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Alberta Energy Regulator

How to Develop a Fugitive Emissions Management Program

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1 Introduction

1.1 About This Manual

This manual is a guide for industry on how to develop fugitive emissions management programs (FEMPs) that comply with *Directive 060: Upstream Petroleum Industry Flaring, Incinerating, and Venting*, section 8.10.1 and appendix 12. It clarifies these requirements and includes best practices for managing fugitive emissions, which companies should consider when developing their programs.

1.2 How to Use This Manual

This manual is organized into sections corresponding to the mandatory elements of a FEMP set out in appendix 12 of *Directive 060*. The appendices provide best practices that relate to these elements.

2 Developing a Fugitive Emissions Management Program

FEMPs are intended to complement a duty holder's overall emissions reduction strategy by establishing a plan and supporting systems to systematically detect and manage fugitive emissions. Section 8.10.1 and appendix 12 of *Directive 060* set out content requirements for FEMPs but leave program design and implementation to the duty holder.

FEMPs and associated data should be reviewed annually.

2.1 Contact Information

A FEMP must clearly identify which individual is accountable for the FEMP and should provide their title and contact information as per section 1 of appendix 12 of *Directive 060*. This person will be the primary contact for any questions from the Alberta Energy Regulator (AER) about the FEMP.

2.2 Resourcing

The FEMP must document internal (e.g., individual staff, groups, departments) and external (e.g., contractors) resources allocated to develop, implement, maintain, and update the FEMP, as per section 2 of appendix 12 of *Directive 060*. Specific responsibilities identified for internal and external resources could include surveying, screening, repairing, tracking, reporting, and training. Table 1 provides an example of how a duty holder might allocate and document FEMP resources and responsibilities.

Table 1. Example of how resources might be allocated and documented in a FEMP

Resource	Responsibility
Corporate management	• Maintain corporate commitment to the FEMP • Approve annual FEMP budget
FEMP management team	• Develop and maintain FEMP review schedule • Create survey and screening schedule • Oversee data management system • Submit annual methane emissions reports • Assess the FEMP's effectiveness and opportunities for continuous improvement • Provide program updates, develop annual reports, and make program recommendations
Fugitive emissions surveyors	• Maintain and calibrate test equipment • Perform surveys and screenings • Generate individual facility reports for operations • Identify components that need to be repaired, replaced, or retrofitted • Determine leak severity or measure emissions rate • Maintain electronic system to capture and retain data • Maintain monitoring schedules • Confirm the integrity of any repair within seven days
Field operators	• Provide guidance on survey and screening schedules • Supervise surveyors and provide them with information about facility performance and operation during surveys and screenings • Review facility reports and develop work plans (work orders) to address recommendations
Maintenance team	• Repair sources of leaks or modify facilities (e.g., install test ports, repipe vent lines) • Close out work orders and record repair details

2.3 Preventive Maintenance

A FEMP must indicate what preventive maintenance practices the duty holder is using to reduce or prevent fugitive emissions as per section 3 of appendix 12 of Directive 060. This might include checklists used by field operators during routine inspections, regularly scheduled maintenance programs, and maintenance programs or standard operating procedures that incorporate preventive maintenance practices. For example, a standard operating procedure might be to conduct fugitive emissions surveys before a planned shutdown.

Preventive maintenance best practices are provided in appendix 1.

2.4 Procedures and Plans

The FEMP must have documented procedures and plans for meeting the required frequency of fugitive emissions surveys and screenings, as per section 4 of appendix 12 of Directive 060, including tracking such information as

- the number of surveys or screenings required at each site,
- the number of surveys or screenings completed at each site,

- the results of surveys and screenings, containing the information set out in the fugitive emissions survey and screening record form in appendix 13 of Directive 060, and
- the status of any required repairs.

Tracking of screenings, surveys, and repairs might be managed through a single data management system or through multiple systems or groups within the duty holder's company.

Fugitive emissions survey and screening requirements in Directive 060 apply only to sites with active wells or facilities that are outside of the Peace River area. Survey frequencies in Directive 060 vary according to facility type or equipment at a site (see frequencies in table 4 of Directive 060), while screenings must be done annually at all well sites except for those described in section 8.10.3.1 of Directive 060. The FEMP should indicate how companies track when surveys or screenings are required and what procedures are in place to ensure that all components in section 8.10.2.3 of Directive 060 are surveyed at each site.

