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Elizabeth Scheehle, Chief
Oil and Gas and Greenhouse Gas Mitigation Branch
California Air Resources Board
1001 "I" St. Sacramento, CA, 95814

Joseph Fischer
Air Resources Engineer
California Air Resources Board
1001 "I" St. Sacramento, CA, 95814

Re: Environmental Defense Fund Comments on Proposed Regulation Order Article 3: Greenhouse Gas Emission Standards for Crude Oil and Natural Gas Facilities: Part I of Comments Related to Leak Detection and Repair Requirements.

Dear Ms. Scheehle and Mr. Fischer:

Thank you for accepting these comments submitted by Environmental Defense Fund ("EDF") on the recent proposal to regulate greenhouse gas emissions from oil and gas facilities. EDF is a national membership organization with over one million members residing throughout the United States, nearly 70,000 of which live and work in California and who are deeply concerned about the pollution emitted from oil and natural gas sources.

I. Introduction

We commend you and your staff at the California Air Resources Board ("CARB") for drafting a proposal that directly regulates methane emissions from a diverse suite of new and existing oil and gas sources. When it comes to protecting public health and the environment, California holds a unique position as a national leader, and there are many elements of the proposal that demonstrate this leadership. In particular, the proposal recognizes the fact that both new and existing facilities are responsible for the current greenhouse gas and other air pollutant emissions from oil and gas activities, and that such facilities will continue to release harmful pollutants into the atmosphere unless rigorous controls are implemented. We strongly support the inclusion of existing sources of air pollution in the proposal.

The proposal also recognizes that there are many points along the natural gas supply chain where greenhouse gases and other pollutants can be emitted. While historically regulators have largely focused on onshore production and processing sector emissions, this proposal acknowledges that "downstream" sources, specifically compressor stations along transmission pipelines and underground storage facilities, as well as offshore sources, can also be significant sources of methane. When taken together, the scope of this rulemaking incorporates important, cross-sectoral sources of methane emissions in a way that can help secure meaningful environmental benefits

Lastly, we are pleased that CARB has drafted a proposal that addresses the diverse and most significant sources of air pollution from well sites, gas processing plants, compressor stations and other facilities. As CARB recognized, emissions occur from a diverse suite of activities and equipment, including compressors, pneumatic devices, storage tanks and components, and therefore comprehensive regulations that address these multiple sources of pollution are necessary.

Notwithstanding these important provisions however, the current draft needs improvement. While CARB has stated that a goal of this proposal is to "obtain the maximum methane emission reductions possible"[1] from the targeted oil and gas sources, the current draft falls short in attaining this eminently achievable goal. In particular, the annual leak detection option fails to ensure the maximum methane emission reductions possible since more frequent, and more comprehensive, inspections are feasible and cost effective. Specifically, as demonstrated below, quarterly inspections of all equipment at oil and gas sites using modern leak detection equipment can go a long way to ensuring cost effective maximum emission reductions from oil and gas sources.

We offer these comments now on the leak detection and repair requirements to help inform the rulemaking as soon as possible. We will submit a separate set of comments addressing the need for improvements to the other requirements in the proposal in the near future.

II. Leak Detection and Repair

Frequent inspections of oil and gas facilities is a critical component of pollution prevention and pollution, including greenhouse gas, mitigation. Recent scientific data obtained by direct measurement of emissions at a wide selection of oil and gas facilities across the country demonstrate that equipment malfunctions and poor maintenance can lead to significant pollution that is not represented in emission inventories. This scientific information demonstrates that oil and gas facilities are considerably leakier than industry reports, that operators do not and cannot predict when such failures will occur, and therefore, that frequent inspections with modern leak detection equipment is necessary to detect and promptly repair such leaks.

Fortunately, modern leak detection equipment exists to quickly and accurately find leaks. Moreover, frequent, namely quarterly inspections, are highly cost effective. Such inspections remove harmful pollution from the atmosphere, while also ensuring a safer and more efficient workplace.

[1] ARB's Oil & Natural Gas Methane Regulation, Public Workshop, California Air Resources Board, Sacramento, California, 6 (December 9, 2014), http://www.arb.ca.gov/cc/oil-gas/meetings/Workshop_Presentation_12-9-14.pdf.

