LEAK DETECTION AND REPAIR RULE MODERNIZATION

Proactive approach for pollution prevention and minimization

November 3, 2017

BACKGROUND

Multiple Clean Air Act (CAA) regulations establish requirements for industrial facilities to implement leak detection and repair (LDAR) programs. The requirements are found in 47 individual subparts, each addressing specific industrial source categories. While each subpart addresses source category-specific concerns related to equipment leaks, the basic work practice requirements for a LDAR program are similar.[1] LDAR regulations seek to address fugitive emissions of volatile organic compounds (VOC) or hazardous air pollutants (HAP) from leaking components (e.g., valves, pumps, and connectors).

Some regulations only require sensory methods (audible, visual, olfactory) for LDAR. However, the majority of the regulations require the use of instrument monitoring for LDAR, and these regulations establish LDAR work practice requirements based on the use of EPA Method 21 (M21) to determine whether regulated components are leaking. M21 requires a person to move an appropriate portable analyzer probe slowly around each individual component to determine if a leak exists based on a specified parts per million by volume (ppmv) concentration reading that varies from 500 ppm to 10,000 ppm depending on the source category-specific regulation, component type, and regulated pollutant (i.e., VOC or HAP). In addition, regulated facilities are required to maintain records on site and submit periodic compliance reports documenting LDAR findings.

Advancements in technology and improvements in the implementation of LDAR have occurred since the rules were originally promulgated. EPA is required to periodically review these rules, and if necessary, revise them. These reviews could serve as opportunities to revisit the LDAR regulations in light of these technology advancements. Even absent of regulatory changes, if a facility owners/operators believe they can achieve the same or greater emissions reduction through means other than the LDAR work practice as it is prescribed in the rules to which the facility is subject (e.g. a different monitoring technology), the CAA provides a mechanism through which they may make a site-specific request for an alternative means of emission limitation (AMEL). If approved, the AMEL would allow for the use of a different monitoring approach prescribed in the applicable regulations. Additionally, in 2009, the EPA promulgated the Alternative Work Practice (AWP) to allow the use of an optical gas imaging (OGI)

[1] Subparts are found within 40 CFR Parts 60, 61, 63, and 65

instrument for LDAR monitoring, provided that the facility also conducts an annual M21 LDAR inspection. This alternative work practice is already available to all source categories that have LDAR requirements. The EPA included the annual M21 monitoring requirement in the AWP because limited information was available on the capabilities of OGI at the time the AWP was promulgated.

Advancements in LDAR monitoring are worth evaluating. With the potential to find and repair leaks faster, greater emission reductions from leaking equipment can be realized. Additionally, being able to apply newer technologies more uniformly across rules reduces compliance issues, as well as recordkeeping, and reporting costs, particularly for facilities subject to multiple LDAR rules. Currently, there are technical and regulatory barriers to incorporating these advancements. While the AWP is available to facilities, the annual M21 requirement is a barrier, as evidenced by its limited use. However, the EPA is not confident enough in OGI at this point to remove that requirement. Likewise, while the facility-specific AMEL option exists, facilities have not utilized this option to date due to difficulties associated with demonstrating equivalency with the M21 LDAR approach.

This paper summarizes the state of technology, where and how it is currently being used, and ongoing research. Based on the body of information to date, this paper sets out recommendations on actions the EPA could take to move forward and push past technical and regulatory barriers.

CHARGE

As part of the state and EPA collaboration on E-Enterprise for the Environment, a small workgroup of EPA and state/local regulators (Team) (see attachment) studied options for modernizing CAA LDAR regulations to include newer technologies and practices that will make compliance evaluation less burdensome and more efficient, increase the efficiency of monitoring, provide more transparency, and standardize recordkeeping and reporting requirements for regulated sources. The Team kick-off meeting occurred in October of 2015.

