# ADVISORY PANEL ON THE LEAK HISTORY OF NEW AND UPGRADED UST SYSTEMS

LEAK SOURCE AND LEAK DETECTION DATA COLLECTION AND ANALYSIS
*(UST Team 3 Report)*

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## I. PURPOSE

The central question examined by the entire panel was whether the standards for new and upgraded UST systems are adequate to protect water resources from MTBE contamination. Team 3 contributed to this effort by gathering data intended to help answer the following more specific questions:

1. Are releases primarily from new, upgraded or non-compliant UST systems?
2. Which portion(s) of the UST system are most likely to fail?
3. How do releases get discovered?
4. How big is the problem before it is discovered?

## II. STUDY APPROACH

The goal of the team was to gather data related to the above questions for as many UST systems as possible. Two distinct but similar data sources were examined. The first source was a subset of the most recent petroleum releases recorded in the State Water Resources Control Board's Leaking Underground Storage Tank Inventory System (LUSTIS). A total of 1691 reported releases during the period June 1, 1996 to July 1, 1998 were considered in this study. Advantages of the database include the fact that it is comprehensive and is easily accessible. Disadvantages include the fact that it only includes systems that have reported a release, and that it does not provide all information necessary to address the questions above. For example, the database contains no information on whether the facility was using a release detection system when the leak was discovered and has no information on dispenser or turbine containment systems that might have been in use.

To gather necessary information not originally reported in the LUSTIS database staff members from SWRCB and local agencies reviewed the original files of cases reported as leaking during this period. A total of 1072 of the 1691 records were reviewed and these records form the basis for all subsequent analysis of the LUSTIS-extracted records. An example of the form used to collect the additional data from the files is included in appendix A-1.

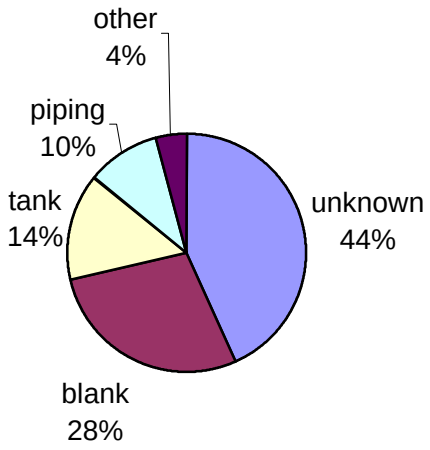
Historical files for release sites frequently lack some of the desired information, even upon careful review. Consequently, the team devised a second data gathering effort that relied upon local agency inspectors to collect the desired information when performing system inspections at tank closure, upgrade or any other time when the excavation was open for visible examination. A data collection form similar to that used for the LUSTIS file review was designed by the team (Appendix A-2). Team members took the lead in coordinating data gathering and reviewing this information. A total of 235 sites were inspected during this effort. The following counties had more than five sites included in the database: Alameda, Butte, Fresno, Humboldt, Los Angeles, Orange, Riverside, Sacramento, San Bernardino, San Diego, San Joaquin, and Shasta. Advantages of the inspection database are that it included sites with and without releases, and that the information tends to be more complete because it was compiled on-site when questions could be answered by a visual inspection. Even for these sites, however, the desired information was not complete in many cases. The most common missing element was leak detection information when it was not readily available to the inspector at the site.

## III. RESULTS

### A. LUSTIS file review

The distribution of release sources in the 1072 LUSTIS database records examined is summarized in Figure 1. Only 24% of the releases were attributed to either the tank or piping, with the remaining 76% classified as "unknown", "other" or left blank on the reporting form. The characteristics of the 155 tanks reported to be the source of releases is detailed in Table 1. The majority (78.7%) of the tanks reported as leaking were bare steel, single-walled tanks that do not comply with current regulations. Only 12.2% of the tanks were of a material considered to be "non-corrosive" and 7.1% were double walled. Most (89%) of the tanks were over 15 years old or were of indeterminate age; 11% were between 0-15 years old. Few leaks in these systems (4.5%) were discovered by routine leak detection activities. Clearly, most tank releases are occurring in tanks that do not meet the definition of "upgraded" under current SWRCB regulations.

**Figure 1. Release sources reported in LUSTIS review**




A similar analysis was performed to determine the characteristics of UST piping at those sites with piping as the reported release source. Table 2 summarizes the major design and operation features of the 108 piping systems identified as release points. A greater percentage (29.7%) of these is constructed of "non-corrosive" material than in the tank case, but over 50% are still bare steel. Double-walled piping was reported to be the source of 19.4% of the piping releases, and most of the systems (90.8%) had either no or unknown containment at the turbine or the dispenser. Submersible pumps were nearly twice as common as suction systems among the leaking systems. Few leaks in these systems (6.5%) were discovered by routine leak detection activities. Piping over 11 years old represented 87% of this group of systems. Once again, the picture that emerges is one in which the systems that leak are predominantly those failing to meet current regulatory standards for piping design and operation.

Routine monitoring of a UST system to provide early warning of a release is one of the most important protections in the regulation, particularly for single walled systems. An earlier report by SWRCB[1] indicated that only 5% of releases were discovered by leak detection and that the vast majority (84.7%) remained undetected until tank closure. Results from this study support these earlier conclusions, with only 4.5% of tank releases and 6.5% of piping releases identified by leak detection methods. Tank closure or removal continued to be the most important means of detecting a leak, with 77.4% of tank releases and 49.1% of piping releases discovered in this manner.

To explore the reasons for the apparently poor performance of leak detection, the present study sought information on which, if any, release detection methods were in use at the time of closure or release. Table 3 summarizes this information and shows that most UST systems in the LUSTIS database are not complying with leak detection requirements. Over 40% of the systems have no dedicated tank leak detection and 56.8% lack piping leak detection. For the systems that have performed leak detection, precision tank and piping tests are the most common methods, utilized by 49.7% and 34.5% of the systems. This parallels the data that 24 out of 35 releases detected by leak detection methods were discovered by tank and piping tests.

