Hazardous Material Underground Storage Tank (UST)
Environmental Indicator Baseline Analysis

Baseline inspections of 96 randomly selected UST facilities (16% of the population, N=608) were conducted by the Office of Waste Management in 2004 using a *Facility Profile and UST Facility Inspection Report* compliance inspection checklist. This checklist contained 118 Y/N regulatory compliance questions (i.e., requiring a return-to-compliance plan for "N" responses) addressing tank corrosion protection, tank leak detection, piping corrosion protection, piping leak detection, spill prevention and overfill protection, spill containment, groundwater monitoring wells, and temporarily closed tanks. In all, more than 11,000 data points were entered into Excel worksheets by two college (undergraduate) interns. Each intern crosschecked the others data for completeness and accuracy. In addition, a third intern (graduate student in statistics) performed a data quality check on 10 of the 96 facility checklists.

All 118 environmental compliance indicators were segregated into three tables according to whether they could be used to measure sector performance improvements in future years. Table I contains 63 indicators that are potentially measurable depending upon future industry performance; i.e., it is mathematically possible to show statistically significant improvements in any of the listed indicators. Table II lists 31 indicators (26% of the total) that showed 98 to 100% compliance and, due to sample size or high performance at baseline, cannot be used to demonstrate statistically significant *improvements* in future years—these indicators may be used, however, to evaluate future trends (i.e., whether observed compliance rates are being sustained over time). Further, since most of the Table II indicators are technology/equipment driven (i.e., compliant equipment—such as, fill pipes equipped with drop tubes, drop tubes end within 6" of bottom, spill buckets have a minimum of 3 gal. capacity, hoses CARB certified—was installed prior to baseline audits), statistically significant compliance rate decreases in performance are unlikely to be found in future years. Table III lists 24 indicators that are not suitable for measurement purposes either due to small sample size (n=2/3) or because they did not apply to any of the facilities in the random sample at baseline. Therefore, only 63 of 118 original checklist questions/indicators (or 53%) have the potential to show statistically significant improvements in future years.

Facility Compliance at Baseline (2004)

Baseline compliance at the sampled facilities ranged from 0 to 100%, $p_1 \times 100$, for the 94 indicators listed in Tables I & II; the number of tanks per facility ranged from 1 to 7, resulting in an upper limit of 312 tanks for some indicators. In Table I, the median compliance rate proportion is shown to be 0.79 (Q_2, the second Quartile or 50^{th} percentile). A comparison between indicators in the first quartile (where 25% of the data are $\leq Q_1$), containing the lowest compliance rate proportions, to those in the upper quartile (where 25% of the data are $\geq Q_3$) shows that the lower Q_1 indicators relate predominantly to periodic equipment testing/calibration, recordkeeping and inspection requirements, whereas upper quartile indicators concern continuous operational or technology requirements—compliance rate proportions for these indicators range from 0.93 to 0.98. By comparison, indicators lying in the interquartile range (the mid fifty percent of the data, Q_1-Q_3) represent a mix of regulatory requirements; however, those

between Q_1 and Q_2 are weighted more heavily toward recordkeeping and inspections. Performance indicators listed in Table II are mostly related to compliant equipment and technology that were installed prior to baseline inspections and do not require a great deal of ongoing attention.

Measurement and Evaluation

In the traditional Environmental Results Program approach, a subset of Environmental Business Practice Indicators (EBPIs) are selected from the total universe of indicators prior to data collection. The general objective is to select, based upon expert opinion, a subset of indicators that can be used to measure sector-wide performance over time. This effort typically involves a deliberative process whereby collective decisions result in a short list of priority indicators. Potentially measurable indicators that are screened out during this process are not carried forward in the analysis.

By comparison, the approach used herein relies on baseline data to segregate compliance indicators into two categories: those that have the potential to show measurable improvement (Table I) and those that do not (Tables II and III). A deliberative process was not undertaken and upfront decisions were not made concerning the relative importance of one regulatory requirement over another, rather the process was driven soley by the data. Using this approach, 53% of the 118 UST checklist questions were found to be potentially measurable (in terms of statistical significance) and 47% not measurable; theoretically, a deliberative process not relying on baseline data would have had a ~50/50 chance of selecting nonmeasurable indicators as EBPIs.