For the example site in figure 1, the duty holder would have to do the following:

1) Conduct a fugitive emissions survey of all equipment within the site boundary once a year. Report results as a single site survey in the annual methane emissions report.
2) Conduct fugitive emissions surveys of only the tanks with vent gas controlled two more times in that same year (the first of the three annual surveys required for these tanks is covered by the initial site survey above). Report results as two separate tank surveys in the annual methane emissions report.
3) If the well was surveyed during the site survey above, it would not need to be screened in that year, and no further results for this well would need to be reported as part of the annual methane emissions report.

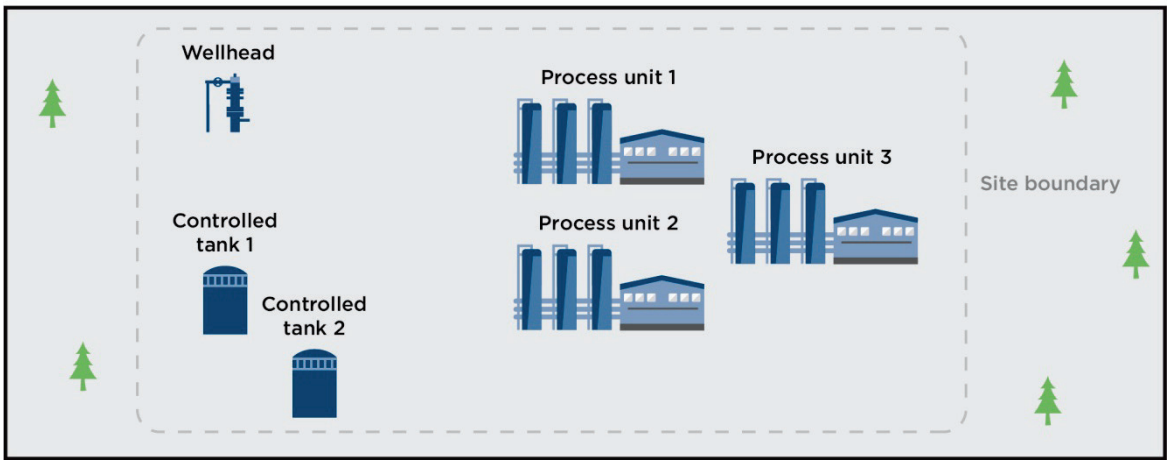

Figure 1. Example of survey frequency for a site: battery with wellhead and tanks with vent gas controlled

Directive 060 makes provisions for a duty holder to adjust survey frequency to align with operational visits at sites where access is restricted. At sites with adjusted survey frequencies, the FEMP must include why access is restricted and why an alternative survey frequency is needed. It should also indicate how the duty holder incorporates these surveys into operational visits and ensures that repairs are completed.

For information on best practices for repairs, see appendix 2. For common sources of fugitive emissions, see appendix 3.

2.5 Techniques and Equipment

A FEMP must describe the methods and equipment used for surveys and screenings, as per section 5 of appendix 12 of Directive 060, including the make and model of survey and screening equipment. It is not necessary to use the same type of equipment for all surveys and screenings.

Surveyors must identify the specific type of equipment or method used for each survey or screening on the fugitive emissions survey or screening record (see appendix 13 of Directive 060).

A duty holder must describe in the FEMP any alternative equipment or methods that it is using for surveys or screenings. The duty holder must also assess and, upon request by the AER, demonstrate the equivalency of these alternatives, as described in section 8.10.2.2 of Directive 060.

For best practices for fugitive emissions surveys and screenings, see appendix 4 and 5, respectively. For information on alternative technologies for conducting surveys and screenings, see appendix 6.

2.6 Equipment Calibration and Maintenance

The FEMP must describe the methods of calibrating and practices for maintaining the survey equipment as per section 6 of appendix 12 of Directive 060. This should include how frequently any maintenance or calibration activities are conducted and any procedures or tracking systems used to ensure that these activities are carried out. To ensure this is being done, a duty holder might add maintenance and calibration requirements to standard operating procedure checklists or assign staff to manage scheduled maintenance.

Documentation to verify that equipment is being maintained and calibrated to the manufacturer's specifications should be made available to the AER upon request.

