LL	47	480	TVA 1000 (FID)						
49	valve	Btfy	C	1	LL	47	480	TVA 1000 (PID)						
50	valve	Gate	M	4	LL	58	75	OVA 108	20	3,000	4,000	3,000	3,000	
50	valve	Gate	M	4	LL	58	75	TLV Sniffer	80	1,200	1,200	1,200	1,200	
50	valve	Gate	M	4	LL	58	75	HNu						
50	valve	Gate	M	4	LL	58	75	TVA 1000 (FID)						
50	valve	Gate	M	4	LL	58	75	TVA 1000 (PID)						
51	valve	Gate	C	6	LL	52	180	OVA 108	10	1,000	1,000	100	100	
51	valve	Gate	C	6	LL	52	180	TLV Sniffer	64	120	120	80	80	
51	valve	Gate	C	6	LL	52	180	HNu						
51	valve	Gate	C	6	LL	52	180	TVA 1000 (FID)						
51	valve	Gate	C	6	LL	52	180	TVA 1000 (PID)						
52	valve	Gate	M	6	LL	52	190	OVA 108	10	1,000	1,000	500	600	
52	valve	Gate	M	6	LL	52	190	TLV Sniffer	80	340	340	220	220	
52	valve	Gate	M	6	LL	52	190	HNu						

API / WSPA Screening Study Data

Refinery L Sequence Number	Component Information: Component Type	Subcategory	Actuation	Size (in.)	Service	Ambient Conditions: Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft/min)	Screening Data: Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
52	valve	Gate	M	6	LL	52	190	TVA 1000 (FID)						
52	valve	Gate	M	6	LL	52	190	TVA 1000 (PID)						
53a	valve	Gate	M	1	LL	51	120	OVA 108	20	3,500	3,500	700	1,200	
53a	valve	Gate	M	1	LL	51	120	TLV Sniffer	90	1,000	1,000	320	320	
53a	valve	Gate	M	1	LL	51	120	HNu						
53a	valve	Gate	M	1	LL	51	120	TVA 1000 (FID)						
53a	valve	Gate	M	1	LL	51	120	TVA 1000 (PID)						
53b	valve	Check	C	3/8	LL	50	140	OVA 108	10	>112,000	>112,000	>112,000	>112,000	High variable with 1cm.
53b	valve	Check	C	3/8	LL	50	140	TLV Sniffer	20	>10,000	>10,000	>10,000	>10,000	
53b	valve	Check	C	3/8	LL	50	140	HNu						
53b	valve	Check	C	3/8	LL	50	140	TVA 1000 (FID)						
53b	valve	Check	C	3/8	LL	50	140	TVA 1000 (PID)						
53c	valve	Gate	M	6	LL	53	230	OVA 108	10	10,000	10,000	4,000	10,000	
53c	valve	Gate	M	6	LL	53	230	TLV Sniffer	75	2,600	2,600	1,100	1,100	
53c	valve	Gate	M	6	LL	53	230	HNu						
53c	valve	Gate	M	6	LL	53	230	TVA 1000 (FID)						
53c	valve	Gate	M	6	LL	53	230	TVA 1000 (PID)						
54	valve	Gate	M	6	GAS	50	29	OVA 108	7	750	750	350	500	
54	valve	Gate	M	6	GAS	50	29	TLV Sniffer	74	370	370	260	260	
54	valve	Gate	M	6	GAS	50	29	HNu	1	300	350	200	220	
54	valve	Gate	M	6	GAS	50	29	TVA 1000 (FID)	4	1,400	1,700	1,800	2,200	Highly variable
54	valve	Gate	M	6	GAS	50	29	TVA 1000 (PID)	5	170	172	170	180	
55	valve	Plug	M	4	LL	47	210	OVA 108	7	800	1,100	200	250	
55	valve	Plug	M	4	LL	47	210	TLV Sniffer	70	350	350	220	220	
55	valve	Plug	M	4	LL	47	210	HNu	1	260	260	260	260	
55	valve	Plug	M	4	LL	47	210	TVA 1000 (FID)	6	500	650	80	100	Highly variable
55	valve	Plug	M	4	LL	47	210	TVA 1000 (PID)	67	110	115	20	45	
56	valve	Plug	M	4	LL	48	230	OVA 108	10	700	3,000	250	250	
56	valve	Plug	M	4	LL	48	230	TLV Sniffer	92	780	780	190	190	
56	valve	Plug	M	4	LL	48	230	HNu	1	250	300	250	300	Visibly wet.
56	valve	Plug	M	4	LL	48	230	TVA 1000 (FID)	1	1,100	1,500	1,300	2,800	Very variable
56	valve	Plug	M	4	LL	48	230	TVA 1000 (PID)	5	150	220	260	300	
57	valve	Gate	C	4	LL	45	250	OVA 108	8	>110,000	>110,000	>110,000	>110,000	Wet and bubbling
57	valve	Gate	C	4	LL	45	250	TLV Sniffer	65	>10,000	>10,000	>10,000	>10,000	
57	valve	Gate	C	4	LL	45	250	HNu	30	>2,000	>2,000	300	400	
57	valve	Gate	C	4	LL	45	250	TVA 1000 (FID)	1	302,400	372,960	163,800	277,200	
57	valve	Gate	C	4	LL	45	250	TVA 1000 (PID)	5	740	790	760	800	
58	valve	Gate	C	--	LL	47	190	OVA 108	10	70	70	15	15	
58	valve	Gate	C	--	LL	47	190	TLV Sniffer	0	0	0	0	0	
58	valve	Gate	C	--	LL	47	190	HNu	2	6	7	2	2	
58	valve	Gate	C	--	LL	47	190	TVA 1000 (FID)	6	8	15	10	11	
58	valve	Gate	C	--	LL	47	190	TVA 1000 (PID)	8	8	8	11	11	
59	valve	Gate	M	1	LL	48	180	OVA 108	8	800	800	700	700	

API / WSPA Screening Study Data

Refinery L Sequence Number	Component Information					Ambient Conditions		Screening Data							
	Component Type	Subcategory	Actuation	Size (in.)	Service	Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft/min)	Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
59	valve	Gate	M	1	LL	48	160	TLV Sniffer	0	440	440	300	300	
59	valve	Gate	M	1	LL	48	160	HNu	1	5	5	15	20	
59	valve	Gate	M	1	LL	48	160	TVA 1000 (FID)	3	900	1,300	600	1,200	
59	valve	Gate	M	1	LL	48	160	TVA 1000 (PID)	6.6	10	10.5	9	9.5	
60	valve	Gate	M	6	LL	46	230	OVA 108	8	6,500	6,500	500	700	
60	valve	Gate	M	6	LL	46	230	TLV Sniffer	0	1,000	1,000	720	800	
60	valve	Gate	M	6	LL	46	230	HNu	0	13	13	16	16	
60	valve	Gate	M	6	LL	46	230	TVA 1000 (FID)	1	6,000	11,000	800	2,100	
60	valve	Gate	M	6	LL	46	230	TVA 1000 (PID)	6.3	21	27	17	20	
61	valve	Gate	M	1	LL	46	26	OVA 108	9	1,000	1,200	550	550	
61	valve	Gate	M	1	LL	46	26	TLV Sniffer	0	220	220	160	160	
61	valve	Gate	M	1	LL	46	26	HNu	0	100	140	20	40	
61	valve	Gate	M	1	LL	46	26	TVA 1000 (FID)	5	83	1,610	590	640	
61	valve	Gate	M	1	LL	46	26	TVA 1000 (PID)	8	36	49	62	62	
62	valve	Gate	C	3	LL	53	40	OVA 108	7	1,000	1,000	500	800	
62	valve	Gate	C	3	LL	53	40	TLV Sniffer	0	400	400	80	100	
62	valve	Gate	C	3	LL	53	40	HNu	0	75	75	90	90	
62	valve	Gate	C	3	LL	53	40	TVA 1000 (FID)	8	1,900	1,965			
62	valve	Gate	C	3	LL	53	40	TVA 1000 (PID)	9	9	11	10	10	
63	con-fl	F	C	6	LL	54	156	OVA 108	8	8,000	10,000	3,000	8,000	Spacer too big.
63	con-fl	F	C	6	LL	54	156	TLV Sniffer	0	2,300	2,300	1,200	1,200	
63	con-fl	F	C	6	LL	54	156	HNu	0	7	7	6	6	
63	con-fl	F	C	6	LL	54	156	TVA 1000 (FID)	10	1,100	16,000	300	400	
63	con-fl	F	C	6	LL	54	156	TVA 1000 (PID)	10	20	25	20	25	
64	valve	Gate	M	1	LL	51	70	OVA 108	7	3,000	3,000	2,500	3,000	
64	valve	Gate	M	1	LL	51	70	TLV Sniffer	0	1,000	1,000	800	800	
64	valve	Gate	M	1	LL	51	70	HNu	0	100	170	60	130	
64	valve	Gate	M	1	LL	51	70	TVA 1000 (FID)	8	5,300	5,900	647	650	
64	valve	Gate	M	1	LL	51	70	TVA 1000 (PID)	8	26	29	17	22	
65	valve	Gate	M	3	LL	57	22	OVA 108	10	>110,000	>110,000	>110,000	>110,000	
65	valve	Gate	M	3	LL	57	22	TLV Sniffer	0	>10,000	>10,000	>10,000	>10,000	
65	valve	Gate	M	3	LL	57	22	HNu	6	6	6	6	6	
65	valve	Gate	M	3	LL	57	22	TVA 1000 (FID)	18	>176,400	>176,400	>176,400	>176,400	
65	valve	Gate	M	3	LL	57	22	TVA 1000 (PID)	12					No test due to FID flame out
66	valve	Gate	M	2	LL	57	25	OVA 108	10	2,300	2,300	200	250	
66	valve	Gate	M	2	LL	57	25	TLV Sniffer	0	1,000	1,000	220	220	
66	valve	Gate	M	2	LL	57	25	HNu	0	7	7	10	10	
66	valve	Gate	M	2	LL	57	25	TVA 1000 (FID)	4	3,100	3,100	1,500	2,000	
66	valve	Gate	M	2	LL	57	25	TVA 1000 (PID)	9	17	19	17	17	
67	valve	Gate	M	6	LL	54	24	OVA 108	7	80	100	60	100	
67	valve	Gate	M	6	LL	54	24	TLV Sniffer	0	0	0	0	0	
67	valve	Gate	M	6	LL	54	24	HNu	0	150	180	150	200	
67	valve	Gate	M	6	LL	54	24	TVA 1000 (FID)	3	160	160	80	130	

API / WSPA Screening Study Data

Refinery L Sequence Number	Component Information					Ambient Conditions		Screening Data							Comments
	Component Type	Subcategory	Actuation	Size (in.)	Service	Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft/min)	Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)		
67	valve	Gate	M	6	LL	54	24	TVA 1000 (PID)	8	80	120	11	25		
68	valve	Gate	M	1	LL	54	24	OVA 108	8	19	19	13	13		
68	valve	Gate	M	1	LL	54	24	TLV Sniffer	0	0	0	0	0		
68	valve	Gate	M	1	LL	54	24	HNu	0	10	10	3	3		
68	valve	Gate	M	1	LL	54	24	TVA 1000 (FID)	2	15	17	10	11		
68	valve	Gate	M	1	LL	54	24	TVA 1000 (PID)	7	10	10	10	11		
68B	valve	Gate	M	3	LL	55	6	OVA 108	7	600	600	300	300		
68B	valve	Gate	M	3	LL	55	6	TLV Sniffer	0	340	340	0	0		
68B	valve	Gate	M	3	LL	55	6	HNu	0	9	9	3	4		
68B	valve	Gate	M	3	LL	55	6	TVA 1000 (FID)	1	500	729	420	50		Invalid readings at 1 cm.
68B	valve	Gate	M	3	LL	55	6	TVA 1000 (PID)	7	9	10	9	9		
69	valve	Gate	M	1	LL	53	180	OVA 108	7	5,000	7,000	5,000	7,000		
69	valve	Gate	M	1	LL	53	180	TLV Sniffer	84	1,800	1,800	3,800	3,800		
69	valve	Gate	M	1	LL	53	180	HNu	0	5	5	9	10		
69	valve	Gate	M	1	LL	53	180	TVA 1000 (FID)	1	18,000	21,000	18,000	21,000		
69	valve	Gate	M	1	LL	53	180	TVA 1000 (PID)	7	23	23	23	23		
70	valve	Gate	M	2	LL	56	42	OVA 108	8	650	800	220	220		
70	valve	Gate	M	2	LL	56	42	TLV Sniffer	52	240	240	350	400		
70	valve	Gate	M	2	LL	56	42	HNu	1	8	8	8	9		
70	valve	Gate	M	2	LL	56	42	TVA 1000 (FID)							Sample line connect broke
70	valve	Gate	M	2	LL	56	42	TVA 1000 (PID)							
71	valve	Gate	M	2	LL	57	200	OVA 108	8	140	300	100	250		
71	valve	Gate	M	2	LL	57	200	TLV Sniffer	0	450	450	140	140		
71	valve	Gate	M	2	LL	57	200	HNu	0	45	50	12	50		
71	valve	Gate	M	2	LL	57	200	TVA 1000 (FID)							
71	valve	Gate	M	2	LL	57	200	TVA 1000 (PID)							
72A	valve	Plug	M	3	LL	56	200	OVA 108	8	1,000	1,000	300	300		
72A	valve	Plug	M	3	LL	58	200	TLV Sniffer	65	680	680	280	280		
72A	valve	Plug	M	3	LL	58	200	HNu	0	20	20	20	40		
72A	valve	Plug	M	3	LL	58	200	TVA 1000 (FID)							
72A	valve	Plug	M	3	LL	58	200	TVA 1000 (PID)							
72B	valve	Gate	M	1/2	LL	58	80	OVA 108	7	750	950	800	1,000		Begin of Star testing
72B	valve	Gate	M	1/2	LL	58	80	TLV Sniffer	0	480	480	550	550		
72B	valve	Gate	M	1/2	LL	58	80	HNu	0	700	900	200	400		
72B	valve	Gate	M	1/2	LL	58	80	TVA 1000 (FID)							
72B	valve	Gate	M	1/2	LL	58	80	TVA 1000 (PID)							
73	valve	Gate	M	1/2	LL	56	132	OVA 108	7	250	250	150	180		
73	valve	Gate	M	1/2	LL	56	132	TLV Sniffer	64	150	150	100	100		
73	valve	Gate	M	1/2	LL	56	132	HNu	0	400	600	100	400		
73	valve	Gate	M	1/2	LL	56	132	TVA 1000 (FID)							
73	valve	Gate	M	1/2	LL	56	132	TVA 1000 (PID)							
74	valve	Plug	M	2	LL	58	70	OVA 108	7	1,800	2,500	350	350		
74	valve	Plug	M	2	LL	58	70	TLV Sniffer	0	800	800	380	380		

API / WSPA Screening Study Data

Refinery L	Component Information					Ambient Conditions		Screening Data						
Sequence Number	Component Type	Subcategory	Actuation	Size (in.)	Service	Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft/min)	Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
74	valve	Plug	M	2	LL	58	70	HNu	0	700	1,000	10	200	
74	valve	Plug	M	2	LL	58	70	TVA 1000 (FID)						
74	valve	Plug	M	2	LL	58	70	TVA 1000 (PID)						
75	valve	Gate	C	2	LL	64	13	OVA 108	7	1,600	2,200	1,100	1,100	
75	valve	Gate	C	2	LL	64	13	TLV Sniffer	64	1,000	1,000	800	800	
75	valve	Gate	C	2	LL	64	13	HNu	0	800	1,000	200	300	
75	valve	Gate	C	2	LL	64	13	TVA 1000 (FID)						
75	valve	Gate	C	2	LL	64	13	TVA 1000 (PID)						
76	valve	Gate	M	8	LL	58	30	OVA 108	7	340	340	80	90	
76	valve	Gate	M	8	LL	58	30	TLV Sniffer	64	240	240	175	175	
76	valve	Gate	M	8	LL	58	30	HNu	0	400	550	100	170	
76	valve	Gate	M	8	LL	58	30	TVA 1000 (FID)						
76	valve	Gate	M	8	LL	58	30	TVA 1000 (PID)						
77	valve	Plug	M	2	LL	57	140	OVA 108	7	>110,000	>110,000	10,000	11,000	
77	valve	Plug	M	2	LL	57	140	TLV Sniffer	54	5,500	5,500	4,300	4,300	
77	valve	Plug	M	2	LL	57	140	HNu	0	800	800	500	600	
77	valve	Plug	M	2	LL	57	140	TVA 1000 (FID)						
77	valve	Plug	M	2	LL	57	140	TVA 1000 (PID)						
78	valve	Gate	C	2	LL	58	70	OVA 108	7	700	1,100	325	325	
78	valve	Gate	C	2	LL	58	70	TLV Sniffer	44	230	230	60	60	
78	valve	Gate	C	2	LL	58	70	HNu	4	400	600	200	200	
78	valve	Gate	C	2	LL	58	70	TVA 1000 (FID)						
78	valve	Gate	C	2	LL	58	70	TVA 1000 (PID)						
79	valve	Plug	M	2	LL	58	20	OVA 108	7	140	140	160	160	
79	valve	Plug	M	2	LL	58	20	TLV Sniffer	0	82	84	42	42	
79	valve	Plug	M	2	LL	58	20	HNu	1	280	300	40	45	
79	valve	Plug	M	2	LL	58	20	TVA 1000 (FID)						
79	valve	Plug	M	2	LL	58	20	TVA 1000 (PID)						
80	valve	Plug	M	1	LL	57	125	OVA 108	7	50	50	45	45	
80	valve	Plug	M	1	LL	57	125	TLV Sniffer	0	10	10	0	0	
80	valve	Plug	M	1	LL	57	125	HNu	0	4	5	2	2	
80	valve	Plug	M	1	LL	57	125	TVA 1000 (FID)						
80	valve	Plug	M	1	LL	57	125	TVA 1000 (PID)						
81	valve	Gate	M	2	LL	60	185	OVA 108	7	500	700	250	250	
81	valve	Gate	M	2	LL	60	185	TLV Sniffer	0	100	100	55	55	
81	valve	Gate	M	2	LL	60	185	HNu	0	250	300	100	130	
81	valve	Gate	M	2	LL	60	185	TVA 1000 (FID)						
81	valve	Gate	M	2	LL	60	185	TVA 1000 (PID)						
82	valve	Gate	M	2	LL	60	460	OVA 108	10	85	85	18	18	
82	valve	Gate	M	2	LL	60	460	TLV Sniffer	0	10	10	0	0	
82	valve	Gate	M	2	LL	60	460	HNu	0	25	25	3	10	
82	valve	Gate	M	2	LL	60	460	TVA 1000 (FID)						
82	valve	Gate	M	2	LL	60	460	TVA 1000 (PID)						