Performance Measures

Using hypothetical runs of the Fisher Exact test, it was determined that responses to 63 of the original 118 UST compliance checklist questions could be used for performance measurement purposes—that is, calculations showed that it was mathematically possible to quantify statistically significant improvements (if observed) in these variables over time.[1] Rather than winnowing down the list of potentially measurable indicators, all 63 variables (Table I) will be carried forward in future performance measurement calculations. Using software that is readily available, this approach provides complete assurance that each area of noncompliance is identified and characterized. Since indicator variables were not screened out at the beginning of the process, all statistically significant changes in performance will be monitored over time. This method follows a traditional research path where all factors of potential importance are identified at the start of the investigation and then tracked and evaluated for relative impact; corrections for multiple comparisons are made during the analysis. Findings are ultimately used to shape and target intervention strategies.

[1] For example, Table I shows that of 13 tanks to which the indicator "E.16 Tightness tests annually +" applied, none ($p_1 = 0.00$) were in compliance with the identified regulatory standard at baseline. Trial runs of the Fisher Exact test using an online statistical program (http://home.clara.net/sisa/fisher.htm), showed that if a second round sample of facility inspections (post-intervention) were to result in a performance improvement of 33% (5/15 tanks), for example, then this difference (i.e., increase in compliance) would be statistically significant at the P<.03 level.

Table I. Potentially measurable performance improvement indicators, 2004 UST baseline data, n=96 facilities

