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Appendix C – Regulations Additional Material

C.1. United States – Federal Fugitive Methane Emission Regulations

C.1.1 U.S. Environmental Protection Agency – New Source Performance Standards (NSPS) for the Oil and Natural Gas Sector Subpart OOOOa (USEPA 2016b); (USEPA 2016a)

USEPA's NSPS Subpart OOOOa ("NSPS OOOOa"), which is a revision to NSPS OOOO, became effective on August 2, 2016 and applies to facilities in the drilling, production, and processing segments of the onshore oil and gas (O&G) sector that commenced construction, modification, or reconstruction after September 18, 2015. A revision to NSPS OOOOa was proposed on September 11, 2018 that includes changes to the leak detection and repair (LDAR) requirements for fugitive emissions and emerging technologies provision. However, a summary of the LDAR and emerging technologies requirements as they currently stand as of the publication date of this document will be provided and as noted in Table 3.

NSPS OOOOa regulates methane and volatile organic compounds (VOCs) from a variety of sources, including fugitive emissions. NSPS OOOOa also includes a provision for approval of emerging or alternative technologies for fugitive emissions detection. The summary below provides an overview of the fugitive emissions/LDAR and emerging technology sections of the rule.

NSPS Subpart OOOOa Requirements for Fugitive Emissions

NSPS OOOOa imposes standards to control greenhouse gases (GHGs) in the form of limitations on methane emissions, and VOC emissions from fugitive emission components at well sites (including centralized tank batteries) and compressor stations (gathering & boosting as well as transmission & storage). Semiannual or quarterly monitoring and repair of equipment and components that may leak or release fugitive emissions at these facilities is required.

Leak monitoring must be conducted using optical gas imaging (OGI), which is often referred to as an infrared (IR) camera, and repairs must be made if any emissions are seen or observed. USEPA determined OGI, which can see emissions not visible to the naked eye, to be what is known as the Best System of Emissions Reduction (BSER) for fugitive emissions from well sites and compressor stations, which means OGI meets the standard of performance established by USEPA for achieving the necessary emission reductions at these facilities. However, OOOOa also allows that Method 21, which detects leaks and indicates their size as a concentration level in air in parts per million (ppm), may be used as an alternative monitoring method to OGI, which can only detect emissions. If Method 21 is used, then component repair must be conducted if the leak concentration level is 500 ppm or greater. Repairs must be made within 30 days of finding fugitive emissions and a resurvey of the repaired component must be made within 30 days of the repair using OGI or Method 21 at a repair threshold of 500 ppm. Monitoring and repair records must be maintained and submitted with semi-annual reports to USEPA or the delegated authority.

If OGI is used, a monitoring plan that covers the collection of fugitive emissions components at well sites or compressor stations within a company-defined area must be developed and implemented. Owners and operators develop a plan that describes the facilities subject to monitoring in that area, including descriptions of equipment, plans for how monitoring will be conducted, etc., that apply to all similar facilities. This allows owners and operators to develop a monitoring plan for groups of similar facilities within an area for ease of implementation and compliance. These plans must include a typical "observation path" that is focused on the field of view of the OGI instrument being used (not the physical location of the OGI operator) to ensure all components get monitored, as well as the maximum viewing distance. The intent is to allow for the use of all types of OGI instruments (e.g., mounted, handheld, or remote controlled) for monitoring. The observation path description may be a simple schematic diagram of the facility site or an aerial photograph of the facility site, as long as such a photograph clearly shows locations of the components and the OGI instrument's monitoring path.

Provision for Emerging Technology

Fugitive emissions monitoring and repair is a work practice standard, as allowed under the Clean Air Act (CAA). A work practice standard is an emission limitation (BSER) that is not necessarily in a numeric format, such as the visualization of fugitive emissions using OGI. The CAA also allows approval of an alternative means of emission limitation (AMEL) for a work practice standard if it can be proven that an equal reduction in emissions will be achieved through that alternative (42 C.F.R. §7411(h)(3)). To that end, and because methane and VOC leak detection technology has been undergoing continuous and rapid development and innovation, potentially yielding, for example, continuous emissions monitoring technologies, NSPS OOOOa includes a process for USEPA to permit the use of an innovative technology for reducing fugitive emissions at well sites and/or compressor stations (40 C.F.R. §60.5398a).

Specifically, owners or operators may submit a request to the USEPA for an AMEL where a technology has been demonstrated to achieve a reduction in emissions at least equivalent to the reductions achieved under the OGI work practice of NSPS OOOOa.

To facilitate the application and review process, NSPS OOOOa identifies information that must be included in the AMEL application in order for USEPA to evaluate the emerging technology, which includes:

- a description of the emerging technology and the associated monitoring instrument or measurement technology;
- a description of the method and data quality used to ensure the effectiveness of the technology;
- a description of the method detection limit of the technology and the action level at which fugitive emissions would be detected;
- a description of the quality assurance and control measures employed by the technology;
- field data (covering a period of at least 12 months and contemporaneously conducting Method 21 or OGI leak detection at prescribed frequency) that verify the feasibility and detection capabilities of the technology; and
- any restrictions for using the technology.