In 95% of these cases, the most recent tank or piping test indicated that no leak was present even though the system eventually ended up on the leaking site list. Table 4 suggests that at least one reason for this poor performance is the infrequent nature of these tests. The average time elapsed between the last tank or piping test and the date of the release discovery is over 600 days, with only about 25% of the tests being performed within the previous year. Overall, the results suggest that leak detection methods fail most commonly because they are not used or are used infrequently. This does not prove that leak detection would work if widely practiced but does imply that greater implementation is required before its efficacy under field conditions can be established.

## B. Data collected during inspections

The major advantage of the data collected during field inspections is the ability to compare design and operating practices for systems that have experienced a release to those that have not. It is important to note that the differentiation between these two categories was based on the best professional judgment of the inspector at the site during the inspection. No external corroborating evidence was sought or obtained. Although significant error may therefore exist in this classification, the comparison was believed to be instructive.

A total of 97 inspections were conducted at facilities deemed to have had “no release” and 138 were conducted at sites with evidence of a release. Tables 5-8 compare the distributions (as percentages) of tank characteristics, piping characteristics, and leak detection utilization between these two categories. In addition tables 5-7 further subdivide the systems with releases into those with the tank, piping or dispenser as a source. There is some overlap between these categories since 34% of sites with a reported release source listed more than one source.

Table 5 clearly reveals that tank releases are found overwhelmingly in old, single walled, bare steel tanks that have not been upgraded in any way. Similarly, piping that is double-walled and newer (<15 years old) is more likely to be found in the “no release”

[1] Farahnak and Drewry, January 1998

category (Table 6). Pressurized, single walled piping that does not include dispenser or turbine containment is more likely to be in the release category. For the sites in the release category (138), review of single walled site cases indicates that 91.7% included piping as one of the release sources and 80% had dispenser listed as one of the sources. For the double walled piping cases, 8.3% included piping as one of the release sources and 16.7% included dispenser area as one of the sources.

Leak detection usage does not differ greatly between the two groups, with the exception that methods associated with secondary containment (interstitial monitors and sumps) are more prevalent in the "no release" category and that mechanical line leak detectors are more prevalent in the release category (Table 7). These observations correspond to previous observations about the prevalence of secondary containment and pressurized piping in the two groups. The frequency of precision tests of tanks and piping also do not differ greatly between the two groups, with the average time since the last test being slightly longer for the "no release" group (Table 8). It is important to note that systems with no releases that are using another method of leak detection are not required to have a tank test on a regular basis; the time since test will be lengthened by inclusion of such systems in the calculated average.

Overall the comparison of characteristics between the "release" and "no release" categories reveals relatively minor differences in regulatory compliance with the notable exception of non-compliant tanks in the tank release category and higher proportions of double walled systems in the no release category. This suggests that preventing non-tank related releases is more difficult and may be primarily related to "unobservable" factors such as careful housekeeping or knowledgeable owner/operators rather than to particular technological features.

The site inspection database also includes more detailed information about the sources, causes and extent of releases than the LUSTIS database. This information is summarized for the 138 systems that were thought to have releases in Table 9. Tanks and piping remain the identified source of between 20-30% of the releases, consistent with findings shown in Figure 1 for the LUSTIS database. The improved detail of the inspection database allows dispenser leaks to be separated out as a source equal in magnitude to tanks or piping. Dispenser area releases were reported as a source for about 20% of the releases. The majority of release causes remain unknown even when the inspector is able to view the open excavation zone. Corrosion is the most commonly identified release cause consistent with the preponderance of bare steel systems in this database. Leak detection remains a fairly minor means of identifying releases, with less than 1% of releases discovered in this manner.

Inspectors were asked to estimate the extent of the release when possible, and were able to do so in about 70% of the cases. About a third (29.7%) of these releases appeared to extend beyond the excavation zone and about the same number being localized to various areas of the excavation zone. Less than 1% of the cases involved known off-site migration of product. However, since the inspectors did not typically have access to any off-site monitoring records, the study design is sure to underestimate the prevalence of such problems.

## C. Analysis of double walled tanks and piping with reported releases

Double-walled tanks and piping are required for all new installations under California regulations. Some double-walled systems were identified as leaking in both the LUSTIS database review and the on-site data collection effort. Consequently, a more complete analysis of records in which both tanks and piping were double walled and releases were reported appears to be warranted. Tables 10 and 11 summarize a variety of characteristics of tanks and piping for the 66 LUSTIS sites and the 16 inspections in which releases were reported and both tanks and piping were double-walled. Clearly some of the follow-up information collected for the LUSTIS database are in error because 30 of the tanks are listed as either bare steel or clad, entries that do not make sense for a double-walled system. Consequently, the 66 sites is probably an overestimate of the extent of the problem. Only 22.7% of these systems included tanks that were fully upgraded by the addition of spill/overfill protection and striker plates. Further examination reveals that only 3% of these sites had both dispenser and turbine containment and that the piping was listed as the major source of releases for these systems. Only 1 system was identified in the database that met all required new tank standards.

Review of the inspection database discovered similar trends in the 16 “fully double-walled systems”, although there were fewer questionable entries such as those found in the LUSTIS database (Table 11). In this case only two systems were identified that met all new tank standards including those for spill and overfill protection and dispenser and turbine containment. A striking feature of both the LUSTIS and site review information is the fact that about half of the double-walled systems reported the use of either interstitial monitors or sump leak detection systems, while all are required to have them according to current regulations. This observation may be due to inadequate documentation of the existence of such systems or may relate to a more fundamental compliance issue.

# IV. FINDINGS

In this section the answers to the four questions posed at the outset of this report are reviewed.

1. *Releases are mainly associated with older, non-compliant systems.* Although a substantial number of motor fuel releases from UST systems continue to be reported to the SWRCB, very few of these releases are occurring from systems that meet all of the applicable regulatory standards. For example, in the inspection database only two cases of a fully upgraded system with a release were identified (out of 138 with releases). The major environmental threat from USTs continues to be posed by substandard tank systems that must be upgraded under current regulatory guidelines. A large fraction of the systems in the current inspection database is not in compliance with California UST regulations with respect to leak detection or system construction and these systems are disproportionately represented among the systems found to be leaking.