2.7 Training

Directive 060 does not set out minimum training requirements for individuals completing fugitive emissions surveys and screenings, but it does require duty holders to ensure that these individuals are sufficiently trained. The FEMP must describe any internal and external surveyor training programs and if certification is provided, as per section 7 of appendix 12 of Directive 060. The FEMP should also

describe the topics covered in the training programs, duration of training and specific training for the types of survey and screening equipment being used.

The FEMP must also indicate how frequently the surveyors will be trained and how often they will be retrained or recertified, as per section 8 of appendix 12 of Directive 060.

If a duty holder hires a contractor to conduct surveys and screenings, the contractors must be sufficiently trained.

For training best practices, see appendix 7.

2.8 Data Management

Companies must have procedures to track, manage, and verify the status of repairs, as per section 9 of appendix 12 of Directive 060, and to meet the reporting and record keeping requirements of Directive 060. The FEMP must describe the data management practices and systems used to ensure that survey and screening results trigger required repairs and that the repairs are captured for annual reporting as per section 10 of appendix 12 of Directive 060. System details might include the names of software programs or applications used and the type of data managed by each system. When multiple systems are used, the FEMP should explain how data flow between systems (e.g., how data from surveys performed by third parties are integrated into the duty holder's internal systems to track repairs).

For best practices for data management and record keeping, see appendix 8 and appendix 9, respectively.

2.9 Continuous Improvement

The FEMP must describe how data will be used to evaluate FEMP performance and inform continuous improvement as per section 11 of appendix 12 of Directive 060.

The following are indicators that could be used to evaluate the performance of a FEMP and to determine if any changes are needed:

- emissions reductions over time (e.g., by corporate or operating area, or by facility type or equipment)
- volume of gas conserved by managing fugitive emissions
- number of leaking components over time (e.g., by corporate or operating area or by facility type or equipment)
- specific components within facilities that are more prone to leaks
- time between leak detection and repair

The FEMP should indicate what methods are used to review data, how often data are reviewed, and how changes will be made to the FEMP following these reviews.

Appendix 1 Best Practices: Preventive Maintenance

The following preventive maintenance practices could be incorporated into operations and maintenance practices to reduce fugitive emissions:

- tighten loose connections (especially in a vibrating service)
- plug or eliminate open-ended lines
- inspect and confirm positive isolation capability of separator dump valves
- inspect and maintain pneumatic instruments (e.g., controller case seals)
- inspect and maintain thief hatches
- close thief hatches if found open on tanks with vent gas control
- ensure combustion systems remain lit when site is pressurized and active
- ensure control equipment is operational (except when it is down for maintenance)
- ensure vapour recovery units are operating and being maintained as designed

Appendix 2 Best Practices: Repairs

Certain repairs could be completed on site during surveys or screenings. This can be done if the surveyor has adequate training to make repairs or is accompanied by maintenance or operations staff capable of repairing leaking components.

Tagging

Physical tagging, in which a tag is affixed to a leaking component, is the most common method of tagging. These tags should be hung either directly on the leaking component or in a position where it is easy to determine the location of the leaking component. Tags should be uniquely numbered, weather resistant, designed for high visibility, and securely hung using plastic zip ties or corrosion-resistant wire.

Alternative methods of tagging, such as geospatial identifiers, should identify fugitive emission sources and provide sufficient information to enable repair. This information should include the time and date the leak was detected and may even include a photo of the leak source.

Appendix 3 Common Sources of Fugitive Emissions

Fugitive emissions come from two sources: standard equipment components and abnormal processes. Surveyors should be aware of both types of fugitive emissions.

Standard Equipment Components

Fugitive emissions from standard equipment components are the result of components wearing out or failing over time, being improperly installed, or loosening due to vibration. These fugitive emissions can often be easily detected during a fugitive emissions survey or screening, and the component can often be immediately refitted, repaired, or replaced.

The following components are common sources of fugitive emissions:

- connections (especially threaded connections) and fittings
- instruments and valves (e.g., pressure-relief valves and control valves)
- seals and housings (e.g., pneumatic controller case seals and tank thief hatch seals)

Abnormal Processes

Fugitive emissions from abnormal processes typically result from equipment malfunctioning or becoming inoperative, or from processes functioning abnormally. These types of emissions may be more difficult to detect because they can be more intermittent and may require a detailed investigation before the source can be identified and repaired.

