GUIDANCE DOCUMENT
ON
LEAK DETECTION AND REPAIR

Department of Environment

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ABBREVIATIONS

VOCs	Volatile Organic Compounds
LDAR	Leak Detection and Repair
VHAPs	Volatile Hazardous Air Pollutants
HAPs	Hazardous Air Pollutants
ID	Identification
P & IDs	Piping & Instrumentation Diagrams
EPA	United States Environmental Protection Agency
CFR	Code of Federal Regulations
QA/QC	Quality Assurance/ Quality Control
NSPS	New Source Performance Standard

PREAMBLE

The information is mainly based on the USEPA "A Best Practice Guide – Leak Detection And Repair (LDAR)" however it is modified to accommodate the Malaysian requirements.

Method 21 by the United States Environmental Protection Agency (USEPA) can be referred in the Appendix of this document.

1.0 PURPOSE

This document is intended to identify some of the problems identified with LDAR programs focusing on Method 21 requirements and describe the practices that can be used to increase the effectiveness of an LDAR program. Specifically this document explains :

1 The importance of regulating equipment leaks
2 The major elements of an LDAR program
3 Typical mistakes made when monitoring to detect leaks
4 Problems that occur from improper management of an LDAR program
5 A set of of best practices that can be used to implement an effective LDAR program

2.0 WHY LEAK DETECTION?

Leaking equipment, such as valves, pumps and connectors are the largest source of emissions of volatile organic compounds (VOCs) and volatile hazardous air pollutants (VHAPs) from petroleum refineries and chemical manufacturing facilities. It is estimated that approximately 70,367 tons per year of VOCs and 9,537 tons per year of HAPs have been emitted from equipment leaks. Emissions from equipment leaks exceed emissions from storage vessels, wastewater, transfer operations or process vents.

VOCs contribute to the formation of ground-level ozone. Ozone is a major component of smog, and causes or aggravates respiratory disease, particularly in children, asthmatics and healthy adults who participate in moderate exercise. Ozone can be transported in the atmosphere and contribute to nonattainment in downwind areas.

Some species of VOCs are also classified as VHAPs. Some known or suspected effects of exposure to VHAPs include cancer, reproductive effects and birth defects. The highest concentrations of VHAPs tend to be closest to the emission source, where the highest public exposure levels are also often detected. Some common VHAPs emitted from refineries and chemical plants include acetaldehyde, benzene, formaldehyde, methylene chloride, naphthalene, toluene and xylene.

3.0 SOURCES, CAUSES AND CONTROL OF EQUIPMENT LEAKS

A typical refinery or chemical plant can emit 600 – 700 tons per year of VOCs from leaking equipment, such as valves, connectors, pumps, sampling connections, compressors, pressure-relief devices, and open-ended lines.

Table 1 shows the primary sources of emissions from components subject to equipment leak regulations. In a typical facility, most of the emissions are from valves and connectors because these are the most prevalent components and can number in the thousands (Table 2). The major cause of emissions from valves and connectors is seal or gasket failure due to normal wear or improper maintenance.

Previous studies have estimated that valves and connectors account for more than 90% of emissions from leaking equipment with valves being the most significant source (Table 3). Newer information suggests that open-ended lines and sampling connections may account for as much as 5-10% of total VOC emissions from equipment leaks.

3.1 How are emissions from leaks reduced ?

Facilities can control emissions from equipment leaks by implementing a leak detection and repair (LDAR) program or by modifying/replacing leaking equipment with “leakless” components. Most equipment leak regulations allow a combination of both control methods.

- Leaks from open-ended lines, compressors and sampling connections are usually fixed by modifying the equipment or component. Emissions from pumps and valves can also be reduced through the use of “leakless” valves and “sealless” pumps. Common leakless valves include bellows valves and diaphragm valves and common sealless pumps are diaphragm pumps, canned motor pumps and magnetic drive pumps. Leaks from pumps can also be reduced by using dual seals with or without barrier fluid.
- Leakless valves and sealless pumps are effective at minimizing or eliminating leaks but their use may be limited by materials of construction considerations and process operating conditions. Installing leakless and sealless equipment components may be a wise choice for replacing individual, chronic leaking components.

LDAR is a work practice designed to identify leaking equipment so that emissions can be reduced through repairs. A component that is subject to LDAR requirements must be monitored at specified, regular intervals to determine whether or not it is leaking. Any leaking component must then be repaired or replaced within a specified time frame.

Table 1 – Sources of equipment leaks

Pumps are used to move fluids from one point to another. Two types of pumps extensively used in petroleum refineries and chemical plants are centrifugal pumps and positive displacement or reciprocating pumps.	**Leaks from pumps** typically occur at the seal.
Valves are used to either restrict or allow the movement of fluids. Valves come in numerous varieties and with the exception of connectors are the most common piece of process equipment in industry.	**Leaks from valves** usually occur at the stem or gland area of the valve body and are commonly caused by a failure of the valve packing or O-ring.
Connectors are components such as flanges and fittings used to join piping and process equipment together. Gaskets and blinds are usually installed between flanges.	**Leaks from connectors** are commonly caused from gasket failure and improperly torqued bolts on flanges.
Sampling connections are utilized to obtain samples from within a process.	**Leaks from sampling connections** usually occur at the outlet of the sampling valve when the sampling line is purged to obtain the sample.
Compressors are designed to increase the pressure of a fluid and provide motive force. They can have rotary or reciprocating designs.	**Leaks from compressors** most often occur from the seals
Pressure relief devices are safety devices designed to protect equipment from exceeding the maximum allowable working pressure. Pressure relief valves and rupture discs are examples of pressure relief devices	**Leaks from pressure relief valves** can occur if the valve is not seated properly, operating too close to the set point or if the seal is worn or damaged. Leaks from rupture disks can occur around the disk gasket if not properly installed.
Open-ended lines are pipes or hoses open to the atmosphere or surrounding environment.	**Leaks from open-ended lines** occur at the point of the line open to the atmosphere and are usually controlled by using caps, plugs and flanges. Leaks can also be caused by the incorrect implementation of the block and bleed procedure

Table 2 – Equipment component counts at a typical refinery or chemical plant

COMPONENT	RANGE	AVERAGE
Pumps	10 – 360	100
Valves	150 – 46,000	7,400
Connectors	600 – 60,000	12,000
Open-ended lines	1 – 1,600	560
Sampling connections	20 – 200	80
Pressure relief valves	5 – 360	90

Source: "Cost and Emission Reductions for Meeting Percent Leaker Requirements for HON Sources." Memorandum to Hazardous Organic NESHAP Residual Risk and Review of Technology Standard Rulemaking docket. Docket ID EPA-HO-OAR-2005-0475-0105

Table 3 – Uncontrolled VOC emissions at a typical facility

COMPONENT	AVERAGE UNCONTROLLED VOC EMISSIONS (ton/yr)	PERCENT OF TOTAL EMISSIONS
Pumps	19	3
Valves	408	62
Connectors	201	31
Open-ended lines	9	1
Sampling connections	11	2
Pressure relief valves	5	1
TOTAL	653	

Source: Emission factors are from Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017, Nov 1995, and equipment counts in Table 3.2.