2. *Piping, particularly near the dispenser, remains the most problematic release source*. At present tank, piping and dispenser releases are of roughly equal frequency. However, virtually all of the tank releases are occurring from old, single walled, bare

steel tanks. With improved compliance and mandatory upgrades these releases should eventually be dramatically reduced. Piping and dispenser leaks occur with greater frequency from upgraded or double walled systems, suggesting that technology alone will not completely eliminate such releases.

3. *Releases are still mostly discovered during closure or removal operations*. Just 4.5% of the releases in the LUSTIS database and only 0.7% of those in the inspection database were discovered by leak detection activities. Routine release detection efforts are a critical element of the protection afforded by upgraded systems. If this portion of the regulations is not complied with, or the methods turn out to be incapable of detecting environmentally relevant leaks, environmental protection will be compromised.

4. *The study provides little information about release size at the time of discovery*. To answer the fourth question posed by the team will require additional investigation including soil and groundwater sampling around tanks with and without reported releases. The time allotted for the present study did not permit such data to be collected.

## V. RECOMMENDATIONS

The following recommendations arise from the findings above:

1. *Improved inspection and enforcement practices*. Although some problems with upgraded systems are suggested by the results described above, it is important to remember that the vast majority of the releases were associated with UST systems that complied with few of the existing regulations. A high priority should be placed on examining current UST inspection and enforcement practices to ensure that substandard tanks are appropriately upgraded or closed. Currently, state law requires facility inspections to be conducted every three years. Therefore, a tank and piping test may be overdue more than three years (as noted in this study) before it is noted by the oversight agency. More frequent site inspections and file reviews may be one approach for improving compliance with leak detection requirements.

2. *Further investigation of double walled systems with releases*. A few cases (16) in the inspection database revealed double walled tank and piping systems that appeared to have had releases. Out of these 16 double walled sites, only 3 had dispenser pans and 9 had turbine containment. These cases and others like them deserve closer review of data to determine whether the releases were significant and what portions of the system failed.

3. *Develop outreach and education programs to improve leak detection utilization*. It is likely that leak detection utilization rates are low partly because of enforcement difficulties (see point 1 above) but also because tank owner/operators do not understand its importance or how to do it. A study of owner and operator attitudes and practices regarding leak detection might provide insight into how to design such an education and outreach campaign.

4. *Field-based research.* This research should quantify the probability and environmental significance of releases from UST systems meeting the 1998 standards. The research should strive to identify the source and cause of releases, and any deficiencies in leak detection systems. It should include single-walled, double-walled, and hybrid UST systems, and should avoid bias toward known leaking systems by including a statistically valid sample of all operating UST systems.

| Table 1. Analysis of tank design for systems indicating the tank as the release source (LUSTIS data, total=155) | | | |
|---|---|---|---|
| Tank Material | Number | Percentage (all) | Percentage (excludes blanks) |
| blank | 14 | 9.0 | |
| bare steel | 122 | 78.7 | 86.5 |
| fiberglass | 11 | 7.1 | 7.8 |
| clad | 6 | 3.9 | 4.3 |
| lined & C.P. | 1 | 0.6 | 0.7 |
| Retrofit C.P. | 1 | 0.6 | 0.7 |
| Tank Walls | | | |
| blank | 23 | 14.8 | |
| single | 121 | 78.1 | 91.7 |
| double | 11 | 7.1 | 8.3 |
| Tank age | | | |
| >15 | 91 | 58.7 | 75.8 |
| 11-15 | 10 | 6.5 | 8.3 |
| 6-10 | 6 | 3.9 | 5.0 |
| 0-5 | 1 | 0.6 | 0.8 |
| unknown | 12 | 7.7 | 10.0 |
| blank | 35 | 22.6 | |
| How Discovered | | | |
| Closure/removal | 120 | 77.4 | 87.6 |
| Leak Detection | 7 | 4.5 | 5.1 |
| Other | 10 | 6.5 | 7.3 |
| Blank | 18 | 11.6 | |
| Leak Detection Used | | | |
| Tank Test | 67 | 43.2 | 72.8 |
| Manual inventory | 52 | 33.5 | 56.5 |
| Statistical inventory | 13 | 8.4 | 14.1 |
| Automatic tank Gauge | 13 | 8.4 | 14.1 |
| Interstitial monitor | 7 | 4.5 | 7.6 |
| None (blank) | 63 | 40.6 | |

| Table 2. Analysis of piping design for systems indicating the piping as the release source (LUSTIS data, total=108) | | | |
|---|---|---|---|
| Piping Material | Number | Percentage (all) | Percentage (excludes blanks) |
| blank | 16 | 14.8 | |
| bare steel | 56 | 51.9 | 60.9 |
| fiberglass | 26 | 24.1 | 28.3 |
| clad | 4 | 3.7 | 4.3 |
| flexible | 2 | 1.9 | 2.2 |
| unknown | 4 | 3.7 | 4.3 |
| Piping Walls | | | |
| blank | 15 | 13.9 | |
| single | 71 | 65.7 | 76.3 |
| double | 21 | 19.4 | 22.6 |
| unknown | 1 | 0.9 | 1.1 |
| Piping age | | | |
| >15 | 44 | 40.7 | 54.3 |
| 11-15 | 23 | 21.3 | 28.4 |
| 6-10 | 5 | 4.6 | 6.2 |
| 0-5 | 2 | 1.9 | 2.5 |
| unknown | 7 | 6.5 | 8.6 |
| blank | 27 | 25.0 | |
| Containment | | | |
| Blank | 61 | 56.5 | |
| None | 37 | 34.3 | 78.7 |
| Dispenser | 6 | 5.6 | 12.8 |
| Turbine | 3 | 2.8 | 6.4 |
| Dispenser/turbine | 1 | 0.9 | 2.1 |
| Pumping System | | | |
| Pressure | 51 | 47.2 | 62.2 |
| Conv. Suction | 29 | 26.9 | 35.4 |
| Safe Suction | 2 | 1.9 | 2.4 |
| Blank | 26 | 24.1 | |
| How Discovered | | | |
| Closure/removal | 54 | 49.1 | 50.0 |
| Leak Detection | 10 | 6.5 | 6.6 |
| Other | 32 | 42.6 | 43.4 |
| Blank | 16 | 1.9 | |
| Leak Detection Used | | | |
| Piping test | 36 | 33.3 | 47.4 |
| MLLD | 28 | 25.9 | 36.8 |
| ELLD | 12 | 11.1 | 15.8 |
| None (blank) | 32 | 29.6 | |

