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A guide to monitoring fugitive emissions and developing a Leak Detection and Repair (LDAR) program

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Overview

What are fugitive emissions?

Fugitive emissions are unintended leaks of gases or vapors from pressurized industrial equipment. For industries that use or produce gases and chemicals that are hazardous to humans or the environment, fugitive emissions can be especially dangerous to workers, the community, and the environment.

How do leaks occur?

Studies by the EPA have estimated that valves and connectors are the most significant source of leaks in the United States.

Here are the most commonly used parts, which account for more than 90% of emissions from leaking equipment.*

Top 7 sources of equipment leaks

1. Valves
2. Connectors (including pipes, flanges, fittings used to join equipment, gaskets, and blinds)
3. Pumps
4. Sampling connections
5. Compressors
6. Pressure relief devices (including relief valves and rupture disks)
7. Open-ended lines

* *"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 HQ-OAR-2005-0475-0105.*

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Why do leaks need to be fixed?

Small leaks add up to big dangers

Workers can become exposed to high concentrations of Volatile Organic Compounds (VOCs). VOCs contribute to smog, which is linked to respiratory disease and asthma. Some VOCs can be volatile hazardous air pollutants, which can cause health effects including cancer, reproductive infertility, and birth defects.

Because of these health concerns, the U.S. Environmental Protection Agency places requirements on companies and enforces rule violations. Read more here on EPA's website.

Protecting your company

Worker safety: The health of your workers may be at stake if your facility processes hazardous gases and vapors, which workers are then exposed to from undetected leaks.

Environmental protection: Escaping greenhouse gases, such as methane, contribute to climate change. This can be risky to the reputation of your company, in addition to the long-term consequences of rising heat and increased severe weather conditions.

Community reputation: Detecting and responding to pollution helps protect the neighboring communities near your facility. Severe leaks can cause unsafe conditions that can require emergency alerts to the community, first responders, or even cause local evacuations.

Government compliance: Facilities may be subject to federal, state, and local regulations. Compliance and maintaining good standing means facilities can avoid the fines and other enforcement actions that result from code violations.

Protecting revenue: Persistent leaks result in a loss of supplies or product produced, which ultimately reduces revenue and hits the bottom line of your company.

Read our blog: Sniffin' out an air quality threat.

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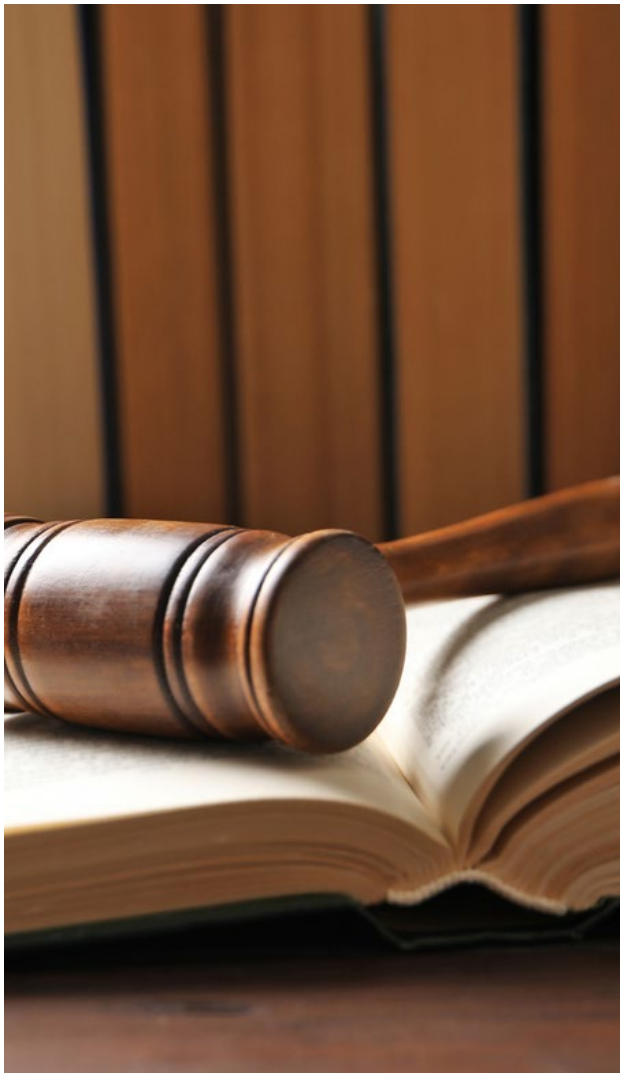
Regulations

