Frequency And Extent Of Dispenser Releases At Underground Storage Tank Facilities In South Carolina

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Introduction

In this document, EPA presents the results of information collected and analyzed from underground storage tank (UST) closure and assessment reports at sites in South Carolina. The report discusses the background, purpose, methodology used, quality assurance and quality control procedures applied, results of the study, and conclusions. Supporting information is in the appendices.

Background

In 1984, Congress responded to the increasing threat to groundwater posed by leaking underground storage tanks by adding Subtitle I to the Resource Conservation and Recovery Act (RCRA). This legislation required the U.S. Environmental Protection Agency (EPA) develop a comprehensive regulatory program for USTs storing petroleum or certain hazardous substances in order to protect the environment and human health from releases. EPA's Office of Underground Storage Tanks (OUST) developed regulations for owners and operators of UST systems covering leak detection, addressing release prevention, and minimizing the potential for USTs to corrode. (The regulations also cover additional requirements, such as financial responsibility and corrective action, not discussed in this report.) The regulatory requirements were phased in over ten years; the final deadline was December 1998.

Federal and state regulations helped EPA achieve its mandate. As a result of these regulatory changes, USTs are now significantly more protective of human health and the environment than those installed before the requirements were implemented. Despite these improvements, however, releases from new and upgraded UST systems continue. To respond to this, OUST initiated an effort to evaluate the performance of UST systems. The specific objectives of the effort are:

- Identify the most common sources and causes of releases.
- Determine how successful leak detection methods are at detecting releases.
- Determine what, if any improvements are needed in the UST program.

EPA has identified releases from UST dispensing systems as a potential concern for the national UST program and state UST regulatory agencies. EPA has gathered anecdotal evidence from representatives of regulatory agencies; the regulated community; UST equipment sales, repair, maintenance, and consulting companies; and UST remediation firms which repeatedly cited fuel dispensers as a source of contamination at UST sites.

Current federal UST leak prevention and leak detection regulations do not address dispensers. In addition, the federal regulations do not explicitly require assessment under dispensers at the time of UST system closure. The requirements for assessment at closure are established in 40 CFR Part 280, Subpart G (280.70-280.74, Out-of-Service UST Systems and Closure). This subpart specifies that assessment is required for the places where contamination is most likely present at an UST site.[1] Initially, the most likely sites of release were usually considered to be under the tank or along the piping system.

Some states now specify requirements for sampling under UST dispenser systems because of this evidence of dispenser releases. For example, Florida now requires sampling near dispensers during site investigations and under dispenser containment (UDC) to contain releases that do occur. Industry has also recognized the potential for dispenser releases and, as a result, installing under dispenser containment is becoming increasingly common for new installations.

South Carolina's Department of Health and Environmental Control (DHEC) first began requiring dispenser sampling at the time of UST system closure[2] in 1990. Additionally, South Carolina determined sampling under a dispenser may also be required if contamination is observed during a compliance inspection.[3] The requirement to sample near or under a dispenser is specified in DHEC's 2000 guidance document *Underground Storage Tank Assessment Guidelines for Permanent Closure and Change-In-Service*. This current guidance specifies:

> All dispenser islands should be sampled. If the dispenser island is located above or immediately adjacent (less than five feet) to the UST, the sample for the island can be incorporated into the sample for that UST. Otherwise, dispenser islands should be individually sampled. Samples should be collected approximately two feet below the bottom of the associated piping. [4]

EPA determined that South Carolina's history of sampling under dispensers provided an excellent source of data for examining the frequency of under dispenser contamination. In order to better evaluate the frequency and severity of releases under dispensers, EPA partnered with DHEC, which has a fairly robust set of data on petroleum contamination found during UST system inspections and closures, including contamination under dispensers.

As mentioned above, it has become common practice in recent years to install UDC (e.g. dispenser pans/sumps) at the time an UST system is installed. Previously, dispenser pans were very rarely installed at the time of installation, so most older dispensers do not have UDC. Because the facilities covered in this study were all closed by 1999, EPA assumed that all of these systems were installed before it was common practice to install dispenser pans. Therefore, the results of this study are assumed to reflect systems without UDC, although a good portion of the current UST population does have UDC, particularly new facilities.

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[1] 40 CFR Part 280 *Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (USTs)*, Subpart G 280.70-280.74, Out-of-Service UST Systems and Closure. U. S. Environmental Protection Agency.

[2] *Procedures for Abandonment of Underground Storage Tanks*. July 25, 1990. Underground Storage Tank Program, South Carolina Department of Health and Environmental Control, Columbia, South Carolina.

[3] Communication with Mark K. Berenbrok. April 2002. Underground Storage Tank Program, South Carolina Department of Health and Environmental Control.

[4] *Underground Storage Tank Assessment Guidelines for Permanent Closure and Change-In-Service*. August 2000. Underground Storage Tank Program, South Carolina Department of Health and Environmental Control, Columbia, South Carolina. The term dispenser island is used to refer to the raised (usually approximately 6 inches high) concrete platform on which one or more fuel dispensers are installed. Dispenser islands are normally 2 to 4 feet wide and may be any length.

Purpose Of This Study

The purpose of this study is to gather and analyze dispenser sampling data[5] from South Carolina DHEC underground storage tank assessment and closure files to determine whether the data showed any patterns of dispenser releases and to identify the likelihood that releases from dispensers will contaminate subsurface media (soil and groundwater). These data provide information about the frequency and impact of releases under dispensers.

Methodology

This report reflects the results of two separate study phases during which data about petroleum releases from dispensers associated with USTs was collected and analyzed. The data came primarily from closure reports, 95 percent of which were received by DHEC between 1996 through 1999.[6] South Carolina's regulations require a closure report for the permanent closure or change in service of an UST system. The closure report must address all components of the tank system, including tanks, piping, and dispensers. The sites with closure reports on file did not necessarily have a confirmed release. Excluding observations made by DHEC personnel, a release is confirmed when analytical results indicate petroleum constituents are present in excess of detection limits. Sampling under dispensers was part of site investigations to determine whether any soil or groundwater contamination existed at the UST facility as a result of a release from the UST system. These files are maintained by DHEC's Underground Storage Tank Program. The first data collection phase was conducted by DHEC in January 2002 to pilot the data collection techniques and forms. EPA, with contractor assistance, conducted the second data collection phase in February and March 2002. Below are more details about the data collection effort. See page 8 for descriptions of the results.

Data Collection

DHEC performed the first phase of data collection in January 2002 to test the effectiveness of the data collection form, identify unanticipated issues or problems, and gauge the level of effort required to review the files. The first phase encompassed review of a set of closure and assessment reports collected in March and April 1996. The reports included: closure and assessment files which described sites with no contamination; contaminated sites that had not been actively remediated but were determined to require no further action (NFA); sites with confirmed releases that had been rehabilitated and determined to require NFA; and confirmed releases that are still being remediated.