4.0 WHAT ARE THE BENEFITS OF AN LDAR PROGRAM?

By implementing LDAR, it is estimated that petroleum refineries could reduce emissions from equipment leaks by 63%. Additionally, it is estimated that chemical facilities could reduce VOC emissions by 56% by implementing such a program.

Table 4 presents the control effectiveness of an LDAR program for different monitoring intervals and leak definitions at a chemical process units and petroleum refineries. Emissions reductions from implementing an LDAR program potentially reduce product losses, increase safety for workers and operators, decreases exposure of the surrounding community, reduce emissions fees and help facilities avoid enforcement actions.

Table 4 – Control effectiveness for an LDAR program at a chemical process unit and a refinery

Equipment Type and Service	Control Effectiveness (% Reduction)		
	Monthly Monitoring 10,000 ppmv	Quarterly Monitoring 10,000 ppmv Leak Definition	500 ppm Leak Definition[a]
Chemical Process Unit			
Valves – Gas Service[b]	87	67	92
Valves – Light Liquid Service[c]	84	61	88
Pumps – Light Liquid Service[c]	69	45	75
Connectors – All Services			93
Refinery			
Valves – Gas Service[b]	88	70	96
Valves – Light Liquid Service[c]	76	61	95
Pumps – Light Liquid Service[c]	68	45	88
Connectors – All Service			81

Source: Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017, Nov 1995

a Control effectiveness attributable to the HON-negotiated equipment leak regulation (40 CFR 63, Subpart H) is estimated based on equipment-specific leak definitions and performance levels. However, pumps subject to the HON at existing process units have a 1,000 to 5,000 ppm leak definition, depending on the type of process.

b Gas (vapour) service means the material in contact with the equipment component is in a gaseous state at the the process operating conditions

c Light liquid service means the material in contact with the equipment component is in a liquid state in which the sum of the concentration of individual constituents with a vapour pressure above 0.3 kilopascals (kPa) at 20°C is greater than or equal to 20% by weight.

4.1 Reducing Product Losses

In the petrochemical industry, saleable products are lost whenever emissions escape from process equipment. Lost product generally translates into lost revenue.

4.2 Increasing Safety for Facility Workers and Operators

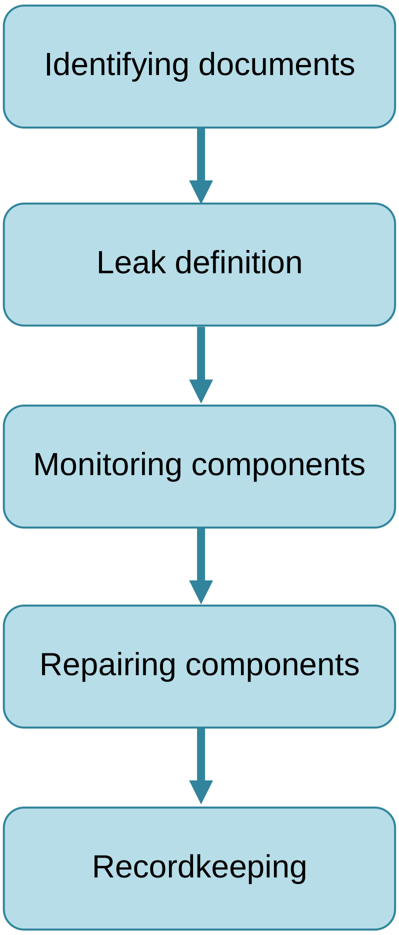
Many of the compounds emitted from refineries and chemical facilities may pose hazard to exposed workers and operators. Reducing emissions from leaking equipment has the direct benefit of reducing occupational exposure to hazardous compounds.

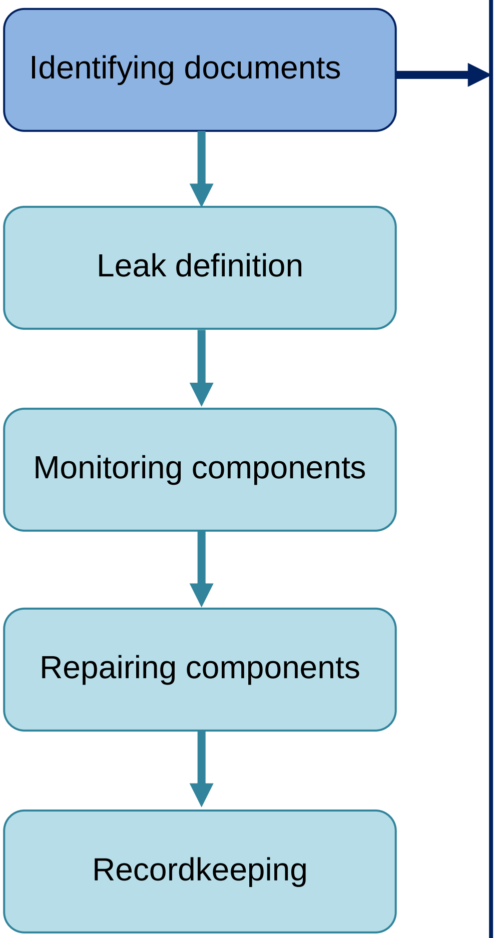
4.3 Decreasing Exposure for the Surrounding Community

In addition to workers and operators at a facility, the population of a surrounding community can be affected by severe, long-term exposure to toxic air pollutants as a result of leaking equipment. Although most of the community exposure may be episodic, chronic health effects can result from long-term exposure to emissions from leaking equipment that is either not identified as leaking or not repaired.

