Equipment Leaks of VOCs and VHAPs
Leak Detection and Repair (LDAR) Programs

PROBLEM:

EPA estimates that an additional 80 million pounds of volatile organic compounds (VOCs), including volatile hazardous air pollutants (VHAPs), are emitted annually from petroleum refineries because leaking valves are not found and repaired. EPA's National Enforcement Investigation Center (NEIC) investigations of the quality of leak detection and repair (LDAR) programs at 17 petroleum refineries has shown a pattern of significantly higher equipment leak rates than the refiners reported. This discrepancy is most likely due to refiners or their contractors deviating from the requirements of Method 21 - Determination of Volatile Organic Compounds Leaks (Method 21). EPA believes that most of the difference in leak rates is due to improper monitoring techniques (the greatest error being not spending enough time at each component).

BACKGROUND:

Why regulate equipment leaks of VOCs and VHAPs?

- VOCs are regulated because they contribute to ozone formation

- VHAPs are regulated because they are hazardous to human health (e.g., benzene and vinyl chloride are on OSHA's list of carcinogens)

- Equipment leaks at refineries are responsible for significant amounts of emissions.

    For example, according to the 1997 TRI Report, of the 50.4 million pounds of toxic pollutants released to air, 25.8 million pounds (51.2%) are fugitive emissions (note: not all fugitive emissions are covered by LDAR programs)

    According to EPA's AIRS database, 227,320 tons per year (TPY) of VOC are reported for petroleum refineries (petroleum refineries account for less than 0.7% of the facilities but more than 12.7% of total AIRS VOC inventory). If we assume the same fugitive percentage as for TRI this means over 116,000 tpy of VOC from refineries are fugitive emissions.

Intent of Equipment Leak Regulations:

The intent of equipment leak regulations is to reduce/eliminate VOC emissions from leaking equipment using a monitoring work practice to find leaks so that they can be fixed. This is achieved by establishing an LDAR program where components requiring monitoring are identified and then monitored at specified intervals to determine whether or not they are leaking. The leaking components must then be repaired or replaced.

Refineries have a large number of components (in some cases, over 100,000 components) such as seals, valves, connectors, pumps, compressors and pressure relief devices that may leak VOCs. Therefore it is important for refiners to implement a tracking program to ensure that all components are monitored on a regular basis and repaired in a timely manner. When the LDAR requirements were developed, it was estimated that emissions from equipment leaks could be reduced by 63% at petroleum refineries by implementing an LDAR program. In some cases NEIC has found leak rates higher than what was assumed for a refinery if standards for equipment leaks did not exist. Therefore, implementing a properly run LDAR program could reduce emissions from equipment leaks by more than 63% over an uncontrolled facility.

Regulatory Requirements:

LDAR programs can be implemented through SIP, NSPS, NESHAP or other state or local requirements and vary in stringency. LDAR programs have many elements in common, such as:

1. Targeting monitoring of components by type
2. Leak definitions (based on concentration)
3. Monitoring frequency (e.g., weekly, monthly, or annually)
4. Record keeping
5. Use of Method 21 for the methodology to detect leaks[1]

LDAR programs consist of three phases (1) identification or tagging of regulated equipment; (2) monitoring potential fugitive emission sources (usually on a process unit basis) to detect leaks and tagging any detected leakers; and (3) repair or replacement of the leaking component. For a leaking component, most rules require a first attempt at repair within 5 days of leak detection component and final repair within 15 days. However, any component that cannot be repaired must be placed on a list to be repaired at the next shutdown cycle. Intervals for monitoring and leak definitions vary by regulatory subpart and component type.

Federal equipment leak standards can be found in the New Source Performance Standards (NSPS), 40 CFR Part 60, and the National Emission Standards for Hazardous Air Pollutants (NESHAP), 40 CFR Part 61 and Part 63. NSPS applies to stationary sources constructed, modified or reconstructed after the date that an NSPS is proposed in the Federal Register. NESHAP requirements apply to both new and existing stationary sources. Equipment leaks of benzene are regulated under Part 61 NESHAP.

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[1]A portable instrument (i.e., Organic Vapor Analyzer (OVA) or Toxic Vapor Analyzer (TVA)) is used to detect leaks from individual components. The instrument must meet specific performance criteria based on response time, response factors and precision. In general the full length of the potential leak interface must be probed to locate the maximum reading on the instrument. Then the probe is placed at the point of maximum reading for approximately twice the response time of the instrument to obtain the maximum instrument reading.