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[5] In this study, the terms dispenser sampling data and dispenser data are used to refer collectively to measured concentrations of common petroleum components, such as benzene, in samples collected under a dispenser.

[6] In a few cases, assessment reports were the source of the site data. An assessment report can be a voluntary submittal prepared as a result of a pending property sale or loan application, or may be requested if an inspector observes site conditions that indicate a release may have occurred.

Data Screening

The first step in collecting the data was to determine whether an UST site report was valid or invalid for purposes of this study. File information reviewed during the first phase was determined to be invalid (i.e., not useful for the purposes of this study) for any of the following reasons:

- No dispenser samples taken/analysis performed.
- UST was within five feet of dispenser(s) with sampling/analysis data.
- Contaminant levels were unknown.
- No dispensers were present (e.g., UST used to store emergency generator fuel, motor oil, or waste oil).

During the second data collection phase, the following additional criteria were also applied to identify information that was considered invalid (for purposes of this study):

- Contamination levels of all chemicals were non-detect, but detection limits for one or more samples were greater than state Risk Based Screening Levels (RBSLs).
- File was incomplete and the reviewer could not determine whether samples were collected under the dispenser and/or whether contamination was present.
- Tank to dispenser distance was unknown.
- Sample locations were unclear.
- Location of dispensers was unknown.

Sites that only contained emergency generator fuel, motor oil, or waste oil were considered invalid in the data screening for both phases. For the most part, such sites were excluded from detailed review because dispensers are generally not used with tanks storing these substances. If a dispenser was within five feet of an UST at a facility, but samples were collected at other dispensers located more than five feet from an UST (and otherwise meeting the above criteria), then the whole facility was considered valid. In such cases, dispensers with valid data were included in the population of data collected.

Data Recording

During the first phase of data collection and as each report was reviewed, the reviewer completed a data form and recorded selected information about the facility and the release (see Appendix 1 on page 13 for a copy of the blank form). During the second phase, data from closure reports were entered directly into an electronic form created in an Access database. Data were entered at DHEC offices in Columbia, South Carolina.

More information was gathered about each report during the second phase of data collection (see Appendix 2 on page 14) compared to the first data collection. Descriptions of the data elements collected during both phases are provided below. Data elements that were only included in the second phase are identified in the descriptions that follow.

- **Facility ID** – Unique site identification number assigned by DHEC.

- **Date Closed** – Date the UST(s) on site were closed and/or removed.

- **Number of Dispensers** – Total number of dispensers at the site.

- **Invalid File** – Box checked if report was invalid, followed by reason(s) why it was invalid.

- **Information on samples taken at the dispenser:**

  - **Dispenser Island ID** – If more than one sample was taken on one island, the sample was labeled as "1a", "1b," "2a," "2b," etc. If one sample was taken at each island, the sample number correlated to the numbers of islands (e.g., sample from island #1 would be "1," sample from island #2 would be "2," etc.).
  - **Piping Type** – Second phase only. One of three types of piping product delivery methods: suction (S), pressurized (P), or unknown (U); additional details about piping are addressed in the "Note on Piping Delivery Types" section below.
  - **Contamination** – If contamination was present, data recorded as "Yes"; specific contamination levels addressed below.
  - **Above State RBSLs (Risk Based Screening Levels)** – Entered as "Yes" or "No" in accordance with contamination levels compared to South Carolina RBSLs.[7]
  - **Benzene**, **Ethylbenzene**, **Toluene**, **Xylenes (total), and Naphthalene Contamination Levels** – If above detectable limits, recorded in ppm (mg/kg); if non-detect, recorded as less than detection limit or non-detect, as appropriate.

- **Contaminants above RBSLs for the dispenser only** – Second phase only. If contamination was present at levels above RBSLs at the dispenser only (and nowhere else at the site), this box was checked. Then EPA obtained a summary report from DHEC's corrective action database and recorded the following information:

  - **Contaminant Medium** – Select whether the contamination reached soil or groundwater, both, or unknown.
  - **South Carolina RBCA Classification** – If the site was classified, enter the South Carolina Risk Based Corrective Action Classification (SCRBCA) level (see Appendix 3 on page 15 for details about the SCRBCA classification levels).
  - **Receptor type** – Multiple choices, including public well, creek, property boundary, etc.

South Carolina's risk-based approach to prioritizing cleanups uses RBSLs established for two types of soils – sand and clay. In order to determine whether contamination under a dispenser exceeded South Carolina RBSLs for each of the contaminants examined in this study, the soil type present at the site had to be identified. If the soil type was not provided in the report

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[7] *South Carolina Risk-Based Corrective Action for Petroleum Releases*, May 15, 2001. Risk-based screening levels for groundwater, soil, and air are listed in Appendix B.

and the contamination level reported fell between two South Carolina RBSLs, then EPA determined the soil type from a map indicating the approximate location of the geologic fall line.[8] Sites to the northwest of the fall line were classified as clays and sites to the southeast were considered to be sands for the purpose of determining whether the dispenser sample concentration was above or below the RBSL for each contaminant.

Collection of information from DHEC's corrective action database was added as part of the second phase data collection effort to allow additional comparisons of the characteristics of the facilities with dispenser releases that may require corrective action with a statewide summary of facility releases available from the corrective action database. DHEC provided the statewide summary discussed in the results section on page 8.

If a report was determined to be invalid, the "Site ID," "Date Closed," "Invalid File," and the appropriate "Reason File Invalid" boxes were the only fields completed on the form. Valid files included sites with at least one soil or groundwater sample (and analytical data) taken at a dispenser. The analytical results are likely to be representative of contamination, or lack of contamination, that can reasonably be attributed to the operation of the dispenser itself and not attributed to a release from other portions of the UST system.

Note On Dispenser Islands

An UST facility may have one or more dispenser islands and each dispenser island may have one or more dispensers. DHEC regulations require that the facility closure process include collection of at least one soil sample at each dispenser island. However, sampling at each dispenser is not required. Results from samples collected for more than one dispenser on a dispenser island may be submitted voluntarily. If the dispenser island is located above or immediately adjacent to (less than five feet from) the UST, then DHEC allows a single sample to meet both a dispenser island and UST sampling requirement. DHEC requires that samples be collected approximately two feet below the bottom of the piping of the dispenser chosen for sampling and that the dispenser with the highest anticipated level of contamination be sampled.

Note On Contaminant Data

Information from the assessment and closure reports for soil contamination levels of benzene, ethylbenzene, toluene, xylene, and naphthalene were recorded in milligrams per kilogram (mg/kg) (parts per million [ppm]) for samples taken at the dispenser(s). If the various species of xylene were reported separately (i.e., xylene [m, o, and p]), then the total of those results was recorded as a single value in the database (i.e., concentration of m-xylene + concentration of o-xylene + concentration of p-xylene). In the case of other contaminants when two analytical results were provided, the higher concentration was always used. If no contamination was present (reported as a "non-detect"), then the result was recorded as less than the reported laboratory detection limit for each contaminant (e.g., "<0.0005 ppm"). If both results for a contaminant were non-detect and the detection limits varied, then the higher detection limit was reported.