API / WSPA Screening Study Data

Refinery L Sequence Number	Component Information: Component Type	Subcategory	Actuation	Size (in.)	Service	Ambient Conditions: Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft/min)	Screening Data: Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
83	valve	Gate	M	2	LL	55	280	OVA 108	7	55	55	25	25	
83	valve	Gate	M	2	LL	55	280	TLV Sniffer	0	0	0	0	0	
83	valve	Gate	M	2	LL	55	280	HNu	0	10	25	10	10	
83	valve	Gate	M	2	LL	55	280	TVA 1000 (FID)						
83	valve	Gate	M	2	LL	55	280	TVA 1000 (PID)						
84	valve	Gate	M	2	LL	56	75	OVA 108	11	55	55	25	25	No component ID number found
84	valve	Gate	M	2	LL	56	75	TLV Sniffer	18	25	25	8	10	
84	valve	Gate	M	2	LL	56	75	HNu	9	136	136	20	20	
84	valve	Gate	M	2	LL	56	75	TVA 1000 (FID)						
84	valve	Gate	M	2	LL	56	75	TVA 1000 (PID)						
85	valve	Gate	C	2	LL	56	48	OVA 108	11	>110,000	>110,000	>110,000	>110,000	
85	valve	Gate	C	2	LL	56	48	TLV Sniffer	22	6,000	6,000	200	200	
85	valve	Gate	C	2	LL	56	48	HNu						
85	valve	Gate	C	2	LL	56	48	TVA 1000 (FID)						
85	valve	Gate	C	2	LL	56	48	TVA 1000 (PID)						
86	valve	Gate	M	3	LL	69	20	OVA 108	7	350	350	250	250	
86	valve	Gate	M	3	LL	69	20	TLV Sniffer	0	220	220	160	160	
86	valve	Gate	M	3	LL	69	20	HNu	6	300	300	60	70	
86	valve	Gate	M	3	LL	69	20	TVA 1000 (FID)						
86	valve	Gate	M	3	LL	69	20	TVA 1000 (PID)						
87	valve	Gate	M	1	LL	61	18	OVA 108	7	4,000	4,000	5,000	5,000	
87	valve	Gate	M	1	LL	61	18	TLV Sniffer	0	1,200	1,200	440	440	
87	valve	Gate	M	1	LL	61	18	HNu	0	650	650	800	800	
87	valve	Gate	M	1	LL	61	18	TVA 1000 (FID)						
87	valve	Gate	M	1	LL	61	18	TVA 1000 (PID)						
88	valve	Gate	M	2	LL	64	65	OVA 108	10	5,000	6,000	2,000	2,000	
88	valve	Gate	M	2	LL	64	65	TLV Sniffer	0	1,000	1,000	70	100	
88	valve	Gate	M	2	LL	64	65	HNu	14	600	800	650	650	
88	valve	Gate	M	2	LL	64	65	TVA 1000 (FID)						
88	valve	Gate	M	2	LL	64	65	TVA 1000 (PID)						
89	valve	Gate	M	2	LL	61	43	OVA 108	20	650	700	300	350	
89	valve	Gate	M	2	LL	61	43	TLV Sniffer	14	340	340	300	300	
89	valve	Gate	M	2	LL	61	43	HNu	18	850	900	650	700	
89	valve	Gate	M	2	LL	61	43	TVA 1000 (FID)						
89	valve	Gate	M	2	LL	61	43	TVA 1000 (PID)						
90	valve	Gate	M	2	LL	66	72	OVA 108	20	450	450	250	250	
90	valve	Gate	M	2	LL	66	72	TLV Sniffer	14	230	230	120	120	
90	valve	Gate	M	2	LL	66	72	HNu	18	650	650	45	50	
90	valve	Gate	M	2	LL	66	72	TVA 1000 (FID)						
90	valve	Gate	M	2	LL	66	72	TVA 1000 (PID)						
91	valve	Gate	M	1	LL	60	60	OVA 108	10	2,400	2,500	1,200	1,600	
91	valve	Gate	M	1	LL	60	60	TLV Sniffer	0	1,000	1,000	200	200	
91	valve	Gate	M	1	LL	60	60	HNu	6	800	800	350	400	

API / WSPA Screening Study Data

Refinery L Sequence Number	Component Information: Component Type	Subcategory	Actuation	Size (in.)	Service	Ambient Conditions: Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft/min)	Screening Data: Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
91	valve	Gate	M	1	LL	60	60	TVA 1000 (FID)						
91	valve	Gate	M	1	LL	60	60	TVA 1000 (PID)						
92	valve	Gate	M	6	LL	60	60	OVA 108	10	10,000	10,000	6,000	6,000	
92	valve	Gate	M	6	LL	60	60	TLV Sniffer	0	600	600	120	120	
92	valve	Gate	M	6	LL	60	60	HNu	7	800	800	70	70	
92	valve	Gate	M	6	LL	60	60	TVA 1000 (FID)						
92	valve	Gate	M	6	LL	60	60	TVA 1000 (PID)						
93	valve	Gate	M	2	LL	55	230	OVA 108	10	180	240	110	110	
93	valve	Gate	M	2	LL	55	230	TLV Sniffer	0	100	100	80	80	
93	valve	Gate	M	2	LL	55	230	HNu	7	180	180	20	110	
93	valve	Gate	M	2	LL	55	230	TVA 1000 (FID)						
93	valve	Gate	M	2	LL	55	230	TVA 1000 (PID)						
94	valve	Gate	M	2	LL	54	220	OVA 108	10	450	450	250	300	
94	valve	Gate	M	2	LL	54	220	TLV Sniffer	0	290	290	120	120	
94	valve	Gate	M	2	LL	54	220	HNu	0	500	550	100	200	
94	valve	Gate	M	2	LL	54	220	TVA 1000 (FID)						
94	valve	Gate	M	2	LL	54	220	TVA 1000 (PID)						
95	valve	Gate	M	2	LL	53	190	OVA 108	8	1,000	2,000	700	800	Surges.
95	valve	Gate	M	2	LL	53	190	TLV Sniffer	0	320	320	320	320	
95	valve	Gate	M	2	LL	53	190	HNu	7	650	650	400	450	
95	valve	Gate	M	2	LL	53	190	TVA 1000 (FID)						
95	valve	Gate	M	2	LL	53	190	TVA 1000 (PID)						
96	valve	Gate	M	2	LL	53	150	OVA 108	8	1,400	1,400	1,000	1,200	Surges.
96	valve	Gate	M	2	LL	53	150	TLV Sniffer	0	800	800	540	540	
96	valve	Gate	M	2	LL	53	150	HNu	3	790	790	700	700	
96	valve	Gate	M	2	LL	53	150	TVA 1000 (FID)						
96	valve	Gate	M	2	LL	53	150	TVA 1000 (PID)						
97	valve	Plug	M	4	LL	49	50	OVA 108	7	25,000	45,000	10,000	10,000	Surges.
97	valve	Plug	M	4	LL	49	50	TLV Sniffer	58	>10,000	>10,000	4,700	4,700	
97	valve	Plug	M	4	LL	49	50	HNu	0	8	9	9	10	
97	valve	Plug	M	4	LL	49	50	TVA 1000 (FID)	4		2,153		927	TVA 1000 (FID) Instr. Id #A1508 Began VOC log mode
97	valve	Plug	M	4	LL	49	50	TVA 1000 (PID)	10		42		40	TVA 1000 (PID) Instr. Id #A1508
98	valve	Plug	M	6	LL	55	175	OVA 108	12	90,000	95,000	9,000	10,000	
98	valve	Plug	M	6	LL	55	175	TLV Sniffer	8	7,800	7,800	1,800	1,800	
98	valve	Plug	M	6	LL	55	175	HNu	0	400	400	380	380	
98	valve	Plug	M	6	LL	55	175	TVA 1000 (FID)	2		23,467		13,140	
98	valve	Plug	M	6	LL	55	175	TVA 1000 (PID)	10		935		230	
99	valve	Plug	M	8	LL	52	28	OVA 108	12	2,000	2,000	600	700	
99	valve	Plug	M	8	LL	52	28	TLV Sniffer	4	1,000	1,000	320	320	
99	valve	Plug	M	8	LL	52	28	HNu	0	150	150	130	130	
99	valve	Plug	M	8	LL	52	28	TVA 1000 (FID)	3		4,749		1,528	
99	valve	Plug	M	8	LL	52	28	TVA 1000 (PID)	12		232		117	
100	valve	Plug	M	8	LL	52	55	OVA 108	10	2,000	2,200	1,400	1,600	

API / WSPA Screening Study Data

Refinery L	Component Information					Ambient Conditions		Screening Data							
Sequence Number	Component Type	Subcategory	Actuation	Size (in.)	Service	Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft/min)	Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
100	valve	Plug	M	8	LL	52	55	TLV Sniffer	21	300	300	340	340	
100	valve	Plug	M	8	LL	52	55	HNu	8	250	250	130	130	
100	valve	Plug	M	8	LL	52	55	TVA 1000 (FID)	3		7,785		2,430	
100	valve	Plug	M	8	LL	52	55	TVA 1000 (PID)	12		431		234	
101	valve	Plug	M	8	LL	55	84	OVA 108	10	2,600	2,600	750	750	
101	valve	Plug	M	8	LL	55	84	TLV Sniffer	0	940	940	760	760	
101	valve	Plug	M	8	LL	55	84	HNu	2.5	2,400	2,400	2,000	2,000	Erroneous readings (beyond range)
101	valve	Plug	M	8	LL	55	84	TVA 1000 (FID)	3		5,975		1,476	
101	valve	Plug	M	8	LL	55	84	TVA 1000 (PID)	12		377		178	
102	valve	Gate	M	6	LL	51	33	OVA 108	10	50,000	50,000	3,000	3,500	
102	valve	Gate	M	6	LL	51	33	TLV Sniffer	0	2,600	2,600	1,000	1,000	
102	valve	Gate	M	6	LL	51	33	HNu	0	185	185	185	185	
102	valve	Gate	M	6	LL	51	33	TVA 1000 (FID)	3		70,870		7,631	
102	valve	Gate	M	6	LL	51	33	TVA 1000 (PID)	12		378		276	
103	valve	Gate	M	2	GAS	50	100	OVA 108	10	>100,000	>100,000	20,000	30,000	
103	valve	Gate	M	2	GAS	50	100	TLV Sniffer	0	2,300	2,300	1,000	1,000	
103	valve	Gate	M	2	GAS	50	100	HNu	0	5	5	4	4	
103	valve	Gate	M	2	GAS	50	100	TVA 1000 (FID)	3		6,802		965	
103	valve	Gate	M	2	GAS	50	100	TVA 1000 (PID)	12		21		14	
104	valve	Gate	M	1	LL	49	88	OVA 108	7	300	320	500	600	
104	valve	Gate	M	1	LL	49	88	TLV Sniffer	0	270	270	160	160	
104	valve	Gate	M	1	LL	49	88	HNu	0	0	0	0	0	
104	valve	Gate	M	1	LL	49	88	TVA 1000 (FID)	3		397		414	
104	valve	Gate	M	1	LL	49	88	TVA 1000 (PID)	12		13		13	
105	valve	Gate	M	6	LL	52	70	OVA 108	7	3,500	3,500	1,400	2,000	
105	valve	Gate	M	6	LL	52	70	TLV Sniffer	0	1,000	1,000	1,000	1,000	
105	valve	Gate	M	6	LL	52	70	HNu	0	250	250	260	260	
105	valve	Gate	M	6	LL	52	70	TVA 1000 (FID)	3		5,845		2,155	
105	valve	Gate	M	6	LL	52	70	TVA 1000 (PID)	10		21		17	
106	valve	Gate	M	6	LL	50	120	OVA 108	7	>100,000	>100,000	10,000	10,000	1 cm - No DR.
106	valve	Gate	M	6	LL	50	120	TLV Sniffer	0	2,100	2,100	45	45	
106	valve	Gate	M	6	LL	50	120	HNu	0	11	11	1	1	
106	valve	Gate	M	6	LL	50	120	TVA 1000 (FID)	3		45,236		9,214	
106	valve	Gate	M	6	LL	50	120	TVA 1000 (PID)	10		38		31	
107	valve	Gate	M	3	LL	48	240	OVA 108	7	>100,000	>100,000	40,000	40,000	
107	valve	Gate	M	3	LL	48	240	TLV Sniffer	5	4,500	4,500	500	600	
107	valve	Gate	M	3	LL	48	240	HNu	0	9	9	8	8	
107	valve	Gate	M	3	LL	48	240	TVA 1000 (FID)	2		99,070		12,400	1 cm - No DR.
107	valve	Gate	M	3	LL	48	240	TVA 1000 (PID)	12		30		33	
108	valve	Gate	M	4	LL	49	140	OVA 108	7	8,000	8,000	800	1,000	
108	valve	Gate	M	4	LL	49	140	TLV Sniffer	8	1,600	1,600	1,000	1,000	
108	valve	Gate	M	4	LL	49	140	HNu	0	200	200	170	170	
108	valve	Gate	M	4	LL	49	140	TVA 1000 (FID)	7		10,050		881	

API / WSPA Screening Study Data

Refinery L	Component Information					Ambient Conditions		Screening Data							
Sequence Number	Component Type	Subcategory	Actuation	Size (in.)	Service	Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft/min)	Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
108	valve	Gate	M	4	LL	49	140	TVA 1000 (PID)	14		307		77	
109	valve	Gate	M	12	LL	50	290	OVA 108	7	>100,000	>100,000	7,000	10,000	1 cm - No DR.
109	valve	Gate	M	12	LL	50	290	TLV Sniffer	0	>10,000	>10,000	>10,000	>10,000	
109	valve	Gate	M	12	LL	50	290	HNu	0	4	4	4	4	
109	valve	Gate	M	12	LL	50	290	TVA 1000 (FID)	2		463,250		19,304	
109	valve	Gate	M	12	LL	50	290	TVA 1000 (PID)	12		27		24	
110	valve	Gate	C	4	LL	50	110	OVA 108	7	450	500	100	120	
110	valve	Gate	C	4	LL	50	110	TLV Sniffer	0	300	300	240	240	
110	valve	Gate	C	4	LL	50	110	HNu	0	7	7	0	0	
110	valve	Gate	C	4	LL	50	110	TVA 1000 (FID)	2	269		78		
110	valve	Gate	C	4	LL	50	110	TVA 1000 (PID)	12	14		13		
111	valve	Gate	M	6	LL	51	270	OVA 108	7	16,000	16,000	10,000	10,000	1 cm - No DR
111	valve	Gate	M	6	LL	51	270	TLV Sniffer	4	6,700	6,700	3,400	3,400	
111	valve	Gate	M	6	LL	51	270	HNu	0	320	320	300	300	
111	valve	Gate	M	6	LL	51	270	TVA 1000 (FID)	2		62,348		3,073	1 cm - No DR.
111	valve	Gate	M	6	LL	51	270	TVA 1000 (PID)	12		637		264	
112	valve	Gate	M	10	LL	48	220	OVA 108	7	>100,000	>100,000	12,000	16,000	
112	valve	Gate	M	10	LL	48	220	TLV Sniffer	5	6,500	6,500	3,600	3,600	
112	valve	Gate	M	10	LL	48	220	HNu	0	260	260	170	170	
112	valve	Gate	M	10	LL	48	220	TVA 1000 (FID)	11		39,310		74,262	
112	valve	Gate	M	10	LL	48	220	TVA 1000 (PID)	12		472		504	
113	valve	Gate	C	14	GAS	50	185	OVA 108	6	60	100	30	30	
113	valve	Gate	C	14	GAS	50	185	TLV Sniffer	5	20	40	25	25	
113	valve	Gate	C	14	GAS	50	185	HNu	0	30	30	10	10	
113	valve	Gate	C	14	GAS	50	185	TVA 1000 (FID)	4		47		13	
113	valve	Gate	C	14	GAS	50	185	TVA 1000 (PID)	13		27		19	
114	valve	Gate	M	14	GAS	53	22	OVA 108	6	600	1,000	200	500	
114	valve	Gate	M	14	GAS	53	22	TLV Sniffer	0	2,600	2,600	1,600	1,600	
114	valve	Gate	M	14	GAS	53	22	HNu	0	50	50	13	13	
114	valve	Gate	M	14	GAS	53	22	TVA 1000 (FID)	4		1,593		71	
114	valve	Gate	M	14	GAS	53	22	TVA 1000 (PID)	13		49		15	
115	valve	Gate	M	8	GAS	52	105	OVA 108	6	50	50	140	140	
115	valve	Gate	M	8	GAS	52	105	TLV Sniffer	0	200	200	96	96	
115	valve	Gate	M	8	GAS	52	105	HNu	0	3	3	3	3	
115	valve	Gate	M	8	GAS	52	105	TVA 1000 (FID)	2		123		99	
115	valve	Gate	M	8	GAS	52	105	TVA 1000 (PID)	14		19		19	
116	valve	Gate	M	6	GAS	50	110	OVA 108	6	600	1,000	200	250	
116	valve	Gate	M	6	GAS	50	110	TLV Sniffer	0	330	330	260	260	
116	valve	Gate	M	6	GAS	50	110	HNu	0	39	39	10	10	
116	valve	Gate	M	6	GAS	50	110	TVA 1000 (FID)	2		439		352	
116	valve	Gate	M	6	GAS	50	110	TVA 1000 (PID)	14		70		42	
117	valve	Gate	M	6	GAS	54	50	OVA 108	6	3,500	9,000	1,600	1,800	
117	valve	Gate	M	6	GAS	54	50	TLV Sniffer	0	660	700	580	580	