INVESTIGATIONS:

Currently, many regulatory agencies determine the compliance status of an LDAR program based on a review of submitted paperwork. Some conduct walk-through inspections consisting of a review of the LDAR records maintained onsite along with a visual check on the monitoring practices. Onsite records review may identify components or process units missing from the LDAR program or may reveal that leaking components are not being repaired within the required time period. A visual check on monitoring practices may reveal open-ended lines (caps on the end of the lines were either missing or not in place). However, the typical walk-through inspection will not likely detect improper monitoring since operators will tend to ensure that they are following proper procedures when they are being watched.

To address the limitations of the walk-through inspection for determining compliance, NEIC has conducted a number of sampling investigations of LDAR programs at petroleum refineries, which consist of records review and comparative leak monitoring (comparing the leak rate found by NEIC to the facility's historic leak rate) at a subset of the facilities' total components. These investigations have shown that the leak rates at many refineries is much higher than the refiners have reported. NEIC's results showed that for the first 17 investigations the facility reported leak rate average was 1.3% while the NEIC inspectors found a leak rate average of 5% - nearly four times as many leaks as reported by the refiners. Each leak not detected is not repaired and results in a lost opportunity to reduce emissions from refineries.

The discrepancy in leak rates between self reporting and sampling investigations has raised questions regarding the petroleum refining industry's compliance with the LDAR regulations in general and with the work practice requirements specified under Method 21 in particular. Many refiners hire contractors to implement the LDAR program and test for leaks (monitor for leaks and make first attempt at repair). Most of the rest use in-house personnel to implement the program. A few facilities use both contractors and in-house personnel to implement the program. In many cases, there appears to be little internal quality control oversight of or accountability for the LDAR program regardless of whether the monitoring is done by contractors or in-house personnel.

In most of the cases below, the companies' monitoring personnel (in-house or contractor), using their own monitoring equipment (OVA's or TVA's), confirmed the leaks found by NEIC. In the few cases (less than ten valves) where the company could not confirm a leak found by NEIC, that leak was not included in the statistics. Since the companies used their own monitoring equipment to confirm the leaks found by NEIC, the fact that NEIC found more leaks can not be due to the differences in monitoring equipment. The only possible explanation is differences in the monitoring technique used in self-reporting and the sampling investigations. Note: The companies did not monitor the valves identified by NEIC as nonleakers. If there were significant differences between the precision and accuracy of the companies' monitoring equipment and NEIC's monitoring equipment, it is possible that had the companies monitored those nonleaking valves, their monitoring equipment may have detected additional leaks (ones not identified by NEIC). Therefore, while NEIC ruled out the possibility of their equipment being able to find more leaks than the companies' equipment, NEIC did not rule out the possibility that there could be differences in monitoring equipment where the companies should find more leaks than NEIC.

Comparative Monitoring Results for 17 Facilities

	Company Monitoring: Valves/Leaks	NEIC Monitoring: Valves/Leaks	Leak Rate (%)		Emissions Rate (lb/hr)		
			Company	NEIC	Company	NEIC	
A	7694/170	3363/354	2.3	10.5	38.8	106.6	67.8
B	7879/223	3407/216	2.8	6.3	44.0	73.5	29.5
C	3913/22	2008/108	0.6	5.4	18.3	90.1	71.8
D	2229/26	1784/24	1.2	1.4	15.5	17.1	1.6
E	5555/96	2109/112	0.7	5.3	50.7	125.8	75.1
F	42505/124	3053/53	0.3	1.7	154.7	382.3	227.6
G	14370/226	3852/236	1.6	6.1	122.2	369.7	247.5
H	20719/736	3351/179	3.6	5.3	332.2	469.7	137.5
I	5339/9	2754/84	0.2	3.1	16.9	76.6	59.7
J	8374/78	2981/55	0.9	1.8	50.8	78.5	27.7
K	6997/101	1658/114	1.4	6.9	56.1	201.2	145.1
L	12686/26	3228/125	0.2	3.8	34.9	84.0	49.1
M	4160/40	1926/222	1.0	11.5	25.7	192.2	166.5
N	5944/29	2487/106	0.5	4.3	26.1	112.3	86.2
O	7181/112	2897/130	1.6	4.5	60.8	140.9	80.1
P	8532/203	4060/181	2.4	4.5	98.8	167.5	68.7
Q	6640/36	2608/74	0.5	2.8	30.5	87.5	57.0