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[8] The boundary zone between older, resistant rocks and younger Coastal Plain sediments.

As noted above at sites with detected contamination, EPA used the available data to determine whether the contamination levels were above or below RBSLs. The data available in the closure reports are based on the results of standard laboratory analyses for the detection and quantification of common petroleum constituents. The accuracy (i.e., the closeness of the measured value to the true value) of the laboratory analysis data depends on a wide range of factors including the contaminant measured, the concentration level, the type of sample (e.g., soil, water), the analytical method, and the equipment used. EPA's "Test Methods for Evaluating Solid Wastes" (SW-846) reports single-laboratory accuracy for Method 5035 (appropriate for the contaminants included in this study) applied to soil samples that approach +/- 20 percent. Use of multiple laboratories (as is the case here) introduces further variation in the measured results. To evaluate the potential effects of these accuracy limitations on the results of this study, EPA identified the situations where the characterization of a data point as being "above" or "below" the RBSL was based on a reported concentration that is within 30 percent of the RBSL. EPA found this occurred between 5 and 10 percent of the time. The percentage of measurements characterized as "above RBSLs" that might actually be below RBSLs (assuming a +/- 30 percent margin of error) is similar to the percentage characterized as "below RBSLs" that actually might be above RBSLs. Therefore, the effect of this inherent analytical uncertainty on conclusions drawn from the data is thought to be small.

There has been increasing concern about contamination of groundwater sources from the gasoline additive methyl tertiary butyl ether (MTBE). Data on MTBE were not available for this study because DHEC did not require analysis of MTBE in soil samples from UST sites. (Since 1995, DHEC has required groundwater encountered during tank closure or assessment activities to be sampled for MTBE.) However, the results of this analysis may be useful in trying to control the release of MTBE – and other constituents found in gasoline – into groundwater.

Note On Piping Product Delivery Types

EPA collected data on the types of pumps used to deliver product through the piping at the sites selected for inclusion in the database. The term "Piping Type" was used on the form in the second phase of data gathering to indicate the type of pump used to deliver product from the tank to the dispenser. The piping type (pump) information was collected to determine whether the presence of the pump in dispensers using suction systems would increase or decrease the likelihood of a release. For those sites at which the pump type was clearly identified, EPA recorded the pump type under piping type on the form. For those sites with multiple tanks and different types of pumps, and where reviewers could not determine which type of pump applied to the dispenser island sampled, the piping type on the form was marked as unknown. The pump type generally was indicated as unknown for the assessment and closure reports reviewed during the first phase of the data collection effort because information on pump type was not collected during that phase. For sites reviewed in the first phase that appeared to have dispenser contamination, information on pump type was collected during the second phase.

Quality Assurance/Quality Control

The following Quality Assurance (QA) strategy was used during the second phase data collection effort, which last two weeks. As part of this strategy, Quality Control (QC) procedures were developed to ensure the quality of the information gathered. While on site, EPA gathered data from DHEC's existing files and recorded the information in an Access database.

Because two individuals entered data from DHEC files into the database, each individual performed a QC check of the data entered by the other. During the first week of data collection, each individual checked every fifth file entered into the database by the other individual, for a review of 20 percent of the data entries. Every field was checked for accuracy on every file reviewed. During the second week of data collection, EPA assessed this procedure and determined it to be more extensive than needed because of the experience of the data collectors and because few errors were detected during the first week. EPA decided that from then on, every tenth file would be checked, for a review of 10 percent of the data entries. This change was implemented for the second week of the two-week data collection effort. Overall, 15.5 percent of the data entries were reviewed for QC (see Table 1).

Table 1 - Summary Of Quality Control Data

Total number of files reviewed	1,218
Number of files double-checked for QC	189
Percentage of files double-checked for QC	15.5
Percentage of files double-checked with errors	3

Double-checking of the files was performed at the end of each workday or the beginning of the next. Each data collector kept a separate list of the files she double-checked throughout the data collection period.

To verify the information recorded in the database was correct, the individual who had not originally entered the data examined each file selected for QC review in detail. Where necessary, the South Carolina corrective action database was consulted. If a discrepancy or error was discovered, this was noted and discussed that day with the other data collector. All discrepancies or errors were resolved and any necessary changes were made in the database. Overall, approximately 3 percent of the files reviewed were revised in the database as a result of this review process.

While no QA/QC strategy was used during the first phase of the study, 12 of the 77 files were reviewed again during the second phase to determine if any files contained samples with contamination above RBSLs at the dispenser only.

EPA provided copies of the draft report to EPA regional offices, states, and industry experts for peer review. The reviewers identified issues and provided recommendations about the report. EPA evaluated the comments and incorporated many of the recommendations into this final version of the report.

Results

For both phases of this study, a combined total of 1,218 files were reviewed, each representing an individual closure action (or in a few cases a voluntary site assessment). DHEC reviewed 77 files in the first phase, of which 54 were invalid; EPA reviewed 1,141 files in the second phase, of which 794 were invalid. The files reviewed are assumed to be generally representative of closure actions undertaken in South Carolina during the period of interest. Of the 1,218 files reviewed, 370 (30.4 percent) provided at least one "valid" (for purposes of this study) sampling result. Of the 848 files without a valid sampling result, 269 (32 percent) were invalid because they lacked dispenser sampling data and 515 (61 percent) were invalid because dispenser(s) with sampling/analysis data were within five feet of an UST. The other 64 files were invalid because they did not have dispensers (17); had all contaminants reported non-detect but with detection limits above RBSLs for one or more contaminants (16); or were incomplete in some way (31) (e.g., sample locations unclear, tank to dispenser distance unknown). Data for the 370 facilities with at least one valid sample are summarized in Appendix 4 on page 17 and discussed below.

The 370 facilities with valid data had a total of 454 dispenser islands with valid data. As shown in Table 2, contamination was found under dispensers at nearly half of all facilities and dispenser islands with valid data and dispenser contamination that exceeded RBSLs was found at just over 25 percent of all facilities and dispenser islands. The distribution of these data by pump type is provided in the tables that follow. Of the 454 dispenser islands with valid data, 56 had data for more than one soil sample. The data for 40 (71 percent) of these 56 dispenser islands indicate that contaminant levels in the multiple samples fall in the same contaminant grouping (i.e., not detected, at least one contaminant detected, or at least one contaminant above RBSL). Of the 40 dispenser islands with contaminant levels in multiple samples in the same contaminant grouping, 27 had no detectable contamination in all samples. For 13 of the remaining 16 dispenser islands from the group of 56 with data for more than one soil sample, at least one sample had a detected contaminant while one or more samples had no detected contaminants.

