V Prentice

Please see the attached comments submitted on behalf of Insight M.

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Texas Commission on Environmental Quality
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RE: Stakeholder Input regarding OOOOc Rulemaking and State Plan
RPN 2024-027-113-AI

I. INTRODUCTION AND EXECUTIVE SUMMARY

Insight M, formerly known as Kairos Aerospace, appreciates the opportunity to provide input on the Texas Commission on Environmental Quality's (TCEQ) OOOOc Rulemaking and State Plan for Existing Crude Oil and Natural Gas Facilities.

Founded in 2014, Insight M is a consultative methane emissions management company and a leading provider of aerial methane detection for the oil and gas industry. Since 2019 we have conducted basin-scale surveys to measure methane emissions from upstream and midstream oil and gas infrastructure across 20 U.S. basins, as well as internationally. In total, we have surveyed more than 4.7 million wells and more than 2.3 million miles of gathering and transmission lines. Through these extensive surveys we have compiled a robust emissions dataset from all major producing basins in the United States, and our data has contributed to the growing understanding of regional emissions distribution variation and the significant impact of large, infrequent emission sources on the overall methane emissions budget of the oil and gas industry.[1]

Insight M has developed a particularly robust emissions dataset for oil and gas operations in the State of Texas, where we have been surveying oil and gas infrastructure with our advanced aerial methane detection technology since 2016. Over the past eight years, we have conducted extensive surveys in all five major oil and gas formations in the State, including the Barnett Shale, Eagle Ford Shale, Granite Wash, Haynesville/Bossier Shale, and the Permian Basin.[2] In 2024 alone, we flew our advanced methane emissions detection technology over:

- **73,000 square miles** of oil and gas operations in Texas;
- assets operated by **1,800 unique oil and gas operators** in the State—including major producers, large midstream operators, as well as hundreds of small independent producers; and

[1] *See, e.g.*, Sherwin, E. D., Rutherford, J. S., Zhang, Z., Chen, Y., Wetherley, E. B., Yakovlev, P. V., Berman, E. S. F., Jones, B. B., Cusworth, D. H., Thorpe, A. K., Ayasse, A. K., Duren, R. M., & Brandt, A. R. (2024). US oil and gas system emissions from nearly one million aerial site measurements. *Nature*, 627, 328–334. https://doi.org/10.1038/s41586-024-07117-5

[2] *See* Texas Railroad Commission. *Major oil and gas formations*. https://www.rrc.texas.gov/oil-and-gas/major-oil-and-gas-formations/

- more than **144,000 unique wells, compressors, and gas plants** within the five major oil and gas formations in the State.

Our technology is designed to detect the most impactful emissions in order to support cost-effective methane mitigation. We offer services that can reliably detect source rates down to <10 kg/hr, and we have detected emissions with rates as small as 1.3 kg/hr in Texas. We have found, however, that it is the larger sources that provide the best opportunity for methane mitigation. While generally rare among a small population of assets, large emissions (those with rates greater than 100 kg/hr) are significant in both number and impact when surveying at a basin scale. For example, in 2023 we detected more than **10,000 large emissions events** with rates greater than 100 kg/hr, representing a summed total of over **6 million kg/hr**. Of these, more than **5,300** were detected in the State of Texas, representing a summed total of over **2.2 million kg/hr**. This sum represents an incredible opportunity for the State of Texas to effectively and efficiently reduce its overall methane intensity.

We regularly leverage the robust emissions datasets from our operations along with state of the art research from our partners to help our customers select and implement cost-effective methane mitigation programs designed to meet operator-specific goals. Through our work to help customers choose and deploy optimized methane mitigation programs, we have helped our customers save over $500 million in gas via operator-confirmed mitigation of fugitive emissions. From time to time, we also utilize our analytic tools and our fully anonymized, aggregated emissions datasets to share valuable insights about methane emissions statistics with policymakers to help inform the development of sensible, cost-effective methane regulations.