| Table 3. Leak detection method utilization (LUSTIS data, total=1072) | | | |
|---|---|---|---|
| Method | Number | Percentage | Leaks Discovered |
| Manual Inventory Control | 422 | 39.4 | 1 |
| Statistical Inventory Control | 86 | 8.0 | 3 |
| Tank test | 533 | 49.7 | 17 |
| Automatic Tank Gauge | 112 | 10.4 | 1 |
| Interstitial Monitor | 81 | 7.6 | 1 |
| Sump | 8 | 0.7 | 0 |
| Groundwater Monitor | 4 | 0.4 | 4 |
| Vapor Monitor | 17 | 1.6 | 0 |
| Piping test | 370 | 34.5 | 7 |
| Mechanical Line Leak Detector | 237 | 22.1 | 1 |
| Electronic Line Leak Detector | 39 | 3.6 | 0 |
| | | | |
| No dedicated tank method (INT,TT,GW,AGT,V,SIR) | 436 | 40.7 | |
| No dedicated piping method (PT, MLLD, ELLD) | 609 | 56.8 | |

| Table 4. Time elapsed between last test and release discovery (LUSTIS data) | |
|---|---|
| | Number or days |
| Tank test samples | 533 |
| incomplete information | 76 |
| Negative values | 37 |
| Average time elapsed | 859.3 days |
| 25th percentile | 329 days |
| 50th percentile | 605 days |
| 75th percentile | 1192 days |
| Piping test samples | 370 |
| incomplete information | 59 |
| Negative values | 26 |
| Average time elapsed | 623.6 days |
| 25th percentile | 245 days |
| 50th percentile | 444 days |
| 75th percentile | 870 days |

**Table 5. Comparison of tank characteristics for systems with and without suspected releases (Inspection database, total=235)**

| | No Release (total =97) | Release (total=138) | Tank Source (total=36) |
|---|---|---|---|
| Tank Material | | | |
| blank | 4.1 | 4.3 | 2.8 |
| bare steel | 59.8 | 67.4 | 94.4 |
| fiberglass | 18.6 | 22.5 | 2.8 |
| clad | 12.4 | 4.3 | 0.0 |
| concrete | 1.0 | 0.0 | 0.0 |
| lined & C.P. | 1.0 | 0.7 | 0.0 |
| Mfr. C.P. | 1.0 | 0.0 | 0.0 |
| Plasteel | 1.0 | 0.7 | 0.0 |
| Other | 1.0 | 0.0 | 0.0 |
| Tank Walls | | | |
| blank | 1.0 | 2.9 | 2.8 |
| single | 71.1 | 78.3 | 94.4 |
| double | 27.8 | 18.8 | 2.8 |
| Tank age | | | |
| >15 | 41.2 | 58.0 | 86.1 |
| 11-15 | 27.8 | 15.2 | 5.6 |
| 6-10 | 17.5 | 10.1 | 0.0 |
| 0-5 | 4.1 | 4.3 | 0.0 |
| unknown | 0.0 | 3.6 | 2.8 |
| blank | 9.3 | 8.7 | 5.6 |
| Upgrades | | | |
| none (blank) | 67.0 | 71.0 | 91.7 |
| spill | 5.2 | 2.2 | 2.8 |
| overfill | 1.0 | 1.4 | 0.0 |
| striker | 0.0 | 2.2 | 2.8 |
| spill/overfill | 5.2 | 5.1 | 0.0 |
| spill/striker | 2.1 | 0.0 | 0.0 |
| overfill/striker | 0.0 | 2.2 | 0.0 |
| Full upgrade | 17.5 | 13.8 | 2.8 |

| Table 6. Comparison of piping characteristics for systems with and without suspected releases (Inspection database, total=235) | | | | |
|---|---|---|---|---|
| | No Release (total=97) | Release (total=138) | Piping source (total=24) | Dispenser source (total=30) |
| Piping Material | | | | |
| blank | 3.1 | 3.6 | 4.2 | 3.3 |
| bare steel | 63.9 | 60.9 | 50.0 | 53.3 |
| fiberglass | 28.9 | 31.9 | 41.7 | 40.0 |
| clad | 3.1 | 0.0 | 0.0 | 0.0 |
| flexible | 2.1 | 0.7 | 4.2 | 3.3 |
| C.P. | 1.0 | 0.7 | 0.0 | 0.0 |
| Other | 1.0 | 0.7 | 0.0 | 0.0 |
| Piping Walls | | | | |
| blank | 8.2 | 5.1 | 0.0 | 3.3 |
| single | 64.9 | 79.0 | 91.7 | 80.0 |
| double | 26.8 | 15.9 | 8.3 | 16.7 |
| Piping age | | | | |
| >15 | 37.1 | 50.0 | 45.8 | 53.3 |
| 11-15 | 27.8 | 18.8 | 33.3 | 10.0 |
| 6-10 | 18.6 | 12.3 | 12.5 | 23.3 |
| 0-5 | 6.2 | 7.2 | 0.0 | 3.3 |
| unknown | 0.0 | 2.9 | 0.0 | 3.3 |
| blank | 10.3 | 8.7 | 8.3 | 6.7 |
| Containment | | | | |
| blank | 21.6 | 10.1 | 0.0 | 6.7 |
| dispenser | 10.3 | 3.6 | 0.0 | 0.0 |
| turbine | 9.3 | 9.4 | 16.7 | 6.7 |
| dispenser&turbine | 6.2 | 6.5 | 8.3 | 6.7 |
| None | 51.5 | 68.1 | 75.0 | 73.3 |
| unknown | 1.0 | 2.2 | 0.0 | 6.7 |
| Pump system | | | | |
| pressure | 34.0 | 60.1 | 91.7 | 66.7 |
| conv. Suction | 40.2 | 20.3 | 4.2 | 16.7 |
| safe suction | 8.2 | 3.6 | 0.0 | 0.0 |
| gravity | 2.1 | 5.1 | 0.0 | 0.0 |
| none | 1.0 | 0.0 | 0.0 | 0.0 |
| blank | 13.4 | 10.9 | 4.2 | 13.3 |