5.0 ELEMENTS OF AN LDAR PROGRAM

The LDAR programs consist of five basic elements. For each element, this section outlines the typical problems found through field inspections and a set of best practices used by facilities with effective LDAR programs.





Current Requirements

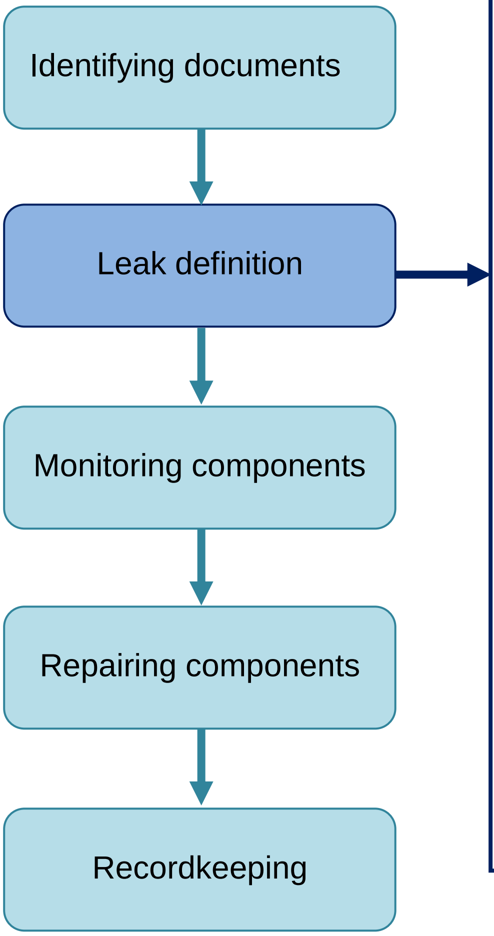
- Assign a unique identification (ID) number to each regulated component
- Record each regulated component and its unique ID number in a log
- Physically locate each regulated component in the facility, verify its location on the piping and instrumentation diagrams (P&IDs) or process flow diagrams and update the log if necessary
- Identify each regulated component on a site plot plan or on a continuously updated equipment log
- Promptly note in the equipment log when new and replacement pieces of equipment are added and equipment is taken out of service

Common Problems

- Not properly identifying all regulated equipment components
- Not properly documenting exempt components

Best Practices

- Physically tag each regulated equipment component with a unique ID number
- Write the component ID number on piping and instrumentation diagrams
- Institute an electronic data management system for LDAR data and records, possibly including the use of bar coding equipment
- Periodically perform a field audit to ensure lists and diagrams accurately represent equipment installed in the plant.



Current Requirements

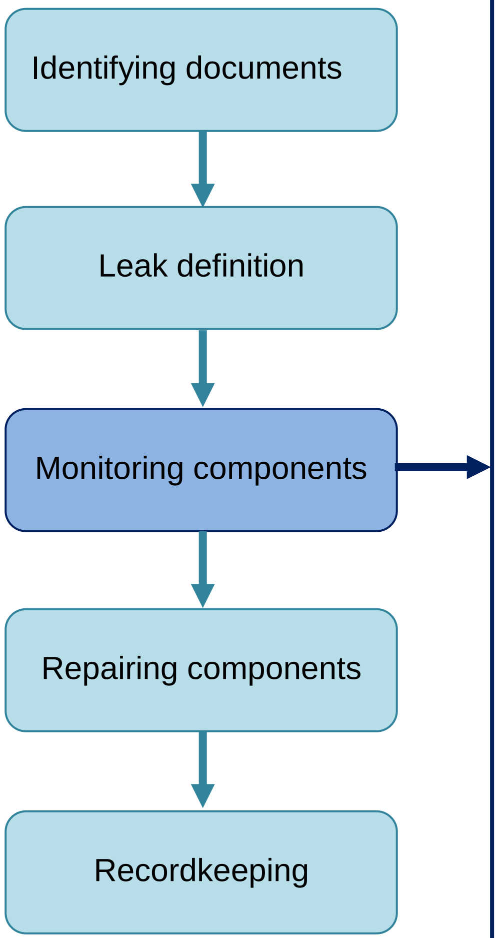
- Method 21 requires VOC emissions from regulated components to be measured in parts per million (ppm). A leak is detected whenever the measured concentration exceeds the threshold standard (i.e. leak definition) for the applicable regulation.
- Many equipment leak regulations also define a leak based on visual inspections and observations (such as fluids dripping, spraying, misting or clouding from or around components), sound (such as hissing) and smell

Common Problems

- Using the wrong leak definition for a particular component due to confusion at facilities where multiple LDAR programs applied

Best Practices

- Utilize a leak definition lower that what the regulation requires
- Simplify the program by using the lowest leak definition when multiple leak definitions exist
- Make the lowest leak definition conservative to provide a margin of safety when monitoring components
- Keep the lowest leak definition consistent among all similar component types. For example, all valves in a facility might have a leak definition of 500 ppm



Current Requirements

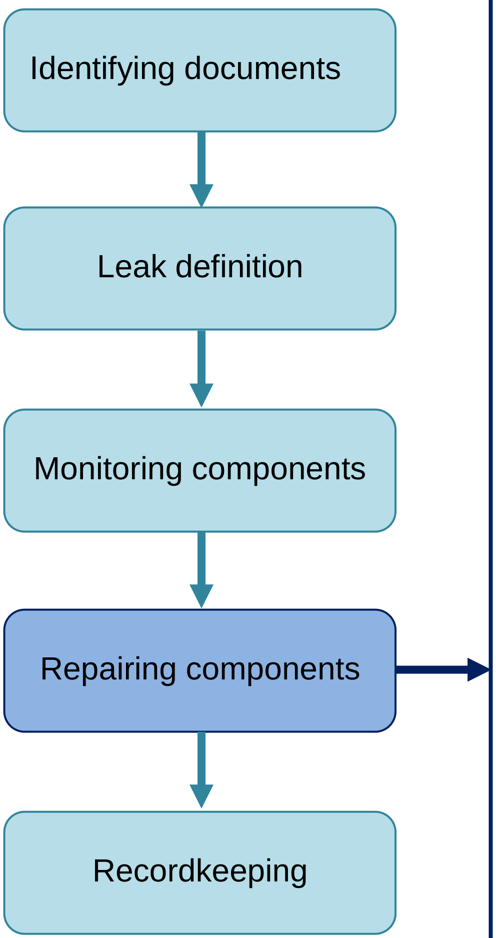
- The primary method for monitoring to detect leaking components is EPA Reference Method 21 (40 CFR Part 60, Appendix A).
- Method 21 is a procedure used to detect VOC leaks from process equipment using a portable detecting instrument.
- Monitoring intervals vary according to the applicable regulation, but are typically weekly, monthly, quarterly, and yearly. For connectors, the monitoring interval can be every 2, 4, or 8 years. The monitoring interval depends on the component type and periodic leak rate for the component type.