API / WSPA Screening Study Data

Refinery L Sequence Number	Component Information					Ambient Conditions		Screening Data							
	Component Type	Subcategory	Actuation	Size (in.)	Service	Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft/min)	Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
117	valve	Gate	M	6	GAS	54	50	HNu	0	120	120	13	14	
117	valve	Gate	M	6	GAS	54	50	TVA 1000 (FID)	2		4,670		2,436	
117	valve	Gate	M	6	GAS	54	50	TVA 1000 (PID)	17		193		126	
118	valve	Gate	M	2	GAS	55	22	OVA 108	8	2,300	2,300	1,800	1,800	
118	valve	Gate	M	2	GAS	55	22	TLV Sniffer	0	>10,000	>10,000	9,000	9,000	
118	valve	Gate	M	2	GAS	55	22	HNu	0	7	7	4	4	
118	valve	Gate	M	2	GAS	55	22	TVA 1000 (FID)	2		2,612		1,489	
118	valve	Gate	M	2	GAS	55	22	TVA 1000 (PID)	19		26		26	
119	valve	Gate	M	2	GAS	56	43	OVA 108	8	45,000	45,000	5,000	5,000	1 cm without DP.
119	valve	Gate	M	2	GAS	56	43	TLV Sniffer	0	>10,000	>10,000	>10,000	>10,000	
119	valve	Gate	M	2	GAS	56	43	HNu	0	7	8	2	2	
119	valve	Gate	M	2	GAS	56	43	TVA 1000 (FID)	2		7,715		10,500	
119	valve	Gate	M	2	GAS	56	43	TVA 1000 (PID)	19		20		26	
120	valve	Gate	M	2	GAS	57	65	OVA 108	8	1,000	1,000	700	800	1 cm spacer too fat
120	valve	Gate	M	2	GAS	57	65	TLV Sniffer	12	1,000	1,000	1,000	1,000	
120	valve	Gate	M	2	GAS	57	65	HNu	0	27	27	30	30	
120	valve	Gate	M	2	GAS	57	65	TVA 1000 (FID)	2		1,155		756	1 cm spacer too fat.
120	valve	Gate	M	2	GAS	57	65	TVA 1000 (PID)	19		42		36	
121	valve	Gate	M	--	GAS	60	90	OVA 108	8	8,000	8,000	5,000	5,000	
121	valve	Gate	M	--	GAS	60	90	TLV Sniffer	12	7,800	7,800	7,000	7,200	
121	valve	Gate	M	--	GAS	60	90	HNu	1	50	58	15	15	
121	valve	Gate	M	--	GAS	60	90	TVA 1000 (FID)	2		6,186		1,401	
121	valve	Gate	M	--	GAS	60	90	TVA 1000 (PID)	19		107		57	
122	valve	Gate	M	4	GAS	51	91	OVA 108	8	12,000	20,000	1,400	2,500	1cm without diluter.
122	valve	Gate	M	4	GAS	51	91	TLV Sniffer	12	4,600	4,600	3,800	3,800	
122	valve	Gate	M	4	GAS	51	91	HNu	0	65	70	30	30	
122	valve	Gate	M	4	GAS	51	91	TVA 1000 (FID)	2		5,678		1,208	
122	valve	Gate	M	4	GAS	51	91	TVA 1000 (PID)	19		103		48	
123	valve	Gate	M	4	GAS	46	315	OVA 108	8	1,200	1,200	1,000	1,000	Stem
123	valve	Gate	M	4	GAS	46	315	TLV Sniffer	0	220	220	320	320	
123	valve	Gate	M	4	GAS	46	315	HNu	0	16	16	14	17	
123	valve	Gate	M	4	GAS	46	315	TVA 1000 (FID)	2		1,191		1,719	
123	valve	Gate	M	4	GAS	46	315	TVA 1000 (PID)	19		37		36	
124	valve	Gate	M	4	GAS	46	315	OVA 108	8	>100,000	>100,000	>100,000	>100,000	Housing
124	valve	Gate	M	4	GAS	46	315	TLV Sniffer	0	>10,000	>10,000	>10,000	>10,000	
124	valve	Gate	M	4	GAS	46	315	HNu	0	50	58	30	46	
124	valve	Gate	M	4	GAS	46	315	TVA 1000 (FID)	2		83,494		35,207	
124	valve	Gate	M	4	GAS	46	315	TVA 1000 (PID)	19		117		126	
125	valve	Gate	M	4	GAS	44	370	OVA 108	20	>100,000	>100,000	50,000	50,000	
125	valve	Gate	M	4	GAS	44	370	TLV Sniffer	0	>10,000	>10,000	>10,000	>10,000	
125	valve	Gate	M	4	GAS	44	370	HNu	0	45	45			
125	valve	Gate	M	4	GAS	44	370	TVA 1000 (FID)	2		179,850		96,656	
125	valve	Gate	M	4	GAS	44	370	TVA 1000 (PID)	19		147		139	

API / WSPA Screening Study Data

Refinery L	Component Information					Ambient Conditions		Screening Data						
Sequence Number	Component Type	Subcategory	Actuation	Size (in.)	Service	Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft/min)	Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
126	valve	Gate	M	4	GAS	44	313	OVA 108	20	>100,000	>100,000	90,000	90,000	Duplicate
126	valve	Gate	M	4	GAS	44	370	TLV Sniffer	0	>10,000	>10,000	>10,000	>10,000	
126	valve	Gate	M	4	GAS	44	370	HNu	0	48	48	43	43	
126	valve	Gate	M	4	GAS	44	370	TVA 1000 (FID)	2		132,980		136,250	
126	valve	Gate	M	4	GAS	44	370	TVA 1000 (PID)	19		134		124	
127	valve	Gate	C	6	GAS	50	210	OVA 108	6	1,400	1,400	700	900	
127	valve	Gate	C	6	GAS	50	210	TLV Sniffer	45	3,800	4,200	2,100	2,100	Invalid. Failed QC check
127	valve	Gate	C	6	GAS	50	210	HNu						
127	valve	Gate	C	6	GAS	50	210	TVA 1000 (FID)	1		1,688		626	
127	valve	Gate	C	6	GAS	50	210	TVA 1000 (PID)	16		16		17	
128	valve	Gate	C	4	GAS	51	30	OVA 108	6	450	450	400	400	
128	valve	Gate	C	4	GAS	51	30	TLV Sniffer	45	4,800	4,800	200	200	Recalibrated at 1515. Invalid. Failed QC check
128	valve	Gate	C	4	GAS	51	30	HNu						
128	valve	Gate	C	4	GAS	51	30	TVA 1000 (FID)	1		885		3	1cm reading checked 2 times
128	valve	Gate	C	4	GAS	51	30	TVA 1000 (PID)	18		23		10	
129	valve	Gate	C	6	GAS	49	320	OVA 108	6	8,000	8,000	2,100	2,500	
129	valve	Gate	C	6	GAS	49	320	TLV Sniffer	45	>10,000	>10,000	>10,000	>10,000	
129	valve	Gate	C	6	GAS	49	320	HNu						
129	valve	Gate	C	6	GAS	49	320	TVA 1000 (FID)	2		18,300		4,020	
129	valve	Gate	C	6	GAS	49	320	TVA 1000 (PID)	19		26		24	
130	valve	Gate	C	4	LL	49	175	OVA 108	10	2,200	2,200	2,500	2,500	
130	valve	Gate	C	4	LL	49	175	TLV Sniffer	35	1,000	1,000	1,000	1,000	
130	valve	Gate	C	4	LL	49	175	HNu						
130	valve	Gate	C	4	LL	49	175	TVA 1000 (FID)	1		1,269		1,013	
130	valve	Gate	C	4	LL	49	175	TVA 1000 (PID)	20		104		74	
131	valve	Gate	M	2	LL	49	310	OVA 108	10	190	190	100	110	
131	valve	Gate	M	2	LL	49	310	TLV Sniffer	35	200	200	390	390	
131	valve	Gate	M	2	LL	49	310	HNu						
131	valve	Gate	M	2	LL	49	310	TVA 1000 (FID)	1		409		48	
131	valve	Gate	M	2	LL	49	310	TVA 1000 (PID)	20		45		25	
132	valve	Gate	C	2	LL	48	330	OVA 108	8	900	900	900	900	
132	valve	Gate	C	2	LL	48	330	TLV Sniffer	28	550	550	960	960	
132	valve	Gate	C	2	LL	48	330	HNu	0					
132	valve	Gate	C	2	LL	48	330	TVA 1000 (FID)	2		758		2,068	
132	valve	Gate	C	2	LL	48	330	TVA 1000 (PID)	21		84		107	
133	valve	...	M	6	LL	50	150	OVA 108	6	>100,000	>100,000	50,000	50,000	
133	valve	...	M	6	LL	50	150	TLV Sniffer	100	9,100	9,100	8,200	8,200	
133	valve	...	M	6	LL	50	150	HNu						
133	valve	...	M	6	LL	50	150	TVA 1000 (FID)	1		113,360		10,790	
133	valve	...	M	6	LL	50	150	TVA 1000 (PID)	21		1,087		1,324	
134	valve	Gate	C	2	LL	48	160	OVA 108	9	300	300	100	180	
134	valve	Gate	C	2	LL	48	160	TLV Sniffer	100	120	120	120	120	
134	valve	Gate	C	2	LL	48	160	HNu						

API / WSPA Screening Study Data

Refinery L	Component Information					Ambient Conditions		Screening Data						
Sequence Number	Component Type	Subcategory	Actuation	Size (in.)	Service	Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft/min)	Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
134	valve	Gate	C	2	LL	48	160	TVA 1000 (FID)	7		627		51	
134	valve	Gate	C	2	LL	48	160	TVA 1000 (PID)	22		26		24	
135	valve	Gate	M	2	LL	48	250	OVA 108	7	75	75	22	22	
135	valve	Gate	M	2	LL	48	250	TLV Sniffer	100	300	300	360	400	
135	valve	Gate	M	2	LL	48	250	HNu						
135	valve	Gate	M	2	LL	48	250	TVA 1000 (FID)	3		156		26	
135	valve	Gate	M	2	LL	48	250	TVA 1000 (PID)	23		24		23	
136	valve	Gate	M	2	LL	49	35	OVA 108	7	1,500	1,500	1,200	1,200	
136	valve	Gate	M	2	LL	49	35	TLV Sniffer	100	800	800	1,000	1,000	
136	valve	Gate	M	2	LL	49	35	HNu						
136	valve	Gate	M	2	LL	49	35	TVA 1000 (FID)	3		3,292		176	
136	valve	Gate	M	2	LL	49	35	TVA 1000 (PID)	23		25		29	
137	valve	Gate	M	1	LL	50	95	OVA 108	7	4,500	4,500	1,500	2,000	
137	valve	Gate	M	1	LL	50	95	TLV Sniffer						Failed QC.
137	valve	Gate	M	1	LL	50	95	HNu						
137	valve	Gate	M	1	LL	50	95	TVA 1000 (FID)	5		6,166		8,337	
137	valve	Gate	M	1	LL	50	95	TVA 1000 (PID)	22		40		41	
138	valve	Gate	M	1	LL	48	290	OVA 108	8	20,000	20,000	5,000	5,000	1 cm without dilutor.
138	valve	Gate	M	1	LL	48	290	TLV Sniffer						Failed QC.
138	valve	Gate	M	1	LL	48	290	HNu						
138	valve	Gate	M	1	LL	48	290	TVA 1000 (FID)	5		101,632		12,900	
138	valve	Gate	M	1	LL	48	290	TVA 1000 (PID)	22		271		231	
139	valve	Gate	M	1	LL	47	180	OVA 108	9	1,800	2,200	1,800	200	Invalid readings at 1 cm.
139	valve	Gate	M	1	LL	47	180	TLV Sniffer						Background too high. Failed QC
139	valve	Gate	M	1	LL	47	180	HNu						
139	valve	Gate	M	1	LL	47	180	TVA 1000 (FID)	4		174		46	
139	valve	Gate	M	1	LL	47	180	TVA 1000 (PID)	23		24		23	
140	valve	Gate	M	12	HL	46	70	OVA 108	8	1,200	1,200	1,300	1,600	Lot of oil
140	valve	Gate	M	12	HL	46	70	TLV Sniffer	8	1,000	1,000	800	800	
140	valve	Gate	M	12	HL	46	70	HNu	0	15	15	10	10	
140	valve	Gate	M	12	HL	46	70	TVA 1000 (FID)	2		1,690		1,753	
140	valve	Gate	M	12	HL	46	70	TVA 1000 (PID)	17		31		31	
141	valve	Gate	M	12	HL	47	95	OVA 108	8	1,700	2,400	1,100	1,100	Duplicate
141	valve	Gate	M	12	HL	47	95	TLV Sniffer	8	1,000	1,000	780	780	
141	valve	Gate	M	12	HL	47	95	HNu	0	10	10	5	5	
141	valve	Gate	M	12	HL	47	95	TVA 1000 (FID)	2		3,629		3,862	Repeatably higher.
141	valve	Gate	M	12	HL	47	95	TVA 1000 (PID)	18		39		41	
142	valve	Gate	C	8	HL	47	230	OVA 108	8	3,000	3,000	600	600	
142	valve	Gate	C	8	HL	47	230	TLV Sniffer	8	1,000	1,000	1,000	1,000	
142	valve	Gate	C	8	HL	47	230	HNu	0	11	11	12	12	
142	valve	Gate	C	8	HL	47	230	TVA 1000 (FID)	2		4,496		1,097	
142	valve	Gate	C	8	HL	47	230	TVA 1000 (PID)	18		42		28	
143	valve	Gate	C	3	HL	49	260	OVA 108	8	200	300	200	400	

API / WSPA Screening Study Data

Refinery L Sequence Number	Component Information					Ambient Conditions		Screening Data							
	Component Type	Subcategory	Actuation	Size (in.)	Service	Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft/min)	Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
143	valve	Gate	C	3	HL	49	260	TLV Sniffer	8	400	400	320	320	
143	valve	Gate	C	3	HL	49	260	HNu	0	10	10	3	3	
143	valve	Gate	C	3	HL	49	260	TVA 1000 (FID)	2		1,164		1,502	
143	valve	c	C	3	HL	49	260	TVA 1000 (PID)	19		32		32	
144	valve	Gate	M	2	HL	50	220	OVA 108	8	1,000	1,000	1,000	1,000	
144	valve	Gate	M	2	HL	50	220	TLV Sniffer	8	650	650	380	380	
144	valve	Gate	M	2	HL	50	220	HNu	0	16	16	3	3	
144	valve	Gate	M	2	HL	50	220	TVA 1000 (FID)	2		2,397		224	
144	valve	Gate	M	2	HL	50	220	TVA 1000 (PID)	20		36		23	
145	valve	Gate	M	2	HL	53	290	OVA 108	8	1,050	1,050	100	150	Duplicate
145	valve	Gate	M	2	HL	53	290	TLV Sniffer	62	600	600	400	400	
145	valve	Gate	M	2	HL	53	290	HNu	0	19	19	3	3	Recalibrated dup on HNu - not exact dup. Invalid dup
145	valve	Gate	M	2	HL	53	290	TVA 1000 (FID)	2		521		3,332	
145	valve	Gate	M	2	HL	53	290	TVA 1000 (PID)	20		29		44	
146	valve	Gate	C	10	HL	55	18	OVA 108	8	3,000	3,000	2,800	2,800	
146	valve	Gate	C	10	HL	55	18	TLV Sniffer	62	1,000	1,000	260	260	
146	valve	Gate	C	10	HL	55	18	HNu	1	6	6	5	5	
146	valve	Gate	C	10	HL	55	18	TVA 1000 (FID)	2		5,324		4,849	
146	valve	Gate	C	10	HL	55	18	TVA 1000 (PID)	16		42		33	
147	valve	Gate	C	10	HL	55	70	OVA 108	8	3,500	5,000	2,400	3,000	
147	valve	Gate	C	10	HL	55	70	TLV Sniffer	60	540	540	83	83	
147	valve	Gate	C	10	HL	55	70	HNu	2	2	2	2	2	
147	valve	Gate	C	10	HL	55	70	TVA 1000 (FID)	2		5,963		14	
147	valve	Gate	C	10	HL	55	70	TVA 1000 (PID)	18		43		18	
148	valve	Gate	C	10	HL	50	140	OVA 108	7	2,200	2,200	300	300	Duplicate.
148	valve	Gate	C	10	HL	50	140	TLV Sniffer	56	62	62	62	62	
148	valve	Gate	C	10	HL	50	140	HNu	1	1	1	1	1	
148	valve	Gate	C	10	HL	50	140	TVA 1000 (FID)	2		3,636		53	
148	valve	Gate	C	10	HL	50	140	TVA 1000 (PID)	17		37		10	
149	valve	Gate	M	2	HL	48	340	OVA 108	7	22	22	14	14	
149	valve	Gate	M	2	HL	48	340	TLV Sniffer	56	60	60	60	60	
149	valve	Gate	M	2	HL	48	340	HNu	1	1	1	1	1	
149	valve	Gate	M	2	HL	48	340	TVA 1000 (FID)	2		20		8	
149	valve	Gate	M	2	HL	48	340	TVA 1000 (PID)	17		17		17	
150	valve	Gate	M	4	HL	50	44	OVA 108	6	300	300	450	450	
150	valve	Gate	M	4	HL	50	44	TLV Sniffer	62	560	560	340	340	
150	valve	Gate	M	4	HL	50	44	HNu	2	2	2	2	2	
150	valve	Gate	M	4	HL	50	44	TVA 1000 (FID)	2		1,744		2,203	
150	valve	Gate	M	4	HL	50	44	TVA 1000 (PID)	17		34		33	
151	valve	Gate	M	4	HL	49	205	OVA 108	6	45,000	45,000	20,000	20,000	
151	valve	Gate	M	4	HL	49	205	TLV Sniffer	56	7,600	7,600	1,000	1,000	
151	valve	Gate	M	4	HL	49	205	HNu	2	20	20	20	20	
151	valve	Gate	M	4	HL	49	205	TVA 1000 (FID)	4		302,470		60,092	