			(average)			

Method for Monitoring:

NEIC's investigations have centered around the issue of proper leak detection. Method 21 applies to the determination of VOC leaks from process equipment (i.e., valves, flanges and other connections, pumps, compressors, etc.). Measuring mass emissions from thousands of components at a typical refinery is not economically practical, so the emission standards set in the various regulations is a limit on the concentration of VOCs emitted from leaking components. A portable instrument, meeting certain specifications and performance criteria, is used to detect VOC leaks from individual sources. As specified in the definitions section of Method 21, the concentration of VOCs emitted from the leaking component is **at the surface interface** (e.g., at the interface between a valve stem and packing or yoke) of the leaking source.

The specifications for the monitoring instrument require that:

- the instrument be able to respond to the compounds being processed;
- both the linear response range and measurable range of the instrument encompass the leak definition;
- the scale of the instrument meter be readable to ± 2.5%;
- an electrically driven pump be used to ensure that a sample is provided to the detector at a constant flow rate and that the nominal flow rate at the tip of the probe be 0.10 to 3.0 liters per minute;
- the instrument be intrinsically safe;
- the probe or probe extension not exceed ¼ in. in outside diameter.

The performance criteria for the monitoring instrument require that:

- the response factor for each VOC to be measured be < 10;
- the response time be ≤ 30 seconds;
- the calibration precision be ≤ 10% of the calibration gas value.

Procedures for monitoring:

- assemble and start up the VOC analyzer - after warmup period calibrate the instrument

- for individual Type I source surveys (this applies to the most common sources):

  Place the probe inlet at the surface of the component interface where leakage could occur. Move the probe along the interface periphery while observing the instrument readout. If an increased meter reading is observed, slowly sample the interface where leakage is indicated until the maximum meter reading is obtained. Leave the probe inlet at this maximum observed meter reading location for approximately two times the instrument response time. If the maximum observed meter reading is greater than the leak definition in the applicable regulation, record and report the results as specified in the regulation.

Method 21 then goes on to provide examples of where to sample for leaks at different types of components.

<u>Compliance issues:</u>

As leaking gas exits the equipment, its concentration will be 1 million parts per million (100%), but as the gas diffuses into the atmosphere, the concentration in the plume will decrease. The larger the leak, or the greater the mass flow rate of the leak, the higher the concentration will be as it moves away from the leak interface. Because the gas from an equipment leak is pulled into the probe under slight negative pressure, the probe dilutes the concentration by pulling in ambient air from around the leaking component. Thus, Method 21 has a very limited distance of effectiveness. The instrument's effectiveness at capturing the leaking gas decreases very rapidly with distance from the leak interface and the inlet to the probe (thus the limit on maximum outside diameter of the probe). Several probe diameters away from the probe inlet (maybe even less than a half inch), there can be almost negligible capture. The poor capture capability of the analyzers makes them especially sensitive to changes in gas flow rates through the analyzer. As the flow rate decreases, the ability to draw in the emission plume decreases. This increases the importance of keeping the probe in close proximity to the component and trying various orientations.

In some cases, leaks may be so great that the operator wants to avoid flame out or condensation problems. In cases where the leak definition is exceeded before monitoring at the interface, there is no need to move the probe closer (e.g., the leak definition is 1000 ppm and the instrument shows a VOC concentration of 10,000 ppm ½ an inch away from the valve housing/valve stem interface, the probe does not need to be moved closer). The concern for flame out or condensation should not discourage the operator from monitoring at the interface surface when leaks are not that great. Finally, monitoring activities should be minimized during rain to avoid problems with water entering the analyzer.

Rules of thumb and actual examples that show deviations from those rules of thumb:

Rule of thumb 1)

A well trained LDAR inspection team (two people) can monitor approximately 500 - 700 valves per day

Example of deviation of Rule from thumb 1:

One person monitoring 1800 difficult to monitor valves (valves that cannot be monitored without elevating the monitoring personnel more than 2 meters above a support surface) in one day.

Rule of thumb 2:

Typical OVA response times are around 5 - 8 seconds.