| Table 7. Comparison of leak detection methods employed for systems with and without suspected releases (Inspection database, total=235) | | | | | |
|---|---|---|---|---|---|
| | No Release (total=97) | Release (total=138) | Tank Source (total=36) | Piping Source (total=24) | Dispenser Source (total=30) |
| Manual Inventory | 29.9 | 30.4 | 44.4 | 29.2 | 40.0 |
| Statistical Inventory | 2.1 | 11.6 | 16.7 | 33.3 | 3.3 |
| Tank test | 25.8 | 29.0 | 27.8 | 50.0 | 40.0 |
| Automatic Tank Gauge | 13.4 | 10.9 | 2.8 | 25.0 | 6.7 |
| Interstitial monitor | 20.6 | 8.7 | 2.8 | 8.3 | 13.3 |
| Sump | 9.3 | 1.4 | 0.0 | 0.0 | 0.0 |
| Groundwater monitor | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Vapor monitor | 4.1 | 4.3 | 0.0 | 4.2 | 13.3 |
| Piping test | 10.3 | 14.5 | 13.9 | 12.5 | 26.7 |
| MLLD | 9.3 | 23.9 | 19.4 | 41.7 | 36.7 |
| ELLD | 5.2 | 5.1 | 2.8 | 4.2 | 6.7 |
| No leak detection | 22.7 | 27.5 | 33.3 | 8.3 | 10.0 |
| No dedicated tank LD | 44.3 | 51.4 | 63.9 | 25.0 | 26.7 |
| No dedicated piping LD | 76.3 | 65.2 | 66.7 | 50.0 | 53.3 |

Note: Totals do not add to 100% since multiple release detection methods were indicated for some systems inspected.

| Table 8. Comparison of tank and piping test results and frequency for systems with and without suspected releases (Inspection database, total=235) | | |
|---|---|---|
| | No Release (total=97) | Release (total=138) |
| Last Tank Test Result | | |
| blank | 41.2 | 35.5 |
| fail | 2.1 | 0.0 |
| pass | 56.7 | 64.5 |
| time since test (days) | | |
| average | 1157.6 | 1018.0 |
| 25th percentile | 399.5 | 375 |
| 50th percentile | 732 | 547 |
| 75th percentile | 1793 | 1364 |
| Last Piping Test Result | | |
| blank | 55.7 | 44.9 |
| fail | 0.0 | 0.7 |
| pass | 44.3 | 54.3 |
| time since test (days) | | |
| average | 952.6 | 689.1 |
| 25th percentile | 238.3 | 340.8 |
| 50th percentile | 648 | 518 |
| 75th percentile | 1075.5 | 858 |

| Table 9. Leak source and method of identification for systems with releases (Inspection database, total=138) | | | |
|---|---|---|---|
| Source | Number | Percentage (all) | Percentage (excludes blanks) |
| blank | 28 | 20.3 | |
| unknown | 25 | 18.1 | 22.7 |
| tank | 19 | 13.8 | 17.3 |
| piping | 11 | 8.0 | 10.0 |
| dispenser | 19 | 13.8 | 17.3 |
| overfill | 6 | 4.3 | 5.5 |
| spill | 1 | 0.7 | 0.9 |
| piping/dispenser | 5 | 3.6 | 4.5 |
| piping/tank | 6 | 4.3 | 5.5 |
| dispenser/tank | 4 | 2.9 | 3.6 |
| overfill/tank | 2 | 1.4 | 1.8 |
| overfill/tank/piping | 2 | 1.4 | 1.8 |
| other combinations | 10 | 7.2 | 9.1 |
| Cause | | | |
| blank | 38 | 27.5 | |
| unknown | 47 | 34.1 | 47.0 |
| corrosion | 16 | 11.6 | 16.0 |
| overfill | 13 | 9.4 | 13.0 |
| loose fitting | 12 | 8.7 | 12.0 |
| physical damage | 4 | 2.9 | 4.0 |
| spill | 2 | 1.4 | 2.0 |
| poor installation | 2 | 1.4 | 2.0 |
| structural failure | 2 | 1.4 | 2.0 |
| construction | 1 | 0.7 | 1.0 |
| corrosion/overfill | 1 | 0.7 | 1.0 |
| Identification | | | |
| leak detection | 1 | 0.7 | 0.7 |
| closure/removal | 87 | 63.0 | 63.0 |
| other | 2 | 1.4 | 1.4 |
| unknown | 48 | 34.8 | 34.8 |
| Extent | | | |
| large (beyond excavation) | 41 | 29.7 | 43.2 |
| localized tank | 27 | 19.6 | 28.4 |
| localized piping | 3 | 2.2 | 3.2 |
| localized dispenser | 18 | 13.0 | 18.9 |
| tank/pipe | 2 | 1.4 | 2.1 |
| pipe/dispenser | 1 | 0.7 | 1.1 |
| dispenser/tank | 1 | 0.7 | 1.1 |
| dispenser/tank/piping | 1 | 0.7 | 1.1 |
| off-site | 1 | 0.7 | 1.1 |
| blank | 43 | 31.2 | |