A. Field Studies Using Direct Measurement Demonstrate the Need for Frequent Instrument-Based Inspections: Significant Emissions May Emanate From Individual Components and Operations

Up until recently, regulators have relied nearly exclusively on emission inventories in order to understand the magnitude of a particular pollution problem as well as the potential reductions associated with a proposed solution. Now however, recent advances in science have added to our knowledge and understanding of emissions from oil and gas facilities. These studies demonstrate that emissions are systematically significant and, at a select number of facilities, actual emissions are magnitudes higher than emission inventories suggest. These studies strongly support at least quarterly inspections using modern leak detection technology to identify malfunctioning or defective equipment. In some instances, repairs can be made instantaneously with the turn of a wrench. A number of studies, as well as industry reports, note that the gas savings associated with fixing such leaks covers the costs associated with repairing them.

The first of these studies, conducted by an independent team of scientists at the University of Texas, found that emissions from equipment leaks, pneumatic controllers and chemical injection pumps were each 38%, 63% and 100% higher, respectively, than as estimated in national inventories.[2] This study also found that 5% of the facilities were responsible for 27% of the emissions.[3]

Two follow-up studies focused specifically on emissions from pneumatic controllers and liquids unloading activities at wells found similar results.[4] Specifically, the studies found that 19 percent of the pneumatic devices accounted for 95 percent of the emissions from the devices tested, and about 20 percent of the wells with unloading emissions accounted for 65 to 83 percent of those emissions. The average methane emissions per pneumatic controller were 17 percent higher than the average emissions per pneumatic controller in EPA's national greenhouse gas inventory.[5]

These findings were reiterated again in a series of direct measurement studies focusing on emissions from compressor stations in the gathering and processing segment and in the transmission and storage segment. The gathering and processing study found substantial venting

[2] Allen, D.T., et al, (2013) "Measurements of methane emissions at natural gas production sites in the United States," *Proc. Natl. Acad.* 2013, 110 (44), available at http://www.pnas.org/content/110/44/17768.full

[3] *See* Allen, D.T., et al, (2014), "Methane Emissions from Process Equipment at Natural Gas Production Sites in the United States: Pneumatic Controllers," *Environ. Sci. Technol.*, 2015, 49 (1), pp. 633–640 (referencing 2013 Allen study), available at http://pubs.acs.org/doi/abs/10.1021/es5040156.

[4] Allen, D.T. et al., "Methane Emissions from Process Equipment at Natural Gas Production Sites in the United States: Liquid Unloadings," *Environ. Sci. Technol.*, 2015, 49 (1), pp 641–648, available at http://pubs.acs.org/doi/abs/10.1021/es504016r.

[5] Allen, D.T., et al, (2014), "Methane Emissions from Process Equipment at Natural Gas Production Sites in the United States: Pneumatic Controllers," *Environ. Sci. Technol.*, 2015, 49 (1), pp 633–640, available at http://pubs.acs.org/doi/abs/10.1021/es5040156.

from liquids storage tanks at approximately 20 percent of the sampled gathering facilities.[6] Emission rates at these facilities were on average four times higher than rates observed at other facilities and, at some of these sites with substantial emissions, the authors found that company representatives made adjustments resulting in immediate reductions in emissions.

In the study on transmission and storage emissions, the two sites with very significant emissions were both due to leaks or venting at isolation valves.[7] The study also found that leaks were a major source of emissions across sources, concluding that measured emissions are larger than would be estimated by the emission factors used in EPA's reporting program.

Other studies resulted in similar findings. In a 2013 study measuring emissions from 200 well pads in the Barnett Shale researchers found that approximately 20% of the well pads were responsible for 80% of the emissions detected.[8] Another study focusing on short-term and maintenance-related emissions at well pads in Texas, Wyoming and Colorado found "a weak correlation between emission and production rates."[9] This multi-state study suggests that maintenance-related stochastic variables and the ways in which facilities and control equipment are designed can be important factors affecting emissions.

The nature of these events, specifically that they are unforeseen and unpredictable, require that operators vigilantly inspect their equipment and operations for leaks. Frequent inspections, i.e., at least quarterly, using modern leak detection equipment is one of the most effective way to minimize the pollution associated with these stochastic events.

B. State LDAR Requirements Demonstrate that Frequent Instrument-Based Inspections are the New Normal and a California Approach on Oil and Gas Should Require Quarterly Inspections Statewide and Leave Open the Ability for Operators to Use New Technology to Perform System Audits

Currently, four major oil and natural gas producing states require quarterly monitoring at oil and gas facilities. Three of these requirements are aimed at identifying methane, as well as non-methane organic compounds.