This process allows for the approval and use of any work practice developed in the future that can demonstrate methane and VOC emission reductions at levels that are at least equivalent to the reductions achieved when using OGI or Method 21 for fugitive emissions monitoring. This process also allows for the use of alternative fugitive emissions mitigations approaches utilizing periodic, continuous, fixed, and mobile (including aerial), or hybrid monitoring approaches.

Consistent with the AMEL provision of the CAA, any application will be publicly noticed in the Federal Register, including all required information for evaluation. The USEPA will provide an opportunity for public hearing and comment on the application and on intended action the USEPA might take. The USEPA then makes a final determination on the AMEL application within six months after the close of the public comment period and publishes its determination in the Federal Register. If the final determination is denial of the application, the USEPA will provide reasoning for denial and recommendations for further development and evaluation of the emerging technology, if appropriate. If an AMEL is granted approval, then it is specific to a single facility and applicant.

Note that in order for a technology to be considered for AMEL under OOOOa it must be capable of detecting methane and VOCs or be able to demonstrate equivalent reductions of methane and VOCs if not all compounds can be detected.

As of the date of this document, USEPA had not received any AMEL applications under OOOOa (USEPA 2016a).

C.1.2 U.S. Environmental Protection Agency – Greenhouse Gas Mandatory Reporting Rule

The Greenhouse Gas Mandatory Reporting Rule (also known as the Greenhouse Gas Reporting Program or GHGRP) was published by the EPA in October 2009 and went into effect in January 2010. The rule requires annual reporting of GHGs, including methane, from large emission sources across a range of industrial categories, including the O&G sector, which is covered under subpart W. The purpose of the rule, as noted by the USEPA (https://www.epa.gov/sites/production/files/2014-09/documents/ghgrp-overview-factsheet.pdf), is to provide for a “collection of comprehensive, nationwide emissions data [that] is intended to provide a better understanding of the sources of GHGs and to guide development of policies and programs to reduce emissions.” Thus, unlike NSPS OOOOa, for example, actual emission reductions are not required under the GHGRP, only calculation and reporting of emissions. Additionally, VOCs are not covered under the GHGRP since they are not GHGs.

Under subpart W, reporters have two options for estimating fugitive emissions, which are results from equipment leak surveys or population counts/population emission factors. Equipment leak surveys are required for certain component types and reporters must use one of the monitoring methods specified in the rule to conduct those surveys, which include OGI, Method 21, Infrared Laser Illuminated Instruments and Acoustic Leak Detection Devices.

The USEPA requested and received comment on the “feasibility, possible regulatory approaches, and provisions necessary to incorporate or allow the use of advanced measurement or monitoring methods in subpart W, and methods to ensure compliance with those provisions in an efficient manner.” The USEPA also requested and received comment on the memorandum “Discussion Paper on Potential Implementation of Alternative Monitoring under the GHGRP”. The USEPA indicated it will consider these comments in the context of any future action related to alternative monitoring (USEPA 2015b) – https://www.gpo.gov/fdsys/pkg/FR-2015-10-22/pdf/2015-25840.pdf.

C.1.3 U.S. Environmental Protection Agency – Alternative Work Practice (AWP) to Method 21 for Leak Detection and Repair

Numerous USEPA air emissions standards, including those for segments of the O&G sector, require a specific work practice (NSPS VV & VVa) that identifies Method 21 for equipment leak detection and repair (LDAR) of fugitive VOC emissions. On April 6, 2006, the USEPA proposed a voluntary AWP for LDAR using OGI, which was a newly developed technology at the time. The AWP was eventually finalized and adopted in 2008 and allows for the voluntary use of OGI in place of Method 21 for any rule that requires LDAR for fugitive VOCs. The AWP still requires annual monitoring using Method 21 but all other periodic monitoring may be performed with OGI.

Note that in NSPS OOOOa, OGI and/or Method 21 is the allowed work practice for LDAR at well sites and compressor stations. However, for gas processing plants subject to OOOOa, OGI is still considered the AWP for purposes of LDAR and Method 21 is the required work practice.

The AWP was the first time USEPA allowed an alternative to Method 21 for LDAR and, in essence, opened the door for potential consideration of other innovative leak detection technologies or methods.

C.1.4 Bureau of Land Management (BLM) – BLM Waste Prevention, Production Subject to Royalties, and Resource Conservation (43 CFR Parts 3100, 3160 and 3170)

The BLM Waste Prevention, Production Subject to Royalties, and Resource Conservation rule (“Waste Prevention Rule”) was proposed in 2016 and became effective on January 17, 2017. On April 4, 2018, a U.S. District Court stayed implementation of certain provisions of the Waste Prevention Rule, including the LDAR requirements, pending finalization or withdrawal of a proposed revised rule by BLM. The original rule includes LDAR requirements for existing and new facilities located on BLM-managed lands, which includes semi-annual leak monitoring at well sites (including oil wells that also produce natural gas and produced water handling facilities) and quarterly monitoring at compressor stations.

