3 Regulations

3.1 Objectives & Introduction

This section provides an overview of current and proposed laws and regulations on methane emissions dealing with leak detection from the oil and natural gas supply chain. Additional detail on these regulations at the federal, state, local, and international levels can be found in Appendix C. These regulations can be placed under the general umbrella term of "Leak Detection and Repair (LDAR)" requirements. Some of these regulations concurrently regulate volatile organic compounds (VOCs) with methane in the fugitive emissions or gas stream.

Methane is considered a greenhouse gas (GHG) while VOCs contribute to the formation of ground-level ozone, which is a criteria air pollutant under the United States Federal Clean Air Act. Some VOCs are also toxic to human health, such as benzene. This section will differentiate between oil and gas fugitive emissions or LDAR regulations that apply to methane only, VOCs only, and methane plus VOCs. Note that regulations that only apply to VOCs have the co-benefit of reducing methane emissions as well since all emissions in the gas stream are addressed through LDAR activities.

In addition, this section identifies regulatory barriers and constraints on the approval, use, and adoption of new or innovative fugitive emission detection technologies, including those specific to methane, and identifies regulatory concerns and considerations in this regard, as well as areas of opportunity.

Regulation of fugitive emissions from the oil and gas sector, particularly in the United States (U.S.), is broken down by the various segments of the sector from drilling and production through transmission and distribution (see the Characterization Section 2 for more details on the oil and gas sector segments and emission sources in those segments). Tables 3 and 4 below summarize these regulations by regulator (federal, state, local, and international government) and segment. U.S. Federal regulatory agencies that oversee fugitive emissions or equipment leaks from the oil and gas sector include the Environmental Protection Agency (USEPA), Bureau of Land Management (BLM), which is part of the Department of Interior, and the Pipeline and Hazardous Materials Safety Administration (PHMSA), which is part of the Department of Transportation. The USEPA and BLM provide federal regulatory oversight for the production and processing segments of the sector, while PHMSA oversees natural gas transmission, storage and distribution (pipelines). BLM's regulations only apply to federal lands managed by BLM. The basis for these regulations varies from public health and environmental protection (USEPA) to resource conservation (BLM) and safety (PHMSA).

States that have been delegated regulatory authority from USEPA and PHMSA, typically implement applicable regulations through a state's environmental department and public utility commission (PUC) or other similar agency. However, states can also adopt their own regulations that may exceed federal requirements, such as those from California, Colorado, Ohio, and Pennsylvania. A number of these states have specifically targeted methane as part of their regulations, with a focus primarily on the production, processing, and storage segments of the oil and gas sector. It should be noted that most states adopt federal regulations since state regulations cannot be less stringent than federal regulations.

A state agency participating in PHMSA's Pipeline Safety Program is required to adopt federal pipeline safety regulations. In addition, a state agency may issue additional or more stringent standards concerning intrastate pipelines as long as they are compatible with federal regulations. States may also specifically target methane in addition to safety requirements in this segment.

Local governments can also adopt their own fugitive emissions regulations and/or have delegated authority to implement federal or state requirements. For example, in California, local air quality management districts implement federal and state rules, in addition to their own LDAR regulations for VOCs, to help meet national ambient air quality standards.

Table 3 summarizes existing and proposed (as of the date of this document) oil and gas fugitive emission regulations by federal, state, local, and international governments with information on prescribed monitoring methods and technologies, including allowance of approved alternative technologies or methods, pollutant regulated (methane, VOCs), instrument-based monitoring frequency, leak standards or definitions, and affected facilities. A more detailed summary of specific

fugitive emission regulations that target or include methane and/or allow use of approved alternative leak detection technologies is provided in Appendix C. Please refer to the Executive Summary of this document for definitions of Optical Gas Imaging (OGI) and USEPA Method 21 as used in Table 3.

Table 4 summarizes applicable fugitive emission/leak detection regulations (existing and pending) by segment in the oil and natural gas supply chain. Please refer to the Characterization Section of this document for details on the oil and natural gas supply chain segments.

Table 3. LDAR regulations by government.