API / WSPA Screening Study Data

Refinery L Sequence Number	Component Information: Component Type	Subcategory	Actuation	Size (in.)	Service	Ambient Conditions: Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft/min)	Screening Data: Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
151	valve	Gate	M	4	HL	49	205	TVA 1000 (PID)	21		62		59	
152	valve	Gate	C	6	GAS	47	60	OVA 108	7	3,000	4,000	2,400	2,400	
152	valve	Gate	C	6	GAS	47	60	TLV Sniffer	74	1,000	1,000	1,000	1,000	
152	valve	Gate	C	6	GAS	47	60	HNu	0	0	0	0	0	
152	valve	Gate	C	6	GAS	47	60	TVA 1000 (FID)	2		2,781		2,710	
152	valve	Gate	C	6	GAS	47	60	TVA 1000 (PID)	19		20		20	
153	valve	Gate	M	3	GAS	47	75	OVA 108	8	9,000	10,000	10,000	10,000	
153	valve	Gate	M	3	GAS	47	75	TLV Sniffer	70	3,500	3,500	3,200	3,200	
153	valve	Gate	M	3	GAS	47	75	HNu	1	20	20	20	20	
153	valve	Gate	M	3	GAS	47	75	TVA 1000 (FID)	4		29,100		13,000	
153	valve	Gate	M	3	GAS	47	75	TVA 1000 (PID)	18		57		52	
154	valve	Gate	M	3	GAS	51	80	OVA 108	7	40,000	40,000	45,000	45,000	Duplicate.
154	valve	Gate	M	3	GAS	51	80	TLV Sniffer	70	4,100	4,100	3,200	3,200	
154	valve	Gate	M	3	GAS	51	80	HNu	1					
154	valve	Gate	M	3	GAS	51	80	TVA 1000 (FID)	4		18,300		18,300	
154	valve	Gate	M	3	GAS	51	80	TVA 1000 (PID)	14		57		56	
155	con-non	Th	...	1	GAS	51	14	OVA 108	7	70	70	35	35	
155	con-non	Th	...	1	GAS	51	14	TLV Sniffer	70	100	100	100	100	
155	con-non	Th	...	1	GAS	51	14	HNu	2	2	2	2	2	
155	con-non	Th	...	1	GAS	51	14	TVA 1000 (FID)	2		142		58	
155	con-non	Th	...	1	GAS	51	14	TVA 1000 (PID)	19		22		21	
156	valve	Gate	M	4	HL	54	145	OVA 108	7	2,500	2,500	2,500	2,900	
156	valve	Gate	M	4	HL	54	145	TLV Sniffer	0	900	900	460	460	
156	valve	Gate	M	4	HL	54	145	HNu	1	1	1	1	1	
156	valve	Gate	M	4	HL	54	145	TVA 1000 (FID)	3		3,160		1,398	
156	valve	Gate	M	4	HL	54	145	TVA 1000 (PID)	13		12		15	
157	valve	Gate	C	4	GAS	56	130	OVA 108	7	18,000	20,000	12,000	12,000	
157	valve	Gate	C	4	GAS	56	130	TLV Sniffer	0	2,000	2,000	2,600	2,600	
157	valve	Gate	C	4	GAS	56	130	HNu	1	1	1	1	1	
157	valve	Gate	C	4	GAS	56	130	TVA 1000 (FID)	5		31,200		12,300	
157	valve	Gate	C	4	GAS	56	130	TVA 1000 (PID)	9		20		21	
158	valve	Gate	M	10	GAS	64	12	OVA 108	7	>100,000	>100,000	90,000	90,000	
158	valve	Gate	M	10	GAS	64	12	TLV Sniffer	0	>10,000	>10,000	>10,000	>10,000	
158	valve	Gate	M	10	GAS	64	12	HNu	0	0	0	0	0	
158	valve	Gate	M	10	GAS	64	12	TVA 1000 (FID)	13		636,230		83,336	
158	valve	Gate	M	10	GAS	64	12	TVA 1000 (PID)	9		9		12	
159	valve	Gate	M	10	GAS	61	95	OVA 108	7	7,000	7,000	4,000	4,000	
159	valve	Gate	M	10	GAS	61	95	TLV Sniffer	0	2,000	2,000	1,100	1,100	
159	valve	Gate	M	10	GAS	61	95	HNu	0	0	0	0	0	
159	valve	Gate	M	10	GAS	61	95	TVA 1000 (FID)	7		17,100		7,346	
159	valve	Gate	M	10	GAS	61	95	TVA 1000 (PID)	9		10		10	
160	valve	Gate	M	10	GAS	61	52	OVA 108	12	40,000	40,000	16,000	20,000	Duplicate.
160	valve	Gate	M	10	GAS	61	52	TLV Sniffer	0	2,800	2,800	2,200	2,200	

API / WSPA Screening Study Data

Refinery L	Component Information					Ambient Conditions		Screening Data							
Sequence Number	Component Type	Subcategory	Actuation	Size (in.)	Service	Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft/min)	Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
160	valve	Gate	M	10	GAS	61	52	HNu	0	0	0	0	0	
160	valve	Gate	M	10	GAS	61	52	TVA 1000 (FID)	1		56,064		20,353	
160	valve	Gate	M	10	GAS	61	52	TVA 1000 (PID)	8		10		14	
161	valve	Gate	M	10	GAS	62	55	OVA 108	12	80,000	80,000	2,500	25,000	
161	valve	Gate	M	10	GAS	62	55	TLV Sniffer	0	>10,000	>10,000	>10,000	>10,000	
161	valve	Gate	M	10	GAS	62	55	HNu	0	0	0	0	0	
161	valve	Gate	M	10	GAS	62	55	TVA 1000 (FID)	1		118,202		17,800	
161	valve	Gate	M	10	GAS	62	55	TVA 1000 (PID)	8		9		9	
162	valve	Gate	M	2	GAS	62	30	OVA 108	10	7,000	10,000	8,000	10,000	
162	valve	Gate	M	2	GAS	62	30	TLV Sniffer	0	2,600	2,600	2,200	2,200	
162	valve	Gate	M	2	GAS	62	30	HNu	0	0	0	0	0	
162	valve	Gate	M	2	GAS	62	30	TVA 1000 (FID)	2		14,200		10,200	
162	valve	Gate	M	2	GAS	62	30	TVA 1000 (PID)	9		9		9	
163	con-non	Th	...	1	GAS	61	170	OVA 108	7	4,500	4,500	4,500	4,500	
163	con-non	Th	...	1	GAS	61	170	TLV Sniffer	0	1,100	1,100	120	120	
163	con-non	Th	...	1	GAS	61	170	HNu	0	0	0	0	0	
163	con-non	Th	...	1	GAS	61	170	TVA 1000 (FID)	2		5,276		597	
163	con-non	Th	...	1	GAS	61	170	TVA 1000 (PID)	9		8		9	
164	con-non	Th	...	1	GAS	81	130	OVA 108	20	1,200	1,200	500	700	
164	con-non	Th	...	1	GAS	81	130	TLV Sniffer	0	80	80	0	0	
164	con-non	Th	...	1	GAS	81	130	HNu	2	1	1	1	1	
164	con-non	Th	...	1	GAS	81	130	TVA 1000 (FID)	7		338		174	
164	con-non	Th	...	1	GAS	81	130	TVA 1000 (PID)	6		7		7	
165	con-non	Th	...	1	GAS	88	35	OVA 108	7	1,100	1,100	700	700	
165	con-non	Th	...	1	GAS	88	35	TLV Sniffer	0	100	100	86	86	Duplicate.
165	con-non	Th	...	1	GAS	88	35	HNu	0	0	0	0	0	
165	con-non	Th	...	1	GAS	88	35	TVA 1000 (FID)	9		718		234	
165	con-non	Th	...	1	GAS	88	35	TVA 1000 (PID)	6		7		7	
166	valve	Gate	M	1	GAS	61	35	OVA 108	6	180	180	160	160	
166	valve	Gate	M	1	GAS	61	35	TLV Sniffer	0	0	0	0	0	
166	valve	Gate	M	1	GAS	61	35	HNu	0	0	0	0	0	
166	valve	Gate	M	1	GAS	61	35	TVA 1000 (FID)	2		174		89	
166	valve	Gate	M	1	GAS	61	35	TVA 1000 (PID)	6		7		7	
167	valve	Plug	M	10	GAS	60	60	OVA 108	6	40,000	40,000	15,000	15,000	
167	valve	Plug	M	10	GAS	60	60	TLV Sniffer	0	1,000	1,000	760	760	
167	valve	Plug	M	10	GAS	60	60	HNu	0	0	0	0	0	
167	valve	Plug	M	10	GAS	60	60	TVA 1000 (FID)	6		43,180		9,563	
167	valve	Plug	M	10	GAS	60	60	TVA 1000 (PID)	6		6		9	
168	valve	Gate	M	2	GAS	62	190	OVA 108	15	650	650	650	650	
168	valve	Gate	M	2	GAS	62	190	TLV Sniffer	0	72	72	56	56	
168	valve	Gate	M	2	GAS	62	190	HNu	0	0	0	0	0	
168	valve	Gate	M	2	GAS	62	190	TVA 1000 (FID)	6		647		617	
168	valve	Gate	M	2	GAS	62	190	TVA 1000 (PID)	6		9		7	

API / WSPA Screening Study Data

Refinery L Sequence Number	Component Information: Component Type	Subcategory	Actuation	Size (in.)	Service	Ambient Conditions: Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft/min)	Screening Data: Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
169	valve	Plug	M	4	GAS	66	60	OVA 108	6	550	550	300	300	
169	valve	Plug	M	4	GAS	66	60	TLV Sniffer	0	100	100	0	0	
169	valve	Plug	M	4	GAS	66	60	HNu	0	0	0	0	0	
169	valve	Plug	M	4	GAS	66	60	TVA 1000 (FID)	1		580		630	
169	valve	Plug	M	4	GAS	66	60	TVA 1000 (PID)	6		7		7	
170	valve	Plug	M	4	GAS	58	420	OVA 108	6	33	33	18	18	
170	valve	Plug	M	4	GAS	58	420	TLV Sniffer	0	0	0	0	0	
170	valve	Plug	M	4	GAS	58	420	HNu	0	0	0	0	0	
170	valve	Plug	M	4	GAS	58	420	TVA 1000 (FID)	1		28		12	
170	valve	Plug	M	4	GAS	58	420	TVA 1000 (PID)	7		6		6	
171	valve	Gate	M	1 1/2	GAS	58	550	OVA 108	6	70	80	15	30	
171	valve	Gate	M	1 1/2	GAS	58	550	TLV Sniffer	0	0	0	0	0	
171	valve	Gate	M	1 1/2	GAS	58	550	HNu	0	0	0	0	0	
171	valve	Gate	M	1 1/2	GAS	58	550	TVA 1000 (FID)	1		48		56	
171	valve	Gate	M	1 1/2	GAS	58	550	TVA 1000 (PID)	7		6		6	

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API / WSPA Screening Study Data

Refinery M Sequence Number	Component Information					Ambient Conditions		Screening Data							
	Component Type	Sub-category	Actuation	Size (in.)	Service	Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft / min)	Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
1	con-non	Th	. . .	5/8	LL	66.6	49	OVA 108	14	4500	5000	3500	3800	OVA 108 Instrument Id #20143
1	con-non	Th	. . .	5/8	LL	66.6	49	TLV Sniffer	14	1100	1100	500	500	TLV Sniffer Instrument Id #WD00546
1	con-non	Th	. . .	5/8	LL	66.6	49	HNu	14	550	600	400	500	HNu Instrument Id #970125
1	con-non	Th	. . .	5/8	LL	66.6	49	TVA 1000 (FID)						TVA 1000 (FID) Instrument Id #A140F
1	con-non	Th	. . .	5/8	LL	66.6	49	TVA 1000 (PID)						TVA 1000 (PID) Instrument Id #A140F
2	con-non	Tu	. . .	11/16	LL	69.2	92	OVA 108	9	280	280	140	140	
2	con-non	Tu	. . .	11/16	LL	69.2	92	TLV Sniffer	9	200	200	110	110	
2	con-non	Tu	. . .	11/16	LL	69.2	92	HNu	9	360	360	200	250	
2	con-non	Tu	. . .	11/16	LL	69.2	92	TVA 1000 (FID)						
2	con-non	Tu	. . .	11/16	LL	69.2	92	TVA 1000 (PID)						
3	con-non	Tu	. . .	11/16	LL	69.2	92	OVA 108	9	2500	2500	300	300	
3	con-non	Tu	. . .	11/16	LL	69.2	92	TLV Sniffer	9	560	560	180	180	
3	con-non	Tu	. . .	11/16	LL	69.2	92	HNu	9	500	500	140	180	
3	con-non	Tu	. . .	11/16	LL	69.2	92	TVA 1000 (FID)						
3	con-non	Tu	. . .	11/16	LL	69.2	92	TVA 1000 (PID)						
4	con-non	Th	. . .	3/4	LL	69.0	7.0	OVA 108	4	300	300	110	190	
4	con-non	Th	. . .	3/4	LL	69.0	7.0	TLV Sniffer	4	320	320	160	160	
4	con-non	Th	. . .	3/4	LL	69.0	7.0	HNu	4	500	500	100	140	
4	con-non	Th	. . .	3/4	LL	69.0	7.0	TVA 1000 (FID)						
4	con-non	Th	. . .	3/4	LL	69.0	7.0	TVA 1000 (PID)						
5	valve	Gate	M	3/8	LL	60.0	57	OVA 108	5	120	120	70	90	
5	valve	Gate	M	3/8	LL	60.0	57	TLV Sniffer	5	77	77	70	70	
5	valve	Gate	M	3/8	LL	60.0	57	HNu	5	160	160	110	130	
5	valve	Gate	M	3/8	LL	60.0	57	TVA 1000 (FID)						
5	valve	Gate	M	3/8	LL	60.0	57	TVA 1000 (PID)						
6	con-non	U	. . .	1	LL	60.0	57	OVA 108	5	260	350	180	250	
6	con-non	U	. . .	1	LL	60.0	57	TLV Sniffer	5					Dead battery on TLV Sniffer instrument
6	con-non	U	. . .	1	LL	60.0	57	HNu	5	240	240	150	180	
6	con-non	U	. . .	1	LL	60.0	57	TVA 1000 (FID)						
6	con-non	U	. . .	1	LL	60.0	57	TVA 1000 (PID)						
7	con-non	Th	. . .	3/8	LL	66.0	49	OVA 108	7	900	1300	200	500	
7	con-non	Th	. . .	3/8	LL	66.0	49	TLV Sniffer	7					
7	con-non	Th	. . .	3/8	LL	66.0	49	HNu	7	450	800	200	250	
7	con-non	Th	. . .	3/8	LL	66.0	49	TVA 1000 (FID)						
7	con-non	Th	. . .	3/8	LL	66.0	49	TVA 1000 (PID)						
8	con-fl	F	. . .	36	LL	71	125	OVA 108	10	>100000	>100000	>100000	>100000	
8	con-fl	F	. . .	36	LL	71	125	TLV Sniffer						
8	con-fl	F	. . .	36	LL	71	125	HNu						
8	con-fl	F	. . .	36	LL	71	125	TVA 1000 (FID)						
8	con-fl	F	. . .	36	LL	71	125	TVA 1000 (PID)						