Table 2 - Summary Of Contamination At Dispenser Islands And Facilities

	Total Number (#)	With At Least One Contaminant Detected		With At Least One Contaminant Above RBSL	
		#	% (95% Confidence Limits)	#	% (95% Confidence Limits)
Dispenser Islands	454	215	47.4 (42.8 - 51.9)	116	25.6 (21.5 - 29.6)
Facilities	370	179	48.4 (43.3 - 53.5)	98	26.5 (22.0 - 31.0)

Figures 1 and 2 visually depict the number of dispenser islands and facilities, respectively, where contamination was discovered, and the number of times the contamination exceeded RBSLs.

Figure 1 - Contamination At 454 Dispenser Islands

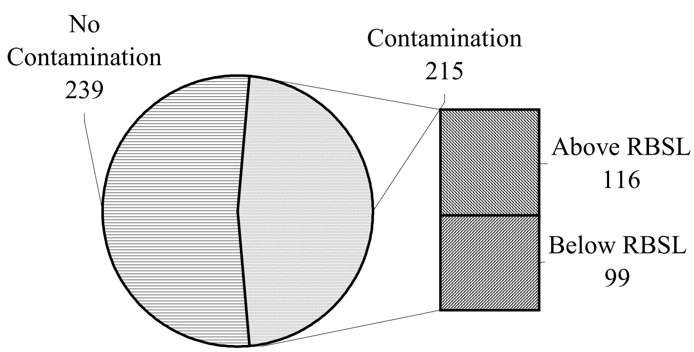

Figure 2 - Contamination At 370 Facilities

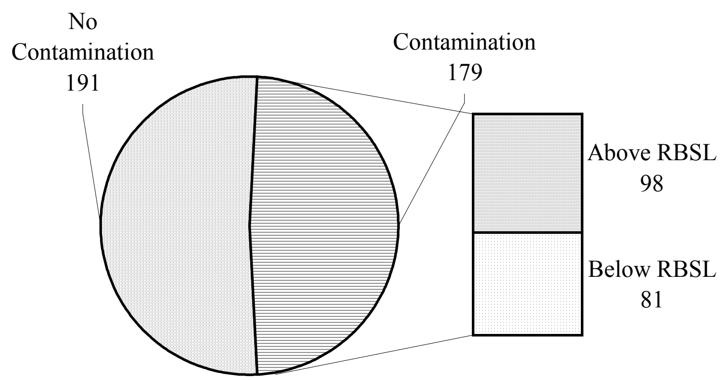

Table 3 shows the distribution of the numbers of sampled facilities, dispenser islands, and individual samples by pump type.

Table 3 - Numbers Of Sampled Facilities, Dispenser Islands, And Samples By Pump Type

Pump Type	Facilities	Dispenser Islands	Samples
All	370	454	534
Pressure	135	183	211
Suction	198	218	261
Unknown	37	53	62

Table 4 shows the frequency of detected contamination and contamination above RBSLs for the 454 dispenser islands. The top portion of Table 4 shows the number of dispenser islands with no detected contamination, at least one contaminant detected, and at least one contaminant above the RBSL. The bottom portion shows the binomial confidence limits for these proportions. As shown, the proportions of pressure and suction piping systems with and without detected contamination appear similar. This is generally confirmed by the results of three statistical significance tests – Pearson's Chi-Squared, Fisher's Exact Test, and a parametric test based on the standard error of the differences in proportions. The results of these tests, which are presented in Appendix 5 on page 25 along with results of other supporting statistical analysis, indicate that the small differences in proportions are not significant, with the exception of dispenser islands without contamination, where the difference between pressure and suction piping systems is marginally significant (p values approach 0.05).

Table 4 - Frequency Of Contamination And Contamination Above RBSLs At Dispenser Islands

Number Of Islands				
Pump Type	With Valid Data	With No Detected Contamination	With At Least One Contaminant Detected	With At Least One Contaminant Above RBSL
All	454	239	215	116
Pressure	183	84	99	49
Suction	218	118	100	59
Unknown	53	37	16	8
Proportion Of Islands, Percent (95% Confidence Limits)				
Pump Type	Percent With Valid Data	Percent With No Detected Contamination	Percent With At Least One Contaminant Detected	Percent With At Least One Contaminant Above RBSL
All	100.0	52.6 (48.0 - 57.2)	47.4 (42.8 - 51.9)	25.6 (21.5 - 29.6)
Pressure	40.3	45.9 (38.7 - 53.1)	54.1 (46.9 - 61.3)	26.8 (20.4 - 33.2)
Suction	48.0	54.1 (47.5 - 60.7)	45.9 (39.3 - 52.5)	27.1 (21.2 - 33.0)
Unknown	11.7	69.8 (57.4 - 82.1)	30.2 (17.8 - 42.5)	15.1 (5.4 - 24.7)

Figures 3 and 4 visually depict the number of dispenser islands with pressure and suction piping systems, respectively, where contamination was discovered under the dispenser, and the number of times the contamination exceeded RBSLs.

Figure 3 - Contamination For Pressure Piping Systems - Dispenser Islands

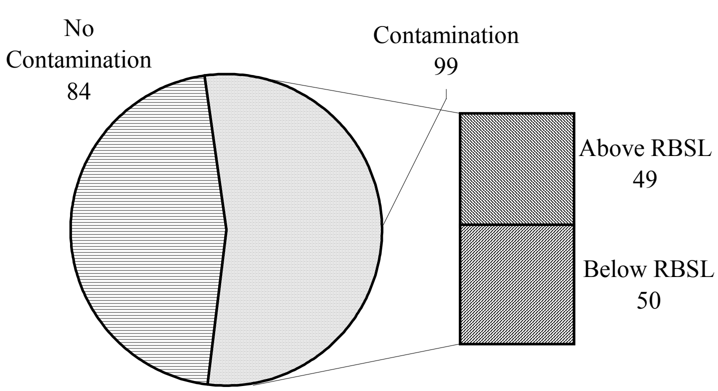

Figure 4 - Contamination For Suction Piping Systems - Dispenser Islands

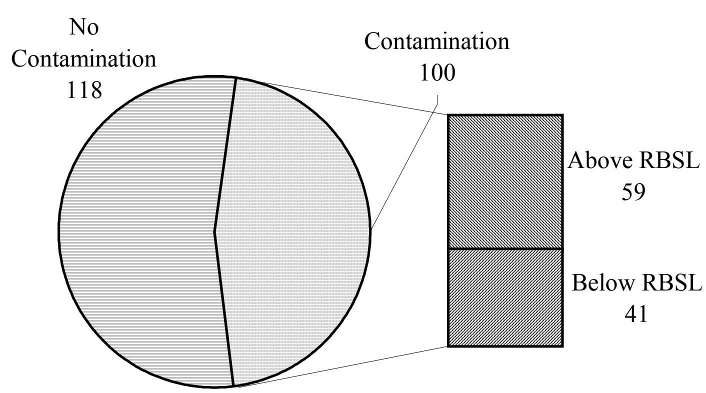

Table 5 is organized identically to Table 4, but shows the frequency of detected contamination and contamination above RBSLs for the 370 facilities. The results of the three statistical significance tests, which are presented in Appendix 5 on page 25 along with results of other supporting statistical analysis, indicate that the small differences in proportions are not significant.