Source: ITRC Methane Team.

View Table 3 in Adobe PDF format.

Government Type (Federal, State, Local, International), Agency & Rule	Required Monitoring Method or Technology	Alternative Monitoring Method or Technology Allowance	Pollutant Regulated	Instrument-Based Monitoring Frequency	Leak Standard (ppm = parts per million)	Affected Facilities
U.S. Federal, USEPA, NSPS OOOOa	Optical Gas Imaging (OGI), Method 21 (M21)	Yes	Methane + VOCs	Quarterly (compressor stations); semi-annual (well pads)	500 ppm (M21); any detectable emissions (OGI)	New and modified production facilities & gas processing plants[1]
U.S. Federal, USEPA, NSPS OOOO	Method 21	Yes (OGI only – Alternative Work Practice)	VOCs	Varies	Varies	Gas processing plants
U.S. Federal, PHMSA, 49 CFR Part 192	Varies	Yes	Methane	Varies based on location (at least every 5 years)	Varies based on location	Natural gas pipeline systems
U.S. Federal, BLM, 43 CFR Parts 3100, 3160, and 3170	OGI, Method 21	Yes	Methane	Quarterly (compressor stations); semi-annual (well pads)	500 ppm (M21); any detectable emissions (OGI)	New and existing production facilities
Canada, Federal, SOR/2018-66	OGI, Method 21	Yes	Methane + VOCs	3 times per year	500 ppm (M21); any detectable emissions (OGI)	New and existing production processing, transmission and storage facilities.
Canada, Provincial, Alberta – Directive 084	OGI, Method 21	Yes	Methane + VOCs	Monthly	500 ppm (M21); any detectable emissions (OGI)	Peace River area only. Existing facilities associated with heavy oil and bitumen operations

Government Type (Federal, State, Local, International), Agency & Rule	Required Monitoring Method or Technology	Alternative Monitoring Method or Technology Allowance	Pollutant Regulated	Instrument-Based Monitoring Frequency	Leak Standard (ppm = parts per million)	Affected Facilities
Canada, Provincial, Alberta-Directive 060 *(PROPOSED)*	OGI, Method 21, Audio/Visual/Olfactory (AVO) sensory method	Yes	Methane	3 times per year (Sweet gas processing plants and compressor stations; controlled liquid hydrocarbon and produced water tanks); Annually (Sour gas processing plants and compressor stations; all batteries – sweet and sour)	10,000 ppm (M21); any detectable emissions (OGI)	New and existing production, processing, and transmission facilities
State, California Air Resources Board (CARB)	Method 21	No	Methane	Quarterly	1,000 ppm (M21)	New and existing production processing, transmission and storage facilities
State, California Air Resources Board (CARB)	Method 21, OGI, or other CARB-approved method	Yes	Methane	Daily/Continuous	Any detectable emissions	Underground gas storage facilities & wells
State, California Public Utilities Commission (CPUC)	OGI, Method 21, or other methods	Yes	Methane	Every 3 calendar years or alternative frequency that demonstrates comparable or better performance.	Develop leak size action threshold methodology with CPUC & CARB; “Find-and-Fix” until then (any detected leaks)	Gas transmission, distribution, and storage facilities & pipelines
State, California, Division of Oil, Gas, & Geothermal Resources *(EMERGENCY REGULATIONS)* **Note: moves to CARB provisions once storage monitoring plans finalized*	OGI or other effective gas leak detection technology	Yes	Methane	Daily	Not specified	Underground gas storage projects & wells