United States

Leak Detection and Repair (LDAR) programs are required by the Environmental Protection Agency for many types of facilities. State or local agencies may have additional requirements too. At the federal level, LDAR programs are required by regulations such as the New Source Performance Standards (NSPS), National Emission Standards for Hazardous Air Pollutants (NESHAP), State Implementation Plans (SIPs), the Resource Conservation and Recovery Act (RCRA).

Multiple regulations can apply to your facility at the same time, depending on the equipment used. There are 25 federal standards that require facilities to implement LDAR programs using the monitoring procedure known as Method 21. An additional 28 federal regulations require at least some Method 21 monitoring, but don't require facilities to have LDAR programs in place. Facilities should always seek to ensure that they are aware of all the regulations that apply to their operations.



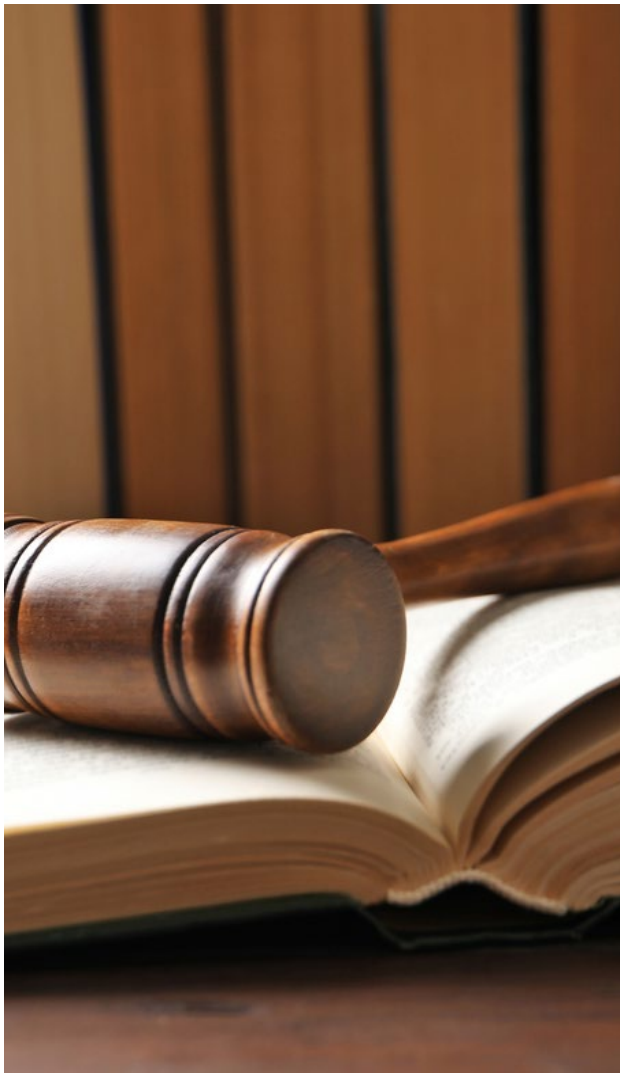
Source: *https://www.epa.gov/emc/method-21-volatile-organic-compound-leaks*

Regulations

Canada

The federal regulations that apply to methane in the upstream oil and gas sector aim to control methane emissions and also reduce the amount of volatile organic compounds (VOCs) released into the air. VOCs are found with methane and are known to have adverse health effects and contribute to smog formation.

These regulations apply generally to facilities that handle significant volumes of gas. They cover key fugitive and venting emission sources in the upstream oil and gas sector.