Common Problems

- Not following Method 21 properly.
- Failing to monitor at the maximum leak location (once the highest reading is obtained by placing the probe on and around the interface, hold the probe at that location approximately two times the response rate of the instrument).
- Not monitoring long enough to identify a leak.
- Holding the detection probe too far away from the component interface.
- The reading must be taken at the interface.
- Not monitoring all potential leak interfaces.
- Using an incorrect or an expired calibration gas.
- Not monitoring all regulated components.
- Not completing monitoring if the first monitoring attempt is unsuccessful due to equipment being temporarily out of service.

Best Practices

- Although not required by Method 21, use an automatic (electronic) data logger to save time, improve accuracy, and provide an audit record.
- Audit the LDAR program to help ensure that the correct equipment is being monitored, Method 21 procedures are being followed properly, and the required records are being kept.
- Monitor components more frequently than required by the regulations.
- Perform QA/QC of LDAR data to ensure accuracy, completeness, and to check for inconsistencies.
- Eliminate any obstructions (e.g., grease on the component interface) that would prevent monitoring at the interface.
- If a rule allows the use of alternatives to Method 21 monitoring, Method 21 should still be used periodically to check the results of the alternative monitoring method.



Current Requirements

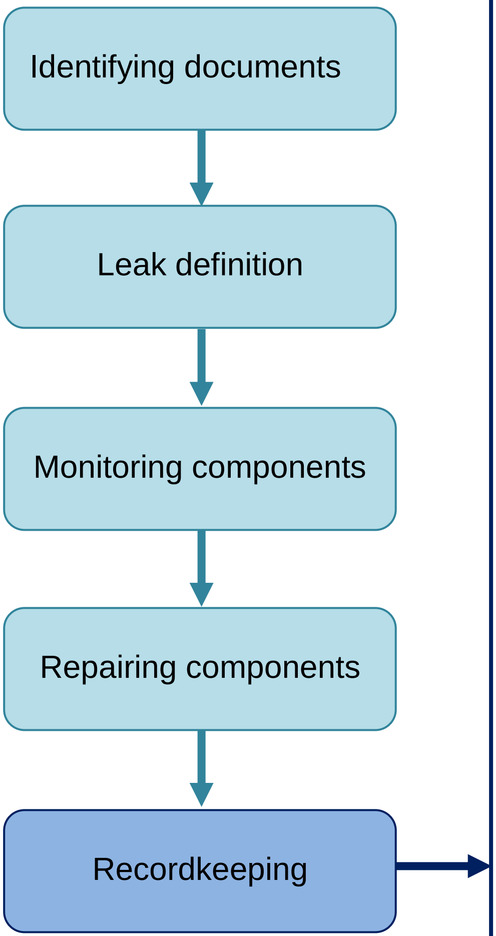
- Repair leaking components as soon as practicable, but not later than a specified number of calendar days (usually 5 days for a first attempt at repair and 15 days for final attempt at repair) after the leak is detected.
- First attempts at repair include, but are not limited to, the following practices where practicable and appropriate:
- Tightening bonnet bolts
- Replacing bonnet bolts
- Tightening packing gland nuts
- Injecting lubricant into lubricated packing
- If the repair of any component is technically infeasible without a process unit shutdown, the component may be placed on the Delay of Repair list, the ID number is recorded, and an explanation of why the component cannot be repaired immediately is provided. An estimated date for repairing the component must be included in the facility records.
- Note: The "drill and tap" method for repairing leaking valves is generally considered technically feasible without requiring a process unit shutdown and should be tried if the first attempt at repair does not fix the leaking valve. See section 6.7 for a discussion of "drill and tap".
- The component is considered to be repaired only after it has been monitored and shown not to be leaking above the applicable leak definition.

Common Problems

- Not repairing leaking equipment within the required amount of time specified.
- Improperly placing components on the Delay of Repair list.
- Not having a justifiable reason for why it is technically infeasible to repair the component without a process unit shutdown.
- Not exploring all available repair alternatives before exercising the Delay of Repair exemption (specifically as it pertains to valves and "drill and tap" repairs).

Best Practices

- Develop a plan and timetable for repairing components.
- Make a first attempt at repair as soon as possible after a leak is detected.
- Monitor components daily and over several days to ensure a leak has been successfully repaired.
- Replace problem components with "leakless" or other technologies.



Current Requirements

For each regulated process:

- Maintain a list of all ID numbers for all equipment subject to an equipment leak regulation.
- For valves designated as "unsafe to monitor," maintain a list of ID numbers and an explanation/review of conditions for the designation.
- Maintain detailed schematics, equipment design specifications (including dates and descriptions of any changes), and piping and instrumentation diagrams.
- Maintain the results of performance testing and leak detection monitoring, including leak monitoring results per the leak frequency, monitoring leakless equipment, and non-periodic event monitoring.

For leaking equipment:

- Attach ID tags to the equipment.
- Maintain records of the equipment ID number, the instrument and operator ID numbers, and the date the leak was detected.
- Maintain a list of the dates of each repair attempt and an explanation of the attempted repair method.
- Note the dates of successful repairs.
- Include the results of monitoring tests to determine if the repair was successful.

Common Problems

- Not keeping detailed and accurate records required by the applicable regulation.
- Not updating records to designate new components that are subject to LDAR due to revised regulations or process modifications.