Government Type (Federal, State, Local, International), Agency & Rule	Required Monitoring Method or Technology	Alternative Monitoring Method or Technology Allowance	Pollutant Regulated	Instrument-Based Monitoring Frequency	Leak Standard (ppm = parts per million)	Affected Facilities
State, California, Division of Oil, Gas & Geothermal Resources *(PROPOSED)*	An accepted industry or regulatory standard	See Required Monitoring Method or Technology	Methane	Annual	Not specified	Gas pipelines in sensitive areas
State, Colorado, Air Quality Control Commission – Regulation No. 7	OGI, Method 21	Yes	Methane + VOCs	Monthly, quarterly, and annually	500 ppm, 2,000 ppm (M21); any detectable emissions (OGI)	New and existing production facilities
State, Colorado Oil & Gas Conservation Commission (COGCC)	AVO, OGI, LASERs, or other detection technology	Yes	Methane + VOCs	Not Specified	Grade 1 Gas Leak	Oil & gas flowlines at/from well production facilities
State, Pennsylvania Dept. of Environmental Protection	OGI, Method 21, AVO	Yes	Methane + VOCs	Quarterly for natural gas compression and processing facilities and natural gas well sites (frequency reduced to semi-annually if the percentage of leaking components is less than 2%). Semi-annually for exempted natural gas well sites.	Any release of gaseous hydrocarbons	Any production facility covered by GP-5, GP-5A or PE #38
State, Ohio Environmental Protection Agency	OGI, Method 21	No	Methane + VOCs	Quarterly, then varies	500 ppm, 10,000 ppm (M21); any detectable emissions (OGI)	Any production facility covered by GPs 12.1, 12.2 and 18.1
State, Utah Dept. of Environmental Quality, R307-509	OGI, Method 21	No	VOCs	Semi-Annually; Annually for difficult to monitor components	Any detectable emissions	Well production facilities

Government Type (Federal, State, Local, International), Agency & Rule	Required Monitoring Method or Technology	Alternative Monitoring Method or Technology Allowance	Pollutant Regulated	Instrument-Based Monitoring Frequency	Leak Standard (ppm = parts per million)	Affected Facilities
State, Utah Dept. of Environmental Quality, General Approval Order Well Site and Tank Battery	OGI, Method 21, Tunable Diode Laser Absorption Spectroscopy (TDLAS) ("laser")	No	VOCs	Quarterly and Annual	500 ppm (M21, TDLAS); any detectable emissions (OGI)	New and existing production facilities
State, Wyoming Dept. of Environmental Quality	OGI, Method 21	Yes	VOCs	Quarterly	Any detectable emissions (OGI); M21 leak threshold not specified (review & approval of threshold request by WY DEQ)	Production facilities in existence prior to January 1, 2014 in ozone non-attainment area
Local, California, Various Air Districts	Method 21	No	VOCs	Varies	Varies	Oil & gas facilities
Local, City of Thornton, CO	OGI	No	Not specified	Monthly, then quarterly after one year	All detectable emissions	New and existing production facilities

Table 4. Applicable fugitive emission/leak detection regulations by segment (oil & natural gas supply chain).

Source: ITRC Methane Team.

View Table 4 in Adobe PDF format.

SEGMENT	Field Production					Processing	Transmission & Storage			Distribution	
REGULATION	Drilling	Well Completion	Producing Wells	Gathering Lines	Gathering and Boosting Compressor Stations	Gas Processing Plant	Transmission Compressor Stations	Transmission Pipeline	Underground Storage	Distribution Mains/Services	Regulators and Meters
NSPS OOOOa (Federal, USEPA)			✔		✔	✔	✔				
NSPS OOOO (Federal, USEPA)						✔					
GHGRP-Subpart W (Federal, USEPA)	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Waste Prevention and Resource Conservation Rule (Federal, BLM)			✔								

SEGMENT	Field Production					Processing	Transmission & Storage			Distribution	
Transmission & Storage Pipeline Safety Rules (Federal, PHMSA)								✔	✔ (pending)	✔	✔
GHG Emission Standards for Oil and Gas (State, California ARB)			✔	✔	✔	✔	✔		✔		
Natural Gas Leak Abatement Rule (State, California PUC)								✔		✔	✔
Underground Gas Storage Requirements (State, California Division of Oil, Gas, and Geothermal Resources (DOGGR)									✔		
Gas Pipeline Requirements (Pending; State, California DOGGR)				✔ (pending)				✔ (pending)			
Regulation No. 7 (State, Colorado Department of Public Health & Environment (CDPHE)			✔		✔						
Flowline rule (State, Colorado COGCC)			✔	✔							
General Permit 5 (Proposed GP-5A) & Permit Exemption #38 (State, Pennsylvania DEP)			✔		✔	✔	✔				
General Permits 12.1, 12.2 & 18.1 (State, Ohio EPA)			✔		✔						
General Approval Order for Well Site and/or Tank Battery (State, Utah DEQ)			✔		✔						
Air Quality Standards & Regulations, Chapter 8 (State, Wyoming DEQ)			✔		✔						