API / WSPA Screening Study Data

Refinery M Sequence Number	Component Information					Ambient Conditions		Screening Data							Comments
	Component Type	Sub-category	Actuation	Size (in.)	Service	Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft / min)	Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)		
9	con-fl	F	---	12	LL	65	67	OVA 108	5	1300	1500	200	300		
9	con-fl	F	---	12	LL	65	67	TLV Sniffer							
9	con-fl	F	---	12	LL	65	67	HNu	5	650	650	600	600		
9	con-fl	F	---	12	LL	65	67	TVA 1000 (FID)							
9	con-fl	F	---	12	LL	65	67	TVA 1000 (PID)							
10	valve	Gate	M	6	LL	70	68	OVA 108	4	250	250	50	55		
10	valve	Gate	M	6	LL	70	68	TLV Sniffer							
10	valve	Gate	M	6	LL	70	68	HNu	4	50	75	25	75		
10	valve	Gate	M	6	LL	70	68	TVA 1000 (FID)							
10	valve	Gate	M	6	LL	70	68	TVA 1000 (PID)							
11	valve	Gate	M	6	LL	62.2	295	OVA 108	4	25	30	10	12		
11	valve	Gate	M	6	LL	62.2	295	TLV Sniffer							
11	valve	Gate	M	6	LL	62.2	295	HNu	4	25	75	1	10		
11	valve	Gate	M	6	LL	62.2	295	TVA 1000 (FID)							
11	valve	Gate	M	6	LL	62.2	295	TVA 1000 (PID)							
12	con-non	Tu	---	3/8	LL	68.2	0	OVA 108	4	17	17	11	11		
12	con-non	Tu	---	3/8	LL	68.2	0	TLV Sniffer							
12	con-non	Tu	---	3/8	LL	68.2	0	HNu	4	6	8	6	8		
12	con-non	Tu	---	3/8	LL	68.2	0	TVA 1000 (FID)							
12	con-non	Tu	---	3/8	LL	68.2	0	TVA 1000 (PID)							
13	con-non	Tu	---	3/8	LL	68.2	0	OVA 108	4	16	16	8	8		
13	con-non	Tu	---	3/8	LL	68.2	0	TLV Sniffer							
13	con-non	Tu	---	3/8	LL	68.2	0	HNu	4	6	6	2	6		
13	con-non	Tu	---	3/8	LL	68.2	0	TVA 1000 (FID)							
13	con-non	Tu	---	3/8	LL	68.2	0	TVA 1000 (PID)							
14	con-non	Th	---	1	LL	69	4	OVA 108	4	30	35	22	28		
14	con-non	Th	---	1	LL	69	4	TLV Sniffer							
14	con-non	Th	---	1	LL	69	4	HNu	4	35	60	0	10		
14	con-non	Th	---	1	LL	69	4	TVA 1000 (FID)							
14	con-non	Th	---	1	LL	69	4	TVA 1000 (PID)							
15	con-non	Tu	---	3/8	LL	69	114	OVA 108	5	1100	1200	300	550		
15	con-non	Tu	---	3/8	LL	69	114	TLV Sniffer							
15	con-non	Tu	---	3/8	LL	69	114	HNu	5	600	600	200	400		
15	con-non	Tu	---	3/8	LL	69	114	TVA 1000 (FID)							
15	con-non	Tu	---	3/8	LL	69	114	TVA 1000 (PID)							
16	con-non	Tu	---	3/8	LL	66	114	OVA 108	5	50	50	20	40		
16	con-non	Tu	---	3/8	LL	66	114	TLV Sniffer							
16	con-non	Tu	---	3/8	LL	66	114	HNu	5	110	130	10	50		
16	con-non	Tu	---	3/8	LL	66	114	TVA 1000 (FID)							
16	con-non	Tu	---	3/8	LL	66	114	TVA 1000 (PID)							
17	con-non	U	---	1/2	LL	66	44	OVA 108	4	80	80	20	30		

API / WSPA Screening Study Data

Refinery M Sequence Number	Component Information					Ambient Conditions		Screening Data						
	Component Type	Sub-category	Actuation	Size (in.)	Service	Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft / min)	Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
17	con-non	U	- - -	1/2	LL	66	44	TLV Sniffer						
17	con-non	U	- - -	1/2	LL	66	44	HNu	4	10	30	50	100	
17	con-non	U	- - -	1/2	LL	66	44	TVA 1000 (FID)						
17	con-non	U	- - -	1/2	LL	66	44	TVA 1000 (PID)						
18	con-non	Tu	- - -	3/8	LL	67.2	45	OVA 108	4	20	20	7	7	
18	con-non	Tu	- - -	3/8	LL	67.2	45	TLV Sniffer						
18	con-non	Tu	- - -	3/8	LL	67.2	45	HNu	4	40	40	2	5	
18	con-non	Tu	- - -	3/8	LL	67.2	45	TVA 1000 (FID)						
18	con-non	Tu	- - -	3/8	LL	67.2	45	TVA 1000 (PID)						
19	valve	Gate	C	1	LL	72	108	OVA 108	4	600	700	50	80	Fluctuating
19	valve	Gate	C	1	LL	72	108	TLV Sniffer						
19	valve	Gate	C	1	LL	72	108	HNu	4	20	30	50	100	
19	valve	Gate	C	1	LL	72	108	TVA 1000 (FID)						
19	valve	Gate	C	1	LL	72	108	TVA 1000 (PID)						
20	valve	Gate	C	1	LL	68	30	OVA 108	4	28	28	14	20	
20	valve	Gate	C	1	LL	68	30	TLV Sniffer						
20	valve	Gate	C	1	LL	68	30	HNu	4	15	20	5	6	
20	valve	Gate	C	1	LL	68	30	TVA 1000 (FID)						
20	valve	Gate	C	1	LL	68	30	TVA 1000 (PID)						
20d	valve	Gate	C	1	LL	68	30	OVA 108	4	25	25	10	16	Duplicate
20d	valve	Gate	C	1	LL	68	30	TLV Sniffer						
20d	valve	Gate	C	1	LL	68	30	HNu	4	20	20	4	6	
20d	valve	Gate	C	1	LL	68	30	TVA 1000 (FID)						
20d	valve	Gate	C	1	LL	68	30	TVA 1000 (PID)						
21	valve	Gate	M	2	LL	66.3	68	OVA 108	4	25	25	8	11	
21	valve	Gate	M	2	LL	66.3	68	TLV Sniffer						
21	valve	Gate	M	2	LL	66.3	68	HNu	4	20	20	5	10	
21	valve	Gate	M	2	LL	66.3	68	TVA 1000 (FID)						
21	valve	Gate	M	2	LL	66.3	68	TVA 1000 (PID)						
22	valve	Gate	C	4	LL	64.5	181	OVA 108	4	8	8	5	5	
22	valve	Gate	C	4	LL	64.5	181	TLV Sniffer						
22	valve	Gate	C	4	LL	64.5	181	HNu	4	5	6	1	1	
22	valve	Gate	C	4	LL	64.5	181	TVA 1000 (FID)						
22	valve	Gate	C	4	LL	64.5	181	TVA 1000 (PID)						
23	valve	Gate	C	2	GAS	65	62	OVA 108	7	170	220	280	280	Visible liquid
23	valve	Gate	C	2	GAS	65	62	TLV Sniffer	7	300	300	100	100	
23	valve	Gate	C	2	GAS	65	62	HNu	7	140	160	30	30	
23	valve	Gate	C	2	GAS	65	62	TVA 1000 (FID)						
23	valve	Gate	C	2	GAS	65	62	TVA 1000 (PID)						
24	valve	Gate	M	6	GAS	66.5	162	OVA 108	7	550	550	50	100	
24	valve	Gate	M	6	GAS	66.5	162	TLV Sniffer	7	340	340	240	240	

API / WSPA Screening Study Data

Refinery M Sequence Number	Component Information					Ambient Conditions		Screening Data							Comments
	Component Type	Sub-category	Actuation	Size (in.)	Service	Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft / min)	Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)		
24	valve	Gate	M	6	GAS	66.5	162	HNu	0	300	300	200	300		
24	valve	Gate	M	6	GAS	66.5	162	TVA 1000 (FID)							
24	valve	Gate	M	6	GAS	66.5	162	TVA 1000 (PID)							
25	valve	Gate	M	1	LL	66.4	202	OVA 108	7	40	50	8	8		
25	valve	Gate	M	1	LL	66.4	202	TLV Sniffer							
25	valve	Gate	M	1	LL	66.4	202	HNu	0	8	8	0	0		
25	valve	Gate	M	1	LL	66.4	202	TVA 1000 (FID)							
25	valve	Gate	M	1	LL	66.4	202	TVA 1000 (PID)							
26	con-non	Th	---	1	LL	73.1	116	OVA 108	5	140	160	20	25		
26	con-non	Th	---	1	LL	73.1	116	TLV Sniffer							
26	con-non	Th	---	1	LL	73.1	116	HNu	0	40	50	5	10		
26	con-non	Th	---	1	LL	73.1	116	TVA 1000 (FID)							
26	con-non	Th	---	1	LL	73.1	116	TVA 1000 (PID)							
27	con-non	Th	---	1	LL	66.4	111	OVA 108	6	12	12	8	8		
27	con-non	Th	---	1	LL	66.4	111	TLV Sniffer							
27	con-non	Th	---	1	LL	66.4	111	HNu	0	0	0	0	0		
27	con-non	Th	---	1	LL	66.4	111	TVA 1000 (FID)							
27	con-non	Th	---	1	LL	66.4	111	TVA 1000 (PID)							
28	con-non	Th	---	1/2	LL	68	28	OVA 108	8	600	600	500	500		
28	con-non	Th	---	1/2	LL	68	28	TLV Sniffer							
28	con-non	Th	---	1/2	LL	68	28	HNu	0	200	250	180	200		
28	con-non	Th	---	1/2	LL	68	28	TVA 1000 (FID)							
28	con-non	Th	---	1/2	LL	68	28	TVA 1000 (PID)							
29	con-non	Th	---	1	LL	67.4	239	OVA 108	7	20	25	25	25		
29	con-non	Th	---	1	LL	67.4	239	TLV Sniffer							
29	con-non	Th	---	1	LL	67.4	239	HNu	0	20	20	5	6		
29	con-non	Th	---	1	LL	67.4	239	TVA 1000 (FID)							
29	con-non	Th	---	1	LL	67.4	239	TVA 1000 (PID)							
30	valve	Gate	C	2	LL	68.6	20	OVA 108	6	45	45	12	12		
30	valve	Gate	C	2	LL	68.6	20	TLV Sniffer							
30	valve	Gate	C	2	LL	68.6	20	HNu	0	20	20	4	6		
30	valve	Gate	C	2	LL	68.6	20	TVA 1000 (FID)							
30	valve	Gate	C	2	LL	68.6	20	TVA 1000 (PID)							
31	valve	Gate	C	2	LL	66	157	OVA 108	5	18	18	8	8		
31	valve	Gate	C	2	LL	66	157	TLV Sniffer							
31	valve	Gate	C	2	LL	66	157	HNu	0	30	40	9	9		
31	valve	Gate	C	2	LL	66	157	TVA 1000 (FID)							
31	valve	Gate	C	2	LL	66	157	TVA 1000 (PID)							
32	valve	Gate	C	12	HL	68	258	OVA 108	5	300	300	150	150		Visible liquid
32	valve	Gate	C	12	HL	68	258	TLV Sniffer	0	200	200	200	200		
32	valve	Gate	C	12	HL	68	258	HNu	0	550	550	175	190		

API / WSPA Screening Study Data

Refinery	Component Information					Ambient Conditions		Screening Data						
Sequence Number	Component Type	Sub-category	Actuation	Size (in.)	Service	Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft / min)	Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
32	valve	Gate	C	12	HL	68	258	TVA 1000 (FID)						
32	valve	Gate	C	12	HL	68	258	TVA 1000 (PID)						
33	valve	Gate	C	10	LL	68.3	72	OVA 108	15	240	240	70	100	
33	valve	Gate	C	10	LL	68.3	72	TLV Sniffer	0	50	50	0	0	
33	valve	Gate	C	10	LL	68.3	72	HNu	0	200	240	100	200	
33	valve	Gate	C	10	LL	68.3	72	TVA 1000 (FID)						
33	valve	Gate	C	10	LL	68.3	72	TVA 1000 (PID)						
34	valve	Gate	M	10	HL	70	262	OVA 108	10	650	650	650	650	Visible liquid.
34	valve	Gate	M	10	HL	70	262	TLV Sniffer	0	300	300	300	300	
34	valve	Gate	M	10	HL	70	262	HNu	0	750	750	680	680	
34	valve	Gate	M	10	HL	70	262	TVA 1000 (FID)						
34	valve	Gate	M	10	HL	70	262	TVA 1000 (PID)						
35	valve	Gate	C	8	LL	72.3	135	OVA 108	15	200	350	100	200	Bonnet.
35	valve	Gate	C	8	LL	72.3	135	TLV Sniffer	0	200	200	40	40	
35	valve	Gate	C	8	LL	72.3	135	HNu	0	300	500	50	180	
35	valve	Gate	C	8	LL	72.3	135	TVA 1000 (FID)						
35	valve	Gate	C	8	LL	72.3	135	TVA 1000 (PID)						
36	valve	Gate	C	8	GAS	72.8	110	OVA 108	10	70	80	35	35	
36	valve	Gate	C	8	GAS	72.8	110	TLV Sniffer	0	0	0	0	0	Debutanizer overhead
36	valve	Gate	C	8	GAS	72.8	110	HNu	0	120	170	30	60	
36	valve	Gate	C	8	GAS	72.8	110	TVA 1000 (FID)						
36	valve	Gate	C	8	GAS	72.8	110	TVA 1000 (PID)						
37	con-non	Th	---	1	LL	68.2	318	OVA 108	8	3000	5000	1200	1200	Plug
37	con-non	Th	---	1	LL	68.2	318	TLV Sniffer	0	2300	2300	1000	1000	
37	con-non	Th	---	1	LL	68.2	318	HNu	0	350	350	350	400	
37	con-non	Th	---	1	LL	68.2	318	TVA 1000 (FID)						
37	con-non	Th	---	1	LL	68.2	318	TVA 1000 (PID)						
38	valve	Gate	M	1/4	GAS	76.3	584	OVA 108	8	250	250	30	35	Gas = Methane
38	valve	Gate	M	1/4	GAS	76.3	584	TLV Sniffer	0	0	0	0	0	
38	valve	Gate	M	1/4	GAS	76.3	584	HNu	0	180	190	20	25	
38	valve	Gate	M	1/4	GAS	76.3	584	TVA 1000 (FID)						
38	valve	Gate	M	1/4	GAS	76.3	584	TVA 1000 (PID)						
39	valve	Gate	M	1/4	GAS	74	266	OVA 108	8	18	18	10	10	Gas = Methane.
39	valve	Gate	M	1/4	GAS	74	266	TLV Sniffer	0	0	0	0	0	
39	valve	Gate	M	1/4	GAS	74	266	HNu	0	5	5	2	2	
39	valve	Gate	M	1/4	GAS	74	266	TVA 1000 (FID)						
39	valve	Gate	M	1/4	GAS	74	266	TVA 1000 (PID)						
40	valve	Gate	M	1	GAS	77	239	OVA 108	8	200	250	40	70	Gas = Methane
40	valve	Gate	M	1	GAS	77	239	TLV Sniffer	0	0	0	0	0	
40	valve	Gate	M	1	GAS	77	239	HNu	0	180	180	20	40	
40	valve	Gate	M	1	GAS	77	239	TVA 1000 (FID)						

API / WSPA Screening Study Data

Refinery	Component Information					Ambient Conditions		Screening Data							
M Sequence Number	Component Type	Sub-category	Actuation	Size (in.)	Service	Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft / min)	Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
40	valve	Gate	M	1	GAS	77	239	TVA 1000 (PID)						
40d	valve	Gate	M	1	GAS	77	239	OVA 108	6	120	120	12	25	Duplicate Gas = Methane
40d	valve	Gate	M	1	GAS	77	239	TLV Sniffer	0	0	0	0	0	
40d	valve	Gate	M	1	GAS	77	239	HNu	0	50	70	10	10	
40d	valve	Gate	M	1	GAS	77	239	TVA 1000 (FID)						
40d	valve	Gate	M	1	GAS	77	239	TVA 1000 (PID)						
41	valve	Gate	M	1	GAS	70.5	199	OVA 108	6	60	70	10	12	Gas = Methane
41	valve	Gate	M	1	GAS	70.5	199	TLV Sniffer	0	0	0	0	0	
41	valve	Gate	M	1	GAS	70.5	199	HNu	0	20	30	0	0	
41	valve	Gate	M	1	GAS	70.5	199	TVA 1000 (FID)						
41	valve	Gate	M	1	GAS	70.5	199	TVA 1000 (PID)						
41a	valve	Gate	C	6	GAS	68.4	167	OVA 108	7	35	35	12	12	
41a	valve	Gate	C	6	GAS	68.4	167	TLV Sniffer	0	0	0	0	0	
41a	valve	Gate	C	6	GAS	68.4	167	HNu	0	140	140	40	50	
41a	valve	Gate	C	6	GAS	68.4	167	TVA 1000 (FID)						
41a	valve	Gate	C	6	GAS	68.4	167	TVA 1000 (PID)						
42	con-non	Th	---	2	GAS	69.8	10	OVA 108	6	25	25	8	8	Plug
42	con-non	Th	---	2	GAS	69.8	10	TLV Sniffer	0	0	0	0	0	
42	con-non	Th	---	2	GAS	69.8	10	HNu	0	5	5	1	1	
42	con-non	Th	---	2	GAS	69.8	10	TVA 1000 (FID)						
42	con-non	Th	---	2	GAS	69.8	10	TVA 1000 (PID)						
43	valve	Gate	M	8	GAS	65.9	244	OVA 108	5	100	140	70	70	
43	valve	Gate	M	8	GAS	65.9	244	TLV Sniffer	0	0	0	0	0	
43	valve	Gate	M	8	GAS	65.9	244	HNu	0	100	180	30	40	
43	valve	Gate	M	8	GAS	65.9	244	TVA 1000 (FID)						
43	valve	Gate	M	8	GAS	65.9	244	TVA 1000 (PID)						
44	valve	Gate	C	4	GAS	64	159	OVA 108	5	160	160	100	140	
44	valve	Gate	C	4	GAS	64	159	TLV Sniffer	0	0	0	0	0	
44	valve	Gate	C	4	GAS	64	159	HNu	0	400	600	30	100	
44	valve	Gate	C	4	GAS	64	159	TVA 1000 (FID)						
44	valve	Gate	C	4	GAS	64	159	TVA 1000 (PID)						
45	con-non	Th	---	2	LL	65	236	OVA 108	7	100	100	30	30	
45	con-non	Th	---	2	LL	65	236	TLV Sniffer	0	0	0	0	0	
45	con-non	Th	---	2	LL	65	236	HNu	0	185	185	50	50	
45	con-non	Th	---	2	LL	65	236	TVA 1000 (FID)						
45	con-non	Th	---	2	LL	65	236	TVA 1000 (PID)						
46	valve	Gate	M	4	LL	57.2	16	OVA 108	10	200	240	55	55	
46	valve	Gate	M	4	LL	57.2	16	TLV Sniffer	10	23	23	10	10	
46	valve	Gate	M	4	LL	57.2	16	HNu						
46	valve	Gate	M	4	LL	57.2	16	TVA 1000 (FID)						
46	valve	Gate	M	4	LL	57.2	16	TVA 1000 (PID)						