***Source**: https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/proposed-methane-regulations-additional-information.html*

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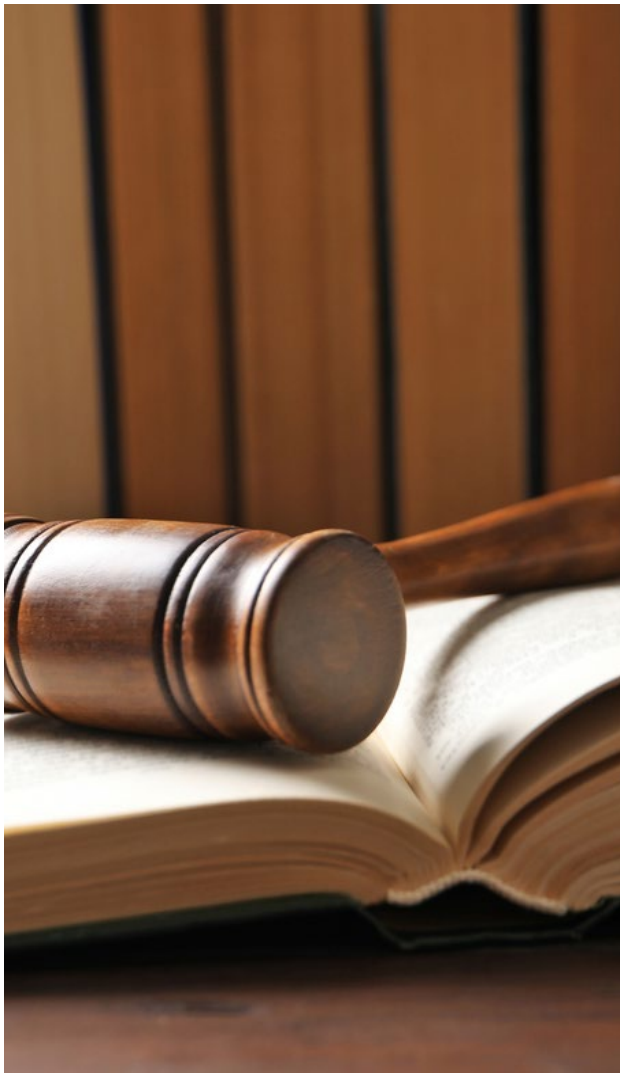
Regulations

EU standards

Standard EN 15446:2008: Fugitive and diffuse emissions of common concern to industry sectors - Measurement of fugitive emission of vapors generating from equipment and piping leaks:

- This standard applies to the measurement of fugitive emissions of volatile organic compounds (VOCs) from process equipment. The leak sources include, but are not limited to, valves, flanges and other connections, pressure relief devices, process drains, open-ended valves, pump and compressor seal systems, agitator seals, and access door seals. The standard is based on the measurement of the gas concentration at the interface of a leak. This concentration is measured with a portable instrument which is converted to a mass emission rate by use of a set of correlations. The scope of this standard includes the complete data processing, from the initial concentration measurement up to the generation of an emission report over a reporting period (which is generally one year). This standard does not prescribe the number of potential emission points that should be screened each year nor the frequency at which these points should be screened. This sampling strategy shall indeed take into account the plant characteristics and the required level of control over fugitive emissions.

- A portable instrument is used to detect VOC leaks from individual sources. Any detector type is allowed, provided it meets the specifications and performance criteria within the specifiction. This procedure is intended to locate the leaks, and to estimate the mass emission rate from individual sources and the total emission of the industrial facility over a reporting period by using:
    - EPA or user-defined correlations whenever possible.
    - Fixed emission factors, in all other cases.



***Source**: https://shop.bsigroup.com/ProductDetail/?pid=000000000301438 22&_ga=2.185297769.1301777209.1583936782-1972194655.1583936782*

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Developing a Leak Detection and Repair (LDAR) program

What is LDAR?

Facilities can control emissions from equipment leaks by implementing a Leak Detection and Repair (LDAR) program.

The EPA defines LDAR as:

"…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."

Source:
https://www.epa.gov/sites/production/files/2014-02/documents/ldarguide.pdf - page 3

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5 Phases of an LDAR program

A Leak Detection and Repair (LDAR) program that follows best practices has at least five phases, which a facility would complete on an on-going basis. The timing and frequency of each phase will vary though, depending on the regulatory requirements, the components, changes to equipment, and other factors.

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Phase 1 - Identify your components

Best practices for identifying components

You can physically tag each regulated equipment component with a unique ID number, then write that number on your Piping and Instrumentation Diagram (P&I Diagram). You should also record any exempt components.

A site plot plan or equipment log should also be updated after any changes. If there is any new equipment, replacements, or parts retired, you should also have a procedure for timely updates to your records.