SEGMENT	Field Production					Processing	Transmission & Storage			Distribution	
VOC Leak Detection Rules (Local, California Air Districts)			✔	✔	✔						
City Regulation CDNo. 2017-176 Sec. 18-870 (Local, City of Thornton, CO)			✔								
Upstream O&G Regulations (International – Canada Federal)			✔	✔	✔	✔	✔	✔	✔		
D-084, Upstream O&G Regulations (International – Alberta, Canada, Provincial, Peace River area)			✔		✔	✔	✔				
D-060, Upstream O&G Regulations (Pending; International-Alberta, Canada, Provincial			✔ (pending)	✔ (pending)	✔ (pending)	✔ (pending)					

3.2 Regulatory Barriers, Limitations, and Considerations

3.2.1 Regulatory Barriers and Limitations

As discussed, there are multiple jurisdictional layers of rules for leak detection and repair requirements at oil and gas facilities throughout the natural gas supply chain. Upstream leak detection regulations are mostly focused on reducing emissions (VOCs and methane) for environmental and health reasons, whereas downstream emission rules for transmission and distribution, which have been in place longer, are more safety-oriented. Federal rules set a baseline minimum and states and localities can be more stringent for air quality and climate change regulations. A similar hierarchy generally exists for state and local environmental regulations, though in some states, local regulations cannot supersede state requirements.

The system of regulations reduces emissions across the supply chain, but there are gaps and limitations. The transmission and distribution sector considers leak repairs for methane or other air emissions primarily for safety. In practice, this means that leaks considered non-hazardous for safety reasons, such as in remote areas, need to be monitored but could also continue to leak if they do not meet the definition of a hazardous safety issue. Additionally, storage facilities are not as strictly regulated for methane and VOC emissions as production and processing facilities. The Aliso Canyon event, which involved a large methane leak from a storage facility in California, raised concerns about the safety and environmental considerations for storage facilities and highlighted the need for enhanced requirements.

Production and processing facilities as well as transmission compressor stations are subject to leak detection and repair requirements both nationally and, in some cases, at the state and local levels. In most cases, these requirements only apply to VOC emissions but can also include methane, and in some jurisdictions these measures are part of State Implementation Plan (SIP) requirements to meet national ambient air quality standards for ozone. As such, any changes in approach under the SIP must be able to be proven to meet or exceed the level of reductions already achieved by existing strategies in the SIP. Sources within these sectors that are often exempt from LDAR are non-active wells (idle, abandoned, and orphan), low producing wells, and very heavy oil wells.

In general, leak detection is based on two main technologies or approaches. Until recently, USEPA’s Method 21 was the only

regulatory option for compliance with LDAR regulations. However, OGI has now been incorporated into national and some state/local requirements.[2] The two currently accepted leak detection approaches have advantages and disadvantages. Method 21 is based on easily enforceable concentration standards with a clearly defined protocol for performing leak detection but can be time- and labor-intensive and may underestimate leaks if not performed properly. OGI offers a quicker, more efficient approach to leak detection with the ability to monitor hard-to-reach or unsafe to monitor equipment.[3] However, OGI generally has a higher detection threshold than Method 21, does not quantify the leak size, and lacks an established monitoring protocol.[4] Although New Source Performance Standards 40 CFR Part 60, Subpart OOOOa (NSPS OOOOa) requires a monitoring plan for OGI, the regulation leaves it up to an operator in how to determine specific limitations, such as maximum viewing distance, wind speed, adequate thermal background, and dealing with adverse monitoring conditions.