| Table 10. LUSTIS database: review of records with double walled tanks and piping (Total=66) | | | |
|---|---|---|---|
| Release Cause | Number | Percentage (all) | Percentage (excludes blanks) |
| blank | 22 | 33.3 | |
| unknown | 31 | 47.0 | 70.5 |
| corrosion | 3 | 4.5 | 6.8 |
| structural failure | 1 | 1.5 | 2.3 |
| other | 7 | 10.6 | 15.9 |
| tank | 2 | 3.0 | 4.5 |
| Tank upgrade | | | |
| blank | 27 | 40.9 | |
| overfill | 3 | 4.5 | 7.7 |
| spill | 4 | 6.1 | 10.3 |
| spill/overfill | 14 | 21.2 | 35.9 |
| spill/striker | 1 | 1.5 | 2.6 |
| striker | 1 | 1.5 | 2.6 |
| complete | 15 | 22.7 | 38.5 |
| none | 1 | 1.5 | 2.6 |
| Tank material | | | |
| bare steel | 12 | 18.2 | 18.2 |
| steel w/ lining | 1 | 1.5 | 1.5 |
| bare steel/plasteel | 1 | 1.5 | 1.5 |
| clad | 18 | 27.3 | 27.3 |
| fiberglass | 33 | 50.0 | 50.0 |
| Tank age | | | |
| blank | 7 | 10.6 | |
| unknown | 3 | 4.5 | 5.1 |
| 0-5 yrs | 7 | 10.6 | 11.9 |
| 6-10 yrs | 23 | 34.8 | 39.0 |
| 11-15 yrs | 20 | 30.3 | 33.9 |
| >15 yrs | 6 | 9.1 | 10.2 |
| Pipe materials | | | |
| blank | 3 | 4.5 | |
| fiberglass | 47 | 71.2 | 74.6 |
| bare steel | 9 | 13.6 | 14.3 |
| steel/fiberglass | 1 | 1.5 | 1.6 |
| PVC | 2 | 3.0 | 3.2 |
| MeOH compatible | 1 | 1.5 | 1.6 |
| flexible | 2 | 3.0 | 3.2 |
| C.P. | 1 | 1.5 | 1.6 |
| Pipe containment | | | |
| blank | 35 | 53.0 | |
| unknown | 1 | 1.5 | 3.2 |
| none | 12 | 18.2 | 38.7 |
| dispenser | 6 | 9.1 | 19.4 |
| turbine | 10 | 15.2 | 32.3 |
| dispenser/turbine | 2 | 3.0 | 6.5 |

| | | | |
|---|---|---|---|
| Pipe pumping | | | |
| blank | 7 | | |
| pressure | 47 | 71.2 | 79.7 |
| conv. Suction | 9 | 13.6 | 15.3 |
| safe suction | 1 | 1.5 | 1.7 |
| gravity | 2 | 3.0 | 3.4 |
| LD/Int | | | |
| yes | 38 | 57.6 | 57.6 |
| no | 28 | 42.4 | 42.4 |
| LD/Sump | | | |
| yes | 3 | 4.5 | 4.5 |
| no | 63 | 95.5 | 95.5 |
| Release Source | | | |
| blank | 20 | 30.3 | |
| piping | 17 | 25.8 | 37.0 |
| tank | 7 | 10.6 | 15.2 |
| unknown | 17 | 25.8 | 37.0 |
| other | 5 | 7.6 | 10.9 |
| How discovered | | | |
| blank | 18 | 27.3 | |
| other | 24 | 36.4 | 50.0 |
| tank closure | 20 | 30.3 | 41.7 |
| inventory control | 1 | 1.5 | 2.1 |
| subsurface monitor | 3 | 4.5 | 6.3 |
| Estimated release age | | | |
| blank | 22 | 33.3 | |
| <1 yr | 3 | 4.5 | 6.8 |
| >1 yr. | 5 | 7.6 | 11.4 |
| unknown | 36 | 54.5 | 81.8 |
| Estimated release size | | | |
| blank | 29 | 43.9 | |
| beyond excavation | 8 | 12.1 | 21.6 |
| localized dispenser | 5 | 7.6 | 13.5 |
| localized piping | 7 | 10.6 | 18.9 |
| localized tank | 8 | 12.1 | 21.6 |
| localized tank, piping | 1 | 1.5 | 2.7 |
| localized piping, dispenser | 1 | 1.5 | 2.7 |
| tank, piping, dispenser | 1 | 1.5 | 2.7 |
| off-site | 2 | 3.0 | 5.4 |
| unknown | 4 | 6.1 | 10.8 |
| Piping age | | | |
| blank | 16 | 24.2 | |
| 0-5 yrs | 6 | 9.1 | 12.0 |
| 6-10 yrs | 17 | 25.8 | 34.0 |
| 11-15 yrs | 20 | 30.3 | 40.0 |
| >15 yrs | 3 | 4.5 | 6.0 |
| unknown | 4 | 6.1 | 8.0 |

| Table 11. Inspection database: review of records (release cases) with double walled tanks and piping (Total=16) | | |
|---|---|---|
| Release Cause | Number | Percentage |
| blank | 8 | 50 |
| unknown | 6 | 37.5 |
| loose fitting | 1 | 6.25 |
| structural failure | 1 | 6.25 |
| Tank upgrade | | |
| blank | 6 | 37.5 |
| overfill | 1 | 6.25 |
| spill/overfill | 1 | 6.25 |
| complete | 8 | 50 |
| Tank material | | |
| blank | 2 | 12.5 |
| clad | 2 | 12.5 |
| fiberglass | 12 | 75 |
| Tank age | | |
| blank | 3 | 18.75 |
| 0-5 yrs | 5 | 31.25 |
| 6-10 yrs | 7 | 43.75 |
| 11-15 yrs | 1 | 6.25 |
| >15 yrs | 0 | 0 |
| Pipe material | | |
| fiberglass | 16 | 100 |
| Pipe containment | | |
| blank | 2 | 12.5 |
| none | 4 | 25 |
| dispenser | 1 | 6.25 |
| turbine | 7 | 43.75 |
| dispenser/turbine | 2 | 12.5 |
| Pipe pumping | | |
| pressure | 14 | 87.5 |
| conv. Suction | 1 | 6.25 |
| safe suction | 0 | 0 |
| gravity | 1 | 6.25 |
| Interstitial LD | | |
| yes | 6 | 37.5 |
| no | 10 | 62.5 |
| Sump LD | | |
| yes | 1 | 6.25 |
| no | 15 | 93.75 |
| Release Source | | |
| blank | 8 | 50 |
| dispenser | 3 | 18.75 |
| piping/dispenser | 1 | 6.25 |
| spill | 1 | 6.25 |
| unknown | 3 | 18.75 |