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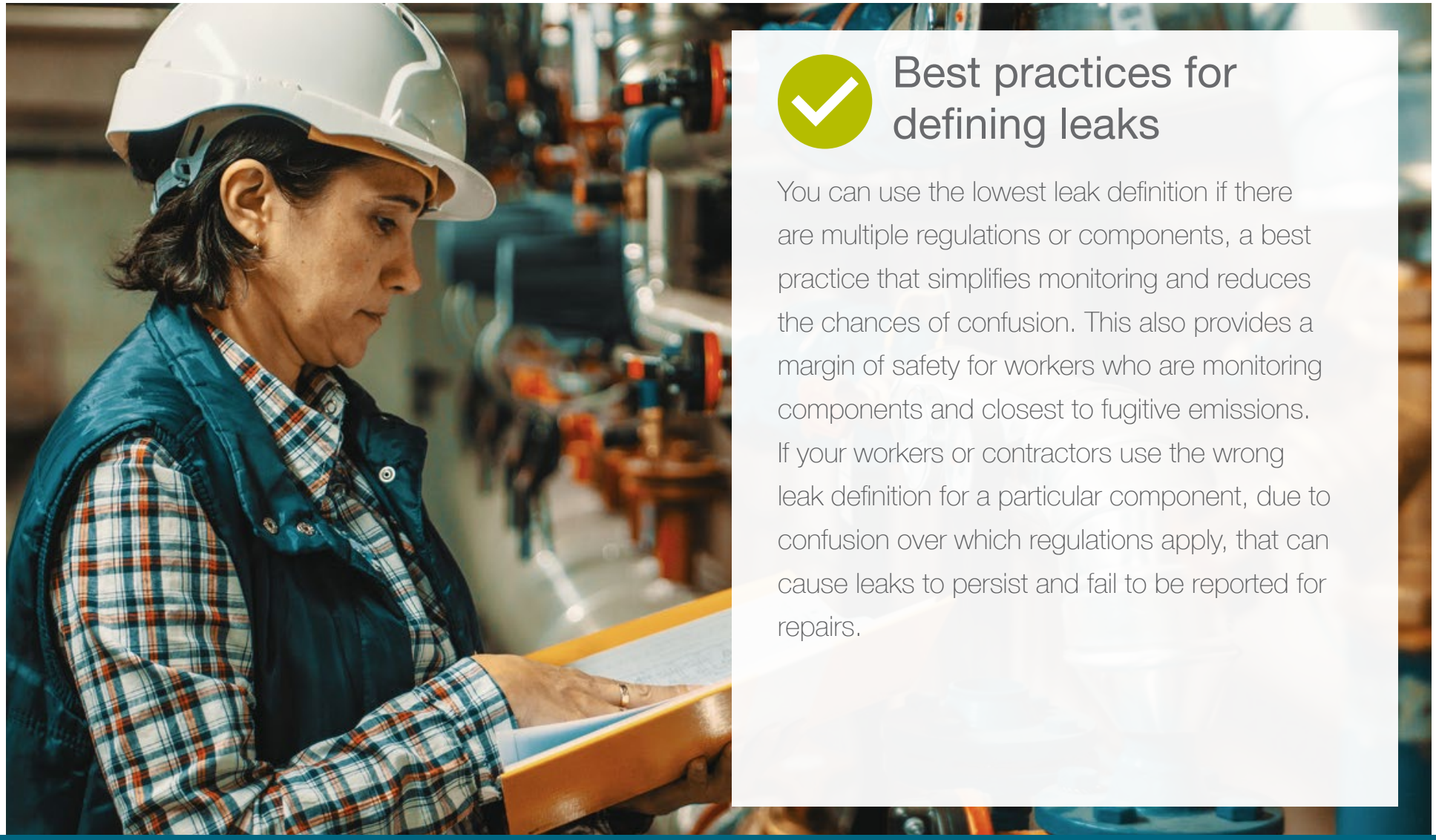
Phase 2 - Define your potential leaks



Best practices for defining leaks

You can use the lowest leak definition if there are multiple regulations or components, a best practice that simplifies monitoring and reduces the chances of confusion. This also provides a margin of safety for workers who are monitoring components and closest to fugitive emissions. If your workers or contractors use the wrong leak definition for a particular component, due to confusion over which regulations apply, that can cause leaks to persist and fail to be reported for repairs.