Alternative technologies/approaches to leak detection exist or are being developed that may provide equivalent or better emission reductions than Method 21 or OGI, but adoption or use of alternatives may be limited if a regulation does not provide a provision or pathway for approval of alternatives. And for regulations that allow approved alternatives, criteria for showing equivalency with Method 21 or OGI can be either undefined or complex. For example, Method 21 and OGI are based on comprehensive periodic monitoring; whereas, some alternative technologies may offer continuous but less sensitive monitoring that can identify larger leaks more quickly but may not identify as many leaks. This demonstrates the challenge in evaluating different technology approaches and trying to determine equivalency.

3.2.2 Regulatory Considerations

As noted, a regulatory provision or pathway for consideration and approval of alternative technologies/methods is necessary if they are to be used to meet regulatory requirements. Including or adding such a provision in a regulation requires certain considerations. For example, the main objective of air quality regulations is to reduce emissions to meet established health-based or environmental standards while considering other factors such as cost. The reduction in emissions is based on assumptions that the methods and approaches relied on for achieving that goal are demonstrated, proven, and verifiable. This means an alternative technology provision should include or require clearly defined criteria or boundaries for approval and use to ensure regulatory goals are met and to establish regulatory certainty for all interested parties. Regulatory considerations for alternative technologies/methods may include the following:

- Cost (particularly if a technology is directly specified in the regulation).
- Commercial availability of a technology (not in development; ready for deployment).
- Option for use of an alternative leak detection program vs an individual technology.
    - More than one technology or method may be used as part of an overall program.
- Technical or operational feasibility and transparency of a technology or program.
    - The technology and/or methodology should be understandable to the regulatory agency and/or end user including how emissions are identified and, if applicable, quantified.
- Capabilities, reliability, and limitations of a technology or program, including restrictions on use.
- Scientific validity or repeatability of a technology's measurements as well as data quality indicators for precision and bias of measurements.
- Quality control and quality assurance procedures to ensure proper operation of the technology or program.
- Equivalency criteria.
    - May need to be clearly defined within the regulation for purposes of SIP or other requirements.
    - Rigorous testing and modeling to demonstrate capabilities/effectiveness.
    - Establishment of appropriate standards/thresholds for response and repair to achieve comparable emission reductions and to determine compliance.
- Enforceability
    - Results should be verifiable/quantifiable through recordkeeping, reporting, inspections, or other verification processes.
    - Credible evidence. Could the results or data from the technology be used or considered as credible evidence? The U.S. Clean Air Act (CAA) provides "statutory authority to use any available information – not just data from reference tests or other federally promulgated or approved compliance methods – to prove CAA violations." (USEPA 2015b). https://www3.epa.gov/ttn/atw/cam/fr24fe97.pdf
- Alternative Technology pilot program.
    - A pilot program could allow for limited use of an alternative technology or method for evaluation purposes and to help demonstrate its effectiveness.

Above all, availability of data drives the regulator's ability to develop and amend regulations. A lack of data can result in regulations that fail to reflect the current state of technology. The challenge for the regulator is to define requirements clearly for a technology within the regulation and to develop the criteria for evaluating equivalence of technologies and methods. The difficulties in developing criteria are apparent even in existing regulations that include alternative compliance methods. Close coordination between technology providers and regulators can lead to a process where regulators are fully informed and have access to the technology and all supporting data to evaluate performance and other relevant parameters. It is important to be aware that process and needs can change by jurisdictions, which speaks to the importance of establishing standardized evaluation methodologies. Proving technologies in individual sectors and participating in rulemakings and research can also help move technologies forward.

3.3 Areas of Opportunity

This sub-section provides an overview of some potential areas of opportunity for use and consideration of alternative technologies and ways that might assist with facilitating alternative technology adoption.