# APPENDIX A-1

## UST Survey Form for Data Review
## California State Water Resources Control Board

UST Survey Form for Data Review
California State Water Resources Control Board

## Agency Information

Reviewer: _____ Agency: _____ Date: _____

## Site Information

Site name : _____

Address _____ _____ _____
Street Address City County

Facility type ☐Retail Gasoline Outlet ☐Other _____

## System Information

Tank : Material: ☐Bare Steel ☐Mfr. C.P. ☐Retrofit C.P. ☐Lined + C.P. ☐Clad ☐Fiberglass ☐Other

Walls: ☐Single wall ☐Double wall

Product: ☐Gasoline ☐Diesel

Age: ☐< 5 yrs ☐5-10yr ☐11-15yr ☐>15yr

Upgrade: ☐Spill ☐Overfill ☐ Striker Plate

Piping:

Material: ☐Bare steel ☐C.P. ☐Rigid fiberglass ☐Flexible

Walls: ☐Single ☐Double

Age: ☐<5yr ☐5-10yr ☐11-15yr ☐>15yr

Containment: ☐Dispenser ☐Turbine ☐None

Pumping: ☐Pressure ☐Conventional Suction ☐Safe suction ☐Gravity

## Leak Detection

Method(s) used at time release identified, or at closure if no release:

☐MIR ☐ Sump dispenser containment LD ☐SIR (Brand/Model_____)

☐TT (Brand/Model_____) ☐PT (Brand/Model_____)

☐INT (Brand/Model_____) ☐ATG (Brand/Model_____)

☐GW (Brand/Model_____) ☐Vadose (Brand/Model_____)

☐Mech. LLD (Brand/Model_____) ☐Elect. LLD (Brand/Model_____)

Last TT? ☐Pass ☐Fail ☐Inconclusive Date _____

Last PT? ☐Pass ☐Fail ☐Inconclusive Date _____

Last SIR? ☐Pass ☐Fail ☐Inconclusive Date _____

## Release Information

Date of confirmed release _____

Cause: ☐Physical damage ☐Corrosion ☐Mechanical failure ☐ Loose Fitting ☐ Overfill

☐Faulty installation ☐ Structural Failure ☐ Spill ☐Unknown ☐Other _____

Source: ☐Tank ☐Piping ☐Dispenser ☐Spill ☐ Overfill ☐ Unknown ☐Other _____

How identified? ☐LD method(s) specify _____ ☐Closure/Removal ☐Other _____

Estimated age release: ☐Recent (< 1yr) ☐Old (>1yr) ☐Unknown

Estimated extent ☐Localized tank ☐Localized piping ☐Localized Dispenser ☐Large (beyond excavated area) ☐Off-site

Product release: ☐Gasoline ☐Diesel

# Instructions

Please exercise your best professional judgment when reviewing the files and completing the survey form.

**System Information**

Material: Please note the material the tank is made of.
Walls: Please note whether the tank is single or double walled.
Product: Please note the contents of the tank at the time of your inspection.
Age: Please provide the age of the tank system. If the site has multiple tanks of different ages, please note that. If this is the case, and there is a release, please note which tank had the release.
Upgrade: Please note whether the tank(s) have spill and overfill devices in place.
Piping: Please note the material of the pipes carrying product.
Walls: Please note whether the pipes are single or double walled.
Age: Please provide the age of the tank system. If the site has piping of different ages, please note that. If this is the case, and there is a release, please note which piping had the release.
Containment: This section refers to the presence or absence of containment sumps under the dispenser or over the tank. Please check the appropriate box if a sump is present.
Pumping: Please note the type of pumping system.

## Leak Detection

To the best of your knowledge, please note the type of leak detection equipment at the site, and whether it was operational at the time of the inspection.
Last Tank Tightness Test (TT): Please note the result of the last tank tightness test.
Last Piping Tightness Test (PT): Please note the results of the last piping tightness test.
Last Statistical Inventory Reconciliation (SIR): If SIR was used at the site, please note the results of the last SIR test.

**Release Information**

Confirmed release date: If the release is discovered at the time of the inspection, please use the date of the inspection. If you have more definite information regarding the release date, please use that date.
Cause/Source: Based upon your best judgment please note the cause and source of the release. For purposes of this survey, please consider a tank leak as any breach in the tank and not directly a part of any piping connection; a piping leak to be any release from any portion of the piping (except as defined as a dispenser leak) up to and including connections to the tank; dispenser leaks are any releases from those portions of the piping which, if the piping is double walled, would be on the dispenser side of the terminus of the double walled condition, or if single walled, those portions of the piping which are exposed above grade under a dispenser.
How identified: Specify how you identified the presence of a release.
Estimated Age: Please estimate the age of the release. If there is evidence of multiple releases, please note that and estimate the age of all releases.
Estimated Extent: Please note the estimated extent of the release, based upon any and all information available to you at the time of the inspection and your best professional judgment.
Product Released: Please note the type of product released. If multiple releases are present, please note all products released.