Always check with current regulations to confirm your facility is using the correct leak definitions.

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Phase 3 - Monitor your components

Best practices for monitoring components

An electronic and automatic data logger saves time, improves accuracy, and provides an audit record. You should audit your LDAR program periodically to determine if all components are being monitored, Method 21* procedures are being properly followed, and required records are being maintained.

Frequent monitoring and quality checks of your LDAR data gives you the assurance that your program is providing accurate, complete, and consistent results.

*Read more here on EPA's website

In some instances, inspectors have discovered workers who appeared to cut corners on monitoring procedures. If records show a person who is claiming to monitor about 1,000 components each hour, which means less than 5 seconds checking one component, you should investigate. Someone who skips components or moves too quickly along a monitoring route will produce unreliable or worthless data.

Phase 4 - Repair components

Best practices for repairing components

Your facility should develop a protocol and timetable for repairing components. Whenever possible, a first attempt at repair should be made as soon as possible after a leak is detected. When possible, installing “leakless” valves and “sealless” components can reduce future fugitive emissions and repeated repairs. If components were recently repaired, you may want to increase the frequency they are monitored to verify a leak was successfully repaired.

Phase 5 - Keep consistent records

Best practices for recordkeeping

You can schedule internal and third-party audits of LDAR records on a regular basis, which can ensure that workers are effectively monitoring all regulated components. With electronic monitoring and databases, quality audits and records maintenance won't require manually sifting through piles of paperwork. Part of your auditing protocol should also include inquiries about new or changed regulatory requirements.

Leaks that are not repaired and reported fixed in a timely manner, or improperly recorded on a delay of repair list, could cause greater problems.

Continuous improvement

Upgrading your LDAR program

Reviewing and updating your written protocols and records is a key part of maintaining an effective LDAR program.

10

10 Tips to upgrade your LDAR program

1. Begin an audit of identified components, comparing that with current P&I diagrams and any changes to equipment.
2. Review and update protocols for your written LDAR program.
3. Launch an audit of monitoring data.
4. Invest in new portable detecting instruments.
5. Upgrade your calibration devices to something that can automatically calibrate multiple detecting instruments.
6. Mandate a training program for your workers or contractors.
7. Inquire with regulatory agencies or industry associations about current or new compliance requirements.
8. Adjust internal leak definitions.
9. Review repair records and check the Delay of Repair list.
10. Take an inventory of your portable detecting instruments and calibrators. Verify they are all working properly, perform preventative maintenance, and send malfunctioning units out for servicing.

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Technology

Technology and products

EPA Method 21 requires that a portable instrument be used to detect Volatile Organic Compound (VOC) leaks from individual sources. The instrument detector must meet the specifications and performance criteria. A leak definition concentration based on a reference compound is specified in each EPA applicable regulation.

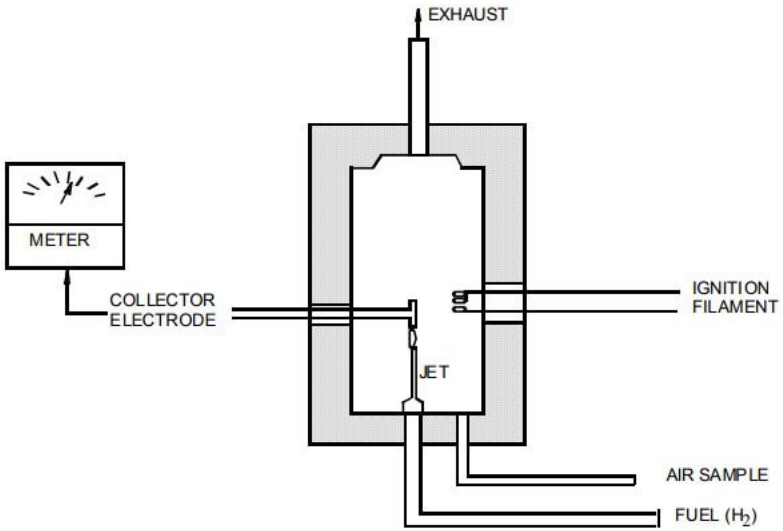
As specified in the EPA Method 21 document,