- As part of compliance and enforcement efforts, the USEPA and/or state regulators may issue Consent Decrees or Orders that require actions to reduce emissions or mitigate past emissions. These actions may include the use of a leak detection or monitoring technology that is currently not required by regulations, which provides an opportunity to implement a new or innovative proven technology.
- It may be possible to allow for use of leak detection technologies with limited capabilities in certain industry segments that have different typical gas compositions. For example, it may not be necessary for an alternative technology to be capable of detecting VOCs for monitored equipment carrying predominantly dry gas. Technology developers should be aware of the specific application(s) for a particular technology, and regulatory programs should remain flexible in evaluation and approval of a particular technology depending on the application.
- USEPA Method 21 is the original, and still a widely-used regulatory option for compliance with LDAR regulations. Historically, flame ionization detector (FID) and photoionization detector (PID) instruments have been used for applying Method 21, but the method is technology neutral. Specifically, Method 21 states the instrument detector type is not specified but must meet the specifications and performance criteria. Alternative technologies that can quantify leaks but do not have a sample pump, sample probe, or are not intrinsically safe, do not meet the method as it is currently written. However, the USEPA may issue broadly approved test method alternatives. Specifically, for Method 21, the process would involve either:

1. A modification to Method 21 itself to incorporate an alternative, or
2. An alternative method that, in whole, replaces Method 21 and is used within the work practice standard containing the requirement for Method 21 measurements in exactly the same manner as Method 21 including, but not limited to the following:
    1. It would have to sample directly at the equipment leak interface.
    2. It would have to deliver the same leak detection readings at the leak definition level as Method 21 (i.e., Method 301-like studies would need to be conducted).
    3. It would be conducted at the same frequency as Method 21.

Thus, an alternative leak detection technology could apply to the USEPA with a request to approve an alternative to Method 21 following the above process.

Another option for new technologies that do not fit Method 21 is available through the USEPA's alternative means of emissions limitation (AMEL) process, such as is covered under NSPS OOOOa's provision for emerging technologies. New technologies must demonstrate they can achieve at least equivalent emission reductions as that which is outlined in the applicable standard. The AMEL application process is found in 40 CFR §60.5398a, which states the applicant must collect, verify, and submit test data, covering a period of at least 12 months to demonstrate the equivalence of the AMEL. The application must include the following information:

i. A description of the technology or process.
ii. The monitoring instrument and measurement technology or process.
iii. A description of performance-based procedures (i.e., method) and data quality indicators for precision and bias; the method detection limit of the technology or process.
iv. For affected facilities under §60.5397a, the action criteria and level at which a fugitive emission exists.

v. Any initial and ongoing quality assurance/quality control measures.
vi. Timeframes for conducting ongoing quality assurance/quality control.
vii. Field data verifying viability and detection capabilities of the technology or process.
viii. Frequency of measurements.
ix. Minimum data availability.
x. Any restrictions for using the technology or process.
xi. Operation and maintenance procedures and other provisions necessary to ensure reduction in methane and VOC emissions at least equivalent to the reduction in methane and VOC emissions achieved under §60.5397a.
xii. Initial and continuous compliance procedures, including recordkeeping and reporting.

If the USEPA agrees the new technology is acceptable for the applicable standard, then it may be used to comply with the standard.

- Technology developers should take on a more active role in helping determine equivalence of new technologies and consider avenues for collaboration with regulators on technology assessment. For example, developers and regulators could work together on government-sponsored research or development programs for the performance and assessment of new technologies/methods so that all parties have the same understanding of regulatory requirements and expectations and how to approach them. Accordingly, the review and approval process for new technologies could then be conducted more efficiently.
- Government, academia, industry, and other stakeholders should explore ways to facilitate data and information exchange to share findings on innovative technologies and approaches for leak detection, as well as tools for assessing alternate technologies.

---

[1] NSPS OOOOa does not regulate methane from equipment leaks at gas processing plants (VOCs only).

[2] Additional information on Method 21 and OGI can be found in Section 4.1.1.

[3] As an example, a facility requested, and the State of Texas issued, an alternative means of compliance (AMOC) that allows semi-annual use of OGI technology for monitoring components considered difficult to monitor using Method 21 (AMOC #6) (USEPA 2015a).

[4] A draft Technical Support Document that includes a protocol for conducting OGI monitoring was issued by USEPA on September 18, 2015, which references thermal backgrounds, wind speeds, observation distances, and limitations on use, such as during rain, fog, or extreme cold (USEPA 2015a).

Publication Date: September 28, 2018