API / WSPA Screening Study Data

Refinery M Sequence Number	Component Information					Ambient Conditions		Screening Data							
	Component Type	Sub-category	Actuation	Size (in.)	Service	Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft / min)	Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
47	con-fl	F	---	4	LL	58	7	OVA 108	10	400	700	100	100	
47	con-fl	F	---	4	LL	58	7	TLV Sniffer	5	100	100	5	5	
47	con-fl	F	---	4	LL	58	7	HNu						
47	con-fl	F	---	4	LL	58	7	TVA 1000 (FID)						
47	con-fl	F	---	4	LL	58	7	TVA 1000 (PID)						
48	valve	Gate	M	4	LL	57.2	120	OVA 108	10	140	140	50	60	
48	valve	Gate	M	4	LL	57.2	120	TLV Sniffer	10	60	60	15	15	
48	valve	Gate	M	4	LL	57.2	120	HNu						
48	valve	Gate	M	4	LL	57.2	120	TVA 1000 (FID)						
48	valve	Gate	M	4	LL	57.2	120	TVA 1000 (PID)						
49	valve	Gate	M	1	LL	58.8	5	OVA 108	10	250	250	60	60	
49	valve	Gate	M	1	LL	58.8	5	TLV Sniffer	5	100	100	60	60	
49	valve	Gate	M	1	LL	58.8	5	HNu						
49	valve	Gate	M	1	LL	58.8	5	TVA 1000 (FID)						
49	valve	Gate	M	1	LL	58.8	5	TVA 1000 (PID)						
50	valve	Gate	M	1	LL	57	65	OVA 108	10	55	55	50	60	
50	valve	Gate	M	1	LL	57	65	TLV Sniffer	5	60	60	32	32	
50	valve	Gate	M	1	LL	57	65	HNu						
50	valve	Gate	M	1	LL	57	65	TVA 1000 (FID)						
50	valve	Gate	M	1	LL	57	65	TVA 1000 (PID)						
51	valve	Gate	M	--	LL	57.2	174	OVA 108	10	5000	5000	1800	2000	Bonnet leaking
51	valve	Gate	M	--	LL	57.2	174	TLV Sniffer	10	1800	1800	1400	1400	
51	valve	Gate	M	--	LL	57.2	174	HNu						
51	valve	Gate	M	--	LL	57.2	174	TVA 1000 (FID)						
51	valve	Gate	M	--	LL	57.2	174	TVA 1000 (PID)						
52	valve	Plug	M	3	LL	56.5	107	OVA 108	12	50	60	20	25	Pump inlet
52	valve	Plug	M	3	LL	56.5	107	TLV Sniffer	0	0	0	0	0	
52	valve	Plug	M	3	LL	56.5	107	HNu						
52	valve	Plug	M	3	LL	56.5	107	TVA 1000 (FID)						
52	valve	Plug	M	3	LL	56.5	107	TVA 1000 (PID)						
53	valve	Gate	M	1	LL	57.4	37	OVA 108	10	38	38	28	28	
53	valve	Gate	M	1	LL	57.4	37	TLV Sniffer	0	0	0	0	0	
53	valve	Gate	M	1	LL	57.4	37	HNu						
53	valve	Gate	M	1	LL	57.4	37	TVA 1000 (FID)						
53	valve	Gate	M	1	LL	57.4	37	TVA 1000 (PID)						
54	valve	Gate	C	2	LL	57.2	274	OVA 108	10	25000	30000	2000	3000	Max at end of test was 6000 @ 0cm
54	valve	Gate	C	2	LL	57.2	274	TLV Sniffer	0	2400	2400	1600	1600	
54	valve	Gate	C	2	LL	57.2	274	HNu						
54	valve	Gate	C	2	LL	57.2	274	TVA 1000 (FID)						
54	valve	Gate	C	2	LL	57.2	274	TVA 1000 (PID)						
55	con-non	Th	---	1	LL	60.2	81	OVA 108	15	170	170	60	60	

API / WSPA Screening Study Data

Refinery	Component Information					Ambient Conditions		Screening Data							
M Sequence Number	Component Type	Sub-category	Actuation	Size (in.)	Service	Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft / min)	Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
55	con-non	Th	- - -	1	LL	60.2	81	TLV Sniffer	5	100	100	0	0	
55	con-non	Th	- - -	1	LL	60 2	81	HNu						
55	con-non	Th	- - -	1	LL	60 2	81	TVA 1000 (FID)						
55	con-non	Th	- - -	1	LL	60.2	81	TVA 1000 (PID)						
56	valve	Gate	M	3	LL	60	189	OVA 108	7	25	25	10	10	
56	valve	Gate	M	3	LL	60	189	TLV Sniffer	0	0	0	0	0	
56	valve	Gate	M	3	LL	60	189	HNu						
56	valve	Gate	M	3	LL	60	189	TVA 1000 (FID)						
56	valve	Gate	M	3	LL	60	189	TVA 1000 (PID)						
57	valve	Gate	M	1	LL	60	81	OVA 108	10	3000	3000	600	600	
57	valve	Gate	M	1	LL	60	81	TLV Sniffer	0	750	750	650	650	
57	valve	Gate	M	1	LL	60	81	HNu						
57	valve	Gate	M	1	LL	60	81	TVA 1000 (FID)						
57	valve	Gate	M	1	LL	60	81	TVA 1000 (PID)						
58	valve	Gate	M	4	LL	59 7	13	OVA 108	10	250	300	220	220	
58	valve	Gate	M	4	LL	59 7	13	TLV Sniffer	0	90	90	45	45	
58	valve	Gate	M	4	LL	59.7	13	HNu						
58	valve	Gate	M	4	LL	59.7	13	TVA 1000 (FID)						
58	valve	Gate	M	4	LL	59.7	13	TVA 1000 (PID)						
59	con-fl	F	- - -	2	LL	59 5	205	OVA 108	10	650	650	140	140	
59	con-fl	F	- - -	2	LL	59 5	205	TLV Sniffer	0	300	300	120	120	
59	con-fl	F	- - -	2	LL	59.5	205	HNu						
59	con-fl	F	- - -	2	LL	59 5	205	TVA 1000 (FID)						
59	con-fl	F	- - -	2	LL	59.5	205	TVA 1000 (PID)						
60	valve	Gate	M	3	LL	62.4	17	OVA 108	10	450	600	200	300	
60	valve	Gate	M	3	LL	62.4	17	TLV Sniffer	0	100	100	30	30	
60	valve	Gate	M	3	LL	62.4	17	HNu						
60	valve	Gate	M	3	LL	62.4	17	TVA 1000 (FID)						
60	valve	Gate	M	3	LL	62.4	17	TVA 1000 (PID)						
60d	valve	Gate	M	3	LL	62.2	197	OVA 108	10	400	450	120	160	Duplicate
60d	valve	Gate	M	3	LL	62 2	197	TLV Sniffer	0	100	100	16	16	
60d	valve	Gate	M	3	LL	62 2	197	HNu						
60d	valve	Gate	M	3	LL	62.2	197	TVA 1000 (FID)						
60d	valve	Gate	M	3	LL	62.2	197	TVA 1000 (PID)						
61	valve	Gate	C	3	LL	61	203	OVA 108	10	30	30	12	18	
61	valve	Gate	C	3	LL	61	203	TLV Sniffer	0	0	0	0	0	
61	valve	Gate	C	3	LL	61	203	HNu						
61	valve	Gate	C	3	LL	61	203	TVA 1000 (FID)						
61	valve	Gate	C	3	LL	61	203	TVA 1000 (PID)						
62	con-fl	F	- - -	4	LL	61	232	OVA 108	10	240	240	60	60	Visible liquid
62	con-fl	F	- - -	4	LL	61	232	TLV Sniffer	0	85	85	5	5	

API / WSPA Screening Study Data

Refinery	Component Information					Ambient Conditions		Screening Data						
M Sequence Number	Component Type	Sub-category	Actuation	Size (in.)	Service	Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft / min)	Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
62	con-fl	F	- - -	4	LL	61	232	HNu						
62	con-fl	F	- - -	4	LL	61	232	TVA 1000 (FID)						
62	con-fl	F	- - -	4	LL	61	232	TVA 1000 (PID)						
63	valve	Gate	M	3	LL	60	425	OVA 108	8	25	25	15	15	
63	valve	Gate	M	3	LL	60	425	TLV Sniffer	0	0	0	0	0	
63	valve	Gate	M	3	LL	60	425	HNu						
63	valve	Gate	M	3	LL	60	425	TVA 1000 (FID)						
63	valve	Gate	M	3	LL	60	425	TVA 1000 (PID)						
64	valve	Gate	M	1	LL	61.6	22	OVA 108	10	40	40	18	18	
64	valve	Gate	M	1	LL	61.6	22	TLV Sniffer	0	0	0	0	0	
64	valve	Gate	M	1	LL	61.6	22	HNu						
64	valve	Gate	M	1	LL	61.6	22	TVA 1000 (FID)						
64	valve	Gate	M	1	LL	61.6	22	TVA 1000 (PID)						
65	con-non	Th	- - -	1	LL	60	315	OVA 108	8	70	70	30	32	
65	con-non	Th	- - -	1	LL	60	315	TLV Sniffer	0	0	0	0	0	
65	con-non	Th	- - -	1	LL	60	315	HNu						
65	con-non	Th	- - -	1	LL	60	315	TVA 1000 (FID)						
65	con-non	Th	- - -	1	LL	60	315	TVA 1000 (PID)						
66	valve	Gate	M	1/2	LL	61.6	300	OVA 108	7	25	25	10	12	
66	valve	Gate	M	1/2	LL	61.6	300	TLV Sniffer	0	0	0	0	0	
66	valve	Gate	M	1/2	LL	61.6	300	HNu						
66	valve	Gate	M	1/2	LL	61.6	300	TVA 1000 (FID)						
66	valve	Gate	M	1/2	LL	61.6	300	TVA 1000 (PID)						
67	valve	Plug	M	3/8	LL	51.2	65	OVA 108	7	600	600	250	250	Retested with OVA at surface at 1100 at end o
67	valve	Plug	M	3/8	LL	51.2	65	TLV Sniffer	0	920	920	240	240	
67	valve	Plug	M	3/8	LL	51.2	65	HNu						
67	valve	Plug	M	3/8	LL	51.2	65	TVA 1000 (FID)						
67	valve	Plug	M	3/8	LL	51.2	65	TVA 1000 (PID)						
68	valve	Gate	M	4	LL	62.1	10	OVA 108	10	80	90	60	60	
68	valve	Gate	M	4	LL	62.1	10	TLV Sniffer	0	0	0	0	0	
68	valve	Gate	M	4	LL	62.1	10	HNu						
68	valve	Gate	M	4	LL	62.1	10	TVA 1000 (FID)						
68	valve	Gate	M	4	LL	62.1	10	TVA 1000 (PID)						
69	valve	Gate	M	2	LL	62.3	102	OVA 108	7	33	33	15	15	
69	valve	Gate	M	2	LL	62.3	102	TLV Sniffer	0	0	0	0	0	
69	valve	Gate	M	2	LL	62.3	102	HNu						
69	valve	Gate	M	2	LL	62.3	102	TVA 1000 (FID)						
69	valve	Gate	M	2	LL	62.3	102	TVA 1000 (PID)						
70	valve	Gate	M	1	LL	68.1	161	OVA 108	6	50	50	30	50	
70	valve	Gate	M	1	LL	68.1	161	TLV Sniffer	0	0	0	0	0	
70	valve	Gate	M	1	LL	68.1	161	HNu						

API / WSPA Screening Study Data

Refinery M Sequence Number	Component Information					Ambient Conditions		Screening Data							Comments
	Component Type	Sub-category	Actuation	Size (in.)	Service	Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft / min)	Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)		
70	valve	Gate	M	1	LL	68.1	161	TVA 1000 (FID)	4	40	40	17	17		
70	valve	Gate	M	1	LL	68.1	161	TVA 1000 (PID)	4	24	24	7	7		
71	con-non	Th	---	1/4	LL	68.3	9	OVA 108	7	110	110	30	30		
71	con-non	Th	---	1/4	LL	68.3	9	TLV Sniffer	0	25	25	10	20		
71	con-non	Th	---	1/4	LL	68.3	9	HNu							
71	con-non	Th	---	1/4	LL	68.3	9	TVA 1000 (FID)	3	70	70	11	11		
71	con-non	Th	---	1/4	LL	68.3	9	TVA 1000 (PID)	3	10	10	7	7		
72	valve	Gate	M	4	LL	62	67	OVA 108	4.5	300	300	8	20		
72	valve	Gate	M	4	LL	62	67	TLV Sniffer	0	90	90	0	0		
72	valve	Gate	M	4	LL	62	67	HNu							
72	valve	Gate	M	4	LL	62	67	TVA 1000 (FID)	2	90	110	20	30		
72	valve	Gate	M	4	LL	62	67	TVA 1000 (PID)	0	20	25	0	0		
73	valve	Gate	C	2	LL	64.7	275	OVA 108	2	2000	2800	100	1000		Done earlier and fixed
73	valve	Gate	C	2	LL	64.7	275	TLV Sniffer	0	1100	1100	450	450		
73	valve	Gate	C	2	LL	64.7	275	HNu							
73	valve	Gate	C	2	LL	64.7	275	TVA 1000 (FID)	2	3000	5000	300	700		
73	valve	Gate	C	2	LL	64.7	275	TVA 1000 (PID)							
74	con-non	Th	---	1	LL	64.3	178	OVA 108	6	300	300	20	20		
74	con-non	Th	---	1	LL	64.3	178	TLV Sniffer	0	20	20	0	0		
74	con-non	Th	---	1	LL	64.3	178	HNu							
74	con-non	Th	---	1	LL	64.3	178	TVA 1000 (FID)	3	110	150	4	4		
74	con-non	Th	---	1	LL	64.3	178	TVA 1000 (PID)							
75	con-fl	F	---	3	LL	64.6	39	OVA 108	7	25	25	18	18		From Tetramur overhead pump and Accu
75	con-fl	F	---	3	LL	64.6	39	TLV Sniffer	0	65	65	59	59		
75	con-fl	F	---	3	LL	64.6	39	HNu							
75	con-fl	F	---	3	LL	64.6	39	TVA 1000 (FID)	2	79	79	40	44		
75	con-fl	F	---	3	LL	64.6	39	TVA 1000 (PID)							
76	valve	Gate	M	4	LL	65	452	OVA 108	8	200	300	100	200		
76	valve	Gate	M	4	LL	65	452	TLV Sniffer	0	100	100	50	50		
76	valve	Gate	M	4	LL	65	452	HNu							
76	valve	Gate	M	4	LL	65	452	TVA 1000 (FID)	3	1000	1200	280	320		
76	valve	Gate	M	4	LL	65	452	TVA 1000 (PID)							
77	con-non	Th	---	1	LL	63.5	11	OVA 108	6	20	35	7	7		Plug.
77	con-non	Th	---	1	LL	63.5	11	TLV Sniffer	0	10	10	0	0		
77	con-non	Th	---	1	LL	63.5	11	HNu							
77	con-non	Th	---	1	LL	63.5	11	TVA 1000 (FID)	38	40	44	55	70		
77	con-non	Th	---	1	LL	63.5	11	TVA 1000 (PID)							
78	valve	Gate	M	4	LL	62.7	133	OVA 108	6	50	50	25	40		Trimmer Btms
78	valve	Gate	M	4	LL	62.7	133	TLV Sniffer	0	40	40	20	20		
78	valve	Gate	M	4	LL	62.7	133	HNu							
78	valve	Gate	M	4	LL	62.7	133	TVA 1000 (FID)	14	90	130	65	65		