Table 5 - Frequency Of Contamination And Contamination Above RBSLs At Facilities

Numbers Of Facilities				
Pump Type	With Valid Data	With No Detected Contamination	With At Least One Contaminant Detected	With At Least One Contaminant Above RBSL
All	370	191	179	98
Pressure	135	65	70	34
Suction	198	103	95	57
Unknown	37	23	14	7
Proportions Of Facilities, Percent (95% Confidence Limits)				
Pump Type	Percent With Valid Data	Percent With No Detected Contamination	Percent With At Least One Contaminant Detected	Percent With At Least One Contaminant Above RBSL
All	100.0	51.6 (46.5 - 56.7)	48.4 (43.3 - 53.5)	26.5 (22.0 -31.0)
Pressure	36.5	48.1 (39.6 - 56.2)	51.9 (43.4 – 60.3)	25.2 (17.9 - 32.5)
Suction	53.5	52.0 (45.0 - 58.9)	48.0 (41.0 - 54.3)	28.8 (22.5 - 35.1)
Unknown	10.0	62.2 (46.6 - 77.8)	37.8 (22.2 - 53.5)	18.9 (6.2 - 31.5)

Figures 5 and 6 visually depict the number of facilities with pressure and suction piping systems, respectively, where contamination was discovered under the dispenser, and the number of times the contamination exceeded RBSLs.

Figure 5 - Contamination For Pressure Piping Systems - Facilities

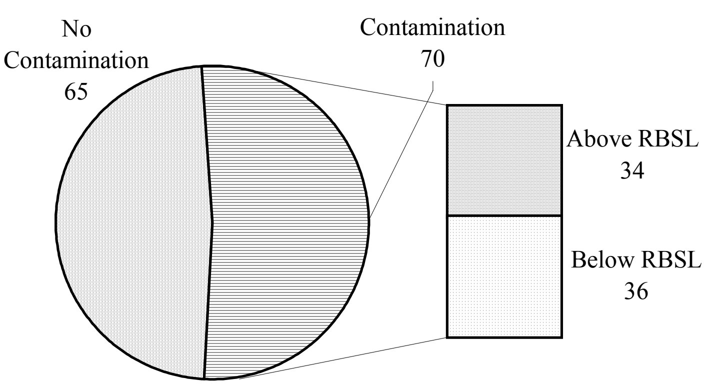

Figure 6 - Contamination For Suction Piping Systems - Facilities

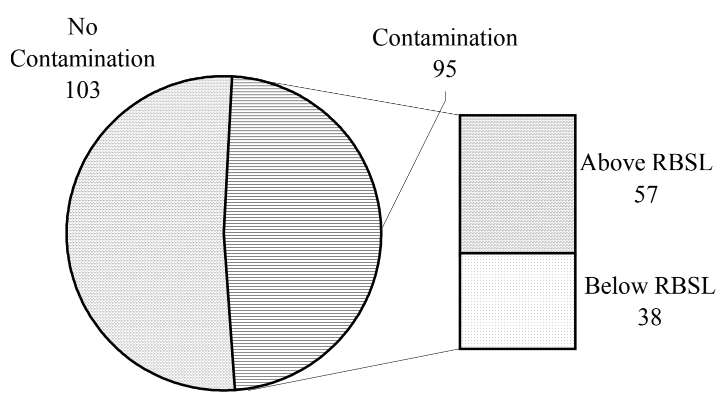

Table 6 provides a comparison of the media affected and the South Carolina RBCA site priority classification (see Appendix 3 on page 15) for the 19 sites found to have contamination above RBSLs only at the dispenser and data for all releases in South Carolina for the period January 1996 through June 2002. As shown, the proportions of facilities that affected groundwater (approximately three-quarters) or only soil (approximately one-quarter) are similar for the facilities with dispenser-only contamination and for all facilities with releases. Although there are some differences with respect to the South Carolina RBCA classifications, the relatively small number of facilities with dispenser only contamination makes it difficult to conclude that these differences are significant.

As discussed on page 3 in the methodology section, information on the type of receptor potentially affected by contamination was included in the data collection effort. Because these data do not indicate whether receptors have actually been affected or not, EPA later decided comparison of these data for the facilities studied with other facilities in the state would not yield meaningful results.

Table 6 - Affected Media And South Carolina RBCA Classification Comparison

	Facilities With Dispenser-Only Contamination		**All Facilities With Release From January 1996 Through June 2002**	
	Number	Percent*	Number	Percent*
Total # Of Facilities	19		1581	
Affected Media				
Groundwater	14	74	1103	70
Soil Only	5	26	478	30
South Carolina RBCA**				
1	1	5	39	3
2B	2	10	309	20
3B	6	32	433	27
4B	1	5	61	4
5	9	47	639	40
Other	0	0	100	6

*Totals may not add to 100 due to rounding.
** See Appendix 3 (page 15) for descriptions of these categories.

Conclusions

For closed facilities in South Carolina, which EPA assumes had no under dispenser containment, releases to the environment near dispensers appear to be quite common; nearly one-half (48 percent) of all facilities included in the study show contamination detected under one or more dispenser islands. This result is likely somewhat lower than actual contamination rates because data was often not available for every dispenser or even every dispenser island at a facility. The frequency of these releases appears to be affected little, if at all, by the type of pump delivery system (pressure or suction) used at the facility. At about 10 percent (19) of the facilities with contamination above RBSLs detected under a dispenser island, the dispenser appears to be the only source of release. Based on a comparison with corrective action data for all releases in South Carolina, the consequences of these dispenser releases in terms of the media affected and the need for corrective action (as measured by the South Carolina RBCA classification) appear to be comparable to those from other sources of release, such as tanks and piping.

Appendix 1 - South Carolina Dispenser Data Gathering Form For First Phase

□ **INVALID FILE - Check here & indicate the reason below:**

- □ No dispenser samples taken/analysis performed.
- □ UST was within five (5) feet of the dispenser.
- □ Contaminant levels are unknown.