The following abnormal processes are common sources of fugitive emissions:

- unlit flares (ignitors and pilots)
- malfunctioning pneumatic instruments
- conservation units (e.g., vapour recovery units) that have unexpectedly quit operating
- equipment components emitting vent gas upstream of equipment actively controlling vent gas

Hydrocarbon storage tanks can also be sources of fugitive emissions from abnormal processes when

- thief hatches are open outside the time required for pressure relief,
- leaking process gas or volatile product moves past the seats of drains or blowdown valves,
- gas and liquids are separated inefficiently allowing gas to carry through,
- piping changes result in high vapour carry through, and
- pigging operations displace large volumes of gas to the tank.

Appendix 4 Best Practices: Fugitive Emissions Surveys

Before using any survey equipment, the surveyor should make sure that it can be safely operated in the area and take any necessary precautions.

Before starting the survey, the surveyor should identify a scanning path to ensure all areas of the facility are surveyed. It is usually best to follow the path of the product from inlet to outlet. The surveyor might also conduct the survey by individual process units and then check off each unit as it is surveyed.

Meteorological conditions, such as rain and wind, can make it more difficult to detect fugitive emissions. For example, higher winds can distribute plumes more quickly, making them harder to detect. Surveyors should also avoid surveying in moderate to heavy rain because water can damage instrument sensors.

Organic Vapour Analyzer

Organic vapour analyzers, sometimes called toxic vapour analyzers, are portable analyzers typically equipped with photoionization detectors or flame ionization devices. Other types of sensors include catalytic oxidation or infrared absorption sensors.

When completing surveys with an organic vapour analyzer, the following best practices are recommended:

- The tip of the analyzer's probe should be traced along the leak interface as close as possible to the component's surface.
- Surveyors should ensure that the analyzer reaches its full meter reading by keeping the analyzer's probe in place until the reading levels out or peaks.
- To prevent falls when surveying elevated components, surveyors should use an extension probe on the analyzer rather than a ladder.
- When multiple components are close together, it can be difficult to identify the location of a leak. Surveyors should take the time to ensure that the correct source is identified and use soap testing, whenever possible, to help confirm the leak location.
- Surveys should be conducted at a pace that is appropriate for the size of the component and its configuration. Larger components will take more time to survey if a uniform probe speed is used. As a general rule, a speed of 3 cm per second should be used, moving more slowly when inspecting areas with higher potential for leaks.

Gas-Imaging Cameras

Gas-imaging cameras, often referred to as optical gas-imaging (OGI) cameras, are a tool for detecting fugitive emission sources. These cameras provide images and video recordings of leaks that are invisible

to the human eye. In addition, they can be used when it is not practical to use an organic vapour analyzer (e.g., when the component is hard to reach or is difficult to access with the analyzer's probe) and can be used to detect fugitive emissions from a distance. These cameras can also be used to estimate the emissions rate (i.e., low, medium, or high).

The ability of an OGI camera to detect fugitive emissions depends on several factors, such as distance from source, atmospheric conditions, thermal gradient, and surveyor competency.

When completing surveys using an OGI camera, the following best practices are recommended:

- Surveyors should stand 1.5 to 3 metres from the equipment being surveyed, depending on the size and accessibility of the equipment.
- Surveyors should divide the field of view in the camera view finder into quadrants and scan each quadrant to look for gas movement from each component. Gas movement might be visible only when the gas moves from the component to the background. If contrast is low or movement is difficult to observe, the high-sensitivity mode of the camera might help with detection.
- Each piece or group of equipment should be scanned from a wide angle in order to identify any apparent emissions. After a wide-angle scan, detailed scans should be done to identify the specific fugitive emissions source and to detect any lower-rate fugitive emissions not visible in the wide-angle scan. Each piece of equipment should also be scanned from at least two separate viewpoints to increase the probability of emissions detection.
- If the temperature of the leaking gas is similar to the surrounding area, surveyors should adjust the temperature span on the camera to compensate for low thermal contrast to improve their ability to identify a leak (e.g., when the component being surveyed is close to a heater or boiler).
- Surveyors should consider whether there are any factors such as ambient weather conditions or surrounding physical structures that could affect the camera's ability to detect fugitive emissions and take these into account when conducting a survey.
- It is difficult to see gas movement when the camera is in motion, so the camera should be held still on one scene for a few seconds before moving on to the next. It is recommended that a tripod is used to improve stability.
- It can be challenging to distinguish between hydrocarbon gas and other hot gases, such as steam. When viewed through a camera, steam will dissipate quickly as it cools, but a hydrocarbon gas plume often remains visible for longer.