- 6.5 The instrument shall be equipped with a probe or probe extension or sampling not to exceed 6.4 mm (1/4in) in outside diameter, with a single end opening for admission of sample.
- 6.6 The instrument shall be intrinsically safe for operation in explosive atmospheres as defined by the National Electrical Code by the National Fire Prevention Association or other applicable regulatory code for operation in any explosive atmospheres that may be encountered in its use. The instrument shall, at a minimum, be intrinsically safe for Class 1, Division 1 conditions, and/or Class 2, Division 1 conditions, as appropriate, as defined by the example code. The instrument shall not be operated with any safety device, such as an exhaust flame arrestor, removed.

Ionization detectors

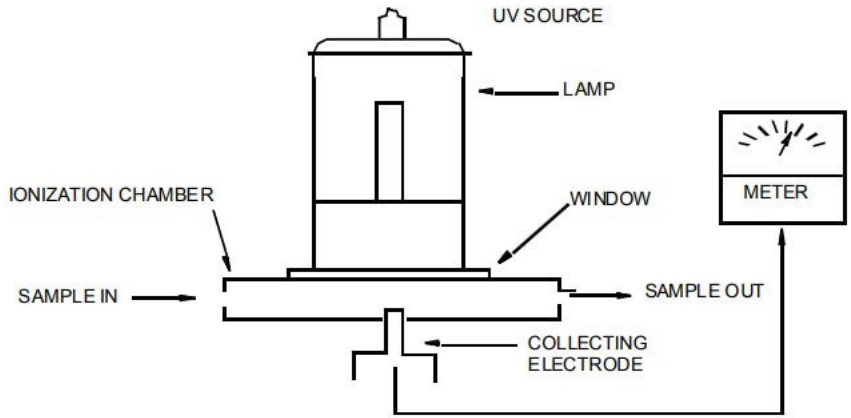
More advanced analyzers are equipped with a Flame Ionization Detector (FID) to measure organic compounds with high sensitivity. The FID technology allows for a wide dynamic and linear range that produces stable and repeatable responses. Some analyzers can be configured with both FID and Photo Ionization Detection (PID) technology for simultaneous detection and enhanced analytical capabilities. This dual configuration is capable of producing a more rapid reading of organic and inorganic compounds as opposed to a single detector technology and provides more comprehensive gas coverage than comparable size devices.

How does a flame ionization detector work in toxic vapor analysis?



Read more ›

How does photoionization detection help identify toxic vapors?



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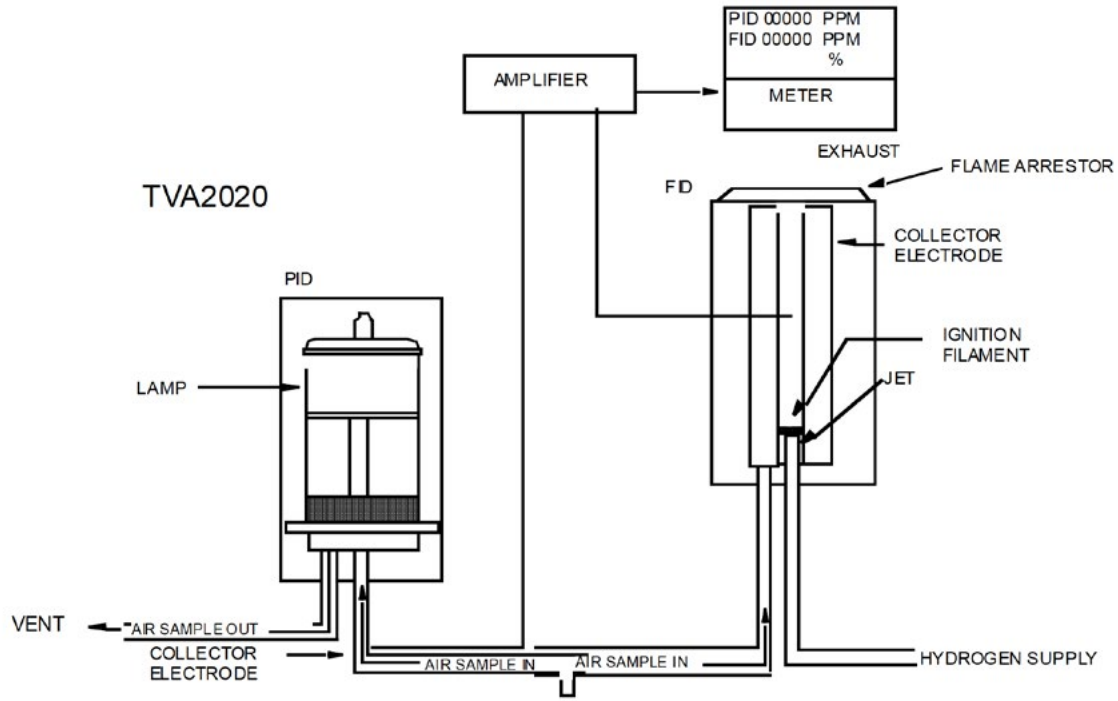
What's better: FID or PID technology?