Best Practices

- Perform internal and third-party audits of LDAR records on a regular basis to ensure compliance.
- Electronically monitor and store LDAR data including regular QA/QC audits.
- Perform regular records maintenance.
- Continually search for and update regulatory requirements.
- Properly record and report first attempts at repair.
- Keep the proper records for components on Delay of Repair lists.

6.0 WHAT PROBLEMS HAVE BEEN FOUND WITH CURRENT LDAR PROGRAMS ?

Each leak that is not detected and repaired is a lost opportunity to reduce emissions. Several important factors contribute to failing to identify and repair leaking components :

6.1 Not identifying all regulated components/units in inventory

If a facility does not properly identify all of its regulated components, some leaks may go unidentified. Unidentified components may leak or have existing leaks that will worsen over time if the components are not properly identified, monitored and repaired. Facilities can fail to identify regulated components when new processes are constructed, existing process are modified or new or revised equipment leak regulations are published.

6.2 Not monitoring components

In some cases, the number of components reported to have been monitored may indicate problems with monitoring procedures. What have been found are :

- A data logger time stamp showed valves being monitored at the rate of one per second with two valves occasionally being monitored within the same 1-second period
- A person reported monitoring 8,000 components in one day (assuming an 8-hour work day, that represents one component every 3.6 seconds)
- Records evaluations showed widely varying component monitoring counts, suggesting equipment might not always be monitored when required
- Equipment was marked “temporarily out of service” because the initial inspection attempt could not be performed. However, the equipment was in service for most of the period and no subsequent (or prior) inspection attempts were performed to meet the monitoring requirement

However, even when the records show a realistic number of components are being monitored, if there are no oversight or accountability checks, then there is no guarantee that components are actually being monitored.

6.3 Insufficient time to identify leak

In other cases, facilities are not following proper monitoring procedures, resulting in a lower number of leaking components being reported.

- If a worker moves the probe around the component interface so rapidly that the instrument does not have time to properly respond, then a component may never be identified as leaking
- If a worker fails to find the maximum leak location for the component and then does not spend twice the responce time at that location, the nthe monitoring instrument will not measure the correct concentration of

hydrocarbons and the leak may go undetected. Optical leak imaging shows the importance of identifying the maximum leak location, as hydrocarbons are quickly an diluted by air currents around the component

6.4 Holding the probe away from the component interface

The probe must be placed at the proper interface of the component being analyzed. Placing the probe even 1 centimeter from the interface can result in a false reading indicating that the component is not leaking, when the fact it is leaking. Eliminate any isssue (e.g., grease on the component interface) that prevent monitoring at the interface (e.g., remove excess grease from the component before monitoring or use a monitor that won't be impacted by the grease and is easy to clean

For equipment with rotating shafts (pumps and compressors), Method 21 requires the probe be placed within 1 centimeter of the shaft-seal interface. Placing the probe at the surface of the rotating shaft is a safety hazard and should be avoided

6.5 Failing to properly maintain monitoring instrument

Factors that may prevent the instrument from identifying leaks are :

- Not using an instrument that meets the specifications required in Method 21, section 6
- Dirty instrument probes
- Leakage from the intrument probes
- Not zeroing instrument meter
- Incorrect calibration gases used
- Not calibrating the detection instrument on a daily basis

6.6 Improperly identifying components as “unsafe” or “difficult” to monitor

Components that are identified as being “unsafe to monitor” or “difficult to monitor” must be identified as such because there is a safety concern or an accessibility issue that prevent the component from being successfully monitored.

All unsafe or difficult-to-monitor components must be included on a log with identification numbers and an explanation of why the component is “unsafe to monitor” or “difficult to monitor”. Monitoring can be deferred for all such components but the facility must maintain a plan that explains the conditions under which the components become safe to monitor or no longer difficult to monitor.

6.7 Improperly placing components/units on the “Delay of Repair” list

Generally, placing a leaking component on the “Delay of Repair” list is permissible only when the component is technically infeasible to repair without a process unit shutdown (e.g. for valves the owner/operator must demonstrate that the emissions from immediate repair will be greater than waiting for unit shutdown).

Repair methods may exist, such as “drill and tap” for valves, that allow leaks to be fixed while the component is still in service. Failing to consider such repair methods before exercising the “Delay of Repair” list may constitute noncompliance with repair requirements. Drill and Tap is a repair method where a hole is drilled into the valve packing gland and tapped, so that a small valve and fitting can be attached to the gland. A packing gun is connected to this fitting and the small valve is opened allowing new packing material to be pumped into the packing gland.

Components placed on the “Delay of Repair” list must be accompanied by their ID numbers and an explanation of why they have been placed on the list. These components cannot remain on the list indefinitely – they must be repaired by the end of the next process unit shutdown.

7.0 MODEL LDAR PROGRAM

Experience has shown that facilities with an effective record of preventing leaks integrate an awareness of the benefits of leak detection and repair into their operating and maintenance program. A successful LDAR programs were developed from :

- Evaluation of best practices identified at facilities with successful LDAR programs
- Analysis of the root causes of noncompliance at facilities that were found to have recurring violations of LDAR regulatory requirements

LDAR programs that incorporate most or all of the elements decribed have achieved more consistent in their LDAR programs, leading to increased compliance and lower emissions.

7.1 Written LDAR Program

A written LDAR program specifies the regulatory requirements and facility-specific procedures for recordkeeping certifications, monitoring and repairs. A written program also delineates the roles of each person on the LDAR team as well as documents all the required procedures to be completed and data to be gathered, thus establishing accountability.

The plan should identify all process units and be updated as necessary to ensure accuracy and continuing compliance.

7.2 Training

A training program will provide LDAR personnel the technical understanding to make the written LDAR program work. It also will educate members of the LDAR team on their individual responsibilities. These training programs can vary according to the level of involvement and degree of responsibility of LDAR personnel.

7.3 LDAR Audits

Whether LDAR monitoring is done in house or contracted to third parties outside the company, the potential exists for LDAR staff not adhere correctly to the LDAR program. Internal and third-party audits of a facility LDAR program are a critical component of effective LDAR programs. The audit check that the correct equipment is being monitored, Method 21 procedures are being followed, leaks are being fixed and the required records are being kept. In short, the audits ensure that the LDAR program is being conducted correctly and problems are identified and corrected.