The Team reviewed various studies and projects, and analyzed the results of the research to identify three recommendations that could serve as options for modernizing the CAA LDAR regulations. They include:

- Implementation of OGI or other alternative technologies
- Installation of low emission (low-E) technology
- Refined reporting and recordkeeping requirements

TEAM RESEARCH

The Team conducted research activities through various mechanisms in order to gather information to support the Team's recommendations. This research was done by both individual team members and contractors with the goals of identifying alternative techniques that were implemented to cost effectively detect leaks with increased benefits. Research activities included:

- Participating in LDAR panel discussions at conferences with industry to exchange information and experiences;
- Reaching out to industry to request information, presentations, and case studies;
- Identifying and reviewing studies and presentations conducted by industry both domestically and internationally;
- Polling various state and local regulatory agencies on their experiences with LDAR programs; and
- Having discussions with technical subject matter experts.

The Team's research covered four main topics that are highlighted in this report.

OGI Monitoring

There have been many efforts by vendors and manufacturers to invest in and develop OGI or other alternative technology for use in LDAR programs. These devices have the potential to allow operators to locate leaking components in a more efficient manner. However, both industry and regulators have raised significant concerns about adopting OGI technology in lieu of the current M21-based procedures, as noted:

1. There is limited evidence to demonstrate that the leaks detected at all applicable industries using OGI result in equal or greater emission reductions than the leaks identified using M21. It is well known the two methods do not necessarily find the same leaks. However, there is limited evidence to demonstrate that the leaks detected using OGI result in equal or greater emission reductions than the leaks identified using M21.
2. EPA does not currently have a standard method for monitoring with OGI.

The CAA allows EPA the authority to provide alternatives to work practice standards. Such authority exists under EPA's general authority to review and amend its regulations as appropriate, e.g., 42 U.S.C. 7411(b)(1)(B), 42 U.S.C. 7412(d)(6). EPA adopted the AWP to allow facilities to use OGI to detect leaks instead of M21. However, the AWP requires M21 to be used on an annual basis. To date, while there have been several facilities within one source category that have incorporated the AWP, wide-spread adoption by industry has not been realized, mostly due to the cost associated with needing to monitor with two separate LDAR instruments (M21 and OGI) and the different requirements associated with each monitoring instrument.

Based on the Team's research, several recent studies and projects were identified that could serve towards addressing the concerns raised above. They include:

1. A study by the American Petroleum Institute which found that over 90% of controllable fugitive emissions come from approximately 0.13% of the process equipment components in a refinery. This suggests that the majority of the fugitive emissions come from a small number of components with high leak rates.[2]
2. A study conducted by Exxon Mobil Chemical Company which suggests that the use of OGI could replace M21. The study's conclusions included: 1. Using OGI for fugitive

[2] Analysis of Refinery Screening Data, American Petroleum Institute, Publication Number 310, November 1997.

emissions control results in lower emissions compared with M21; and 2. Finding the larger leaks sooner and repairing them more quickly offsets the smaller leaks that may not be detected using OGI.[3]

3. A field campaign project conducted by CONCAWE – Environmental Science for the European Refining Industry developed technical evidence to support OGI as a stand-alone LDAR technique. Results indicated that the monitoring was faster and safer than M21, and that the technology has been improved to have much lower detection limits. Their overall conclusion was that OGI could be used as a stand-alone method for LDAR.[4]

Many companies have taken a proactive approach to implement OGI into their LDAR programs. The actual use of OGI to detect leaks at the following oil and natural gas facilities has resulted in significant benefits as described below:

1. ConocoPhillips Refinery: ConocoPhillips performed an "Optical Leak Detection and Measurement Pilot Study" at 22 of their Canadian oil and gas facilities. For this study, fugitive emissions were identified using an OGI camera and then quantified separately using other approved methods. The study determined that greenhouse gas emissions reductions associated with fixing the leaks found would be 21,420.7 tons CO_2/year and result in a cost savings of $358,012/year.[5]
2. Jonah Energy: Began using OGI cameras to detect fugitive emissions at their oil and natural gas facilities. Since 2010, the company has reduced fugitive emissions by 75% and realized a cumulative cost savings of over $5 million, more than covering the cost of the cameras and operators using them.[6]
3. Southwestern Energy: Implemented an enhanced LDAR program using OGI cameras in conjunction with a remote methane leak detector (infrared device that screens for leaks from below ground and above ground pipelines). Compared to 2013, the company reduced the number of leaks by 35% and the volume of gas leaking by 55%.[7]

Other regulatory agencies besides EPA have implemented OGI technology.

1. On April 1, 2017, Canada's Alberta Energy Regulator Directive 84 became effective. This regulation allows the use of OGI or M21. If OGI is selected then M21 is not required.

2. On September 4, 2015, Texas Commission on Environmental Quality issued Alternative Means of Control (AMOC-6) that requires semi-annual use of OGI technology for

[3] "Smart LDAR: Pipe Dream or Potential Reality?" Derek Reese, Charles Melvin, and Wayne Sadik, presented at the AIChE 2008 National Meeting. Available at http://www.flir.com/uploadedFiles/Thermography_USA/Industries/OGI/5_Smart_LDAR.pdf.
[4] "Parallel LDAR campaigns with sniffing and OGI: Summary of the field campaign project." Pety Kangas and Kaisa Vaskinen, Concawe OGI ad-hoc group. February 24, 2015
[5] "PILOT STUDY: Optical Leak Detection & Measurement," Terence Trefiak, ConocoPhillips, October 16, 2006.
[6] "Optical Gas Imaging at Jonah Energy: Saving Gas and Saving Money Through Regular OGI Surveys," FLIR, April 2016. Available at http://www.ogj.com/content/ogj/en/whitepapers/2016/05/optical-gas-imaging-at-jonah-energy-saving-gas-and-saving-money-through-regular-ogi-surveys.whitepaperpdf.render.pdf
[7] See Southwestern Energy Presentation to Energy Information Administration, James Vick, July 12, 2016. Available at: https://www.eia.gov/conference/2016/pdf/presentations/vick.pdf.

difficult to monitor LDAR components. If leaks are detected by OGI then an annual M21 is required.

On June 3, 2016, EPA promulgated the new source performance standards found at 40 CFR Part 60 Subpart OOOOa that apply to crude oil and natural gas production, transmission and distribution.[8] The rule requires monitoring for fugitive emissions with the use of OGI (with M21 as an alternative) at oil and natural gas well sites and natural gas compressor stations. However, these requirements are separate from the LDAR requirements that are discussed in the background of this paper. Similarly, state regulations for the oil and gas industry have also included the use of OGI as an option. In the state of Colorado, operators are overwhelmingly choosing OGI over M21 when given the option to use either to meet state requirements for fugitive emissions monitoring at oil and natural gas facilities.

The implementation of OGI as a stand-alone monitoring technique for LDAR program could yield significant benefits not only to the environment and human health, but also to industry and regulators. These benefits could include, but are not limited to:

a. The potential to monitor components more quickly as compared to current work practices;
b. The need for fewer personnel to monitor a facility;
c. Lower costs for some facilities;
d. Identifying leaks at non-regulated sources that otherwise would not be monitored (i.e., components not defined in the LDAR regulations, such as storage vessels);
e. Improved safety (e.g., capability to view components that are difficult-to-monitor and unsafe-to-monitor; monitoring startup and shutdown activities);
f. Decreased product losses; and
g. Locating leaks which are not accessible (e.g., under insulation).

However, we note that because OGI alone may not result in the same quantity of emission reductions as the current use of M21, because there are still questions about the limitations of OGI technology, and because there is no standard method for the use of OGI similar to M21, additional options that combine OGI with other work practices or equipment standards should be evaluated if M21 is not used.