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[6] Mitchell, A.L., et al, (2015) "Measurements of Methane Emissions from Natural Gas Gathering Facilities and Processing Plants," *Environ. Sci. Technol*, 2015, 49 (5), pp 3219–3227, available at http://pubs.acs.org/doi/abs/10.1021/es5052809.

[7] R. Subramanian, et al, (2015) "Methane Emissions from Natural Gas Compressor Stations in the Transmission and Storage Sector: Measurements and Comparisons with the EPA Greenhouse Gas Reporting Program Protocol," *Environ. Sci. Technol*, available at http://pubs.acs.org/doi/abs/10.1021/es5060258.

[8] Rella, Chris W., et al, (2015), "Measuring Emissions from Oil and Natural Gas Well Pads Using the Mobile Flux Plane Technique," *Environ. Sci. Technol*., 2015, 49 (7), available at http://pubs.acs.org/doi/abs/10.1021/acs.est.5b00099.

[9] Brantley, Halley L., et al, (2014), "Assessment of Methane Emissions from Oil and Gas Production Pads Using Mobile Measurements," *Environ. Sci. Technol*., 2014, 48 (24), available at http://pubs.acs.org/doi/abs/10.1021/es503070q.

Colorado was the first state to promulgate comprehensive LDAR requirements aimed at reducing methane, as well as other pollutant emissions from a diverse suite of oil and gas facilities. Colorado's rules require operators to inspect for and repair hydrocarbon leaks, consisting of methane as well as other organic compounds, at three types of facilities: compressor stations, well sites, and storage tank batteries. The rules require quarterly inspections at mid-sized facilities.[10] The size of the facility is determined based on the potential to emit volatile organic compounds (VOCs), although operators are required to repair hydrocarbon leaks including leaks from components that primarily emit methane.[11] Colorado chose to use VOC emissions as the threshold for triggering inspection requirements because it has a robust inventory of leaking VOC emissions, but does not currently require operators to report methane or total hydrocarbon emissions.

Colorado provides operators flexibility in determining what type of leak detection equipment to use. Operators may use either an IR camera, Method 21, or "other Division approved instrument based monitoring device or method."[12] To date, the Division has approved one additional device, the Rebellion photonics camera.

Colorado also provides operators with flexibility in determining whether or not to quantify leaks from well sites and compressor stations. At well sites and compressor stations, if an operator uses an IR camera, they have the option of either fixing all leaks detected with the camera, or measuring all detected leaks with a device capable of quantifying the hydrocarbon content of the leak.[13] Based on conversations with the Colorado Air Pollution Control Division, most operators choose to fix all leaks detected with an IR camera. If an operator chooses to quantify a leak, they must fix all leaks with a hydrocarbon concentration of 500 ppm from components located at new and existing well sites and new compressor stations.[14] At older, existing compressor stations, the leak threshold triggering repair is 2,000 ppm.[15]

If an operator finds a leaking access point, such as a thief hatch or pressure relief valve, at a storage tank, they must fix it regardless of the leak size. Colorado requires access points at storage tanks to operate without venting during normal operation.[16] Therefore, any leaking from an access point is a violation of the rules, regardless of the leak size, and subject to repair requirements.[17]

Pennsylvania, the second largest shale gas producing state, requires quarterly inspections of all onshore gas processing plants and compressor stations in the gathering and boosting

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[10] 5 C.C.R. 1001-9, CO Reg. 7, §§ XVII.C.2.b.(ii), XVII F, (Feb. 24, 2014). Quarterly inspections are required at gathering sector compressor facilities with uncontrolled emissions between 12 and 50 tons of VOCs from equipment leaks and at well sites and tank batteries with uncontrolled emissions between 20 and 50 tons of VOCs from the largest condensate or oil storage tank onsite.
[11] See *Id*., at XVII.a.5.
[12] *Id*. at § XVII.A.2.
[13] *Id*. at § XVII.F.6.e.
[14] *Id*. at § XVII.F.6.a,b.
[15] *Id*. at § XVII.F.6.a.
[16] *Id*. at § XVII.C.2.a, b.
[17] Confirmation with Mark McMillan, Supervisor of the Oil and Gas Team, Colorado Air Pollution Control Division.

sector.[18] Like Colorado, Pennsylvania requires operators inspect for and repair methane leaks as well as VOC leaks. Pennsylvania requires operators utilize either a forward looking infrared camera ("FLIR") or "other leak detection monitoring devices approved by the Department".[19] In its leak detection and repair requirements for well sites, Pennsylvania requires that operators "perform a leak detection and repair (LDAR) program that includes either the use of an optical gas imaging camera such as a FLIR camera or a gas leak detector capable of reading methane concentrations in air of 0% to 5% with an accuracy of +/- 0.2% or other leak detection monitoring devices approved by the Department."[20] A leak of 5% methane is the equivalent of 50,000 ppm. By our calculations, the requirement that the device must have a detection accuracy of +/- 0.2% equates to a detection limit of 2,000 ppm.