	Environmental Business Practice Indicators *N = 608 Facilities*	Number of tanks (n_1)	Proportion in compliance p_1	95% LCL	95% UCL	MOE	
1	E.16 Tightness tests annually +	13	0.00	0.00	0.00	0.00	
2	E.17 Passing results for each rqd. Yr.	12	0.00	0.00	0.00	0.00	
3	B.21 Is system tested every 3 yrs + w/in 6 mos. of repair	19	0.11	-0.03	0.25	0.14	
4	I.4 Records of GW monitoring well checks for past 3 yrs.	56	0.20	0.10	0.30	0.10	
5	B.17 Records of all repairs/test results	15	0.27	0.05	0.49	0.22	
6	B.25 Records of all repairs/test results	19	0.37	0.15	0.59	0.22	
7	C.28 W/ ATG, >20 yrs: tightness test passing results, 2 yrs.	48	0.40	0.26	0.54	0.14	
8	B.11 Record rectifier readings every 60 dys/keep log	21	0.43	0.22	0.64	0.21	
9	B.13 Is system tested every 2 yrs + w/in 6 mos. of repair	18	0.44	0.21	0.67	0.23	
10	E.22 System calibrated and inspected last yr	24	0.46	0.26	0.66	0.20	
11	F.3 Inspect spill buckets daily	287	0.52	0.46	0.58	0.06	
12	E.4 Records of LLD tests for last 3 yrs.	240	0.60	0.54	0.66	0.06	
13	E.21 Records of system checks/repairs	29	0.62	0.44	0.80	0.18	
14	C.20 Monitoring system been calibrated/inspected past yr.	145	0.66	0.58	0.74	0.08	
15	E.12 System calibrated/inspected last yr	192	0.67	0.60	0.74	0.07	
16	I.5 Well caps closed tightly and locked	93	0.68	0.59	0.77	0.09	Q_1
17	C.14 ATG sys calibrated and inspected last yr	233	0.69	0.63	0.75	0.06	
18	B.16 System pass most recent test	14	0.71	0.47	0.95	0.24	
19	E.20 Continuously use interstitial monitoring	35	0.71	0.56	0.86	0.15	
20	E.11 Records of system checks/repairs	197	0.74	0.68	0.80	0.06	
21	I.2 Wells equipped w/road box and lock cap	92	0.74	0.65	0.83	0.09	
22	C.31 Records of inventory control	280	0.76	0.71	0.81	0.05	
23	F.11 Sumps free of water/debris/product	243	0.76	0.71	0.81	0.05	
24	F.2 Tank have operational spill containment device	294	0.76	0.71	0.81	0.05	
25	G.24 Employee(s) attended training session	312	0.76	0.71	0.81	0.05	
26	G.25 Training documentation maintained	312	0.76	0.71	0.81	0.05	
27	F.32 Inspected on a weekly basis	243	0.77	0.72	0.82	0.05	
28	G.26 System inspected weekly	312	0.77	0.72	0.82	0.05	
29	G.27 Inspection records maintained	312	0.77	0.72	0.82	0.05	
30	C.19 Records of monthly sys checks for past 36 mos.	151	0.78	0.71	0.85	0.07	
31	F.33 Records of inspection maintained at facility	243	0.78	0.73	0.83	0.05	
32	C.10 Use ATG to conduct leak rate tests	239	0.79	0.74	0.84	0.05	Q_2
33	C.12 Records of last 36 mos. leak test	194	0.80	0.74	0.86	0.06	
34	C.13 Records of last 36 mos. ATG sys checks	233	0.80	0.75	0.85	0.05	
35	E.7 Conducted tightness test w/in past yr	49	0.80	0.69	0.91	0.11	
36	C.30 Perform inventory control properly	273	0.84	0.80	0.88	0.04	
37	F.34 Fills and adapter tight	243	0.84	0.79	0.89	0.05	
38	F.8 Containment sump present	294	0.84	0.80	0.88	0.04	
39	C.11 Recent ATG leak rate tests pass	185	0.85	0.80	0.90	0.05	
40	F.12 Sumps have sensors	245	0.85	0.81	0.89	0.04	
41	I.3 Wells equipped w/ pipe not screened at top	92	0.85	0.78	0.92	0.07	
42	F.13 Sensors upright and at correct height	214	0.86	0.81	0.91	0.05	
43	F.19 Qualified UST contractor check device	263	0.86	0.82	0.90	0.04	
44	F.15 Sensors mounted properly	212	0.87	0.82	0.92	0.05	
45	F.31 Drop tube gasket in good condition	243	0.88	0.84	0.92	0.04	
46	C.26 W/ ATG, <20 yrs: tightness test passing results	64	0.89	0.81	0.97	0.08	
47	G.8 Operating instruction stickers posted	312	0.93	0.90	0.96	0.03	
48	I.6 Are any well caps submerged under water	92	0.93	0.02	0.12	0.05	Q_3
49	C.7 Leak detection system currently operating properly	280	0.93	0.90	0.96	0.03	
50	F.39 Poppet cap/gasket in good condition	243	0.93	0.90	0.96	0.03	
51	E.10 Interstitial monitoring for leaks	211	0.94	0.91	0.97	0.03	
52	F.17 Secondary piping test boot disconnected	219	0.94	0.91	0.97	0.03	
53	E.1 Leak detection method in place for each run	280	0.95	0.92	0.98	0.03	
54	F.14 Sensors functioning properly	211	0.95	0.92	0.98	0.03	
55	F.6 Fill pipes/box covers labeled/marked	295	0.95	0.93	0.97	0.02	
56	G.17 Nozzle spouts tight	312	0.95	0.93	0.97	0.02	
57	G.13 Face plates/vapor guards intact	312	0.96	0.94	0.98	0.02	
58	G.14 Hoses intact	312	0.96	0.94	0.98	0.02	
59	C.18 Continuously use interstial monitoring for leaks	173	0.97	0.94	1.00	0.03	
60	G.9 Nozzles CARB certified	312	0.97	0.95	0.99	0.03	
61	B.1 Corrosion protection for each tank	271	0.98	0.96	1.00	0.02	
62	C.1 Have leak detection in place for each tank	264	0.98	0.96	1.00	0.02	
63	D.1 Corrosion protection for piping (each tank)	281	0.98	0.96	1.00	0.02	

Notes: LCL = Lower Confidence Limit; UCL = Upper Confidence Limit; MOE = Margin of Error
Q_n = Quartile

Table II. UST performance trend indicators*, n=96 facilities at baseline (2004)