Alternative Monitoring Technologies Beyond the Use of Handheld OGI Cameras

Vendors and manufacturers have also been investing in the development of alternative technologies for use in LDAR programs. A couple of examples include:

1. Multiple IR sensors that provide a mechanism to alert the operator once a leak is detected.
2. Continuous monitoring cameras using OGI or hyperspectral imaging that may be fixed or movable (pan-and-tilt) installed throughout the facility and then networked to provide

[8] For those activities when construction, modification or reconstruction commenced after September 18, 2015

instant notification to the control room or operator(s) on duty. The images can be saved locally in the camera, remotely in the control room, or in the cloud.

Other leak detection technologies that are also being developed and tested include point sensors and aerial and long distance monitoring systems. However, none of these new technologies has yet been developed to the point of allowing a determination of the quantity of emissions reductions as compared to the current use of M21.

Low Emission Equipment

Vendors and manufacturers have been increasing the development of low emission (low-E) technology over the last ten years. Low-E technology generally refers to equipment or technology designed to leak significantly less frequently than standard equipment. The most common types of low-E technologies are related to valves and valve packing, although advances have been made in low-E technology for connectors/flanges and pumps. Vendors, manufacturers, and industry have commonly referred to certified low-E valves or packing as those where a manufacturer has issued a written guarantee that the valve or packing will not leak above 100 ppm for five years, when installed and maintained in accordance with the manufacturer installation instructions and warranty conditions. The typical regulatory definition for a leak ranges from 500 ppm to 10,000 ppm.

As the development of the technology matured, EPA and some states (e.g. West Virginia) began requiring the implementation of low-E technology in consent decrees (CD) issued to industries such as refiners, chemical plants, and natural gas processing plants. Examples of the requirements include:

a. Requirement to install certified low-leaking valve packing technology whenever repacking any valve in gas/vapor or light liquid VOC service.
b. Requirement to ensure each newly-installed valve is a certified low-leaking valve or is fitted with certified low-leaking valve packing technology.
c. Requirement to replace chronically leaking valves with a certified low-leaking valve or certified low-leaking valve packing technology.

While many companies have implemented low-E technology as a result of the CDs, in many states (e.g. Texas), companies have also begun to implement low-E technology in a proactive manner. The implementation of such technology has resulted in significant environmental benefits. Some examples include:

1. BP Whiting Refinery: Implemented a valve replacement and improvement program that required the refinery to purchase valves and valve packing that meet the requirements for certified low-leaking valve or certified low-leaking valve packing technology. BP stated that these new measures seem to be effective and have reduced leaks in one process unit by 20 percent.
2. Chevron Refinery: Chevron embarked in a detailed study to determine the best valve technologies and manufacturers. In 2005 they implemented low-E technology which resulted in a 37% decline in the rate of valve leaking between 2006 and 2010.

Several studies conducted by industry and other organizations (e.g. third party contractors) have found that, although the cost of low-E technology is slightly higher, the cost savings for its implementation is greater, resulting in an overall cost savings.[9] A five-year study for one facility indicated:

1. Direct Costs: An increase cost of $24,996 when utilizing low-E equipment ($539,171) compared to regular equipment ($514,175).
2. Indirect Costs: An increase cost of $32,969 when utilizing low-E equipment ($711,160) compared to regular equipment ($678,190).
3. Monitoring Costs: A decrease cost of $18,200 when utilizing low-E equipment ($9,800) compared to regular equipment ($28,000).
4. Leak Repair Costs: A decrease cost of $62,880 when utilizing low-E equipment ($1,120) compared to regular equipment ($64,000).

Recordkeeping & Reporting

LDAR requirements vary across regulations in terms of whether sensory monitoring or M21 instrument monitoring is required, leak definitions, and specific components subject to monitoring (e.g., the inclusion of connectors). These differences arose from consideration of the technical and economic feasibility of requirements on a category-specific basis, within the constraints of the requirements of the particular part of the CAA under which the regulations were developed (e.g., sections 111 or 112). These varying LDAR requirements lead to different recordkeeping and reporting requirements in the rules. Additionally, many facilities are subject to multiple rules, which means they may have multiple LDAR programs, with different recordkeeping and reporting requirements per program.