□ Other: ______________________________________

Facility ID: ___________________

Date Closed: __________________

Number Dispensers: _________________

Assessment Report / Closure Report (Circle One)

Dispenser Island ID	Contamination	Above State RBSLs	Benzene	Ethylbenzene	Toluene	Xylenes	Naphthalene
	(Yes/No)		(mg/kg)				

Instructions:

1. **Dispenser Island ID** - If more than 1 sample is taken at an island, ID the islands as 1a and 1b.
2. If more than one constituent is reported [i.e., for xylenes - xylene (m,p) and zylene (o)], add those numbers together for reporting purposes.
3. If value is not reported, indicate with **N/A**.
4. If value below detection level, indicate the detection limit by using "<" followed by the detection limit value.

SC RBSLs in Clays (mg/kg): Benzene 0.008; Ethylbenzene 6.168; Toluene 1.167; Xylenes 22.495; Naphthalene 0.069
SC RBSLs in Sands (mg/kg): Benzene 0.007; Ethylbenzene 1.150; Toluene 1.450; Xylenes 14.500; Naphthalene 0.036

Appendix 2 - South Carolina Dispenser Data Gathering Form For Second Phase

Site ID: ____________________ **Date Closed:** __________________ **Number of Dispensers:** _____________

□ **INVALID FILE - Check here & indicate the reason below:**

- □ No dispenser samples taken/analysis performed.
- □ UST was within five (5) feet of the dispenser.
- □ Contaminant levels are unknown.

□ Other: _____________________________________

□ **Contaminants are above RBSLs for the dispenser only**
(If yes, print out a corrective action summary report using the site ID)

Contaminant Medium __________________________
SC RBCA Classification ________________________
Receptor Type ________________________________

Dispenser Island ID	Piping Type (S) = Suction (P) = Pressurized (U) = Unknown	Contamination	Above State RBSLs	Benzene	Ethylbenzene	Toluene	Xylenes	Naphthalene
		(Yes/No)		(mg/kg)				

Additional Comments:

SC RBSLs in Clays (mg/kg): Benzene 0.008; Ethylbenzene 6.168; Toluene 1.167; Xylenes 22.495; Naphthalene 0.069
SC RBSLs in Sands (mg/kg): Benzene 0.007; Ethylbenzene 1.150; Toluene 1.450; Xylenes 14.500; Naphthalene 0.036

Appendix 3 – South Carolina RBCA Site Priority Classification System

1. Sites are placed in Classification 1 if:

   1A an emergency situation exists
   1B a fire or explosion hazard exists
   1C vapors or free product exists in a structure or utility
   1D concentrations of chemical of concern (CoC) have been detected in a potable water supply or surface water supply intake
   1E free product exists on surface waters
   1F CoC exists in surface water

2. Sites are placed in Classification 2 if:

   Classification 2a:

   2AA a significant near term (0 to 1 year) threat to human health, safety, or sensitive environmental receptors exists
   2AB potable supply wells or surface water supply intakes are located < 1 year ground water travel distance downgradient of the source area

   Classification 2b:

   2BA free product exists in a monitoring well at a measured thickness > 1 foot
   2BB potable supply wells or surface water supply intakes are located < 1000 feet downgradient of the source area (where groundwater velocity data is not available)

3. Sites are placed in Classification 3 if:

   Classification 3a:

   3AA a short-term (1 to 2 years) threat to human health, safety, or sensitive environmental receptors exists
   3AB potable supply wells or surface water supply intakes are located > 1 year and < 2 years groundwater travel distance downgradient of the source area
   3AC sensitive habitats or surface water exist < 1 year groundwater travel distance downgradient of the source area and the groundwater discharges to the sensitive habitat or surface water

   Classification 3b:

   3BA free product exists in a monitoring well at a measured thickness > 0.01 foot
   3BB concentrations of CoC above the RBSL have been detected in a non-potable water supply well
   3BC hydrocarbon containing surface soil (< 3 feet below grade) exists in areas that are not paved

3BD sensitive habitats or surface water used for contact recreation exist < 500 feet downgradient of the source area (where groundwater velocity and discharge location data are not available)

3BE the site is located in a sensitive hydrogeologic setting, determined based on the presence of fractured or carbonate bedrock hydraulically connected to the impacted aquifer

3BF groundwater is encountered < 15 feet below grade and the site geology is predominantly sand or gravel

4. Sites are placed in Classification 4 if:

<u>Classification 4a:</u>

4AA a long term (> 2 years) threat to human health, safety, or sensitive environmental receptors exists

4AB potable supply wells or surface water supply intakes are located > 2 years and < 5 years groundwater travel distance downgradient of the source area

4AC non-potable supply wells are located < 1 year ground water travel distance downgradient of the source area

<u>Classification 4b:</u>

4BA free product exists as a sheen in any monitoring wells

4BB non-potable supply wells are located < 1000 feet downgradient of the source area (where groundwater velocity is not available)

4BC the ground water is encountered < 15 feet and the site geology is predominantly silt or clay

5. Sites are placed in Classification 5 if:

5A there is no demonstrable threat, but additional data are needed to show that there are no unacceptable risks posed by the site
assessment data for the site indicate concentrations in some samples are above the RBSL or Site-Specific Target Level (SSTL), as appropriate, and further assessment is needed

5B assessment data for the site indicate concentrations in samples are below the RBSL or SSTL, as appropriate, but the samples are determined not to be representative; therefore, further assessment is needed

Appendix 4 - Summary Of Results

Total number of facilities reviewed	1,218
Number of facilities with valid data	370
Number of dispenser islands with valid data	454
Number of facilities with invalid data	848
Number of facilities with contamination above RBSLs at dispenser only	19
Number of **facilities** with detectable contamination under dispensers*	179
Number of **facilities** with detectable contamination **above** RBSLs	98
Number of **facilities** with detectable contamination **below** RBSLs	81
Number of **facilities** with no detectable contamination under dispensers	191
Number of **dispenser islands** with detectable contamination under dispensers*	215
Number of **dispenser islands** with detectable contamination **above** RBSLs	116
Number of **dispenser islands** with detectable contamination **below** RBSLs	99
Number of **dispenser islands** with no detectable contamination under dispensers	239

Pressurized Pumping System Data	
Number of **facilities** with pressurized pumping	**135**
Number of **facilities** with **pressurized** pumping systems and contamination under dispensers*	70
Number of **facilities** with **pressurized** pumping systems and contamination under dispensers **above** RBSLs	34
Number of **facilities** with **pressurized** pumping systems and contamination under dispensers **below** RBSLs	36
Number of **facilities** with **pressurized** pumping systems and no detectable contamination under dispensers	65
Number of **dispenser islands** with pressurized pumping	**183**
Number of **dispenser islands** with **pressurized** pumping systems and contamination under dispensers*	99
Number of **dispenser islands** with **pressurized** pumping systems and contamination under dispensers **above** RBSLs	49
Number of **dispenser islands** with **pressurized** pumping systems and contamination under dispensers **below** RBSLs	50
Number of **dispenser islands** with **pressurized** pumping systems and no detectable contamination under dispensers	84