## *Key to abbreviations*

| | | | |
|---|---|---|---|
| C.P. | Cathodic Protection | INT | Interstitial Monitor |
| LD | Leak Detection | TT | Tank Tightness Test (precision test) |
| MIR | Manual Inventory Reconciliation | PT | Piping Test (hydrostatic) |
| SIR | Statistical Inventory Reconciliation | ATG | Automatic Tank Gauging System |
| GW | Groundwater Monitoring System | Vadose | Vadose Zone Monitoring System |
| Mech. LLD | Mechanical Line Leak Detector | Elect. LLD | Electronic Line Leak Detector |

**Comments**

# APPENDIX A-2

## Current UST Site Survey Form
## California State Water Resources Control Board

Current UST Site Survey Form
California State Water Resources Control Board

**Agency Information** Reviewer: _____ Agency: _____ Date: _____

**Reason for inspection** ☐Removal ☐Repair ☐Release Investigation ☐Compliance Inspection
☐Other _____

**Site Information** Site name: _____

Address: _____ _____ _____
Street Address City County

Facility type: ☐Retail Gasoline Outlet ☐Other _____

**System Information**

Tank: Material: ☐Bare Steel ☐Mfr. C.P. ☐Retrofit C.P. ☐Lined + C.P. ☐Clad ☐Fiberglass ☐Other

Walls: ☐Single Wall ☐Double Wall

Product: ☐Gasoline ☐Diesel

Age: ☐<5yr ☐5-10yr ☐11-15yr ☐>15yr

Upgrade: ☐Spill ☐Overfill ☐ Striker Plate

Piping:

Material: ☐Bare steel ☐C.P. ☐Rigid Fiberglass ☐Flexible

Walls: ☐Single ☐Double

Product: ☐Gasoline ☐Diesel

Age: ☐<5 yr ☐5-10 yr ☐11-15 yr ☐>15 yr

Containment: ☐Dispenser ☐Turbine ☐None

Pumping: ☐Pressure ☐Conventional Suction ☐Safe suction ☐Gravity

**Leak Detection**

Method(s) used at time release identified, or at closure if no release:

☐MIR ☐ Sump dispenser containment LD ☐SIR (Brand/Model_____)

☐TT (Brand/Model_____) ☐PT (Brand/Model_____)

☐INT (Brand/Model_____) ☐ATG (Brand/Model_____)

☐GW (Brand/Model_____) ☐Vadose (Brand/Model_____)

☐Mech. LLD (Brand/Model_____) ☐Elect. LLD (Brand/Model_____)

Last TT? ☐Pass ☐Fail ☐Inconclusive Date: _____

Last PT? ☐Pass ☐Fail ☐Inconclusive Date: _____

Last SIR? ☐Pass ☐Fail ☐Inconclusive Date : _____

**Release Information**

☐No Release Suspected (skip remainder of section) Date of Confirmed Release: _____

Cause: ☐Physical Damage ☐Corrosion ☐Mechanical Failure ☐ Loose Fitting ☐Overfill

☐Faulty Installation ☐Structural Failure ☐Spill ☐Unknown ☐Other _____

Source: ☐Tank ☐Piping ☐Dispenser ☐Spill ☐Overfill ☐Unknown ☐Other _____

How identified? ☐LD method(s) Specify: _____ ☐Closure/Removal ☐Other _____

Estimated age of release: ☐Recent (< 1yr) ☐Old (>1yr) ☐Unknown

Estimated extent ☐Localized Tank ☐Localized Piping ☐Localized Dispenser ☐Large (beyond excavated area) ☐Off-site

Product released ☐Gasoline ☐Diesel ☐MTBE detected ☐Highest Level

# Instructions

This form should be completed only when USTs which contain gasoline or diesel fuel. The survey should be filled out even if there is no evidence of a leak. Please exercise your best professional judgment when evaluating the tank systems, their components and any possible release.

**System Information**

Material: Please note the material the tank is made of.
Walls: Please note whether the tank is single or double walled.
Product: Please note the contents of the tank at the time of your inspection.
Age: Please provide the age of the tank system. If the site has multiple tanks of different ages, please note that. If this is the case, and there is a release, please note which tank had the release.
Upgrade: Please note whether the tank(s) being inspected have spill and overfill devices in place.
Piping: Please note the piping material of the pipes carrying product.
Walls: Please note whether the pipes are single or double walled.
Age: Please provide the age of the tank system. If the site has piping of different ages, please note that. If this is the case, and there is a release, please note which piping had the release.
Containment: This section refers to the presence or absence of containment sumps under the dispenser or over the tank. Please check the appropriate box if a sump is present.
Pumping: Please note the type of pumping system.

## Leak Detection

To the best of your knowledge, please note the type of leak detection equipment at the site, and whether it was operational at the time of the inspection.
Last Tank Tightness Test (TT): Please note the result of the last tank tightness test.
Last Piping Tightness Test (PT): Please note the results of the last piping tightness test.
Last Statistical Inventory Reconciliation (SIR): If SIR was used at the site, please note the results of the last SIR test.

**Release Information**

Confirmed release date: If the release is discovered at the time of the inspection, please use the date of the inspection. If you have more definite information regarding the release date, please use that date.
Cause/Source: Based upon your best judgment please note the cause and source of the release. For purposes of this survey, please consider a tank leak as any breach in the tank and not directly a part of any piping connection; a piping leak to be any release from any portion of the piping (except as defined as a dispenser leak) up to and including connections to the tank; dispenser leaks are any releases from those portions of the piping which, if the piping is double walled, would be on the dispenser side of the terminus of the double walled condition, or if single walled, those portions of the piping which are exposed above grade under a dispenser.
How identified: Specify how you identified the presence of a release.
Estimated Age: Please estimate the age of the release. If there is evidence of multiple releases, please note that and estimate the age of all releases.
Estimated Extent: Please note the estimated extent of the release, based upon any and all information available to you at the time of the inspection and your best professional judgment.
Product Released: Please note the type of product released. If multiple releases are present, please note all products released.

***Key to Abbreviations***

| | | | |
|---|---|---|---|
| C.P. | Cathodic Protection | INT | Interstitial Monitor |
| LD | Leak Detection | TT | Tank Tightness Test (precision test) |
| MIR | Manual Inventory Reconciliation | PT | Piping Test (hydrostatic) |
| SIR | Statistical Inventory Reconciliation | ATG | Automatic Tank Gauging System |
| GW | Groundwater Monitoring System | Vadose | Vadose Zone Monitoring System |
| Mech. LLD | Mechanical Line Leak Detector | Elect. LLD | Electronic Line Leak Detector |

**Comments**