Advancements in leak monitoring technologies have the potential to be technically and economically feasible across source categories and industrial sectors, and thus this could lead to uniformity in LDAR requirements. Additionally, when updates are made to LDAR regulations, improving uniformity in recordkeeping and reporting can be achieved. This also has the potential benefit of making electronic reporting (e-reporting) an easier transition for LDAR programs, since reporting forms can be standardized across different subparts.

The Team discussed specific benefits, as set forth below, of modifying the recordkeeping & reporting portion of the LDAR regulations, based on past experience. Specifically, standardization of requirements and e-reporting could facilitate the ability of regulators to conduct compliance queries. Specific benefits discussed by the Team include the following:

a. E- reporting is in keeping with the current trends in data availability and transparency;
b. E-reporting also makes data more accessible for review, analysis, and sharing; simplifies data entry; eliminates redundancies; and minimizes data reporting errors;
c. Improves compliance by facilitating the ability of regulated facilities to demonstrate compliance with requirements and by facilitating the ability of EPA and delegated agencies to assess and determine compliance; and
d. Reduces burden on regulated facilities, delegated air agencies, and the EPA.

[9] "Low-Leak Valve Technology: An Update" John Butow of ERM presented at the ISA 2016 Conference

TEAM RECOMMENDATIONS[10]

Recognizing that any changes to the current LDAR rules requires formal rulemaking activities, the Team has divided its recommendations based on short-term, ongoing, and long-term activities. While the research focused on the separate concepts described above, the Team recognizes that these are not necessarily separate concepts and could be combined in various ways within the LDAR rules.

Within the next 2 to 3 years, the Team recommends continued work to identify alternatives to M21 that could be paired with OGI or other technologies and included in an amended AWP. Continuing to evaluate OGI and alternative technologies while identifying work practices and equipment standards as alternative practices in LDAR programs can lead to future modifications of LDAR regulations. Additionally, the Team recommends considering requirements to utilize low-E technologies to further reduce emissions by proactively preventing leaks instead of reactively identifying and repairing leaks after they occur.

The Team is advocating for ongoing research, both within EPA and externally to further support the recommendations. Workshops, forums, and other discussions should be held to foster continued discussion in these areas. In addition, partnering with individual companies, vendors, states, etc. to advance research and use of alternative technologies should be considered. Research should focus on continued development of other leak detection technology; the development of continuous monitoring technologies; and low-E technologies.

In the longer term, once research and instrument capability are advanced, the Team recommends establishing a protocol specific to the use each alternative identified and that would establish specific requirements to permit the use of these alternative technologies or programs as stand-alone work practices. Once these protocols are in place, the AWP and/or individual rules could be amended to allow another monitoring method or approach in lieu of M21.

In addition to the recommendations above that relate to specific technologies, the Team recommends that recordkeeping and reporting requirements be re-visited, at a minimum, to standardize the information for compliance determinations using an e-reporting system. As noted above, while the recordkeeping and reporting requirements are similar across the rules, each facility-specific report received by regulatory agencies may be different, thus causing some difficulties with compliance determinations.

[10] These are the recommendations of the Team members and have not yet been presented to or endorsed by the E-enterprise Leadership Council

ATTACHMENT

LDAR RULE MODERNIZATION TEAM

Keith Sheedy (Co-Chair) – Texas Commission on Environmental Quality
Lisa Dorman (Co-Chair) – Pennsylvania Department of Environmental Protection
Esteban Herrera (Co-Chair) – Environmental Protection Agency (EPA) (OECA initially and then Region 6 starting January of 2017)
Kelly Poole – Environmental Council of the States
Robert Burchard – E-Enterprise for the Environment
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