Ohio also requires quarterly inspections for hydrocarbon, including methane, leaks at unconventional well sites.[21] Per the Ohio requirements, operators may use either a FLIR camera or a Method 21 compliant analyzer. When using a FLIR camera, a leak is defined as any visible emissions. When using an analyzer, a leak is defined using a 10,000 ppm threshold for all components except compressors and closed vent systems, which use a 500 ppm threshold. Operators may reduce the inspection frequency if no more than 2% of the components are found leaking after six consecutive inspections, but the frequency reverts back to the original monitoring frequency upon detection of a higher leak threshold.[22]

Lastly, **Wyoming** requires quarterly instrument-based inspections at all new and modified well sites in its Upper Green River Basin with the potential to emit 4 tons of volatile organic compounds from fugitive components,[23] and has proposed to require the same for existing well sites and compressor stations in the Basin.[24] Operators may use either Method 21 or an optical gas imaging instrument, or other approved instrument. Wyoming's rules and permit requirements are focused on reducing VOC and HAP emissions.

While each of these states allows the use of either Method 21, an IR camera, or a different equally effective instrument-based method, there are certain advantages to optical gas imaging technologies such as IR cameras. IR cameras allow operators to scan an entire facility

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[18] Pa. Dep't of Envtl. Prot., General Permit for Natural Gas Compression and/or Processing Facilities (GP-5), Section G, http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-94153/2700-FS-DEP4403.pdf.
[19] PA GP-5, Section H.
[20] Pa. Dep't of Envtl. Prot., Air Quality Permit Exemptions, No. 275-2101-003, http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-96215/275-2101-003.pdf.
[21] Ohio EPA, General Permit for High Volume Hydraulic Fracturing, Oil and Gas Well Site Production Operations, http://epa.ohio.gov/Portals/27/oil%20and%20gas/GP12.1_PTIOA20140403final.pdf.
[22] *Id*. The initial quarterly inspection may be decreased to semi-annual, and then again to annual, following each set of six inspections and compliance with the 2% leaking component threshold.
[23] Wyoming Department of Environmental Quality, Oil and Gas Production Facilities Permitting Guidance (Sept. 2013), (WY Permitting Guidance) http://deq.state.wy.us/aqd/Oil%20and%20Gas/September%202013%20FINAL_Oil%20and%20Gas%20Revision_UGRB.pdf.
[24] Wyoming Department of Environmental Quality proposed changes to Air Quality Division Standards and Regulations, Nonattainment Area Regulations, Ch. 8, Sec. 6, (UGRB proposal) available at http://sgirt.webfactional.com/filesearch/content/Air%20Quality%20Division/Programs/Rule%20Development/Proposed%20Rules%20and%20Regulations/AQD_Rule-Development_Chapter-8-NAA-Existing-Source-IBR-draft_02-02-15-Strike-and-Underline.pdf; WY Permitting Guidance, 22.

for leaks efficiently and safely from one vantage point. A clear illustration of this is that operators can detect leaks atop storage tanks using an IR camera that would otherwise go undetected unless an inspector climbed to the top of the tank. Oftentimes, an open thief hatch can be immediately closed upon detection, thus eliminating significant emissions. The Colorado Air Pollution Control Division estimates operators can scan a facility for leaks twice as quickly using an IR camera as they can using a Method 21 complaint device.[25] Some suggest that this is a conservative estimate of the time-savings associated with the use of IR cameras, and that IR camera scans can be performed even more efficiently.