Alternative Technology Provisions

The Waste Prevention Rule applies to hydrocarbon emissions (methane plus VOCs) and, similar to NSPS OOOOa, allows for the use of OGI or Method 21 for leak monitoring, as well as approved alternatives. The rule specifies that any person may request approval of an alternative monitoring device and protocol (e.g., a device that monitors continuously, but is less sensitive than OGI, might achieve results equivalent to OGI due to the gas savings from early detection) by submitting a Sundry Notice to BLM that includes the following information:

> *(1) Specifications of the proposed monitoring device, including a detection limit capable of supporting the desired function;*
>
> *(2) The proposed monitoring protocol using the proposed monitoring device, including how results will be recorded;*
>
> *(3) Records and data from laboratory and field testing, including but not limited to performance testing;*
>
> *(4) A demonstration that the proposed monitoring device and protocol will achieve equal or greater reduction of gas lost through leaks compared with OGI semiannual/quarterly monitoring;*
>
> *(5) Tracking and documentation procedures; and*
>
> *(6) Proposed limitations on the types of sites or other conditions on deploying the device and the protocol to achieve the demonstrated results.*

BLM may approve an alternative monitoring device and associated inspection protocol if the BLM finds that the alternative would achieve equal or greater reduction of gas lost through leaks compared with OGI semiannual/quarterly monitoring. BLM will provide public notice of a submission for approval and may approve an alternative device and monitoring protocol for use in all or most applications (i.e., once approved, any operator could use it, which differs from NSPS OOOOa), or for use on a pilot or demonstration basis under specified circumstances that limit where and for how long the device may be used. BLM will post on its website a list of each approved alternative monitoring device and protocol, along with any limitations on its use. BLM intends that the decision to approve the use of an alternative monitoring device would be made only at the national level, by the Director, Deputy Director, or an Assistant Director, as, once approved, the alternative monitoring device could be used at any facility subject to BLM requirements.

In addition to the alternative monitoring device option, the Waste Prevention Rule also includes a provision for approval of an alternative instrument-based leak detection program. BLM may approve an operator's request to use an alternative instrument-based leak detection program if BLM finds that the alternative program would achieve equal or greater reduction of gas lost through leaks compared with OGI semiannual/quarterly monitoring. For example, an operator might propose a program that included more frequent inspections for some sites and less frequent inspections for others, or an operator may be able to deploy an alternative leak detection device or system, approved by BLM, on a continuous basis and achieve results that would allow for less frequent inspections using OGI or Method 21. In essence, the alternative leak detection program allows for flexibility to potentially combine the use of an alternative leak detection monitoring device with an already-approved monitoring device or method under the rule (OGI and Method 21).

The operator must submit its request for an alternative leak detection program through a Sundry Notice that includes the following information:

> *(1) A detailed description of the alternative leak detection program, including how it will use OGI and/or Method 21, along with sensory leak detection methods (audio/visual/olfactory or AVO), and an identification of the specific instruments, methods and/or practices and elements of the approach;*
>
> *(2) The proposed monitoring protocol;*
>
> *(3) Records and data from laboratory and field testing, including, but not limited to, performance testing, to the extent relevant;*
>
> *(4) A demonstration that the proposed alternative leak detection program will achieve equal or greater reduction of gas lost through leaks compared to OGI or Method 21 with AVO semiannual/quarterly monitoring;*
>
> *(5) A detailed description of how the operator will track and document its procedures, leaks found, and leaks repaired; and*
>
> *(6) Proposed limitations on types of sites or other conditions on deployment of the alternative leak detection program.*

Unlike the alternative monitoring device approval, a BLM State Director could approve an alternative leak detection program if the alternative program is determined to achieve equal or greater reduction of gas lost through leaks compared to the leak detection program required under the rule. However, the rule does not allow other operators to use an alternative leak detection program requested by and approved for a specific operator, as the results may not be transferable.

BLM may also approve an alternative leak detection program if the operator demonstrates, and BLM agrees, that compliance would impose such costs as to cause the operator to cease production and abandon significant recoverable oil or gas reserves under the lease. The operator must consider the costs and revenues of the combined stream of revenues from both the gas and oil components and provide the operator's projections of O&G prices, production volumes, quality (i.e., heating value and hydrogen sulfide content), revenues derived from production, and royalty payments on production over the next 15 years or the life of the operator's lease as part of the alternative leak detection program request.

Finally, the Waste Prevention Rule also allows an operator to choose to comply with the USEPA fugitive emissions monitoring requirements in NSPS OOOOa in lieu of complying with the LDAR provisions in the Waste Prevention Rule for all sites and equipment not already deemed in compliance with the BLM LDAR provisions. This provision allows an operator with some facilities subject to NSPS OOOOa and the Waste Prevention Rule, and other facilities only subject to the Waste Prevention Rule, to apply a single leak detection regime to all of their facilities, rather than complying with NSPS OOOOa for some facilities and the BLM requirements for others. If an operator decides to comply with NSPS OOOOa, they must also look for leaks on tank covers and closed vent systems (whose inspection requirements reside in a different part of OOOOa than the LDAR provisions).

As of the date of this document, the BLM State Director for New Mexico has approved the use of Tunable Diode Laser Absorption Spectroscopy (TDLAS) as part of an alternative instrument-based leak detection program (USEPA 2016a).