7.4 Contractor Accountability

Contractors performing monitoring are frequently compensated for the number of components they monitor which might provide an incentive to ruch through monitoring procedures and not adhere to Method 21 requirements for response time, monitoring distance, etc. If this happens, some equipment leaks may not be detected. To overcome this potential problem, facilities should have in place sufficient oversight procedures to increase the accountability of contractor.

7.5 Internal Leak Definition for Valves and Pumps

The varying leak definitions that can apply to different process units and components can be confusing and lead to errors in properly identifying leaks. To counter this potential problem, operate the LDAR program using an internal leak definition for valves and pumps in light liquid or gas vapor service. Monitoring against a uniform definition that is lower than the applicable regulatory definition will reduce errors and provide a margin of safety for identifying leaking components. The internal leak definition would apply to valves and pumps (and possibly connectors) in light liquid or gas vapor service

7.6 More Frequent Monitoring

Many regulations allow for less frequent monitoring (i.e. skip periods) when good performance (as defined in the applicable regulation) is demonstrated. Skip period is an alternative work practice found in some equipment leak regulations and usually applies only to valves and connectors. After a specified number of leak detectiob periods (e.g. monthly) during which the percentage of leaking components is below a certain value (e.g. 2% for NSPS facilities), a facility can monitor less frequently (e.g. quarterly) as long as the percentage of leaking components remains low. The facility must keep a record of the percentage of the component type found leaking during each leak detection period.

Experience has shown that poor monitoring rather than good performance has allowed facilties to take advantage of the less frequent monitoring provisions. To ensure that leaks are still being identified in a timely manner and that previously unidentified leaks are not worsening over time, implement a plan for more frequent monitoring for components that contribute most to equipnment leak emissions.

7.7 Repairing Leaking Components

To stop detected leaks while they are still small, most rules require a first attempt at repair within 5 days of the leak detection and a final repair within 15 days. However, any component that cannot be repaired within those time frames must be placed on a “Delay of Repair” list to be repaired during the next shutdown cycle.

First attempts at repair include, but are not limited to, the following best practices where practicable and appropriate :

- Tightening bonnet bolts;
- Replacing bonnet bolts;
- Tightening packing gland nuts; and
- Injecting lubricant into lubricated packing.

7.8 Delay of Repair

Any component that cannot be repaired during the specified repair interval must be placed on a “Delay of Repair” list to be prepared during the next shutdown cycle. Delay of repair procedures ensure that the appropriate equipment is justifiably on the “Delay of Repair” list and that facilities have a plan to fix these components.

7.9 Electronic Monitoring and Storage of LDAR Data

Electronic monitoring and storage of LDAR data will help evaluate the performance of monitoring personnel (via time/date stamps), improve accuracy, provide an effective means for QA/QC and retrieve records in a timely manner for review purposes. Incorporate and maintain an electronic database for storing and reporting LDAR data. Use data loggers or other data collection devices during all LDAR monitoring.

7.10 QA/QC of LDAR Data

QA/QC audits ensure that Method 21 procedures are being followed and LDAR personnel are monitoring the correct components in the proper manner. Develop and implement a procedure to ensure QA/QC review all data generated by LDAR monitoring technicians on a daily basis or at the conclusion of each monitoring episode.

7.11 Calibration/Calibration Drift Assessment

Always calibrate LDAR monitoring equipment using an appropriate calibration gas, in accordance with 40 CFR Part 60, EPA Reference Test Method 21.

7.12 Records Maintenance

Organized and readily available records are one potential indication of an effective LDAR program. Well-kept records may also indicate that the LDAR program is integrated into the facility's routine operation and management.

Elements:

Records to maintain:

- A certification that the facility implemented the "first attempt at repair" program.
- A certification that the facility implemented QA/QC procedures for review of data generated by LDAR technicians.
- An identification of the person/position at each facility responsible for LDAR program performance as defined in the written program.
- A certification that the facility developed and implemented a tracking program for new valves and pumps added during maintenance and construction defined in the written program.
- A certification that the facility properly completed calibration drift assessments.
- A certification that the facility implemented the "delay of repair" procedures.
- The following information on LDAR monitoring:
  (1) The number of valves and pumps present in each process unit during the quarter;
  (2) The number of valves and pumps monitored in each process unit;
  (3) An explanation for missed monitoring if the number of valves and pumps present exceeds the number of valves and pumps monitored during the quarter;
  (4) The number of valves and pumps found leaking;
  (5) The number of "difficult to monitor" pieces of equipment monitored;
  (6) A list of all equipment currently on the "Delay of Repair" list and the date each component was placed on the list;
  (7) The number of repair attempts not completed promptly or completed within 5 days;
  (8) The number of repairs not completed within 30 days and the number of components not placed on the "Delay of Repair" list; and
  (9) The number of chronic leakers that do not get repaired.
- Records of audits and corrective actions. Prior to the first third-party audit at each facility, include in your records a copy of each audit report from audits conducted in the previous the calendar year and a summary of the actions planned or taken to correct all deficiencies identified in the audits.
- For the audits performed in prior years, identification of the auditors and documentation that a written plan exists identifying corrective action for any deficiencies identified and that this plan is being implemented.

APPENDIX – METHOD 21

GENERAL PROCEDURE

Failure of facilities to follow Method 21 can lead to them not properly identifying and subsequently repairing leaking components.

1. **Evaluate Instrument Performance**
   Performance criteria for the monitoring instrument:

   - For each VOC measured, the response factor should be <10 unless specified in the applicable regulation. Response factor is the ratio of the known concentration of a VOC compound to the observed meter reading when measured using an instrument calibrated with the reference compound specified in the applicable regulation.
   - The calibration precision should be <10 percent of the calibration gas value. Calibration precision is the degree of agreement between measurements of the same known value, expressed as the relative percentage of the average difference between the meter readings and the known concentration to the known concentration.
   - The response time should be ≤30 seconds. Response time is the time interval from a step change in VOC concentration at the input of the sampling system to the time at which 90% of the corresponding final value is reached as displayed on the instrument readout meter.

2. **Calibrate Instruments**
   Before each monitoring episode

   - Let the instrument warm up
   - Introduce the calibration gas into the instrument probe
   - Adjust the instrument meter readout to match the calibration gas concentration value.