To support TCEQ's rulemaking, we have run two types of modeling using our data in combination with leading, peer-reviewed research. Based on our experience and the results of these analyses, we provide the following recommendations for TCEQ's development of its rule as it relates to the standards for fugitive emissions components and the monitoring requirements for covers and closed vent systems (CVS):

- Include an alternative standard to OGI in order to support operator flexibility and the most cost-effective compliance options.

- Include a 30 kg/hr program option, as was supported by EPA's own modeling in support of the final EG as well as modeling conducted by other stakeholders such as the Environmental Defense Fund (EDF).

- Determine the equivalency of alternative advanced technology periodic screening programs with the Emission Guideline (EG)'s presumptive standards by conducting modeling that relies on emissions data specific to oil and gas producing regions in the State of Texas.

- Support operator flexibility and unlock more cost-effective compliance options by including a greater variety of survey options—wherever equivalency is supported by Texas-specific modeling—including options at 30–50 kg/hr sensitivities and additional options for 10–30 kg/hr sensitivities that do not require annual OGI screenings.

- Reduce administrative burden in the advanced technology approval process by coordinating with EPA to allow EPA approvals to cross-apply to the use of approved technologies in alternative survey program options allowed under the state plan, even where they differ from those defined in OOOOb (as long as the sensitivity of deployment is no higher than the sensitivities at which the technology has already been approved).

II. DISCUSSION

A. TCEQ Can and Should Use Texas-Specific Data to Determine the Equivalency of Advanced Screening Programs as Compared to the EG's OGI-Based Presumptive Standards.

EPA will review state OOOOc plans according to the standards laid out in 40 C.F.R. 60.27a.[3] As most relevant here, a state must demonstrate "that the State plan submittal is projected to achieve emissions performance under the applicable emission guidelines."[4] State standards of performance "must 'reflect[]' the emission targets that the EPA has determined are achievable," but "the Clean Air Act affords States significant flexibility in designing and enforcing standards that employ other approaches so long as they meet the emission guidelines prescribed by the Agency."[5]

The relevant OOOOc emissions performance standards to TCEQ's current rulemaking are summarized in Table 4 ("Summary of Final BSER and Final Presumptive Standards for GHGs From Designated Facilities (EG OOOOc)") and Table 26 ("Summary of Final EG Subpart OOOOc Presumptive Non-Numerical Standards") of EPA's final rule.[6] Notably, the alternative standards for fugitive emissions are ***not*** included within either table of presumptive standards. Rather, the presumptive standards for fugitive emissions monitoring are all based on EPA's determination of OGI screening as the best system of emission reduction (BSER).[7] These final presumptive performance standards based on the OGI BSER are the standards with which states must demonstrate emissions equivalency.

In the final rule's preamble, EPA helpfully laid out several pathways by which a state may demonstrate equivalency to the EG's presumptive standards. Most notably, EPA highlights that states may "conduct a state-wide emissions comparison, in which the state would apply the designated facility presumptive standard to data reflecting the population of sources in the state (*e.g.,* using activity data (number of sources) and actual emissions data) and calculate the state-wide emission reduction that would be achieved by apply [sic] the presumptive standard, and then demonstrate that the state program requirements for a designated facility would achieve the same or greater emissions reduction."[8]

[3] 40 C.F.R. § 60.5367c.
[4] 40 C.F.R. § 60.27a(g)(3)(iv).
[5] *American Lung Ass'n v. EPA*, 985 F.3d 914 (D.C. Cir. 2021) (quoting and citing 42 U.S.C. § 7411(a)(1)), *rev'd and remanded on other grounds, West Virginia v. EPA*, 597 U.S. 697 (2022).
[6] U.S. Environmental Protection Agency ("EPA"), *Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review*, 89 Fed. Reg. 16820, 16833–34 & 16993–94 (Mar. 8, 2024).
[7] *Id.* at 16833–34; *see also id.* at 16871, https://www.federalregister.gov/d/2024-00366/p-671 (describing final standards under OOOOb for fugitive emissions as requiring AVO and/or OGI monitoring at frequencies defined by asset type, and making no mention of alternative advanced technology periodic screening programs); *id.* at 16873, https://www.federalregister.gov/d/2024-00366/p-717 (confirming that final standards for OOOOc for fugitive emissions are the same as those provided for OOOOb).
[8] *Id.* at 16996.