We note the benefits of an IR camera not to suggest that ARB limit the available leak detection technology solely to optical gas imaging or IR technologies, but rather to emphasize the need for flexibility in the requirements. Just as the IR camera has certain advantages, so too do Method 21 compliance devices that are capable of quantifying leaks. The methane leak detection technology landscape is highly dynamic, with innovation happening in real time, for example through ARPA-E's MONITOR project and EDFs Methane Detectors Challenge project in partnership with Shell, six other large producers and other stakeholders. It is crucial for new CARB rules to create space for innovative technologies, which may be able to deliver improved environmental performance at reduced cost. We strongly urge the agency to adopt a robust alternative compliance pathway that is minimally prescriptive and specifically creates an entry point for appropriately qualified/demonstrated methane selective and/or multiple hydrocarbon detecting approaches. Such an approach will help catalyze a race to the top in technology, control costs for the regulated community, and potentially boost environmental outcomes. We urge CARB to let operators choose from a list of approved devices, and to obtain approval from CARB for an equally effective device, rather than dictating technology in the rule.

While we recognize the importance of quantifying emissions for inventory purposes, we wish to point out that the goal of this rule is to reduce, rather than measure, emissions. While, in many instances, a strong rule that provides maximum emission reductions also facilitates measurement, here we caution against requiring that operators utilize leak detection equipment capable of quantifying emissions if the result is a trade-off in inspection frequency. Frequent, at least quarterly, instrument monitoring is a prerequisite to a strong LDAR program.

C. Leading Companies Support Frequent and Ongoing LDAR, and Available Data Suggests Companies Settle Into Leak Detection Requirements over Time and Without Difficulty

One important piece of information that supports our recommendation that CARB require quarterly instrument-based inspections on a continuing basis is available data that demonstrates that a steady state of leak detection occurs over time – and that emissions are lower in quarterly inspection and repair regimes as opposed to annual inspection and repair regimes.

[25] Colorado Department of Health and Environment, Final Cost-Benefit Analysis for Proposed Revisions to AQCC Regulations No. 3 and 7 (February 7, 2014) (cost effectiveness of quarterly inspections at mid-sized compressor stations are $607 per ton of CH4/ethane reduced calculated as net annual leak inspection and repair costs in Table 26 divided by CH4/ethane reductions in Table 32); (well site inspections as cost effective at $679 per ton of CH4/ethane reduced calculated as net annual leak inspection and repair costs in Table 30 divided by CH4/ethane reductions in Table 33).

Colorado recently proposed, and ultimately adopted, a leak detection and repair requirement that requires operators inspect for leaks at all but the smallest sites on a continuous annual, quarterly, or monthly basis.[26] This proposal had the support of three large oil and gas producers, Noble Energy, Anadarko Petroleum Corporation, and Encana. Notably, Encana submitted testimony regarding its own voluntary LDAR program which requires monthly instrument-based inspections. According to Encana, "Encana's experience shows leaks continued to be detected well into the established LDAR program."[27] Viewed somewhat differently, Encana's data suggests that while the largest reductions in VOC emissions occur in the first year of an LDAR program, emissions reductions are still being realized in subsequent years of the LDAR program."[28]

Other information presented during the Colorado rulemaking further supports the need for frequent inspections over time. During the rulemaking, industry opponents of the Division's proposal submitted data collected from their own LDAR monitoring experience. This data demonstrated an initial component leak rate frequency (before the first LDAR inspection) at new and modified gas processing plants of 1.7%.[29] The leak rate frequency falls to 0.4% after the first monitoring period and averages 0.3% over 12 consecutive calendar quarters. While it does support a decline after the first monitoring period, the data evidences a steady state of leak detection after that.

The successor to Encana's operations in Wyoming, Jonah Energy, has also expressed its support of at least quarterly instrument-based inspections. Jonah Energy supports the WY DEQ's quarterly instrument-based LDAR program for existing well sites, noting that it already complies with the proposal as "each month, Jonah Energy conducts infrared camera surveys using a FLIR camera at each of our production facility locations."[30] According to Jonah, "the estimated gas savings from the repair of leaks identified often exceeds the labor and material cost of repairing the identified leaks" while also significantly reducing pollution.