Example of deviation from Rule of thumb 2:

One person monitoring 8000 components in one day (assuming an 8 hour work day, that represents one component every 3.6 seconds).

Rule of thumb 3:

Typical TVA response times are around 2 - 4 seconds.

Example of deviation from Rule of thumb 3:

Data logger time stamp showing valves being monitored at the rate of one per second with an occasional 2 valves being monitored within the same one second period.

Likely explanation for leak rate differences:

1) Not monitoring.

In one particularly egregious case, automatic data logger information revealed that one person recorded a measurement for leaks at an average rate of one valve every two or three seconds for an entire work shift. According to the automatic data logger, the worker occasionally monitored more than one valve in a one second period. Monitoring multiple valves in one second is physically impossible since measuring multiple valves in one second is shorter than the time it would take to walk from one valve to the next in many cases. Even if it were possible to move the monitor from one valve to another and take a reading in less than one second, no monitor has a response time fast enough to allow that rate of sampling and the operator still be following Method 21 procedures properly. This means the worker was merely pulling the trigger without monitoring any components.

2) Not taking long enough to find leak.

A worker may monitor the component, but move the probe around the component interface so rapidly that the instrument doesn't have time to properly respond.

Additionally, the worker may not spend twice the response time at the maximum leak location identified for that component

3) Holding probe away from interface:

California's Bay Area Air Quality Management District rule effectiveness study showed that if an operator measured 1 centimeter (0.4 inches) from the component leak interface the operator would only find 79% of valves leaking between 100 ppm and 500 ppm and only 43% of the valves leaking above 500 ppm.

DESIRED OUTCOME:

Ensuring Future Compliance:

In order to ensure future compliance with the LDAR requirements, refiners need to adopt a "model" LDAR program. Programs with most or all of the elements described below have been able to achieve a consistent leak rate of approximately 0.5%.

Elements of Model LDAR (summed up as independent audits and beyond compliance):

- more frequent monitoring

Some refiners have used operators to routinely check for equipment leaks in between their regularly scheduled monitoring for LDAR compliance. For example, at a facility that elects to comply with the alternative standards for valves, operators may monitor the components of a process unit for leaks once/month in addition to their quarterly or annual LDAR monitoring.

- lower leak definition

The internal leak definition is fixed at or below lowest regulatory leak definition for all components. This allows components that start leaking to be fixed before they meet the leak definition and therefore, never officially leak. This also simplifies the LDAR program if subject to multiple leak definitions.

• inspector training

Reinforces importance of proper monitoring

• empowered LDAR program coordinator

Has authority and resources to properly run LDAR program

• ownership/accountability

Improves quality of monitoring program when people know the quality of their work is important

• continual review of components/process unit status

This helps ensure that not components or process units are inadvertently left out of the LDAR program.

• data loggers

A quick review of data logger information can show whether or not someone is not spending enough time to monitor individual components.

• rewards/penalties

Encourages desired behavior

• review for "repeat" leakers and installation of improved technology (leakless components)

Improves preventative maintenance and simplifies monitoring program when components are replaced with certain "approved" technologies designed to reduce/eliminate leaks

• independent program audits (including comparative monitoring)

Comparative monitoring ensures a high quality LDAR program through independent verifiable quality checks

APPENDIX

On its face, enforcing the LDAR work practice is problematic. When the percentage of leak rates detected by an inspection results in a discrepancy from the facility reported leak rate, it is difficult to show whether the discrepancy is due to continuing leaks (which should have been detected by testing i.e. a violation) or new leaks which were not present during the last testing cycle (no violation). Thus, we have to develop an enforcement program for LDARs that can accurately detect when industry or their contractors are under reporting leaks.

Investigations of a company's LDAR program should include an audit of the program. This includes a review of the company's LDAR database or records, reports, and information recorded by dataloggers.

Comparative monitoring:

Objective:

To determine if personnel (in house or contractor) are monitoring properly using the work practices required by Method 21, the audit must include comparative monitoring (assuming obvious violations are not detected through the paperwork/database audit).