3. **Monitor Individual Components**
   When monitoring components

   - Place the probe at the surface of the component interface where leakage could occur
   - Move the probe along the interface periphery while observing the instrument readout
   - Locate the maximum reading by moving the probe around the interface
   - Keep the probe at the location of the maximum reading for 2 times the response factor
   - If the concentration reading on the instrument readout is above the applicable leak definition, then the component is leaking and must be repaired

DETERMINATION OF VOLATILE ORGANIC COMPOUND LEAKS

1.0 Scope and Application

1.1 Scope

This method is applicable for the determination of VOC leaks from process equipment. These source include, but are not limited to, valves, flanges and other connections, pumps and compressors, pressure relief devices, process drains, open-ended valves, pump and compressor seal system degassing vents, accumulator vessel vents, agitator seals and access door seals.

1.2 Data quality objectives

Adherence to the requirements of this method will enhance the quality of data obtained from air pollutant sampling methods.

2.0 Summary of Methods

2.1 A portable instrument is used to detect VOC leaks from individual sources. The instrument detector type is not specified, but it must meet the specifications and performance criteria. This method is intended to locate and classify leaks only, and is not to be used as a direct measure of mass emission rate from individual sources

3.0 Definitions

3.1 Calibration gas means VOC compound used to adjust the instrument meter reading to a known value. The calibration gas is usually the reference compound at a known concentration approximately equal to the leak definition concentration

3.2 Calibration precision means the degree of agreement between measurements of the sane known value, expressed as the relative percentage of the average difference between the meter readings and the known concentration to the known concentration

3.3 Leak definition concentration means the local VOC concentration at the surface of a leak source that indicates that a VOC emission (leak) is present. The leak definition is an instrument meter reading based on a reference compound

3.4 No detectable emission means a local VOC concentration at the surface of a leak source, adjusted for local VOC ambient concentration, that is less than 2.5% of the specified leak definition concentration. That indicates that a VOC emission (leak) is not present

3.5 Reference compound means the VOC species selected as the instrument calibration basis for specification of the leak definition concentration (For example, if a leak definition concentration is 10,000 ppm as methane, then any source emission that results in local concentration that yields a meter reading of 10,000 on an instrument meter calibrated with methane would be classified as leak. In this example, the leak definition concentration is 10,000 ppm and the reference compound is methane)

3.6 Response factor means the ratio of known concentration of a VOC compound to the observed meter reading when measured using and instrument calibrated with the reference compound specified in the applicable regulation

3.7 Response time means the time interval from a step change in VOC concentration at the input of the sampling system to the time at which 90% of the corresponding final value is reached as displayed on the instrument readout meter

4.0 Safety

4.1 Disclaimer

This method may involve hazardous materials, operations and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method

4.2 Hazardous Pollutants

Several of the compounds, leaks of which may be determined by this method may be irritating or corrosive to tissues (e.g. heptane) or may be toxic (e.g. benzene, methyl alcohol). Nearly all are fire hazards. Compounds in emissions should be determined through familiarity with the source.

5.0 Equipment and Supplies

A VOC monitoring instrument meeting the following specifications is required :

5.1 The VOC instrument detector shall respond to the compound being processed. Detector types that may meet this requirement include, but are not limited to, catalytic oxidation, flame ionization, infrared absorption and photoionization

5.2 The instrument shall be capable of measuring the leak definition concentration specified in the regulation

5.3 The scale of the instrument meter shall be readable to ±2.5% of the specified leak definition concentration

5.4 The instrument shall be equipped with an electrically driven pump to ensure that a sample is provided to the detector at a constant flow rate. The nominal sample flow rate, as measured at the sample probe tip, shall be 0.10 to 3.0 l/min (0.004 to 0.1 ft^3/min) when the probe is fitted with a glass wool plug or filter that may be used to prevent plugging of the instrument

5.5 The equipment shall be equipped with a probe or probe extension or sampling not to exceed 6.4 mm (¼ in) outside diameter with a single end opening for admission of sample

5.6 The instrument shall be intrinsically safe for operation in explosive atmospheres. The instrument shall not be operated with any safety device, such as an exhaust flame arrestor, removed.

6.0 Reagents and Standards

6.1 Two gas mixtures are required for instrument calibration and performance evaluation

6.1.1 Zero Gas

Air, less than 10 parts per million by volume (ppmv) VOC

6.1.2 Calibration Gas

For each organic species that is to be measured during individual source surveys, obtain or prepare a known standard in air at a concentration approximately equal to the applicable leak definition specified in the regulation

6.2 Cylinder Gases

If cylinder calibration gas mixtures are used, they must be analyzed and certified by the manufacturer to be within 2% accuracy, and a shelf life must be specified. Cylinder standards must be either reanalyzed or replaced at the end of the specified shelf life

6.3 Prepared Gases

Calibration gases may be prepared by the user according to any accepted gaseous preparation procedure that will yield a mixture accurate to within 2%. Prepared standards must be replaced each day of use unless it is demonstrated that degradation does not occur during storage

6.4 Mixture with non-Reference Compound Gases

Calibrations may be performed using a compound other than the reference compound. In this case, a conversion factor must be determined for the alternative compound such that the resulting meter readings during source surveys can be converted to reference compound results

7.0 Sample Collection, Preservation, Storage and Transport

7.1 Instrument Performance Evaluation

Assemble and start up the instrument according to the manufacturer's instructions for recommended warm up period and preliminary adjustsments

7.1.1 Response Factor

A response factor must be determined for each compound that is to be measured either by testing or from reference sources. The response factor test are required before placing the analyzer into service, but do not have to be repeated at subsequent intervals

7.1.1.1 Calibrate the instrument with the reference compound as specified in the applicable regulation. Introduce the calibration gas mixture to the analyzer and record the observed meter reading. Introduce zero gas until a stable reading is obtained. Make a total of three measurements by alternating between the calibration gas and zero gas. Calculate the response factor for each repetition and the average response factor

7.1.1.2 The instrument response factors for each of the individual VOC to be measured shall be less than 10 unless otherwise specified in the applicable regulation. When no instrument is available that meets this specification when calibrated with the reference VOC specified in the applicable regulation the available instrument may be calibrated with one of the VOC to be measured, or any other VOC, so long as the instrument then has a response factor of less than 10 for each of the individual VOC to be measured

7.1.1.3 Alternatively, if response factors have been published for the compounds of interest for the instrument or detector type, the response factor determination is not required, and existing results may be referenced.