D. Quarterly Inspections Are Highly Cost Effective

Quarterly instrument-based inspections can remove significant methane, HAPs, and VOCs, from the atmosphere for very low costs. When considering the value of natural gas that can be sold to end users instead of being leaked into the air, and when considering the value of the each reduced pollutant in addition to methane, quarterly inspections simply make economic sense. This is supported by an ICF International recent analysis of the cost effectiveness of requiring quarterly inspections using IR cameras at well sites, gas processing plants, compressor

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[26] 5 C.C.R. 1001-9, CO Reg. 7, §§ XVII.C.2.b.(ii), XVII F, (Feb. 24, 2014).
[27] Rebuttal Statement of Encana Oil and Gas (USA) Inc., p. 10, Before Colorado Air Quality Control Commission, Regarding Revisions to Regulation Numbers 3,7 and 9., on file with EDF.
[28] *Id*. at 10-11.
[29] Prehearing Statement of WPX Energy Rocky Mountain, LLC'S AND WPX Energy Production LLC, Ex. A, Before Colorado Air Quality Control Commission, Regarding Revisions to Regulation Numbers 3,7 and 9., on file with EDF.
[30] Comments submitted to Mr. Steven A. Dietrich from Jonah Energy LLC on Proposed Regulation WAQSR, Chapter 8, Nonattainment Area Regulations, Section 6, Upper Green River Basin Permit by Rule for Existing Sources (April 13, 2015), available at http://deq.wyoming.gov/aqd/rule-development/resources/proposed-rules-and-regulations/.

stations and local distribution company metering and regulating stations. In this study, ICF found quarterly inspections to be cost effective at all such facilities.[31] Similarly, the state of Colorado found quarterly inspections to be cost effective for mid-size facilities, and monthly inspection cost effective for larger facilities.[32]

We updated the emissions data in the ICF report to reflect more recent EPA emissions data, and converted the analysis into metric tons of methane reduced.[33] Per our analysis:

- Quarterly IR camera inspections at well sites with the potential to emit 58.1 metric tons of methane (the equivalent of 17.8 short tons per year of VOCs) can be accomplished for a negative cost of $210 per metric ton of methane reduced, assuming a credit for recovered gas. Operators of well sites should be able to monetize any recovered gas they produce. However, even if an operator were to assume no credit for the recovered gas, quarterly IR camera inspections are still highly cost effective at $58 per metric ton of methane reduced.

- Quarterly IR camera inspections at gathering and transmission stations are also highly cost effective. At gathering sector facilities, quarterly LDAR can be accomplished for a cost of $37 per metric ton of CH4, assuming no credit for recovered gas and a negative cost of $230 per metric ton of CH4, assuming a credit for recovered gas.

- Quarterly IR camera inspections at transmission facilities can be accomplished for a cost of $146 per metric ton of CH4, assuming no credit for recovered gas and a negative cost of $87 per metric ton of CH4, assuming a credit for recovered gas.

Quarterly Method 21 inspections are also cost effective. To estimate these costs we doubled the inspection time and labor costs in the ICF report, in order to account for the additional time it takes to monitor each component with a Method 21 compliant hydrocarbon analyzer. Like ICF, we assumed $5,000 for the purchase of the measurement device. We concluded that quarterly Method 21 inspections can be accomplished for the following:

- $184 per MT of CH4 reduced, assuming no credit for gas, at a production site. Negative cost of $83 per MT of CH4 reduced, assuming gas savings.
- $120 per MT of CH4 reduced, assuming no credit for gas, at a gathering site. Negative cost of $148 per MT of CH4 reduced, assuming gas savings.
- $466 per MT of CH4 reduced, assuming no credit for gas, at a transmission site. $233 per MT of CH4 reduced, assuming gas savings.

[31] ICF International, "Economic Analysis of Methane Emission Reduction Opportunities in the U.S. Onshore Oil and Natural Gas Industries," (March 2014).
[32] See *supra* note 25.
[33] To estimate the potential to emit, ICF relied on emissions information contained in EPA's Technical Support Document (TSD) for the proposed oil and gas New Source Performance Standards (2011). EPA later updated the emissions information when it promulgated the NSPS. We rely here on the updated emissions information in the final TSD (2012).

Lastly, we analyzed the cost effectiveness of requiring a hybrid inspection approach where operators conduct an initial facility wide inspection using an IR camera, and then re-check any leaking components using a Method 21 compliant device. The costs associated with this approach are not significantly higher than the costs associated with a single IR camera inspection requirement. This is because the available data suggests that operators are likely to find approximately 1% of components leaking during the first inspection of a facility. Therefore, operators need only re-check one percent of all leaks identified with an IR camera using a photoionization device (PID). Using these assumptions, our estimated cost-effectiveness calculations are as follows:

- $59 per MT of CH4 reduced, assuming no credit for gas, at a production site. Negative cost of $208 per MT of CH4 reduced, assuming gas savings.
- $39 per MT of CH4 reduced, assuming no credit for gas, at a gathering site. Negative cost of $229 per MT of CH4 reduced, assuming gas savings.
- $150 per MT of CH4 reduced, assuming no credit for gas, at a transmission site. Negative cost of $83 per MT of CH4 reduced, assuming gas savings.