Theory:

The idea is that using equipment that meets the specifications contained in Method 21 should allow a facility operator to find "major leakers" (components that have high mass emissions) indirectly by measuring VOC concentration at the individual components. For a population of components, there is a correlation between VOC concentration measured using Method 21 and mass emissions. Method 21 is designed to locate and classify leaks, and is not a direct measure of mass emission rates from individual sources. There are a number of potential sources of error in determining whether or not a component is "leaking." We will assume that for many leaks, the components leak consistently above the leak definition (e.g., the leak is not an intermittent leak). Using equipment that meets the specifications required under Method 21, sources of error include:

calibration gas error (± 2%);

error between the analyzer reading and the calibration gas (precision ± 10%);

error between the analyzer and sampled gas (affects response factor which must be > 10);

error in reading the analyzer meter (± 2.5%);

NEIC asked the refiners or their contractors to confirm the leaks that they had found. Sixteen of the seventeen companies chose to accompany NEIC and attempt to confirm the leaks. Where the companies did monitor, there were less than 10 valves that the refiners or their contractors could not confirm. They did confirm approximately 2,000 leaks at valves. The companies did not confirm the valves identified by NEIC as nonleakers therefore, the companies' true leak rates could be higher if it is due to differences in equipment but it is assumed that their results would have been similar to NEIC's.

With that background we need to determine if it is reasonable that NEIC consistently finds more leaks that the refiners report in their LDAR program. The LDAR work practice requires a complete survey of all components on the monitoring list. Because NEIC does not have the resources to monitor all of the components subject to LDAR requirements at all of the refineries, for its investigations, NEIC monitors a subset of each refinery's component population. Therefore, the NEIC results are an estimate of the leak rate (specifically for the process units monitored at the facility and possibly for the facility as a whole) at the time of monitoring. However, the leak rates estimated from the sample are sufficiently accurate to demonstrate in most cases a clear difference from the stated process units leak rates obtained in the last inspection or the facility's historic leak rate average for the same process units monitored by NEIC.

For the sake of simplicity, the following discussion will consider a single component type, say valves. During the time period of an enforcement inspection, there will be a fixed but unknown number of leaking components. Denote this number as L and the total number of valves as N. Say the inspection sample obtains l leaking valves out of n inspected components. Assuming that the sample is random, the probability of obtaining the observed sample results, given L and N, is given by the hypergeometric distribution, so that

$$P(l|N,L,n) = \frac{\binom{N-L}{n-l}\binom{L}{l}}{\binom{N}{n}}$$

where $\binom{L}{l} = \frac{L!}{(L-l)!l!}$. The total number of leaking valves can be estimated by the use of Bayes' theorem, so that

$$P(L|N,l,n) = \frac{P(l|N,L,n)P(L|N)}{\sum_i P(l|i,N,n)P(i|N)}$$

The quantity $P(L|N)$ is known as the prior distribution. If this distribution is uniform for each value of L in N and for the large sample sizes typical of the NEIC inspection, then this value will cancel and the estimates obtained through Bayes' theorem will be equivalent to those obtained using the maximum likelihood method. The quantity in the denominator is not simple but can be easily calculated using a computer. All calculations here were made with the S-Plus statistical software package.

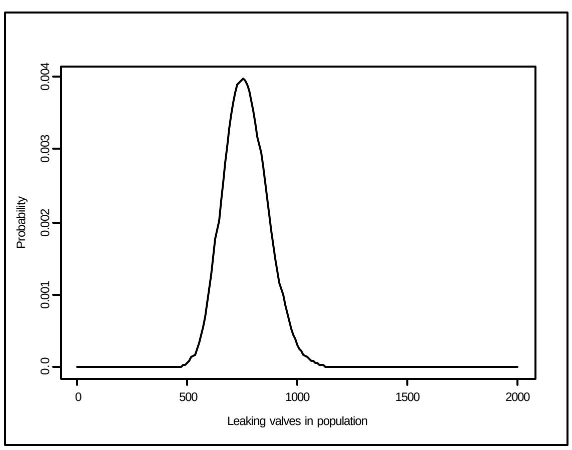
As an example, consider Facility F. There are 42,505 components and there were 124 leaking components claimed at the last inspection. The sampling inspection found 53 leaking components in a sample of 3,053 components. The probability of obtaining 53 leaking components in this sample may be obtained as

$$P(l|N,L,n) = \frac{\binom{42{,}505-124}{3{,}053-53}\binom{124}{53}}{\binom{42{,}505}{3{,}053}}$$

The denominator in Bayes' theorem was evaluated numerically to be 1.44. Thus, the probability distribution for L is

$$P(L|N,l,n) = 0.693\frac{\binom{42{,}505-L}{3{,}053-53}\binom{L}{53}}{\binom{42{,}505}{3{,}053}}$$

This distribution can be calculated for various values of L. A graph of this distribution is shown in Figure 1. Over 95% of the probability mass for L is located between 570 and 980. Thus, obtaining a leak rate of 124 is very unlikely given the sampling results.