Suction Pumping System Data	
Number of **facilities** with **suction** pumping	**198**
Number of **facilities** with **suction** pumping systems and contamination under dispensers*	95
Number of **facilities** with **suction** pumping systems and contamination under dispensers **above** RBSLs	57
Number of **facilities** with **suction** pumping systems and contamination under dispensers **below** RBSLs	38
Number of **facilities** with **suction** pumping systems and no detectable contamination under dispensers	103
Number of **dispenser islands** with **suction** pumping	**218**
Number of **dispenser islands** with **suction** pumping systems and contamination under dispensers*	100
Number of **dispenser islands** with **suction** pumping systems and contamination under dispensers **above** RBSLs	59
Number of **dispenser islands** with **suction** pumping systems and contamination under dispensers **below** RBSLs	41
Number of **dispenser islands** with **suction** pumping systems and no detectable contamination under dispensers	118

Unknown Pumping System Data	
Number of **facilities** with **unknown** pumping	**37**
Number of **facilities** with **unknown** pumping systems and contamination under dispensers*	14
Number of **facilities** with **unknown** pumping systems and contamination under dispensers **above** RBSLs	7
Number of **facilities** with **unknown** pumping systems and contamination under dispensers **below** RBSLs	7
Number of **facilities** with **unknown** pumping systems and no detectable contamination under dispensers	23
Number of **dispenser islands** with unknown pumping	**53**
Number of **dispenser islands** with **unknown** pumping systems and contamination under dispensers*	16
Number of **dispenser islands** with **unknown** pumping systems and contamination under dispensers **above** RBSLs	8
Number of **dispenser islands** with **unknown** pumping systems and contamination under dispensers **below** RBSLs	8
Number of **dispenser islands** with **unknown** pumping systems and no detectable contamination under dispensers	37

* Number in shaded box indicates total of two subsets of data below, which include contamination detected above and below state RBSLs.

Dispenser Data	
Number of dispensers at facilities with valid data	1,251
Average number of dispensers per facility	3.38

Values within 30% of RBSL value	
Number of **facilities** with contamination **above** RBSLs within 30% of sand RBSL value	5*
Number of **facilities** with contamination **below** RBSLs within 30% of sand RBSL value	8
Number of **dispenser islands** with contamination **above** RBSLs within 30% of sand RBSL value	5*
Number of **dispenser islands** with contamination **below** RBSLs within 30% of sand RBSL value	9

* An additional 6 facilities/dispenser islands were within 30% of the clay RBSL only

Data For Facilities With Contamination Above RBSLs At Dispenser Only

Number Of Records	Contaminant Medium
14	Groundwater
5	Soil

Number Of Records	South Carolina RBCA Classification
1	1D Chemicals detected in water
1	2BA Free product >1 ft
1	2BB Water supply wells <1000 ft downgrade
1	3BA Free product >0.01 ft thick
1	3BE Sensitive hydrologic setting
4	3BF GW < 15 ft in sand or gravel
1	4BC GW < 15 ft in silt of clay
3	5A No pending threat, additional data
6	5B Assessment data NOT conclusive

Appendix 5 - Statistical Analysis

This appendix presents the results of statistical analyses done to investigate whether variation in facility closure date, size, or other characteristics might affect contamination patterns and, thus, the conclusions that can be drawn from the data collected.

Characteristics Of Closures And Closed Facilities

Valid data files included closures that took place between 1982 and 1999. The primary focus of the data collection effort was on closures that occurred between 1995 and the present, but some earlier closures were also included (see Table A). As shown, almost half of the closures (162, or 44 percent) occurred in 1998. (The regulatory deadline for replacing or upgrading tank systems was December 1998.) The table also shows that the relative proportions of closures at facilities with different piping delivery types changed somewhat over the time period covered in the database, with the proportion of pressure (P) closures generally increasing and the proportion of suction (S) facilities decreasing.

Table A - Distributions Of Closures By Year And Pump Type

Year	Total Closures	Pressurized Facilities Closed	Suction Facilities Closed	Unknown Facilities Closed
Pre-1996	20	1 (5)	11 (55)	8 (40)
1996	52	14 (27)	31 (60)	7 (13)
1997	80	21(26)	53 (66)	6 (8)
1998	162	75(46)	79 (49)	8 (5)
1999	56	24(43)	24 (43)	8 (14)
All	370	135 (37)	198 (54)	37 (10)

Note: Values outside of parentheses represent total number of facilities in the specific category; values inside parentheses represent the percent of facilities in the specific category.

The size of closed facilities, as indicated by the numbers of dispensers present, also varied (Table B).[1] The bulk of the closures took place at small facilities; slightly fewer than 30 percent of the facilities had only one dispenser, and about 84 percent had four dispensers or fewer. The largest facility had 50 dispensers. There was a slight tendency for the largest facilities that were closed (e.g., those with more than six dispensers) to have pressure piping. Facilities with three or fewer dispensers were also more likely to have suction piping. There was no significant correlation between closure date and size of facility.

[1] The data collection effort did not include collection of data on the number of dispenser islands at the closed facilities.

Table B - Size Distribution Of Facilities Closed (Number Of Dispensers)

Dispensers	Total Closures	Pressurized Facilities Closed	Suction Facilities Closed	Unknown Facilities Closed
1	109 (29)	44 (40)	55 (51)	10 (9)
2	84 (23)	24 (29)	50 (60)	10 (12)
3	74 (20)	26 (35)	43 (58)	5 (7)
4	45 (12)	15 (33)	24 (53)	6 (13)
5	13 (4)	3 (23)	8 (62)	2 (15)
6-10	31 (8)	16 (52)	13 (42)	2 (7)
>10	14 (4)	7 (50)	5 (36)	2 (14)
All	370 (100)	135 (37)	198 (54)	37 (10)

Note: Values outside of parentheses represent total number of facilities in the specific category; values inside parentheses represent the percent of facilities in the specific category.

Analyses of Soil Contamination Data

Valid data collected included 534 samples. Of the 370 facilities in the data set, 273 (74 percent) included only one sample result. A total of 454 dispenser islands were sampled at least once. Multiple dispenser islands were sampled at 57 facilities, including 41 facilities with results from two islands. The bulk of dispenser islands (398, or 88 percent) were sampled only once; 56 islands were sampled two, three, or four times each. As evident from these data, the number of dispensers at the facility is not necessarily representative of the number of dispenser islands sampled. It is possible there were some islands at a given facility that were not sampled, or which were not recorded on the data form; but for each facility, at least one island had a valid sample.

Analytical results were reported for benzene, toluene, ethylbenzene, xylenes, and naphthalene (Table C). Individual analytes were reported above detection limits in between 15.7 percent (benzene) and 34.6 percent (xylenes) of the chemical analyses. Detection limit values were not reported for 28 samples (5 percent) of the samples. Among the analytes, only benzene's RBSLs are close to the typical analytical detection limits.