As demonstrated above, quarterly inspections using modern leak detection equipment, is highly cost effective. Unfortunately though, the recent rule proposal shows that CARB initially rejected a quarterly inspection requirement on the basis that estimated quarterly inspections are four times that cost of annual inspections. The basis for that assumption is not explained, however. Based on our analysis quarterly inspections are much closer to 1.5 times the cost of annual inspections. To estimate the difference in costs between annual and quarterly inspections, we assumed the following:

- Capital costs remain the same as these are one-time costs unrelated to inspection frequency;
- Initial set up costs (training, procedures) remain the same as these are one-time costs unrelated to inspection frequency;
- Increased the repair time and the inspection frequency based on assumptions in the ICF report and Colorado analysis; and
- Quarterly inspections are 60% effective at reducing leaks compared to annual inspections which are 40% effective.

Annual **IR Camera and Method 21 LDAR Cost Analysis**

Method	IR Camera - Annual LDAR			Method 21 - Annual LDAR			IR Camera/Method 21 Hybrid - Annual LDAR [6]		
Sector	Well Pads [1]	Gathering [1]	Transmission [2]	Well Pads [1]	Gathering [1]	Transmission [2]	Well Pads [1]	Gathering [1]	Transmission [2]
Emissions Reductions (%) [3]	40%	40%	40%	40%	40%	40%	40%	40%	40%
Hourly LDAR Cost [4]	$101.64	$101.64	$101.64	$162.28	$162.28	$162.28	$101.64/$162.28	$101.64/$162.28	$101.64/$162.28
Cost w/o Credit ($/Mcf CH4)	$0.75	$0.49	$1.91	$2.41	$1.57	$6.11	$0.78	$0.50	$1.97
Cost w/ Credit ($/Mcf CH4) [5]	-$4.32	-$4.59	-$2.52	-$2.67	-$3.51	$1.68	-$4.30	-$4.57	-$2.46
Cost w/o Credit ($/mt CH4)	$39.70	$25.82	$100.64	$126.79	$82.47	$321.38	$40.82	$26.55	$103.47
Cost w/ Credit ($/mt CH4) [5]	-$227.46	-$241.34	-$132.53	-$140.38	-$184.70	$88.21	-$226.34	-$240.61	-$129.69

[1] For well pads and gathering, methane content of natural gas assumed to be 78.8%.

[2] For transmission, methane content of natural gas assumed to be 90.3%.

[3] Annual LDAR is assumed to correlate with 40% reductions.

[4] Method 21 hourly cost assumes twice the IR LDAR inspection time and labor costs, but does not include cost for the IR camera.

[5] Price of natual gas assumed to be $4.00/Mcf.

[6] IR Camera/Method 21 Hybrid costs assume annual IR camera inspections in addition to Method 21 inspections for the assumed 1% of leaking components.

Quarterly **IR Camera and Method 21 LDAR Cost Analysis**

Method	IR Camera - Quarterly LDAR			Method 21 - Quarterly LDAR			IR Camera/Method 21 Hybrid - Quarterly LDAR [6]		
Sector	Well Pads [1]	Gathering [1]	Transmission [2]	Well Pads [1]	Gathering [1]	Transmission [2]	Well Pads [1]	Gathering [1]	Transmission [2]
Emissions Reductions (%) [3]	60%	60%	60%	60%	60%	60%	60%	60%	60%
Hourly LDAR Cost [4]	$101.64	$101.64	$101.64	$162.28	$162.28	$162.28	$101.64/$162.28	$101.64/$162.28	$101.64/$162.28
Cost w/o Credit ($/Mcf CH4)	$1.09	$0.71	$2.77	$3.50	$2.27	$8.86	$1.13	$0.73	$2.86
Cost w/ Credit ($/Mcf CH4) [5]	-$3.98	-$4.36	-$1.66	-$1.58	-$2.80	$4.43	-$3.95	-$4.34	-$1.57
Cost w/o Credit ($/mt CH4)	$57.61	$37.47	$146.02	$183.97	$119.66	$466.31	$59.35	$38.60	$150.44
Cost w/ Credit ($/mt CH4) [5]	-$209.56	-$229.69	-$87.14	-$83.20	-$147.50	$233.15	-$207.82	-$228.56	-$82.73

[1] For well pads and gathering, methane content of natural gas assumed to be 78.8%.