API / WSPA Screening Study Data

Refinery M Sequence Number	Component Information: Component Type	Sub-category	Actuation	Size (in.)	Service	Ambient Conditions: Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft / min)	Screening Data: Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
78	valve	Gate	M	4	LL	62.7	133	TVA 1000 (PID)						
79	valve	Gate	M	2	LL	62	96	OVA 108	6	12	12	8	10	
79	valve	Gate	M	2	LL	62	96	TLV Sniffer	0	0	0	0	0	
79	valve	Gate	M	2	LL	62	96	HNu						
79	valve	Gate	M	2	LL	62	96	TVA 1000 (FID)	10	30	55	30	35	
79	valve	Gate	M	2	LL	62	96	TVA 1000 (PID)						
80	con-non	Th	---	1/2	LL	62	70	OVA 108	6	190	190	50	70	
80	con-non	Th	---	1/2	LL	62	70	TLV Sniffer	0	92	92	45	45	
80	con-non	Th	---	1/2	LL	62	70	HNu						
80	con-non	Th	---	1/2	LL	62	70	TVA 1000 (FID)	10	700	710	50	110	
80	con-non	Th	---	1/2	LL	62	70	TVA 1000 (PID)						
80d	con-non	Th	---	1/2	LL	62	80	OVA 108	6	150	150	35	40	Duplicate Trimmer tower BW 2036 271 02
80d	con-non	Th	---	1/2	LL	62	80	TLV Sniffer	12	120	120	45	45	
80d	con-non	Th	---	1/2	LL	62	80	HNu						
80d	con-non	Th	---	1/2	LL	62	80	TVA 1000 (FID)	5	500	800	125	130	
80d	con-non	Th	---	1/2	LL	62	80	TVA 1000 (PID)						
81	valve	Gate	M	1	LL	61	65	OVA 108	6	25	30	12	12	
81	valve	Gate	M	1	LL	61	65	TLV Sniffer	10	30	30	20	20	
81	valve	Gate	M	1	LL	61	65	HNu						
81	valve	Gate	M	1	LL	61	65	TVA 1000 (FID)	5	24	40	15	21	
81	valve	Gate	M	1	LL	61	65	TVA 1000 (PID)						
82	valve	Gate	M	2	LL	61	239	OVA 108	5	320	320	50	70	
82	valve	Gate	M	2	LL	61	239	TLV Sniffer	0	100	100	40	40	
82	valve	Gate	M	2	LL	61	239	HNu						
82	valve	Gate	M	2	LL	61	239	TVA 1000 (FID)	5	630	1000	200	500	
82	valve	Gate	M	2	LL	61	239	TVA 1000 (PID)						
83	valve	Gate	M	1/2	LL			OVA 108	5	18	18	12	16	
83	valve	Gate	M	1/2	LL			TLV Sniffer	20	36	36	20	22	
83	valve	Gate	M	1/2	LL			HNu						
83	valve	Gate	M	1/2	LL			TVA 1000 (FID)	6	29	33	20	60	
83	valve	Gate	M	1/2	LL			TVA 1000 (PID)						
84	valve	Gate	C	2	LL	61.2	46	OVA 108	7	7500	10000	600	700	
84	valve	Gate	C	2	LL	61.2	46	TLV Sniffer	0	3000	3000	3200	3200	
84	valve	Gate	C	2	LL	61.2	46	HNu						
84	valve	Gate	C	2	LL	61.2	46	TVA 1000 (FID)	4	4000	9000	1400	2800	
84	valve	Gate	C	2	LL	61.2	46	TVA 1000 (PID)						
85	valve	Gate	C	3	LL	62.6	11	OVA 108	5	35	65	25	35	
85	valve	Gate	C	3	LL	62.6	11	TLV Sniffer	20	82	82	52	52	
85	valve	Gate	C	3	LL	62.6	11	HNu						
85	valve	Gate	C	3	LL	62.6	11	TVA 1000 (FID)	4	30	50	12	20	
85	valve	Gate	C	3	LL	62.6	11	TVA 1000 (PID)						

API / WSPA Screening Study Data

Refinery	Component Information					Ambient Conditions		Screening Data							
M Sequence Number	Component Type	Sub-category	Actuation	Size (in.)	Service	Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft / min)	Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
86	valve	Gate	C	3	LL	64	70	OVA 108	5	700	1100	300	900	
86	valve	Gate	C	3	LL	64	70	TLV Sniffer	12	360	360	450	600	
86	valve	Gate	C	3	LL	64	70	HNu						
86	valve	Gate	C	3	LL	64	70	TVA 1000 (FID)	4	300	800	50	100	
86	valve	Gate	C	3	LL	64	70	TVA 1000 (PID)						
87	valve	Gate	C	3	LL	64.1	63	OVA 108	5	120	120	80	110	
87	valve	Gate	C	3	LL	64.1	63	TLV Sniffer	20	95	95	40	40	
87	valve	Gate	C	3	LL	64.1	63	HNu						
87	valve	Gate	C	3	LL	64.1	63	TVA 1000 (FID)	4	150	200	11	11	
87	valve	Gate	C	3	LL	64.1	63	TVA 1000 (PID)						
88	valve	Gate	M	1	LL	66.6	93	OVA 108	5	25	35	25	35	
88	valve	Gate	M	1	LL	66.6	93	TLV Sniffer	20	55	60	40	40	
88	valve	Gate	M	1	LL	66.6	93	HNu						
88	valve	Gate	M	1	LL	66.6	93	TVA 1000 (FID)	4	20	30	17	23	
88	valve	Gate	M	1	LL	66.6	93	TVA 1000 (PID)						
89	valve	Gate	C	2	LL	63.6	10	OVA 108	5	50	80	12	20	
89	valve	Gate	C	2	LL	63.6	10	TLV Sniffer	20	72	72	20	40	
89	valve	Gate	C	2	LL	63.6	10	HNu						
89	valve	Gate	C	2	LL	63.6	10	TVA 1000 (FID)	6	30	35	6	8	
89	valve	Gate	C	2	LL	63.6	10	TVA 1000 (PID)						
90	con-non	Th	- - -	3/8	LL	63.2	30	OVA 108	5	80000	100000	2000	6000	
90	con-non	Th	- - -	3/8	LL	63.2	30	TLV Sniffer	25	>10000		4000	5000	
90	con-non	Th	- - -	3/8	LL	63.2	30	HNu						
90	con-non	Th	- - -	3/8	LL	63.2	30	TVA 1000 (FID)	6	100000	150000	200	400	
90	con-non	Th	- - -	3/8	LL	63.2	30	TVA 1000 (PID)						
91	valve	Gate	C	4	LL	62.7	35	OVA 108	5	200	250	100	200	
91	valve	Gate	C	4	LL	62.7	35	TLV Sniffer	0	175	175	100	100	
91	valve	Gate	C	4	LL	62.7	35	HNu						
91	valve	Gate	C	4	LL	62.7	35	TVA 1000 (FID)	4	200	250	40	80	
91	valve	Gate	C	4	LL	62.7	35	TVA 1000 (PID)						
92	con-non	Th	- - -	1/4	LL	60.7	43	OVA 108	5	1200	1200	200	200	Plug No tags
92	con-non	Th	- - -	1/4	LL	60.7	43	TLV Sniffer	0	525	525	50	50	
92	con-non	Th	- - -	1/4	LL	60.7	43	HNu						
92	con-non	Th	- - -	1/4	LL	60.7	43	TVA 1000 (FID)	6	2500	3000	40	80	
92	con-non	Th	- - -	1/4	LL	60.7	43	TVA 1000 (PID)						
93	valve	Gate	C	2	LL	61.5	24	OVA 108	8	32	32	14	20	
93	valve	Gate	C	2	LL	61.5	24	TLV Sniffer	0	0	0	0	0	
93	valve	Gate	C	2	LL	61.5	24	HNu						
93	valve	Gate	C	2	LL	61.5	24	TVA 1000 (FID)	4	36	36	9	11	
93	valve	Gate	C	2	LL	61.5	24	TVA 1000 (PID)						
94	valve	Gate	C	4	LL	50.8	221	OVA 108	8	20	20	14	14	

API / WSPA Screening Study Data

Refinery M Sequence Number	Component Information					Ambient Conditions		Screening Data							Comments
	Component Type	Sub-category	Actuation	Size (in.)	Service	Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft / min)	Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)		
94	valve	Gate	C	4	LL	50.8	221	TLV Sniffer	0	0	0	0	0		
94	valve	Gate	C	4	LL	50.8	221	HNu							
94	valve	Gate	C	4	LL	50.8	221	TVA 1000 (FID)	8	30	30	12	12		
94	valve	Gate	C	4	LL	50.8	221	TVA 1000 (PID)							
95	valve	Gate	C	2	LL	49.6	353	OVA 108	9	100	100	30	30		
95	valve	Gate	C	2	LL	49.6	353	TLV Sniffer	0	75	75	0	0		
95	valve	Gate	C	2	LL	49.6	353	HNu							
95	valve	Gate	C	2	LL	49.6	353	TVA 1000 (FID)	7	200	200	15	15		
95	valve	Gate	C	2	LL	49.6	353	TVA 1000 (PID)							
96	con-non	Th	---	2	LL	56.3	35	OVA 108	8	80	80	15	18		
96	con-non	Th	---	2	LL	56.3	35	TLV Sniffer	0	20	20	0	0		
96	con-non	Th	---	2	LL	56.3	35	HNu							
96	con-non	Th	---	2	LL	56.3	35	TVA 1000 (FID)	6	30	60	10	12		
96	con-non	Th	---	2	LL	56.3	35	TVA 1000 (PID)							
97	con-non	Th	---	3/8	LL	55.2	47	OVA 108	7	65	65	40	50		
97	con-non	Th	---	3/8	LL	55.2	47	TLV Sniffer	0	30	30	22	22		
97	con-non	Th	---	3/8	LL	55.2	47	HNu							
97	con-non	Th	---	3/8	LL	55.2	47	TVA 1000 (FID)	6	100	100	80	80		
97	con-non	Th	---	3/8	LL	55.2	47	TVA 1000 (PID)							
98	valve	Gate	M	6	LL	54.4	3	OVA 108	8	60	60	14	25		
98	valve	Gate	M	6	LL	54.4	3	TLV Sniffer	0	50	50	0	0		
98	valve	Gate	M	6	LL	54.4	3	HNu							
98	valve	Gate	M	6	LL	54.4	3	TVA 1000 (FID)	7	50	100	22	22		
98	valve	Gate	M	6	LL	54.4	3	TVA 1000 (PID)							
99	valve	Gate	M	3	LL	55.5	100	OVA 108	8	40	50	14	20		
99	valve	Gate	M	3	LL	55.5	100	TLV Sniffer	0	6	6	0	0		
99	valve	Gate	M	3	LL	55.5	100	HNu							
99	valve	Gate	M	3	LL	55.5	100	TVA 1000 (FID)	6	60	60	14	14		
99	valve	Gate	M	3	LL	55.5	100	TVA 1000 (PID)							
100	valve	Gate	M	3	LL	55	3	OVA 108	7	90	140	60	90		
100	valve	Gate	M	3	LL	55	3	TLV Sniffer	0	30	30	15	15		
100	valve	Gate	M	3	LL	55	3	HNu							
100	valve	Gate	M	3	LL	55	3	TVA 1000 (FID)	8	40	70	40	70		
100	valve	Gate	M	3	LL	55	3	TVA 1000 (PID)							
100d	valve	Gate	M	3	LL	54.5	0	OVA 108	7	85	85	90	90		Duplicate
100d	valve	Gate	M	3	LL	54.5	0	TLV Sniffer	0	32	32	30	30		
100d	valve	Gate	M	3	LL	54.5	0	HNu							
100d	valve	Gate	M	3	LL	54.5	0	TVA 1000 (FID)	7	110	180	40	45		
100d	valve	Gate	M	3	LL	54.5	0	TVA 1000 (PID)							
101	valve	Gate	M	4	LL	54.9	16	OVA 108	7	30	40	30	30		
101	valve	Gate	M	4	LL	54.9	16	TLV Sniffer							

API / WSPA Screening Study Data

Refinery	Component Information					Ambient Conditions		Screening Data							
M Sequence Number	Component Type	Sub-category	Actuation	Size (in.)	Service	Ambient Temp. (Fahrenheit)	Ambient Windspeed (ft / min)	Instrument Type	Background Screening Value (ppm)	Maximum Sustainable Screening at Surface (ppm)	Peak Screening at Surface (ppm)	Maximum Sustainable Screening at 1 cm (ppm)	Peak Screening at 1 cm (ppm)	Comments
101	valve	Gate	M	4	LL	54.9	16	HNu						
101	valve	Gate	M	4	LL	54.9	16	TVA 1000 (FID)	14	40	48	30	40	
101	valve	Gate	M	4	LL	54.9	16	TVA 1000 (PID)						
102	valve	Gate	M	6	LL	56.5	93	OVA 108	8	25	30	30	30	
102	valve	Gate	M	6	LL	56.5	93	TLV Sniffer						Dead
102	valve	Gate	M	6	LL	56.5	93	HNu						
102	valve	Gate	M	6	LL	56.5	93	TVA 1000 (FID)	7	20	22	10	14	
102	valve	Gate	M	6	LL	56.5	93	TVA 1000 (PID)						

APPENDIX B

Statistical Analysis Details

B.1 Regression Analysis with Errors in Both X and Y

The fitting of a line to describe the relationship between two variables (X and Y) involves estimating a Y-intercept (β_0) and a slope (β_1). When both X and Y variables have measurement errors, measurement error methods (MEM), such as those described by Fuller (1987), can be used to determine the regression line. Whereas, in ordinary least squares (OLS) methods, one assumption is that there are no errors in X or that the errors in X are negligible when compared to the errors in Y, MEM techniques account for the errors in both the X and Y values. Thus, whereas, the OLS method chooses parameter estimates for β_0 and β_1 as those values which minimize the sum of squares of the vertical distances from the data points to the presumed regression line; MEM techniques involve minimizing the sum of the squares of the X values and Y values, for given estimates of the errors in X and Y.

The MEM technique detailed below is discussed by Fuller (1987) and Mandel (1964). All regression analyses performed for this study were done in log-space. Taking the natural logarithms of the screening values results in model errors that are normally distributed with constant variances. The use of natural logarithms (log base e), as opposed to common logarithms (log base 10), is the natural approach. If common logarithms are used, a correction factor of $\log_e(10)$ is needed at various points throughout the analysis; this needless complication is avoided by using natural logarithms.

Let

Y_i = Log_e (Screening value one for component i)

= $\text{Log}_e (y_i)$,

and

X_i = Log_e (Screening value two for component i).

= $\text{Log}_e (x_i)$

So that:

$$\text{Log}_e \text{ (Screening value one)} = \beta_0 + \beta_1 \text{ Log}_e \text{ (Screening value two)},$$

or

$$Y_i = \beta_0 + B_1 X_i$$

describes the regression line in log space.

In OLS regression analysis, the slope and intercept, β_0 and β_1, are determined to minimize the following:

$$S = \sum_{i=1}^{n} (Y_i - \hat{Y}_i)^2$$

where

$$\hat{Y}_i = \hat{\beta}_0 + \hat{\beta}_1 \hat{X}_i$$

The "hat" notation has been used to indicate the estimate of a given quantity; e.g., $\hat{a}$ is an estimate of a.

This approach produces biased estimates of β_0 and β_1 when there is an error in X as well as Y. In this case, the correct approach is to determine the estimates of β_0 and β_1 using MEM techniques that minimize the following:

$$S' = \sum_{i=1}^{n} \frac{(X_i - \hat{X}_i)^2}{\sigma_X^2} + \sum_{i=1}^{n} \frac{(Y_i - \hat{Y}_i)^2}{\sigma_Y^2}$$

The quantities $X_i - \hat{X}_i$ and $Y_i - \hat{Y}_i$ are estimates of the model errors in X_i and Y_i, respectively. The values σ_x^2 and σ_y^2 are the measurement errors in X and Y, respectively.

We define the variable λ as:

$$\lambda = \frac{\sigma_X^2}{\sigma_Y^2}$$

In the development here, λ is assumed known. (For the regression analyses performed λ was assumed equal to 1. Thus, the measurement errors in the X values were assumed equal to the measurement errors in the Y values. Duplicate screening value measurements were collected to test this assumption. Results of the analysis of the duplicate screening measurements are discussed in Section B.4 of this appendix).

Minimizing S' is equivalent to minimizing S'':

$$S'' = \sum_{i=1}^{n} [(X_i-\hat{X}_i)^2 + \lambda (Y_i-\hat{Y}_i)^2]$$

$$= \sum_{i=1}^{n} [(X_i-\hat{X}_i)^2 + \lambda (Y_i-(\hat{\beta}_o+\hat{\beta}_1\hat{X}_i))^2]$$

While the $\hat{X}_i$ values come into play in the optimization process, their values are not of primary interest here. Expressions for the estimates of the slope and intercept, which are of primary interest, are available in closed form.

Define

$$v = n \sum_{i=1}^{n} (X_i - \bar{X})^2$$

$$w = n \sum_{i=1}^{n} (Y_i - \bar{Y})^2$$

$$p = n \sum_{i=1}^{n} (X_i - \bar{X})(Y_i - \bar{Y})$$

where,

$$\bar{X} = \frac{\sum_{i=1}^{n} X_i}{n} \text{, and}$$

$$\bar{Y} = \frac{\sum_{i=1}^{n} Y_i}{n}$$

Then the estimates of the slope and intercept are as follows:

$$\hat{\beta}_1 = \frac{\lambda w - v + \sqrt{(v - \lambda w)^2 + 4\lambda p^2}}{2\lambda p}$$

$$\hat{\beta}_o = \bar{Y} - \hat{\beta}_1 \bar{X}$$

Finally, estimates of σ_X^2 and σ_Y^2 are given by the formulas:

$$\hat{\sigma}_x^2 = \frac{\lambda \sum d_i^2}{\left(1 + \lambda \hat{\beta}^2\right)(N - 2)}$$

$$\hat{\sigma}_y^2 = \frac{\sum d_i^2}{\left(1 + \lambda \hat{\beta}^2\right)(N - 2)}$$

Where,

$$\sum d_i^2 = \frac{w - 2\hat{\beta} p + \hat{\beta}^2 u}{N}$$

The estimates of σ_x^2 and σ_y^2 given above are needed to calculate the scale bias correction factor (SBCF) as discussed in Section B.2 of this appendix. The estimates of σ_x^2 and σ_y^2 are also used in the calculation of confidence intervals for the regression.

Confidence intervals were not calculated for this study; however, the methods for calculating confidence intervals for the MEM regression are described in Appendix D of the 1993 Refinery Study Report (Radian, 1993).