Concentrations were highly variable, with relatively few high results (> 1 mg/kg). Representative concentrations of toluene (geometric mean 0.085 mg/kg) and benzene (0.088 mg/kg) were the lowest, followed by ethylbenzene (0.159 mg/kg), with xylenes (0.294 mg/kg) and naphthalene (0.352 mg/kg) having the highest geometric mean concentrations in samples where contamination was detected.

Table C - Summary Of Analytical Results

Analyte	Frequency Of Detection (percent)	Representative Concentration, Geometric Mean/Standard Deviation (mg/kg)	Representative Detection Limit (mg/kg)	RBSLs For Sand/Clay (mg/kg)
Benzene	15.7	0.088 / 2.87	0.001 - 0.005	0.007 / 0.008
Ethylbenzene	24.9	0.159 / 3.05	0.001 - 0.005	1.15 / 6.17
Toluene	29.2	0.085 / 3.46	0.001 - 0.005	1.45 / 1.17
Xylenes	34.6	0.294 / 3.65	0.001 - 0.015	14.5 / 22.5
Naphthalene	31.8	0.352 / 3.11	0.002 - 0.005	0.036 / 0.069

Preliminary analysis suggested that average contaminant concentrations and frequencies of detection were higher in samples from large facilities (i.e., those with larger number of dispensers), and that contaminant concentrations were generally lower in samples from more recent closures. EPA found the latter trend to be driven primarily by higher concentrations from a relatively few early closures and there were no significant trends in contaminant concentrations in closures after 1995. Results of the preliminary analysis prompted more detailed evaluation of detection frequencies and exceedences of RBSLs discussed below.

Analysis Of Frequency Of Detection And Frequency Of Occurrence Above RBSLs

The distribution of the numbers of sampled facilities, dispenser islands, and individual samples, as well as the frequency of contaminant detection and the frequency of occurrence above RBSLs are presented in Tables 2 through 4 in Section VI of this report.

ICF used three significance tests to evaluate the differences in proportions of facilities with detected contamination and with contamination above RBSLs: Pearson's Chi-Squared, Fisher's Exact Test, and a parametric test based on the standard error of the difference in proportions.[2] All give results that are generally consistent, but vary slightly depending on the size of the data set and the magnitude of the difference in proportions.

Both the Fisher's exact test and Chi-Squared procedure assume that individual observations are not correlated (are independent). Fisher's Exact Test is the most robust and reliable test for small sample sizes, while the Chi-Squared generally is considered to be reliable as long as the number of observations in the smallest group is not too small. The results of these

[2] Sheskin, DJ, *Parametric and Nonparametric Statistical Procedures*, Chapman and Hall, New York, 200, p.381.

two tests may differ slightly because the Chi-Squared test uses an approximation of the distribution of difference between proportions, while Fisher's exact test calculates the difference between proportions explicitly. The parametric test assumes that the difference between the proportions is normally distributed, and may therefore be somewhat less robust than the other two procedures. EPA included this test as a contingency in case the data set resulted in Fisher's calculations that exceeded the capability of a typical computer (which did not occur).

Tables D and E present the frequencies of having at least one sample with detected contamination or one sample with contamination above RBSLs at dispenser islands and facilities, respectively, with pressure (P) and suction (S) piping systems. The modest differences in the proportions of P and S islands with contamination are marginally significant (p - values approach 0.05) by two of the three significance tests (Table D). The very small difference in the proportions of P and S islands that have contamination above RBSLs is, as expected, not significant. Similarly, the small differences in the frequencies of contamination seen at the P and S facilities also are not significant by any of the statistical tests.

Table D - Significance Test Results For Difference In Proportions Of Dispenser Islands With Contamination

	Chi^2	Fisher's Exact Test	Diff. in Proportions
Proportions of Islands With, Without Detected Contamination			
P vs S	NS	P ~ 0.05	p ~ 0.05
Proportions of Islands with Contamination > RBSLs			
P vs S	NS	NS	NS

Table E - Significance Test Results For Differences In Proportions Of Facilities With Contamination

	Chi^2	Fisher's Exact Test	Diff. in Proportions
Proportions of Facilities With, Without Detected Contamination			
P vs S	NS[1]	NS	NS
Proportions of Facilities with Contamination Above one or More RBSLs			
P vs S	NS	NS	NS

1. NS = not significant at p = 0.05

Frequency Of Contamination Above RBSLs As A Function Of Facility Size

Table F shows the patterns of contaminant occurrence (detection and presence above RBSLs) in facilities of different sizes. When analyzed as a whole, the data generally indicate weak, insignificant, positive relationships between the frequency of contamination and the number of dispensers. This means the frequency of detected contamination increases with the number of dispensers. However, this relationship is inconsistent. The smaller facilities (one dispenser) have more frequent contamination than the middle-size facilities (four dispensers). To the extent there is a positive trend, it appears to be limited to the largest facilities (>10 dispensers). The high frequency of contamination at these facilities (71.4 percent) and their dispenser islands (64.9 percent) are driven by a relatively high frequency of contamination in individual samples (61.9 percent). The reasons for the apparent higher frequency of contamination in samples from the largest facilities are not clear; they may reflect real differences, or may be a statistical artifact associated with the relatively small number of samples (42) from this size range.

Table F - Frequency Of Contamination As A Function Of Facility Size (In Percent)

Number Of Dispensers	Facilities		Dispenser Islands		Samples	
	Detected	>RBSL	Detected	>RBSL	Detected	>RBSL
1	51.4	28.4	51.8	28.2	51.3	27.4
2	45.2	19.0	44.3	18.2	42.9	16.3
3	40.5	24.3	42.4	28.2	38.7	26.1
4	46.7	22.2	42.2	15.6	37.5	13.8
5	53.8	30.8	46.7	26.7	44.4	22.2
6-10	56.7	41.9	45.5	34.5	43.1	34.7
>10	71.4	42.9	64.9	32.4	61.9	31.0

The proportion of facilities with contamination above RBSLs also increases with increasing facility size (Table F). However, in this case, there is no corresponding increase in contamination above RBSLs at individual dispenser islands or in individual samples. Thus, the increase at the facility level may be a consequence of more samples and/or more dispensers per facility at larger sizes. In such a case, a constant proportion of independent samples above RBSLs would naturally translate into larger numbers of dispenser islands and facilities with at least one sample above RBSLs. (For example, if the probability of any sample being above an RBSL were 50 percent, a facility with two samples would have a 75 percent chance of having at least one sample above an RBSL.) The fact that the proportion of dispenser islands and facilities with values above RBSLs is only slightly higher than the proportion of samples above RBSLs illustrates that sampling results from the same islands and/or facilities are highly correlated.

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