C.1.5 Pipeline and Hazardous Material Safety Administration (PHMSA) – Federal Gas Pipeline Safety Regulations

The safety of natural gas pipeline systems are regulated by the U.S. Department of Transportation's (DOT) Pipeline and Hazardous Material Safety Administration (PHMSA). PHMSA directly administers the pipeline safety program and develops and enforces requirements for interstate and intrastate pipelines. These regulations are written to ensure safety in the design, construction, testing, operation, and maintenance of pipeline facilities and in the siting, construction, operation, and maintenance of liquefied natural gas (LNG) facilities. PHMSA ensures compliance with regulations through operator inspections, enforcement actions, and accident investigations.

PHMSA also administers grant-in-aid funding to states that provides reimbursement for up to 80% of qualified expenses incurred by the state program for pipeline inspection activities. Each participating state delegates responsibility for pipeline safety to a state agency. State agency duties normally consist of operator inspections, compliance and enforcement, safety programs, accident investigations, pipeline construction inspections, and record maintenance and reporting.

The state agency may adopt additional or more stringent standards for intrastate pipeline facilities provided such standards are compatible with federal regulations.[1] Under an *agreement* or *interstate* agent agreement, the state agency assumes inspection responsibility for facilities and reports probable violations to PHMSA for compliance action.[2]

PHMSA Natural Gas Pipeline Regulations

PHMSA requires operators of pipeline facilities to follow regulations applicable to the commodity being transported. For natural gas, which is mostly methane, the requirements are found in Code of Federal Regulations 49 Part 192 (49 CFR Part 192) – Transportation of Natural and Other Gasses by Pipeline, and include leak monitoring or survey requirements, which will be discussed here.

An important aspect of the natural gas pipeline safety regulations is that for each operations and maintenance technical requirement found in Part 192, there must be a corresponding operator procedure for meeting that requirement. Operators are required to follow both the technical requirements found in Part 192 and the procedures it has developed for meeting those requirements, including leak monitoring and repair. It is also important to note that the requirements found in Part 192 are considered minimum requirements, meaning each operator can, and often does, have procedures that are more prescriptive and more stringent than the requirements found in Part 192.

Operations and Maintenance

Each pipeline operator is required to prepare and follow a manual of written procedures for conducting operations and maintenance activities for each pipeline, including leak monitoring and repair.

> *(1) Each transmission line and distribution main must be surveyed at regular intervals for indications of leaks using leak detection equipment and hazardous leaks must be repaired promptly. A hazardous leak is a leak that represents an existing or probable hazard to persons or property and requiring prompt action, immediate repair, or continuous action until the conditions are no longer hazardous.*
>
> *(2) Compressor stations, pressure regulating stations, and valves along pipelines also need to be tested and inspected at regular intervals to ensure that the equipment is operating as designed and able to be used when needed. These testing and inspection activities normally include leak detection and repair.*

Leak Detection

As noted, Part 192 requires leakage surveys be conducted using "leak detector equipment," which is a performance-based requirement, meaning that any equipment capable of detecting all leaks in gas distribution or transmission systems may be used. The regulations do not mandate the use of any specific type of leak detection equipment and since natural gas is primarily methane, equipment that can only detect methane is acceptable. However, it is imperative that procedures exist for proper use and calibration of the equipment. In addition, since state pipeline safety regulations are allowed to be more specific and more stringent than federal regulations, a state may adopt leak detection equipment requirements of its own for conducting leakage surveys in its specific jurisdiction.

Another important aspect of pipeline safety related to leak surveys is integrity management (IM). Transmission and distribution operators are required to have IM programs to evaluate and address risks on their pipelines, which include using performance metrics to measure the number of hazardous leaks either eliminated or repaired, and the total number of leaks either eliminated or repaired, categorized by cause.

C.2 State Government Fugitive Emission/LDAR Regulations

In addition to federal requirements, some state governments have adopted their own fugitive emission/LDAR regulations for the O&G sector that supplement or go beyond federal requirements. Some of these regulations target or include methane and some do not. Additionally, some of the regulations allow for the approval of innovative or alternative leak detection technologies, while others mandate that only certain types of technologies or methods may be used. A summary of specific state fugitive emission/LDAR regulations is provided below.

ITRC conducted a survey of state and local governments concerning fugitive emission/LDAR regulations for the O&G sector that was coordinated by ITRC's state points of contact (POCs). Information obtained through that survey helped inform what is included in this section.

C.2.1 State Government Regulations that Apply to Fugitive Methane Emissions

C.2.1.1 California – Greenhouse Gas Emission Standards for Crude Oil and Natural Gas Facilities (Air Resources Board)

California is unique among states to have the only O&G regulation focused exclusively on methane. California's "Greenhouse Gas Emissions Standards for Crude Oil and Natural Gas Facilities" regulation, which became effective January 1, 2017 and requires full compliance by December 31, 2018, is aimed at reducing statewide methane emissions from new and existing facilities in the O&G production, processing, and storage sectors, and from transmission compressor stations. Its requirements include:

- Vapor collection on uncontrolled separators and tanks;
- LDAR at facilities not already covered by local air districts' VOC rules;
- LDAR monitoring at underground gas storage facilities, as well as ambient air monitoring and daily or continuous wellhead monitoring;
- Emissions standards for both reciprocating and centrifugal compressors, in addition to LDAR; and
- No-bleed requirements for pneumatic devices and pumps.