B.2 SCALE BIAS CORRECTION FACTOR

In order to predict the mean y value for a given x value (in linear space), one must first transform the results of the regression from log-log space back to arithmetic scales. To do this, a scale bias correction factor (SBCF) is required to obtain the following predictive equation:

$$\hat{y} = SBCF \times e^{(\hat{\beta}_0)} \times (x)^{\hat{\beta}_1}$$

or,

$$\hat{y} = SBCF \times e^{\hat{Y}}$$

The SBCF is needed to account for the fact that a nonlinear transformation is being performed on the means. A SBCF was developed specifically for this application. The derivation of this SBCF is described in Appendix D of 1993 Refinery Study report (Radian, 1993).

The SBCF is defined as follows:

$$SBCF = e^{(\hat{\sigma}_Y^2 - \hat{\beta}_1^2 \hat{\sigma}_X^2)/2}$$

B.3 CORRELATION COEFFICIENT

The sample correlation coefficient is a statistical measure of the linear relationship between two variables. The correlation between two variables, X and Y, is computed as:

$$r_{XY} = \frac{\Sigma\,(X_i - \bar{X})\cdot(Y_i - \bar{Y})}{\sqrt{\Sigma\,(X_i - \bar{X})^2\cdot\Sigma\,(Y_I - \bar{Y})^2}} \quad ,$$

and is bounded:

$$-1 \le r_{XY} \le 1 \quad .$$

The correlation coefficient squared (r_{XY}^2) can be interpreted as the fraction of the total variance of one variable that can be explained in terms of the other variable. In other words, r_{XY} measures how closely the two variables are related. If the total variation is all explained by the regression line, i.e., if $r_{XY}^2 = 1$ or $r_{XY} = \pm 1$, we say there is a perfect linear correlation. On the other hand, if there is no linear relationship between sample values of X and Y, then r_{XY} will have a value near zero. In addition, if $r_{XY} > 0$, then the response variable (Y) increases as the independent variable (X) does. If $r_{XY} < 0$, the response decreases as the independent variable increases.

B.4 ANALYSIS OF DUPLICATE SCREENING DATA TO ESTIMATE λ

Duplicate screening data were collected on twelve components. An evaluation of the duplicate data was performed to determine whether or not the assumption of $\lambda = 1$ (i.e., that the variability in the X value was equal to the variability in the Y value) was false. Ideally, it would be desirable to collect a very large number of replicate results, so that λ could be estimated with sufficient accuracy. However, this was not feasible within the confines of the current study. It was hypothesized, however, that the measurement variability for different types of screening value measurements would be comparable. In general, sufficient data were collected to test this hypothesis.

Attachment B.1 to this appendix shows the duplicate results that were collected for the twelve components, for each of the five instrument types. Given in Attachment B.1 is the sample id, the sample type (normal or duplicate), and the maximum sustainable screening values at the surface and at 1 cm. The duplicate analysis was only performed on the maximum sustainable screening values (instead of the peak screening values), since this is the type of screening value measurement specified in Method 21 and the type of measurement typically collected by refineries. The screening values given in Attachment B.1 have been adjusted for background (i.e., the background screening values have been subtracted from the component screening values). As shown in Attachment B.1 duplicate screening measurements were not always obtained for every type of screening value, for every instrument. Thus, for example, there were usually 12 or close to 12 duplicate pairs for the OVA and TLV instruments, but fewer for the HNu and TVA instruments.

Table B-1 shows the variability estimates for screening values obtained at the surface and at 1 cm for the maximum sustainable screening values. Given in Table B-1 is the instrument type, the number of duplicate pairs used to develop the variability estimate, the pooled standard deviation (in ppm), and the pooled coefficient of variation (in percent). The coefficient of variation (CV) is calculated as the standard deviation divided by the mean, and is pooled in the same way standard deviations are pooled. Whereas the standard deviation shows the *absolute* variability and is expected to increase as screening values increase, the CV is a measure of *relative* variability and is not expected to vary as much for different ranges of screening values.

As shown in Table B-1 the standard deviations appear to be fairly similar when comparing the standard deviation at the surface versus the standard deviation at 1 cm for a given component. If fact, it was speculated that if there were differences between the variability estimates, that the variability at 1 cm would be larger that the variability at the surface, since measurements obtained at 1 cm are more subject to ambient conditions (e.g., windspeed, temperature, etc.). However, this is not supported by the data shown in Table B-1.

Table B-1
Analysis of Screening Value Variability in Linear Space

Instrument Type	Variability Estimates for Screening Values Obtained at the Surface			Variability Estimates for Screening Values Obtained at 1 cm		
	Number of Duplicate Pairs	Standard Deviation (ppm)	Coefficient of Variation (%)	Number of Duplicate Pairs	Standard Deviation (ppm)	Coefficient of Variation (%)
OVA 108	11	9657.05	44.0	12	11132.27	69.3
TLV Sniffer	10	248.80	45.4	10	246.97	60.6
HNu	8	32.57	31.7	7	3.00	59.1
TVA 1000 FID	2	103.76	55.1	2	40.00	50.0
TVA 1000 PID	0	--a.	--a.	0	--a.	--a.

a. Insufficient data to evaluate variability.

Table B-1 also shows the standard deviations obtained for different instruments. As shown in the table, the standard deviations vary considerably for different instrument types, with the OVA instrument showing the largest standard deviations and the HNu instrument showing the smallest standard deviations. However, there were also higher screening values recorded for the OVA instrument, whereas no screening values greater than 5,000 ppm were recorded for the HNu instrument. The CV provides a more representative measure of how the variability within instruments differs from instrument to instrument in this case, since it is a measure of the relative variability. The CVs shown in Table B-1 do not vary considerable between instruments. The CVs vary from 31.7% to 55.1% for screening values obtained at the surface, and from 50.0% to 69.3% for screening values obtained at 1 cm.

Table B-2 shows the same types of variability estimates presented in Table B-1, except the analysis of the duplicate data was performed on the natural logarithms of the data. Statistical tests to test for the equivalence of variability estimates were only performed on the variability estimates presented in Table B-2. Since the correlation and regression analysis was performed on the logarithms of the data, it follows that the analysis of the variability results should be done in log-space. Furthermore, for this study, λ is the ratio of the variances of X and Y in log-space.

F-tests (Snedecor and Cochran, 1989) were performed to test whether there was a difference between the variances at the surface versus the variances at 1 cm, for each instrument type. The result of the F-tests are shown in the last two columns of Table B-2. There was only one instance (for the TLV instrument) where the F-test indicated a significant difference between the variances at the surface versus 1 cm. No statistically significant differences were indicated for the other instrument types tested ($\alpha = 0.05$).

Bartlett's test (Snedecor and Cochran, 1989) was used to test the equality of variances when more than two variances were being compared (i.e., when comparing variances across different instrument types). The result of Bartlett's test are shown in the last row

Table B-2
Analysis of Screening Value Variability in Log Space

Instrument Type	Variability Estimates for Screening Values Obtained at the Surface			Variability Estimates for Screening Values Obtained at 1 cm			Conclusions for the F-Test for Equal Variances	
	Number of Duplicate Pairs	Standard Deviation (ppm)	Coefficient of Variation (%)	Number of Duplicate Pairs	Standard Deviation (ppm)	Coefficient of Variation (%)	P-value	Variance at Surface Significantly Different From Variance at 1 cm?
OVA 108	11	0.52	5.9	12	0.88	18.6	0.0949	No
TLV Sniffer	9	1.13	29.9	8	0.53	21.0	0.0440	Yes
HNu	5	0.44	11.4	3	0.40	18.0	0.9184	No
TVA 1000 FID	2	0.61	14.7	2	0.55	13.0	0.8998	No
TVA 1000 PID	0	--a.	--a.	0	--a.	--a.	--a.	--a.
P-value & Conclusions for Bartlett's Test of Equal Variances	p-value = 0.0695 Conclusion: the measurement error variances are not significantly different for the different instrument types			p-value = 0.3986 Conclusion: the measurement error variances are not significantly different for the different instrument types			Conclusion: In general, the measurement error variances are not significantly different for the different screening distances	

a. Insufficient data to evaluate variability.

of the table. As shown in the table, the Bartlett's test results did not indicate that the measurement errors variances were significantly different for the different instrument types tested (α = 0.05).

In summary, there were six separate tests for equality of variances in all. If the unknown, true variances being tested were equal in a given test, there would be a 95% probability that the test would indicate that there was no significant difference. That is, there is a 5% chance of erroneously concluding that there was a difference because of random effects in the data.

When six tests are performed, the probability of occurrence of at least one false conclusion of inequality of variances is higher than 5%. If the six tests were independent, and if all sets of true variances tested were in fact equal, then the probability that there would be no false conclusions at all would be $0.95^6 = 0.735$. Thus, there would be more than one chance in four that at least one test would falsely indicate that the variances tested were unequal.

The six tests are not strictly independent, since each variance is used in two of the tests. Nevertheless, the point has been made, that one result out of six that is barely statistically significant at the 5% level does not strongly indicate that the assumption of equal variances should be abandoned.

In conclusion, the duplicate data evaluated did not suggest that there were significant differences between measurement errors across different instrument types, for measurements obtained at the surface or at 1 cm. Also, in general, for a given instrument, significant differences were not found between measurement errors for screening values obtained at the surface versus screening values obtained at 1 cm (the only exception was for the TLV instrument). Thus, the assumption that λ is equal to 1 when using the measurement error method to develop regression equations appears to be a reasonable assumption for this study.

REFERENCES

1. Fuller, Wayne A. Measurement Error Models, John Wiley & Sons, 1987.

2. Mandel, John, The Statistical Analysis of Experimental Data, Interscience Publishers, 1964.

3. Radian Corporation, 1993 Study of Refinery Fugitive Emission from Equipment Leaks. Prepared for Western State Petroleum Association. Glendale, CA. February 1994.

4. Snedecor, George W. and William G. Cochran. Statistical Method, Eighth Edition, Iowa State University Press, 1989.

Attachment B.1

Duplicate Screening Value Measurements

WSPA Screening Study
Duplicate Data

------------------------------ INSTR=OVA 108 ------------------------------

Refinery	Sample ID	Sample Type (N or D)	Type	Phase	Max.Sus. SV @ Surface	Peak SV @ Surface	Max.Sus. SV at 1 cm	Peak SV at 1 cm
M	20	N	valve	LL	24	24	10	16
M	20	D	valve	LL	21	21	6	12
M	40	N	valve	GAS	192	242	32	62
M	40	D	valve	GAS	114	114	6	19
M	60	N	valve	LL	440	590	190	290
M	60	D	valve	LL	390	440	110	150
M	80	N	con-non	LL	184	184	44	64
M	80	D	con-non	LL	144	144	29	34
M	100	N	valve	LL	83	133	53	83
M	100	D	valve	LL	78	78	83	83
L	125	N	valve	GAS	.	.	49980	49980
L	125	D	valve	GAS	.	.	89980	89980
L	140	N	valve	HL	1192	1192	1292	1592
L	140	D	valve	HL	1692	2392	1092	1092
L	144	N	valve	HL	992	992	992	992
L	144	D	valve	HL	1042	1042	92	142
L	147	N	valve	HL	3492	4992	2392	2992
L	147	D	valve	HL	2193	2193	293	293
L	153	N	valve	GAS	8992	9992	9992	9992
L	153	D	valve	GAS	39993	39993	44993	44993
L	159	N	valve	GAS	6993	6993	3993	3993
L	159	D	valve	GAS	39988	39988	15988	19988
L	164	N	con-non	GAS	1180	1180	480	680
L	164	D	con-non	GAS	1093	1093	693	693

N = 24

WSPA Screening Study
Duplicate Data

------------------------------ INSTR=TLV Sniffer ------------------------------

Refinery	Sample ID	Sample Type (N or D)	Type	Phase	Max.Sus. SV @ Surface	Peak SV @ Surface	Max.Sus. SV at 1 cm	Peak SV at 1 cm
M	20	N	valve	LL	.	.	.	.
M	20	D	valve	LL	.	.	.	.
M	40	N	valve	GAS	0	0	0	0
M	40	D	valve	GAS	0	0	0	0
M	60	N	valve	LL	100	100	30	30
M	60	D	valve	LL	100	100	16	16
M	80	N	con-non	LL	92	92	45	45
M	80	D	con-non	LL	108	108	33	33
M	100	N	valve	LL	30	30	15	15
M	100	D	valve	LL	32	32	30	30
L	125	N	valve	GAS	.	.	.	.
L	125	D	valve	GAS	.	.	.	.
L	140	N	valve	HL	992	992	792	792
L	140	D	valve	HL	992	992	772	772
L	144	N	valve	HL	642	642	372	372
L	144	D	valve	HL	538	538	338	338
L	147	N	valve	HL	480	480	23	23
L	147	D	valve	HL	4	4	4	4
L	153	N	valve	GAS	3430	3430	3130	3130
L	153	D	valve	GAS	4030	4030	3130	3130
L	159	N	valve	GAS	2000	2000	1100	1100
L	159	D	valve	GAS	2800	2800	2200	2200
L	164	N	con-non	GAS	80	80	0	0
L	164	D	con-non	GAS	100	100	86	86

N = 24

WSPA Screening Study
Duplicate Data

INSTR=HNu

Refinery	Sample ID	Sample Type (N or D)	Type	Phase	Max.Sus. SV @ Surface	Peak SV @ Surface	Max.Sus. SV at 1 cm	Peak SV at 1 cm
M	20	N	valve	LL	11	16	1	2
M	20	D	valve	LL	16	16	0	2
M	40	N	valve	GAS	180	180	20	40
M	40	D	valve	GAS	50	70	10	10
M	60	N	valve	LL	.	.	.	.
M	60	D	valve	LL	.	.	.	.
M	80	N	con-non	LL	.	.	.	.
M	80	D	con-non	LL	.	.	.	.
M	100	N	valve	LL	.	.	.	.
M	100	D	valve	LL	.	.	.	.
L	125	N	valve	GAS	45	.	.	.
L	125	D	valve	GAS	48	48	43	43
L	140	N	valve	HL	15	15	10	10
L	140	D	valve	HL	10	10	5	5
L	144	N	valve	HL	16	16	3	3
L	144	D	valve	HL	19	19	3	3
L	147	N	valve	HL	0	0	0	0
L	147	D	valve	HL	0	0	0	0
L	153	N	valve	GAS	19	19	19	19
L	153	D	valve	GAS	.	.	.	.
L	159	N	valve	GAS	0	0	0	0
L	159	D	valve	GAS	0	0	0	0
L	164	N	con-non	GAS	0	0	0	0
L	164	D	con-non	GAS	0	0	0	0

N = 24

WSPA Screening Study
Duplicate Data

------------------------- INSTR=TVA 1000 (FID) -------------------------

Refinery	Sample ID	Sample Type (N or D)	Type	Phase	Max.Sus. SV @ Surface	Peak SV @ Surface	Max.Sus. SV at 1 cm	Peak SV at 1 cm
M	20	N	valve	LL	.	.	.	.
M	20	D	valve	LL	.	.	.	.
M	40	N	valve	GAS	.	.	.	.
M	40	D	valve	GAS	.	.	.	.
M	60	N	valve	LL	.	.	.	.
M	60	D	valve	LL	.	.	.	.
M	80	N	con-non	LL	690	700	40	100
M	80	D	con-non	LL	495	595	120	125
M	100	N	valve	LL	32	62	32	62
M	100	D	valve	LL	103	173	33	38
L	125	N	valve	GAS	.	179848	.	98654
L	125	D	valve	GAS	.	132978	.	136248
L	140	N	valve	HL	.	1688	.	1751
L	140	D	valve	HL	.	3627	.	3860
L	144	N	valve	HL	.	2395	.	222
L	144	D	valve	HL	.	519	.	3330
L	147	N	valve	HL	.	5981	.	12
L	147	D	valve	HL	.	3636	.	51
L	153	N	valve	GAS	.	29096	.	12996
L	153	D	valve	GAS	.	18296	.	18296
L	159	N	valve	GAS	.	17093	.	7339
L	159	D	valve	GAS	.	56083	.	20352
L	164	N	con-non	GAS	.	331	.	167
L	164	D	con-non	GAS	.	709	.	225

N = 24

WSPA Screening Study
Duplicate Data

--------------------------- INSTR=TVA 1000 (PID) ---------------------------

Refinery	Sample ID	Sample Type (N or D)	Type	Phase	Max.Sus. SV @ Surface	Peak SV @ Surface	Max.Sus. SV at 1 cm	Peak SV at 1 cm
M	20	N	valve	LL	.	.	.	.
M	20	D	valve	LL	.	.	.	.
M	40	N	valve	GAS	.	.	.	.
M	40	D	valve	GAS	.	.	.	.
M	60	N	valve	LL	.	.	.	.
M	60	D	valve	LL	.	.	.	.
M	80	N	con-non	LL	.	.	.	.
M	80	D	con-non	LL	.	.	.	.
M	100	N	valve	LL	.	.	.	.
M	100	D	valve	LL	.	.	.	.
L	125	N	valve	GAS	.	128	.	120
L	125	D	valve	GAS	.	115	.	105
L	140	N	valve	HL	.	14	.	14
L	140	D	valve	HL	.	21	.	23
L	144	N	valve	HL	.	16	.	3
L	144	D	valve	HL	.	9	.	24
L	147	N	valve	HL	.	25	.	0
L	147	D	valve	HL	.	20	.	0
L	153	N	valve	GAS	.	39	.	34
L	153	D	valve	GAS	.	43	.	42
L	159	N	valve	GAS	.	1	.	1
L	159	D	valve	GAS	.	2	.	6
L	164	N	con-non	GAS	.	1	.	1
L	164	D	con-non	GAS	.	1	.	1

N = 24

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