	Performance Trend Indicators	Number of tanks (n_1)	Proportion in compliance p_1	95% LCL	95% UCL
1	F.24 Device set to shutoff at 95% full	58	0.98	0.94	1.02
2	C.33 Measure water in tank once every 30 dys	279	0.99	0.98	1.00
3	F.16 Boots sealed to prevent infiltration	238	0.99	0.98	1.00
4	F.18 Properly operating overfill protection	293	0.99	0.98	1.00
5	F.35 Swivel/rotatable fill adapters installed	147	0.99	0.97	1.01
6	F.37 Drop tubes intact	239	0.99	0.98	1.00
7	F.7 Tank equipped w/ submerged fill drop tube	291	0.99	0.98	1.00
8	G.21 10" loop or less	312	0.99	0.98	1.00
9	B.10 Cathodic protection system operate continuously	21	1.00	1.00	1.00
10	B.20 Cathodic protection operate continuosly	20	1.00	1.00	1.00
11	B.24 System pass most recent test	14	1.00	1.00	1.00
12	C.32 Measuring equip. nearest 1/8th" over tank height	279	1.00	1.00	1.00
13	F.1 Tank fill equipped w/ spill containment	294	1.00	1.00	1.00
14	F.21 Device set for 90% full	55	1.00	1.00	1.00
15	F.22 Alarm audible/visible to delivery person	66	1.00	1.00	1.00
16	F.26 Set to restrict flow when tank 90% full	180	1.00	1.00	1.00
17	F.30 Used during all gasoline refueling	240	1.00	1.00	1.00
18	F.36 Fill pipe equipped w/ drop tube	239	1.00	1.00	1.00
19	F.38 Drop tube end w/in 6" of tank bottom	231	1.00	1.00	1.00
20	F.4 Spill bucket surrounded by impervious surface	287	1.00	1.00	1.00
21	F.43 Proper vent valve	243	1.00	1.00	1.00
22	F.5 Spill bucket capacity >=3 gal.	294	1.00	1.00	1.00
23	G.10 Hoses CARB certified	311	1.00	1.00	1.00
24	G.11 Breakaways CARB certified	312	1.00	1.00	1.00
25	G.12 Swivels CARB certified	312	1.00	1.00	1.00
26	G.15 Hose retractors intact	312	1.00	1.00	1.00
27	G.16 Nozzel check valves operating	312	1.00	1.00	1.00
28	G.18 Nozzle bellows intact	312	1.00	1.00	1.00
29	G.19 Clamps in place on bellows	312	1.00	1.00	1.00
30	G.20 Hoses not contacting ground	308	1.00	1.00	1.00
31	G.22 Liquid removal device in hose	312	1.00	1.00	1.00

Notes: LCL = Lower Confidence Limit; UCL = Upper Confidence Limit

*These indicators can not be used to measure performance improvement, but are useful for tracking data trends related to whether performance is maintained over time.

Table III. UST indicators not measurable at 2004 baseline, n=96 facilities

	Indicators Not Measurable	Number of tanks (n)	Proportion in compliance p_1
1	B.6 Tanks pass most recent liner inspection	2	1.00
2	C.24 No ATG: Tightness test passing results for past 5 yrs.	3	0.00
3	D.6 Cathodic protection system operate continuously	0	NM
4	D.7 Inspect rectifier every 60 dys/keep log	0	NM
5	D.9 System tested every2yrs/6mos. of repair	0	NM
6	D.12 System pass most recent test	0	NM
7	D.13 Records of repairs/test results	0	NM
8	D.16 Cathodic protection sys operate contin.	0	NM
9	D.17 System tested every 3 yrs.	0	NM
10	D.20 System pass most recent test	0	NM
11	D.21 Records of repair/test results	0	NM
12	F.28 Stage I vapor recovery installed	0	NM
13	F.40 Poppet cap close tight	0	NM
14	F.41 Vapor lid in good condition	0	NM
15	F.42 Vapor lid color-coded orange	0	NM
16	G.7 Stage II vapor recovery installed	0	NM
17	G.23 Nozzles out of service/tagged out	0	NM
18	G.28 Defective parts repaired/replaced	0	NM
19	G.29 All three test performed annually	0	NM
20	G.30 Leak test annually	0	NM
21	G.31 Vapor space tie test annually	0	NM
22	G.32 Ten-gal per minute test annually	0	NM
23	G.33 Air to liquid ratio test performed annually	0	NM
24	G.34 Records of all Stage II testing maintained	0	NM

Notes: NM = Not Measured