The statewide methane regulation's LDAR provision requires quarterly inspections using detection and measurement instruments compatible with Method 21, with the final leak standard being 1,000 ppmv. Currently, there is no alternative leak detection method or technology allowed, but the California Air Resources Board (CARB), which administers the rule, may consider allowing alternative methodologies in future amendments if, for example, OGI technology evolves to allow quantification in addition to detection. However, the underground gas storage provision does allow for different and more innovative instrument technologies. This provision includes daily or continuous leak monitoring at the wellheads as well as ambient air monitoring and the use of OGI in the case of a well blowout.

California has eight O&G producing local air districts that have their own LDAR rules – some for decades – to reduce VOC emissions from O&G operations. California used these district VOC rules as a starting point for its methane regulation's LDAR provision. For the most part, the district and CARB LDAR provisions are similar, but there are some differences. For example, inspections may be less frequent in district rules, and the leak concentration standards vary. The district LDAR rules typically exempt components at O&G facilities that exclusively handle gas, vapor, or liquid with a VOC content of 10% by weight or less. It is these components that the CARB regulation covers. District VOC rules cover about 80% of all the components in the sector.

C.2.1.2 California – Oil & Gas Transmission and Distribution System Requirements (California Public Utilities Commission)

On June 15, 2017, the California Public Utilities Commission (CPUC) approved the Natural Gas Leak Abatement Program establishing best practices (BPs) and reporting requirements for the CPUC Natural Gas Leak Abatement Program developed in consultation with CARB to support the goal of reducing methane emissions in the state by 40% by 2030.

The BPs include six related to leak detection including: 1) a three-year distribution leak survey cycle, 2) special targeted leak surveys on more vulnerable pipeline types, 3) enhanced methane detection such as mobile or aerial surveys, 4) stationary methane detectors for early detection of leaks in above ground facilities, 5) frequent leak surveys, which may use Method21, OGI, or other methods, at above ground transmission and high pressure distribution facilities including compressor stations, gas storage facilities, city gates, and metering & regulating (M&R) stations, as appropriate, and 6) leak quantification and geographic tracking and evaluation (CPUC 2017).

More detailed information can be found at:
http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Safety/Risk_Assessment/Final%20Best%20Practices%20Revised%20Staff%20Recommendations%20with%20BP%20Matrix%20January2017.pdf

C.2.2 State Government Regulations or Permits That Apply to Fugitive Methane plus VOC Emissions

C.2.2.1 Colorado – Regulation No. 7 (Air Pollution Control Division)

In 2014 and 2017, Colorado's Air Quality Control Commission (AQCC) adopted updates to Regulation No. 7 that focus on reducing methane and VOC emissions from the upstream O&G sector, which includes well production facilities, natural gas compressor stations, and natural gas processing plants (AQCC 2017) – https://www.colorado.gov/pacific/sites/default/files/5-CCR-1001-9_1.pdf.

The regulation includes LDAR provisions for well production facilities and compressor stations that require one-time or periodic monitoring for leaks from components using an Approved Instrument Monitoring Method (AIMM), which may be OGI, Method 21 or other Division-approved, instrument-based monitoring device or program (i.e., alternative AIMM). An alternative AIMM must be able to demonstrate it is capable of achieving emissions reductions at least as effective as using OGI or Method 21. Section XII.L.8, which applies to the 8-hour Ozone Control Area only, specifies the information that must be provided for an alternative AIMM application, which is also included in the application and guidance documents developed for alternative AIMM applications by Colorado's Air Pollution Control Division (see below).

If OGI is used as AIMM, a leak is defined as any detectable emissions observed using the OGI instrument. If Method 21 is used, a leak is defined as either a hydrocarbon concentration of 2,000 ppm or 500 ppm, depending on the facility type, when it was constructed, or if it is located in the 8-hour Ozone Control Area. For an alternative AIMM, leak identification requiring repair will be established as set forth in an approval under Section XII.L.8.

There are also separate requirements specific to atmospheric storage tanks that store hydrocarbon liquids, which includes condensate, oil, and produced water, known as Storage Tank Emission Management (STEM). STEM requires that all storage tank hydrocarbon emissions must be routed to air pollution control equipment. To help accomplish this, a STEM plan has to be developed and implemented to identify technologies, practices, and strategies to prevent the release of tank emissions to the atmosphere. Additionally, periodic AIMM monitoring and AVO inspections of affected tank must be conducted to check for the release of emissions. Any detectable tanks emissions must be addressed or repaired.

Updates to Regulation No. 7 in 2017 also require periodic AIMM inspections of gas-actuated pneumatic controllers at well production facilities and natural gas compressor stations in the 8-hour Ozone Control Area to find and address controllers in need of repair, adjustment, or replacement. The expectation is that these pneumatic controller inspections will occur during the same inspections, and using the same AIMM, that are conducted for compliance with the LDAR requirements of Regulation 7. If detectable emissions from a pneumatic controller are observed, a determination must be made whether the pneumatic controller is operating properly within five (5) working days after detecting the emissions, and if the pneumatic controllers are determined to not be operating properly, then specific actions must be taken to return the pneumatic controller to proper operation as defined in the rule.