[2] For transmission, methane content of natural gas assumed to be 90.3%.

[3] Quarterly LDAR is assumed to correlate with 60% reductions.

[4] Method 21 hourly cost assumes twice the IR LDAR inspection time and labor costs, but does not include cost for the IR camera.

[5] Price of natual gas assumed to be $4.00/Mcf.

[6] IR Camera/Method 21 Hybrid costs assume quarterly IR camera inspections in addition to Method 21 inspections for the assumed 1% of leaking components.

E. LDAR Must be Comprehensive

As discussed above, the science around leaks demonstrates that operators must inspect for leaks frequently, and that such inspections must apply to the entire suite of equipment at a facility. Pneumatic devices, storage tanks, compressors, as well as traditional fugitive components such as valves, are all susceptible to leaks.

We strongly urge CARB to finalize a program for leak detection and repair that includes all potential sources of leaks and inadvertent venting. Specifically, the scientific studies discussed above and investigations by EPA and other state air pollution control divisions[34] demonstrate that storage tanks, control devices, and pneumatic devices are often the cause of stochastic emissions events. And, further, that requiring frequent instrument-based inspections of such equipment can result in immediate emissions reductions.

We are pleased to see hatches, pressure relief valves and piping included in the list of components covered by LDAR. We suggest CARB confirm that the term "hatch" refers to thief hatches on storage tanks, and include all access points on storage tanks in the LDAR program.

CARB has proposed to require that intermittent devices "shall not leak when idle." Similarly, the proposal prohibits continuous bleed pneumatic devices from venting to the atmosphere. We urge CARB include intermittent and continuous bleed devices in the LDAR inspections in order to ensure that operators can meet these standards. In addition, we urge CARB to include vapor collection systems and flares in the LDAR program as well.

F. Consistency with local air district requirements

One of ARB's stated goals for this proposal is to harmonize requirements with current local regulations and to minimize administrative burdens for the air districts.[35] We agree these are important goals and support ARB's efforts to do so, provided the proposal does not weaken existing requirements.

There are four air districts in Southern California with existing inspection and maintenance requirements aimed at detecting non-methane hydrocarbon leaks.[36] Each of these requires quarterly inspections as a baseline. In some instances, operators may reduce the inspection frequency to annual after at least a year of conducting quarterly inspections. Importantly, however, this "step-down" to annual inspections is only permitted for certain types of components, and for those specifically enumerated components eligible for a reduction in inspection frequency, is only permitted if the leaks from such components remain below

[34] *See e.g*., Consent Decree *U.S. v. Noble Energy*, (No. 1:15 cv 00841, D. CO., April 22, 2015), available at http://www.justice.gov/sites/default/files/enrd/pages/attachments/2015/04/23/lodged_consent_decree.pdf.
[35] See *supra* note 1.
[36] San Joaquin Valley Air Pollution Control District R. 4409 (2005); South Coast Air Quality Management District R. 1173 (1989); Santa Barbara County Air Pollution Control District R. 331 (1991); Ventura County Air Pollution Control District R.74.10 (1989).

specified thresholds. In addition, even if a reduction in inspection frequency is allowed, operators must return to quarterly inspections at any time if a subsequent inspection reveals leaks above the specified threshold.

The current proposal, which allows for annual Method 21 inspections as an available compliance mechanism, cannot be harmonized with these current requirements. It lacks the fundamental baseline quarterly requirement, and it lacks the narrowly tailored nature of the component by component "step-down" provision. For both of these reasons, it sets forth a markedly less protective standard.

III. Conclusion

Notwithstanding the great importance of this rule for covering a wide array of new and existing sources, in both gas and oil service, more needs to be done to ensure the proposed regulation results in maximum methane emissions reductions from leaking equipment. We urge CARB to require quarterly instrument inspections of all components and equipment with the potential to leak or inadvertently vent methane. Finalizing a comprehensive LDAR requirement that requires quarterly instrument inspections of all oil and gas facilities subject to this proposal will ensure that CARB retains its status as a leader in clean air measures and protector of public health and the environment.

Thank you for your consideration of these comments.

Sincerely,

Timothy O'Connor
Director and Senior Attorney
Environmental Defense Fund

Elizabeth Paranhos
Attorney and Oil and Gas Consultant
Delone Law Inc.

Hillary Hull
Research Analyst
Environmental Defense Fund