It depends, so the best instrument offers simultaneous detection. Since both detectors may be displayed and logged simultaneously, the relative response of the two detectors may give some clues about the identity of the compound being measured. For instance, the PID does not respond to methane at all, but the FID responds very well. A high FID reading with virtually no PID response might indicate the presence of methane. Consequently, PIDs respond very well to some inorganic gases that FIDs cannot detect. A high PID reading with no FID reading might suggest the presence of an inorganic compound.



TVA2020 dual detector configuration

With readings from both detectors readily available, the dual detection analyzer can help a user make decisions about the type of compound present and which detector reading to use in order to comply with U.S. EPA Method 21 and LDAR programs.

TVA2020 toxic vapor analyzer

Product details ›

Portable toxic vapor analyzers enable you to quickly detect fugitive emissions of organic and inorganic compounds for Method 21 compliance, LDAR applications and site remediation.

This lightweight, intrinsically safe portable gas leak detector can be configured as an FID analyzer (flame ionization detector) or dual detection FID analyzer and PID analyzer (photo ionization detector).

Note: The Thermo Scientific™ MIC-6 multi-instrument calibrator complements the Thermo Scientific™ TVA2020 toxic vapor analyzer to improve accuracy and save time for optimizing LDAR compliance monitoring.

Click here to watch the video: Sniffin' 101

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MIC-6 multi instrument calibrator

Product details ›

EPA mandated Leak Detection and Repair (LDAR) compliance monitoring can be automated and optimized using the MIC-6 multi Instrument Calibrator to improve accuracy and save time. The MIC-6 can automatically calibrate up to six TVA2020 toxic vapor analyzers. It can also be used in a manual mode to calibrate the legacy TVA1000B toxic vapor analyzer, or manually calibrate any other manufacturer's portable field analyzer.

Click here to watch the MIC-6 in action

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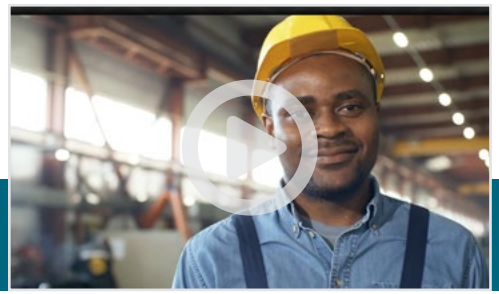
Sentinel PRO environmental mass spectrometer

Product details ›

Mass spectrometry has been widely used for many years for multi-point, multi-component monitoring of a wide range of Volatile Organic Compounds (VOCs) in the workplace. Process mass spectrometers can help prevent exposure to VOCs by enabling leak detection and correction before any release exceeds maximum exposure levels. The Thermo Scientific™ Sentinel PRO environmental mass spectrometer provides broad coverage and rapid response when configured to monitor fugitive and point source emissions. A single Sentinel PRO analyzer monitors 100 or more sample points within 15 minutes and can replace an entire rack of less sensitive, discrete analyzers to improve detection capabilities and significantly reduce maintenance and ongoing operating costs.