This technique can be applied to the other inspected facilities to calculate the probability of obtaining the facility leak rate or less given the results of the NEIC sampling inspection. For 11 of the 17 inspections, there were more components identified as leaking in the sample then claimed for the entire facility in the last inspection. Thus, the probability that the leak rate at the time of the NEIC inspection was less than or equal to the facility leak rate at the last reporting is 0. In other words, sampling error cannot explain the discrepancy between the two inspection results. For the remaining 6 facilities, this probability is

Facility	$P(L \leq FLR \mid N,l,n)$
B	$<10^{-20}$
D	.017
F	3.5×10^{-11}
H	1.7×10^{-10}
J	4.3×10^{-11}
P	1.8×10^{-11}

Only in facility D is there a reasonable probability that the leak rate at the time of monitoring was the same as at the previous LDAR inspection.

Calculation of these probabilities depend upon the assumption that sampling was random. However, components were not selected randomly. Usually, all readily accessible components are selected from certain process units. Since the difficult to monitor components were not included, it is expected that the expected number of leaking components within each process unit would be greater since the difficult to monitor components are less likely to be monitored or repaired. The possible selection bias due to selection of process units can often be controlled for because many facilities report leak rates by process units.

Another possible factor in the discrepancy is differences in the performance of Method 21. However, because industry representatives confirmed the leak determinations of 2000 of 2010 components, analytical bias does not explain this difference.

Because sampling cannot explain the observed discrepancy, the only other possible explanation is that the number of leaking components is underestimated during the industry survey. If every valve is surveyed, then there must be a systematic bias in the performance of Method 21.

A more simplistic model that is used for large populations may be used to quickly determine if there is a significant difference between monitoring techniques. This model may not be as accurate as the model above, but should be sufficient as a quick check. Given that NEIC has shown that companies were able to confirm leak rates as measured by NEIC, we can assume that the leak rate differences are not due to differences in equipment calibrations etc. The only possible differences are random error or monitoring techniques. Using a standard simplified method for determining confidence interval levels and an example of NEIC monitoring results we can show that it is extremely unlikely that random error accounts for the leak rate difference.

The probability that the leak rate in the population of valves is less than or equal to p at the time of inspection, given that the results of a sampling inspection gave n leakers in N inspected valves, may be approximated by calculating the standard normal value where

$$z = \frac{p - n / N}{s}$$

and

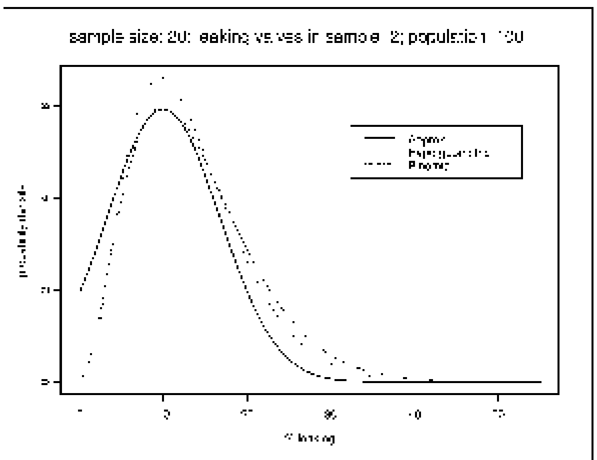
$$s = \frac{n(N-n)}{N\sqrt{n(N-n)^2 + n^2(N-n)}}$$