7.1.2 Calibration Precision

The calibration precision test must be completed prior to placing the analyzer into service and at subsequent 3 month intervals or at the next use, whichever is later

7.1.2.1 Make a total of three measurements by alternately using zero gas and the specified calibration gas. Record the meter readings. Calculate the average algebraic difference between the meter readings and the known value. Divide this average difference by the known calibration value and multiply by 100 to express the resulting calibration precision as a percentage

7.1.2.2 The calibration precision shall be equal to or less than 10% of the calibration gas value

7.1.3 Response Time

The response time test is required before placing the instrument into service. If a modification to the sample pumping system or flow configuration is made that would change the response time, a new test is required before further use

7.1.3.1 Introduce zero gas into the instrument sample probe. When the meter reading has stabilized, switch quickly to the specified calibration gas. After switching, measure the time required to attain 90% of the final stable reading. Perform this test sequence three times and record the results. Calculate the average

7.1.3.2 The instrument response time shall be equal to or less than 30 seconds. The instrument pump, dilution probe (if any), sample probe and probe filter that will be used during testing shall all be in place during the response time determination

7.2 Instrument Calibration

Calibrate the VOC monitoring instrument according to Section 8.0

7.3 Individual Source Surveys

7.3.1 Type I – Leak Definition Based on Concentration

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 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 reporting requirements. Examples of the application of this general technique to specific equipment type are :

7.3.1.1 Valves. The most common source of leaks from valves is the seal between the stem and housing. Place the probe at the interface where the stem exits the packing gland and sample the stem circumference. Also, place the probe at the interface of the packing gland take-up flange seat and sample the periphery. In addition, survey valve housings of multipart assembly at the surface of all interfaces where a leak could occur

7.3.1.2 Flanges and Other Connections. For welded flanges, place the probe at the outer edge of the flange-gasket interface and sample the circumference of the flange. Sample other types of nonpermanent joints (such as threaded connections) with s similar traverse

7.3.1.3 Pumps and Compressors. Conduct a circumferential traverse at the outer surface of the pump or compressor shaft and seal interface. If the source is a rotating shaft, position the probe inlet within 1 cm of the shaft-seal interface for the survey. If the housing configuration prevents a complete traverse of the shaft periphery, sample all accessible portions. Sample all other joints on the pump or compressor housing where leakage could occur

7.3.1.4 Pressure Relief Devices. The configuration of most pressure relief devices prevents sampling at the sealing seat interface. For those devices equipped with an enclosed extension, or horn, place the probe inlet at approximately the center of the exhaust area to the atmosphere

7.3.1.5 Process Drains. For open drains, place the probe inlet at approximately the center of the area open to the atmosphere. For covered drains, place the probe at the surface of the cover interface and conduct a peripheral traverse

7.3.1.6 Open-ended Lines or Valves. Place the probe inlet at approximately the center of the opening to the atmosphere

7.3.1.7 Seal System Degassing Vents and Accumulation Vents. Place the probe inlet at approximately the center of the opening to the atmosphere

7.3.1.8 Access Door Seals. Place the probe inlet at the surface of the door seal interface and conduct a peripheral traverse

7.3.2 Type II – “No Detectable Emission”

Determine the local ambient VOC concentration around the source by moving the probe randomly upwind and downwind at a distance of one to two meters from the source. If an interference exists with this determination due to a nearby emission or leak, the local ambient concentration may be determined at distances closer to the source, but in no case shall the distance be less than 25 centimeters. Then move the probe inlet to the surface of the surface of the source and determine the concentration as outlined in Section 7.3.1. The difference between these concentrations determines whether there are no detectable emissions. Record and report the results as specified by the regulation. For those cases where the regulation requires a specific device installation or that specified vents be ducted or piped to a control device, the existence of these conditions shall be visually confirmed. When the regulation also requires that no detectable emissions exist, visual observations and sampling surveys are required. Examples of this technique are :

7.3.2.1 Pump or Compressor Seals. If applicable, determine the type of shaft seal. Perform a survey of the local area ambient VOC concentration and determine if detectable emissions exist as described in Section 7.3.2

7.3.2.2 Seal System Degassing Vents, Accumulator Vessel Vents, Pressure Relief Devices. If applicable, observe whether or not the applicable ducting or piping exists. Also, determine if any sources exist in the ducting or piping where emissions could occur upstream of the control device. If the required ducting or piping exists and there are no sources where the emissions could be vented to the atmosphere upstream of the control device, then it is presumed that no detectable emissions are present. If there are sources in the ducting or piping where emissions could be vented or sources where leaks could occur, the sampling surveys described in Section 7.3.2 shall be used to determine if detectable emissions exist

7.3.3 Alternative Screening Procedure

7.3.3.1 A screening procedure based on the formation of bubbles in a soap solution that is sprayed on a potential leak source may be used for those sources that do not have continuously moving parts, that do not have surface temperatures greater than the boiling point or less than the freezing point of the soap solution, that do not have open areas to the atmosphere that the soap solution cannot bridge, or that do not exhibit evidence of liquid leakage. Sources that have these conditions present must be surveyed using the instrument technique of Section 7.3.1 or 7.3.2

7.3.3.2 Spray a soap solution over all potential leak sources. The soap solution may be a commercially available leak detection solution or may be prepared using concentrated detergent and water. A pressure sprayer or squeeze bottle may be used to dispense the solution. Observe the potential leak sites to determine if any bubbles are formed. If no bubbles are observed, the source is presumed to have no detectable emissions or leaks as applicable. If bubbles are observed, the instrument techniques of Sections 7.3.1 or 7.3.2 shall be used to determine if a leak exists, or if the source has detectable emissions, as applicable

8.0 Calibration and Standardization

8.1 Calibrate the VOC monitoring instrument as follows. After the appropriate warm up period and zero internal calibration procedure, introduce the calibration gas into the instrument sample probe. Adjust the instrument meter readout to correspond to the calibration gas value.
Note : If the meter readout cannot be adjusted to the proper value, a malfunction of the analyzer is indicated and corrective actions are necessary before use