Click here to watch the video on 5 steps to implementing a Leak Detection and Repair (LDAR) program

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SOLA iQ on-line sulfur analyzer

Product details ›

Flare stacks emit excess hydrocarbon gases that cannot be recovered or recycled. These gases combined with steam and/or air are burnt off in the flare system to produce water vapor and carbon dioxide. Processing companies are required to monitor the various emissions from their plant stacks and flares to reduce the amount of pollution entering the atmosphere. We offer a solution for continuous and accurate determination of total sulfur in flare gas with the Thermo Scientific™ SOLA iQ flare analyzer. Utilizing unique Pulsed Ultraviolet Fluorescence (PUVF) technology and the proven Pyrolysis system, the SOLA iQ flare analyzer builds on the success of the Thermo Scientific™ SOLA II flare analyzer.

Click here to watch the Prima Pro in action

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Additional resources

EPA Leak Detection and Repair best practices guide
https://www.epa.gov/compliance/leak-detection-and-repair-best-practices-guide

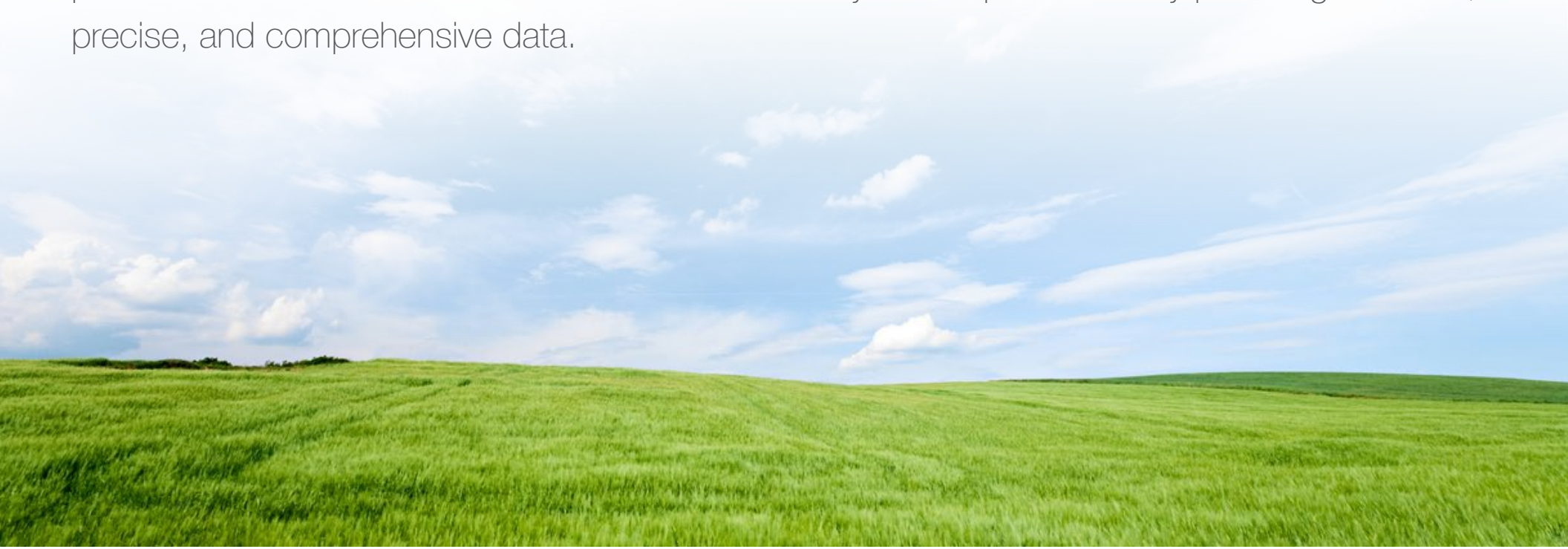
EPA reference method 21 (40 CFR part 60, appendix A)
https://www.epa.gov/emc/method-21-volatile-organic-compound-leaks

EPA compliance assistance
https://www.epa.gov/compliance

EPA policy & guidance
https://www.epa.gov/laws-regulations/policy-guidance

Thermo Scientific environmental & process monitoring instruments

EPM instruments are used in a wide variety of customer applications and market segments from utilities, state and governmental agencies, oil and gas, mining, iron and steel, pharmaceutical manufacturing, cement, power generation, and other industrial applications. Our instruments make the world healthier, cleaner, and safer and are used globally to regulate and improve air quality along with keeping miners safe and minimize their exposure to particulates. Also, our products enable our customers to maximize efficiency in their processes by providing accurate, precise, and comprehensive data.



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