Colorado's Air Pollution Control Division (APCD) has developed guidance and an application form for technologies or methods seeking to gain approval as alternative AIMM under Regulation No. 7. The guidance and application documents are based on the alternative AIMM application requirements found in Regulation No. 7, Section XII.L.8.a., which are as follows:

- The proposed alternative AIMM manufacturer information;
- Whether the proposed alternative AIMM is a quantitative detection method, and how emissions are quantified, or qualitative leak detection method;
- Whether the proposed alternative AIMM is commercially available;
- Whether the proposed alternative AIMM is approved by other regulatory authorities and for what application

(e.g., pipeline monitoring, emissions detected);

- The leak detection capabilities, reliability, and limitations of the proposed alternative AIMM, including, but not limited to, the ability to identify specific leaks or locations, detection limits, and any restrictions on use, as well as supporting data;
- The frequency of measurements and data logging capabilities of the proposed alternative AIMM;
- Data quality indicators for precision and bias of the proposed alternative AIMM;
- Quality control and quality assurance procedures necessary to ensure proper operation of the proposed alternative AIMM;
- A description of where, when, and how the proposed AIMM will be used; and
- Documentation (e.g., field or test data, modeling) adequate to demonstrate the proposed alternative approved instrument monitoring method or program is capable of achieving emission reductions that are at least as effective as the emission reductions achieved by the leak detection and repair provisions in the rule using OGI or Method 21.

If the alternative AIMM will be used in the Ozone Control Area, it is also subject to public notice and comment, as well as USEPA review and approval after APCD has determined approval. APCD grants final approval of an alternative AIMM through issuance of an approval letter to the applicant that outlines the conditions or requirements for use of the alternative AIMM and posts the approval letter on the APCD's AIMM web page. Once an alternative AIMM is approved, it may be used by any company operating in Colorado to meet Regulation No. 7 requirements.

As of the date of this document, two technologies have been approved as alternative AIMM by APCD.

C.2.2.2 Pennsylvania – General Permit 5 and Permit-Exemption Category No. 38

Pennsylvania's General Permit 5 (GP-5) is a General Plan Approval and/or General Operating Permit for midstream natural gas gathering, compression and/or processing facilities that are classified as minor sources of air pollution.

GP-5 was first approved by the Pennsylvania Department of Environmental Protection (PDEP) on February 1, 2013 (PDEP 2013). An owner or operator of a facility subject to GP-5 must conduct leak monitoring at the facility on a monthly basis using AVO methods and on a quarterly basis using an OGI camera or other leak detection monitoring device approved by the PDEP. A leak is defined as any release of gaseous hydrocarbons detected by the OGI camera or through AVO methods.

Permit-exemption category no. 38 (PE #38) was finalized on August 10, 2013 and applies to unconventional wells, wellheads, and associated equipment and requires an LDAR program within 60 days after a well is put into production, and annually thereafter, as a condition of meeting the permit exemption. The LDAR program must utilize an OGI camera or a gas leak detector capable of reading in-air methane concentrations of 0% to 5% with an accuracy of +/- 0.2%, or other leak detection monitoring devices approved by the PDEP. LDAR must be conducted on valves, flanges, connectors, storage vessels/storage tanks, and compressor seals in natural gas or hydrocarbon liquid service.

As of the date of this document, PDEP has not published any guidance on the application and evaluation procedures for "other leak monitoring devices" to gain approval for use under GP-5 and PE #38. A Frequently Asked Questions (FAQ) document published by PDEP for GP-5 and PE #38 states that an alternate leak detection technology could be used if "it is approved by DEP following a case-by-case evaluation of the device or technology" (PDEP 2015).

As of the date of this document, no requests for approval of alternate leak detection technologies or methods had been submitted to the PDEP.

C.2.2.3 Ohio – General Permits 12.1, 12.2 and 18.1

The Ohio Environmental Protection Agency (OH EPA) approved two types of general permits for high-volume horizontal hydraulic fracturing, O&G well site production operations (General Permits 12.1 and 12.2) in May 2014 and a general permit for equipment leaks from natural gas compressor stations (GP 18.1) in early 2017 (OEPA 2018).

Each of these permits require development and implementation of an LDAR program for equipment that has the potential to leak (e.g., pumps, compressors, pressure relief devices, connectors, valves, flanges, intermittent/snap-action pneumatic controller, vents, covers, any bypass in a closed vent system, and each storage vessel) using an OGI camera or Method 21. Leak monitoring must be conducted within 60 or 90 days of startup and quarterly thereafter. GP 12.1 and 12.2 allow the monitoring frequency to be reduced after the first four quarters of monitoring if the leak rate of the equipment at a facility is determined to be less than 2.0%. A leak is defined as any detectable emissions with the OGI camera or concentrations between 500 – 10,000 ppm depending on the component if Method 21 is used.