Recommendation: We recommend that TCEQ follow a pathway similar to the example offered by EPA and utilize emissions data specific to Texas oil and gas regions to determine and support the equivalency of various advanced technology periodic screening programs with the EG's presumptive OGI standards for fugitive emissions monitoring. To support this effort, we include a discussion of the results of our modeling for three of the five major oil and gas producing regions in Texas in Section II.C., below.

B. An Alternative Standard to OGI Monitoring Provides Operators with Essential Options for Cost-Effective Compliance with Fugitive Emissions and CVS Survey Requirements.

In the OOOOc EG, EPA lays out an alternative standard for compliance with the rule's monitoring requirements for fugitive emissions components and covers and closed vent systems.[9] For example, while the BSER for fugitive emissions components at well sites with major production and processing equipment is defined as quarterly OGI monitoring, the EG provides that operators can instead choose to comply with an alternative standard that makes use of advanced periodic screening technologies in lieu of quarterly OGI.

Insight M urges TCEQ to include a similar alternative standard in its OOOOc state plan, because advanced periodic screening alternatives offer a host of advantages over ground-based monitoring. First, as described in detail in Section II.E., below, advanced technology survey program options generally offer a far more cost-effective approach to compliance than quarterly OGI. Moreover, reducing the number of on-the-ground OGI surveys reduces operator safety risks. Third, advanced periodic screening technologies, especially at lower sensitivities, unlock the opportunity to implement more frequent survey timelines (e.g., 6x-12x per year) while remaining cost-effective; frequent surveys allow operators to find and fix emissions in a more timely manner, which can often provide significant economic benefits to operators. Finally, an inclusive alternative standard will give operators more choice and operational flexibility in how they meet compliance requirements year to year. Again, additional flexibility makes it easier for operators to comply with these regulations (lower resource constraints) while generally driving down the cost of compliance.

Recommendation: TCEQ should maximize operator flexibility in compliance by including an alternative standard for fugitive emissions and CVS monitoring requirements that captures all periodic screening programs that would achieve emissions results equivalent to the OGI BSERs.

C. EPA's Emissions Modeling in Support of the Final EG Demonstrated That an Alternative Survey Program at 30 kg/hr Sensitivity with Annual OGI Was Equivalent to Quarterly OGI.

In its December 2022 supplemental notice of proposed rulemaking for the OOOOb and OOOOc rules, EPA proposed to allow operators to conduct advanced technology periodic screening surveys at various program options ranging in sensitivity from 1 to 30 kg/hr.[10] Specifically, EPA's matrix of advanced technology survey options for sites with major production or processing equipment included the option of 30 kg/hr surveys at a frequency of 12 times per year, with one annual OGI screening. This

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[9] 40 C.F.R. § 60.5398c.

[10] EPA, *Standards of performance for new, reconstructed, and modified sources and emissions guidelines for existing sources*, 86 Fed. Reg. 74729, 74742 (Dec. 6, 2022). https://www.federalregister.gov/d/2022-24675/p-485

proposal was supported by EPA's emissions modeling that demonstrated that this 30 kg/hr survey option met or exceeded the quarterly OGI emissions performance standard.[11]

In issuing the final rule, EPA decided to drop the monthly 30 kg/hr program with annual OGI. EPA's reasoning for dropping this program option, however, was not based on a new determination regarding the program's equivalency with the rule's BSER. In fact, the modeling EPA presented in the final rule's Technical Support Document continued to show that a monthly 30 kg/hr program with annual OGI would achieve equivalent emissions reductions as the quarterly OGI BSER.[12] In other words, EPA's own modeling for the final EG supports a 30 kg/hr program option under EPA's equivalency standard. Achieving equivalent emissions reductions to the EG's OGI BSER is the key legal standard for TCEQ's state plan adequacy. Accordingly, TCEQ is not beholden to EPA's decision to drop the 30 kg/hr program from its EG for any reason other than equivalency.