Appendix 5 Best Practices: Fugitive Emissions Screenings

This appendix describes two of the most common screening methods: audio, visual, and olfactory (AVO) inspections and soap testing. Other methods or equipment that is capable of detecting fugitive emissions may also be used for screenings (see appendices 4 and 6).

AVO Inspections

When carrying out AVO inspections, check for the following:

- stains, wet areas, or dripping around thief hatches, pressure vacuum relief valves, and gauge board assemblies on storage tanks
- frosting or sweating of valves and pressure-relief devices connected to vent lines
- visible vapour or steam plumes from components
- normally closed valves connected to vents or open-ended lines that are not fully closed or plugged
- components that have been temporarily removed for inspection, maintenance, or other purposes and have not been put back in place
- unlit pilots and flares
- odours inside buildings and downwind of piping, process equipment, and storage tanks
- sounds indicative of a leak
- responses on hydrocarbon detection monitors (personal monitors)

Duty holders should make fugitive emissions screenings part of their routine site visits.

Soap Testing

Soap or bubble testing is an easy and low-tech method to detect smaller leaks. A sprayer or squeeze bottle is used to apply a soapy solution to an area where a leak is suspected. If a leak is present, bubbling occurs at the location of a leak. Soap testing can be used to identify leaks as small as 1×10-4 standard cubic centimetres per second (ASTM 2011).

Soap tests may not be effective in detecting leaks from equipment that is inaccessible, has continuously moving parts, or has a surface temperature greater than the boiling point or less than the freezing point of the soap solution.

Appendix 6 Alternative Technologies

A number of technologies are available or in development that can detect methane emissions at a local or regional scale and might be considered for inclusion in a FEMP. These technologies cannot replace the use of organic vapour analyzers (in accordance with Method 21; US EPA 1993) and OGI cameras in fugitive emissions surveys, unless the duty holder can demonstrate these technologies are equally capable of detecting fugitive emissions, including having similar ability to identify emissions sources and similar minimum detection limits. However, they can be used for fugitive emissions screenings or to complement surveys using organic vapour analyzers or OGI cameras. Several examples of these technologies are discussed below.

Vehicles With Mounted Sensors

Vehicles equipped with methane sensors and anemometers to account for atmospheric conditions can be used to detect methane emissions over a large area in a short amount of time. Data are tracked by location using a GPS system, and methane concentrations and fluctuation rates can be calculated for the routes travelled. Road accessibility can limit the use of these vehicles, and their sensors cannot differentiate between fugitive emissions and venting emissions. Once emissions are detected, further follow-up is needed to isolate the source.

Piloted Aircraft and Unmanned Aerial Vehicles

Aerial vehicles, such as piloted aircrafts or unmanned aerial vehicles, mounted with a methane detection sensor can also be used to detect emissions over large areas in a short amount of time. Aerial vehicles may not be able to differentiate between fugitive emissions and vented emissions or be able to isolate the source of an emission.

Satellites

Satellites that use optical imaging technologies, such as thermal and short-wave infrared sensors, can be used to detect emissions over large areas. Satellites provide low-resolution imagery, so they cannot be used to identify the source of the emission or low-level emissions, but because they can collect data frequently (daily or weekly), they can be used to identify abnormal or stochastic emission sources that are challenging to identify during on-site inspections. Satellites are less effective at detecting emissions from components with reflective surfaces, or during periods of darkness or cloud cover.

Laser Spectrometry

Handheld laser spectrometer methane detection sensors are smaller and lighter than handheld OGI cameras and can detect emissions at rates as low as one part per billion per second (Aeris Technologies 2017). Further performance testing is required to assess whether this technology can be used as an

alternative to conventional fugitive emissions survey methods (i.e., organic vapour analyzers [Method 21] and OGI cameras).

Continuous Monitoring Systems

Facilities may be equipped with monitoring systems (e.g., building gas detection systems or fenceline monitoring systems) that continuously monitor for elevated, anomalous, or stochastic emissions both indoors and outdoors. Some of these systems may be specifically designed to detect fugitive emissions, while others may be designed for other purposes (such as worker health and safety) but could be useful for detecting fugitive emission. For example, fixed-building lower explosive limit (LEL) detectors are designed to identify high concentrations of flammable gas, mainly to protect workers. The emission detection capabilities of these systems vary, and some of these systems may not be able to detect fugitive emissions at low concentrations or identify the source of fugitive emissions.