C.2.3 State Government Regulations or Permits that apply to Fugitive VOC Emissions

C.2.3.1 Utah – Rule R307-509. Oil and Gas Industry: Leak Detection and Repair Requirements

On March 5, 2018, the Utah Air Quality Board adopted LDAR requirements for well sites to control VOC emissions from components. Leak monitoring of a component as defined in 40 CFR 60.5430a, Subpart OOOOa (NSPS OOOOa) must be completed no later than January 1, 2019, or no later than 60 day after startup of production, and then semiannually thereafter with consecutive monitoring surveys conducted at least four months apart. Annual monitoring shall be required for "difficult to monitor" components and as required by the owner or operator's monitoring plan for "unsafe-to-monitor" components.

Leak monitoring shall be conducted using OGI and/or Method 21. The OGI equipment shall be capable of imaging gases in the spectral range for the compound of highest concentration in the potential fugitive emissions source.

A leak is defined as any detectable fugitive emissions from a component and a leaking component must be repaired and re-monitored within specified timeframes."

C.2.3.2 Wyoming – Air Quality Standards & Regulations, Chapter 8

In June 2015, the Wyoming Department of Environmental Quality (WYDEQ) finalized revisions to Chapter 8 of the Wyoming Air Quality Standards and Regulations (WAQSR). The revisions include a requirement in Section 6 for multiple or single well production facilities and all compressor stations with fugitive emissions greater than or equal to four tons per year of VOCs in existence prior to January 1, 2014 in the Upper Green River Basin ozone nonattainment area to develop and implement an LDAR program by January 1, 2017. Operators must monitor components quarterly using Method 21, an OGI/IR camera, or other instrument-based technology or method, along with AVO inspections.

The rule also requires that companies submit the protocols for their LDAR program to WYDEQ for approval. Thus, if the protocol includes a request to use an alternative instrument-based monitoring method or technique besides Method M21 or an OGI/IR camera, then WYDEQ could approve it if deemed to be acceptable.

As of the date of this document, no company has submitted an LDAR protocol to WYDEQ requesting the use of an alternative instrument-based monitoring method or technique.

Wyoming regulations are available at http://soswy.state.wy.us/Services/RulesInformation.aspx. (WYDEQ 2017).

C.3 Local Government Fugitive Emission/LDAR Regulations

C.3.1 City of Thornton, Colorado

On August 22, 2017, the City Council for Thornton, CO adopted regulations for O&G operation within city limits. The regulations include requirements for a LDAR plan to detect and promptly repair leaks in equipment and facilities. As stated in the regulations in Section 18-870(f)(19), "At a minimum, the plan shall be comparable to Method 21, and provide for:

1. Monthly infrared camera and olfactory inspections of new and existing wells, related facilities, and equipment. After one year of operation, inspections shall be made at least quarterly.
2. Baseline inspections within 60 days after authorization of the oil and gas operation.
3. Computerized monitoring and leak detection with 24-hour reporting capabilities to the operator, who will then immediately provide notice to the Thornton Fire Department and emergency and safety administrator."

Details of the regulations may be found at https://www.cityofthornton.net/government/citydevelopment/Documents/oil-gas/Finalsigned%20regulationordinance.pdf (Thornton 2017).

The Colorado Oil & Gas Association (COGA) and the American Petroleum Institute's Colorado Petroleum Council (CPC) jointly sued the City of Thornton over the regulations. In April 2018, a judge struck down the well setback and gathering pipelines requirements of the regulation but let stand the well site requirements.

C.4 International Methane Emission Regulations

Outside of the U.S., a few other countries have adopted or are in the process of adopting regulations to reduce methane emissions from the O&G sector. The basis for these regulations is often to help meet commitments for GHG reductions under international climate agreements. A summary of select countries with methane regulations or methane reduction requirements for the O&G industry is summarized below.

C.4.1 Canada – Federal

In Canada, federal regulations to regulate hydrocarbon emissions from the upstream O&G sector were published on April 26, 2018. The requirements cover five main hydrocarbon (methane and VOCs) emission sources, including leaks from equipment. The regulations cover production sites, gas processing facilities, and transmission facilities. Operators must inspect equipment components three times per year using portable monitoring instruments or OGI instruments. Operators are allowed to design an alternate leak detection program that would achieve the same emission reductions as would result from the use of the prescribed regulatory program. The operator must keep extensive records of the nature of the alternate program and must also notify the Minister of Environment and Climate Change of any changes to the program.

C.4.1.1 Canadian Provinces

There are provincial directives in place to manage fugitive emissions, particularly in British Columbia and Alberta, where the majority of on-shore O&G activities are occurring. Saskatchewan, a major O&G producing province, has a directive in place to address venting, but does not address the management of fugitive emissions. The provincial directives do not cover all sources of fugitive and venting emissions. Directives are generally considered non-binding and non-enforceable unless incorporated by reference in a regulation or permit. Permits issued by the provinces are site-specific authorizations for a specific activity or industry and can vary in the type of sources covered and the stringency of requirements.

Regulatory measures

Directive 084, published by the Alberta Energy Regulator (AER), and effective April 2017, requires monthly leak surveys at facilities in the Peace River area of heavy oil and bitumen production. Allowed leak survey instruments include OGI IR cameras, organic vapor analyzers, and other techniques or equipment that provide an equivalent leak detection capability, if the equivalence has been demonstrated to AER’s satisfaction.