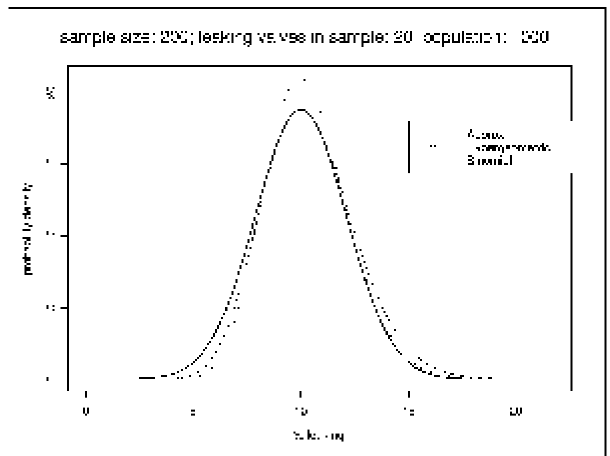
The value of z can be compared to a value in a standard normal table. If p is less than n/N, then z will be negative and the probability will be less than 50%. The typical way to look up this value in a standard normal table is to find the probability that corresponds to the positive value of z from the table and then taking the This formula relies on two approximations. The first is to assume the binomal distribution as an likelihood function for the hypergeometric. The second is to approximate the log-likelihood as a normal distribution. This approximation will be reasonably accurate as long as there is a reasonably large sample size and the number of valves in the population is also large. The exact value will be required to be calculated when these conditions do not hold.

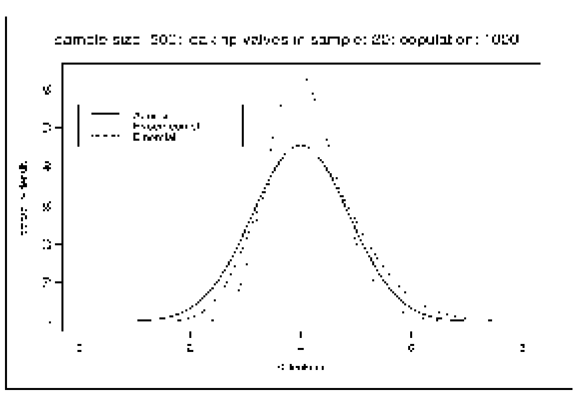
For example, consider the case when the sampling results are 10 leaking valves in a sample size of 100, so the estimated leak rate is 10%. Then the standard deviation σ is

$$s = \frac{10 \cdot 90}{100\sqrt{10 \cdot 90 \cdot 90 + 90 \cdot 10 \cdot 10}} = 0.03$$

If the facility claims a leak rate of 1%, then z = (0.01 - 0.1)/0.03 = -3. This corresponds to a probability of 0.13%. The exact probability, using a hyper-geometric likelihood, is 4.7×10^{-10}%. Thus, the approximate version is considerably less skeptical then the exact version.







Again, using Refinery F as an example
Company reported leak rate (p): 0.3% or 0.003
NEIC sample size (N) = 3053
Number of leaking valves found by NEIC (n) = 53

$\sigma = (53(3053\text{-}53))/(3053\sqrt{(53(3053\text{-}53)^2 + (3053\text{-}53)53^2)} = 0.00236$

$z = (0.003 - (53/3053))/0.00236 = - 6.075$

Looking at a table for z we find that the likelihood of this occurring randomly is less than 1×10^{-4}%.

SOURCES OF USEFUL INFORMATION

EPA-340/1-86-015 Portable Instruments User's Manual For Monitoring VOC Sources

EPA 340/1-90-026a, d, e, f (revised may 1993) Course #380 Inspection Techniques For Fugitive VOC Emission Sources

EVIDENCE REQUIREMENTS FOR USING STATISTICAL ANALYSIS TO PROVE VIOLATION

Q. How many components/what percentage of total components would we have to inspect?

A. According to the statistician at EPA we would only have to inspect a total of 1500 components to have statistically valid data (1500 is used to represent an unlimited size population). To ensure a higher degree of confidence and since the inspections are not completely random, we recommend inspecting around 3000, but this can vary depending on the facility and the number of valves it has. For each process unit investigated, it is recommended that the inspectors monitor that at least 30% of the components (ideally, split among components in gas and liquid service where applicable). This will eliminate most any claim that the monitoring was not representative for the process unit.

Q. What components would we have to test, i.e. would we test those most likely to leak or an equal amount of valves, flanges etc. or a few from each process unit?

A. Since we’re going to compare our results to the company data for each component or process unit tested, this is not relevant. Concentrating on one component type might be the quickest. We have focused on valves and pumps.

Q. Would we have to inspect on a component or process unit basis?

A. We need to ensure that we use the same units to calculate the both the leak rate calculated by the facility and our (EPA’s)leak rate. It is helpful (but not necessary) to follow the same process lines most recently tested at the facility especially if the company’s monitors are not going to confirm leaking components.