Appendix 7 Best Practices: Training

The individuals doing the fugitive emissions surveys and screenings must be trained in operating and calibrating the equipment. To effectively use the equipment, these individuals should be trained on the principles of detecting emissions with the equipment or method; sources of fugitive emissions; factors that affect estimating fugitive emissions (e.g., weather, temperature) and how to account for them in surveys and screenings; and interpreting survey and screening results. Surveyors should also have experience detecting, recording, and reporting fugitive emissions. Additionally, it is expected that surveyors will have applicable site safety training and certification.

For training on how to conduct survey using Method 21, companies can refer to an existing training and certification document, *Training and Certification of EPA Method 21 Operators* (Eastern Research Group 1997), available online through the National Technical Reports Library. This is a self-instruction manual that teaches the procedures and practices required for Method 21 testing.

Surveyors should also receive training on the type of organic vapour analyzer being used to conduct surveys or screenings because there are many types of analyzers, each with their own calibration and maintenance requirements.

Surveyors should receive training on the proper use of OGI cameras, including both classroom instruction and hands-on training. Hands-on practice is necessary before a surveyor can become proficient enough to use OGI cameras to conduct fugitive emissions surveys or screenings.

Appendix 8 Best Practices: Data Management

One of the most difficult components of any FEMP is managing the collection and flow of data. Most programs that fail are due to inconsistent or incomplete data collection and inadequate communication of data among the FEMP team.

Data Management Systems

Data management systems allow companies to track, manage, and analyze fugitive emissions data. These systems

- track completed surveys, screenings, and repairs (including work orders) and
- track scheduled surveys, screenings, and upcoming repairs (including tagging).

They should also be able to

- track site and component performance data over time,
- enable data analysis to identify trends, and
- generate data summaries for use in regulatory reports.

Using a consistent platform and data and file naming conventions across the organization will improve the effectiveness of any data management system.

When designing or selecting a data management system, consider the following

- **Data Collection:** Does the system collect data relevant to surveys and screenings and leak repair?
- **Data Synchronization:** How are data collected on site (i.e., in the field) transferred to the main database and how much effort is required?
- **Centralized Data Storage:** Can all users easily access the data they need to implement the FEMP?
- **Leak and Repair Tracking:** Does the system track leaks as they are identified, as well as the status of repairs and follow-up monitoring, and communicate this to users?
- **Analysis and Reporting:** Does the system allow the users to analyze FEMP performance and carry out field, corporate, and regulatory reporting?

Appendix 9 Best Practices: Record Keeping

Detailed records are required for regulatory reporting. Appendix 13 of Directive 060 provides an example of a survey form that identifies all information that duty holders are required to collect during a survey (also available on the Directive 060 landing page on the AER website, www.aer.ca). However, duty holders should consider collecting additional information during surveys and screenings. Records that capture a greater level of detail and context will be useful for assessing performance of a FEMP and making continuous improvements in it.

Additional information that might be useful to record during surveys and screenings includes the following:

- date and details of the first attempt to repair a component
- weather conditions at time of survey or screening
- components that are difficult or unsafe to monitor and reason for this
- history of previous leaks of the component
- estimated leak size or emission rate

Duty holders should regularly perform quality checks and audits of their records and data management systems to ensure data are accurate and complete, and these systems are working properly.

Appendix 10 References

Aeris Technologies. 2017. MIRA Pico Mobile LDS Natural Gas Leak Detection System w/GPS. http://aerissensors.com/wp-content/uploads/2017/11/picoLDS.pdf.

ASTM 2011. ASTM E515 – 11 Standard Practice for Leaks Using Bubble Emission Techniques. https://www.astm.org/Standards/E515.htm.

Eastern Research Group. 1997. Training and Certification of EPA Method 21 Operators. Volume 1. Self-Instruction Manual. Technical Assistance Document. Available at https://ntrl.ntis.gov/NTRL/dashboard/searchResults/titleDetail/PB97143085.xhtml.

US EPA (United States Environmental Protection Agency). 1993. United States Environmental Protection Agency. Method 21 - Determination of Volatile Organic Compound Leaks. https://www.epa.gov/sites/production/files/2016-06/documents/m-21.pdf.