Proposed modifications to Directive 060, published by the AER, as of April 24, 2018, would require triannual fugitive emissions surveys at sweet gas plants and compressor stations, as well as controlled liquid hydrocarbon tanks and controlled produced water storage tanks. Annual inspections would be required at sour gas processing plants, sour gas compressor stations, all tank battery types (sweet and sour), custom treating facilities and injection/disposal facilities. Allowed leak survey instruments include organic vapor analyzers, which detect hydrocarbons at a concentration of 500 ppm and are operated in accordance with Method 21, and gas imaging IR cameras which can detect methane emitted at a rate of one gram per hour. Other methods or equipment that are equally capable of detecting fugitive emissions are permitted, as long as equivalence is demonstrated to the satisfaction of the AER. Further guidance on survey methods and equipment will be provided in a forthcoming publication.

Voluntary measures

The Canadian Association of Petroleum Producers (CAPP), an industry association, developed the voluntary *Best Management Practice: Management of Fugitive Emissions at Upstream Oil and Gas Facilities* (BMP) in 2007 (http://www.capp.ca/publications-and-statistics/publications/116116) for reducing fugitive emissions of methane and VOCs at O&G facilities (CAPP 2007). The BMP provides guidance for developing fugitive management programs which focus on areas most likely to offer significant cost-effective control opportunities (on specific component types and service applications). This BMP is referenced in British Columbia’s Flaring and Venting Reduction Guideline and Alberta’s Directive 060, which state that facilities must develop and implement a program which “meets or exceeds the CAPP *Best Management Practice for Fugitive Emissions Management.*” The CAPP BMP lists a number of methods that could be used to detect, measure, or estimate leaks, such as portable monitoring instruments, OGI instruments, and quantitative remote sensing techniques, and assesses qualitatively the effectiveness and approximate cost of these methods.

C.4.2 Norway

According to the Norwegian Environmental Agency, “Methane emissions are covered by Norway’s GHG reduction goals. Norway plans to reduce its global GHG emissions by the equivalent of 30% of its own 1990 emissions by 2020. By 2030, Norway plans to reduce its GHG emissions by the equivalent of 40% compared to the 1990 emissions” (NEA 2018) – http://www.miljodirektoratet.no/en/Areas-of-activity1/Climate/Short-Lived-Climate-Pollutants/Key-regulations-and-goals-on-SLCPs-in-Norway/.

Norway regulates methane emissions from the O&G sector through several acts or laws, including the Pollution Control Act, Greenhouse Gas Emission Trading Act, CO_2 Tax Act (offshore) and the Petroleum Act.

C.4.3 Mexico

As a result of Mexico's participation in the United Nations Framework Convention on Climate Change, the state-owned oil company of Mexico, Petróleos Mexicanos (PEMEX), has taken steps to reduce methane emissions from its operations, including implementation of the Nationally Appropriate Mitigation Actions (NAMA) with the assistance of the British Embassy Prosperity Fund. The goal of NAMA is to reduce methane emissions in natural gas processing, transport, and distribution systems through periodic LDAR activities. NAMA outlines both qualitative and quantitative methods for detecting leaks, including bubble tests, OGI, ultrasonic leak detectors, portable organic vapor analyzers, quantitative remote sensing techniques, and engineered estimates. PEMEX may also follow internationally recognized methods for leak identification, such as Method 21. A proposed methane regulation for the oil and gas industry that includes leak detection requirements with options for using OGI or internationally recognized methods or technologies for leak detection was introduced by the Mexican government in July 2018.

C.4.4 Saudi Arabia

Saudi Arabia requires semi-annual LDAR inspections at O&G facilities that can be reduced to annual inspections if leaks are reduced. Facility operators must keep track of all leaks found and repaired and report them on an annual basis. Note, however, that the regulations do not outline proper leak detection methods or provide repair guidelines, therefore, operators can implement different methods and repair thresholds and timeframes.

C.4.5 Australia – New South Wales

The state of New South Wales in Australia has regulations to limit methane emission leaks from coal seam gas (CSG) operations. The regulations require CSG operators to develop and implement an LDAR program for their operations. Leak monitoring must be conducted in accordance with Method 21 and U.S. EPA's Best Practices Guide for Leak Detection and Repair (NSW-EPA 2015) – http://www.epa.nsw.gov.au/resources/epa/2564-methane-fact-sheet.pdf.

[1] To qualify for Section 60105 of Chapter 601 gas or hazardous liquid certification, the state agency must have adopted and be enforcing each federal safety standard applicable to intrastate pipelines under its jurisdiction as of the date of the certification.

[2] By mutual agreement between the Secretary and the state agency, a Section 60106 of Chapter 601 agreement permits the state agency to undertake safety activities concerning intrastate pipelines when the state agency does not qualify for Section 60105 of Chapter 601 certification. A state agency conducting a pipeline safety program under a Section 60106 of Chapter 601 agreement inspects intrastate operators for compliance with safety standards. Under such an agreement, the state agency will conduct all pipeline safety program activities that the state agency is allowed to conduct under Section 60105 of Chapter 601 certification except that, in the event of a probable violation of the pipeline safety standards, the state agency must notify PHMSA. PHMSA remains the authority having jurisdiction over all compliance actions.

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