The equivalency of a 30 kg/hr program option was further supported by other stakeholders' modeling submitted to EPA as comments on the proposed EG rule. For example, EDF commented that its own modeling using nationally representative emissions distributions supported EPA's inclusion of a monthly 30 kg/hr program option.[13]

Thus, even without engaging in equivalency modeling using state-specific emissions distributions as we recommend, TCEQ can find ample support in EPA's own rulemaking to reintroduce a 30 kg/hr survey program option to the State's OOOOc plan. As described in further detail in Section II.E., below, doing so will unlock more flexibility for operators and provide a more cost-effective compliance option for many operators in the State of Texas.

D. Texas-Specific Modeling Supports Even More Flexible and Cost-Effective Periodic Screening Options as Equivalent to the OGI BSER.

1. Emissions Modeling Methodology

To quantify the efficacy of various possible advanced technology periodic screening program options in Texas oil and gas producing regions and to test the possible programs' equivalency against

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[11] *Id.*; EPA, (Oct. 2022). *Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review. Supplemental Background Technical Support Document for the Proposed New Source Performance Standards (NSPS) and Emissions Guidelines (EG)* ("Supplemental TSD"), pp. 22–27. https://downloads.regulations.gov/EPA-HQ-OAR-2021-0317-1578/content.pdf. Tables 11, 12, and 13 of the Supplement TSD all show monthly 30 kg/hr surveys in combination with annual OGI as resulting in lower average emissions than OGI BSER surveys.

[12] EPA, (Nov. 2023). *EPA-HQ-OAR-2021-0317-3988: Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review, Background Technical Support Document (TSD) for the Final New Source Performance Standards (NSPS) and Emissions Guidelines (EG)* ("Final TSD"), pp. B-23-B-29. https://www.regulations.gov/document/EPA-HQ-OAR-2021-0317-3988. Notably, Tables 11, 12, and 13 in the Final TSD reflect the same data as presented in the similarly numbered tables in the Supplemental TSD, but generally rounded to the nearest integer. Results for monthly surveys at 30 kg/hr with annual OGI are still all shown to be equivalent to the OGI BSER.

[13] Environmental Defense Fund, et al., (Feb. 13, 2023). Docket No. EPA-HQ-OAR-2021-0317-2433, pp. 49, 54 https://www.regulations.gov/comment/EPA-HQ-OAR-2021-0317-2433

EPA's OGI BSER in terms of emission reductions, we ran analyses using the Leak Detection and Repair Simulator (LDAR-Sim).

a. Background

LDAR-Sim is a peer reviewed, thoroughly vetted numerical modeling tool developed at the University of Calgary that simulates a "virtual world" to estimate emissions mitigation and cost-effectiveness of LDAR programs.[14] LDAR-Sim is a useful tool to answer questions like, "How does a quarterly OGI inspection program compare to emissions reductions under an alternative technology survey program?" Here, we use LDAR-Sim to compare the performance of quarterly OGI surveys to remote sensing programs surveying 6–12 times per year at 10–50 kg/hr detection sensitivities.

LDAR-Sim modeling inputs include stationary sources of emissions, a measurement-based emissions leak rate distribution (described further below), and rules for inspection and repair. Emission sources are simulated stochastically and are detected probabilistically. Sources detected by close-range, ground-based methods are tagged for repair in accordance with estimated reporting delays and repair intervals. Sources detected by aerial surveys or other advanced screening methods produce flags that trigger ground-based follow-up. Methane emissions and emission reductions are then calculated based on the number, duration, and size of leaks generated in the model.

b. Advantages

LDAR-Sim has several advantages over other models, including but not limited to:

- Various LDAR programs are tested against the same field of leaks to allow for accurate comparisons, which is especially critical when assessing the impact of inspection frequency and sensitivity on performance in a field with super-emitters. LDAR-Sim also directly compares emissions under two or more monitoring programs. Critically, testing programs against the same virtual field of methane leaks allows for accurate relative comparisons of emissions results under each program, even where absolute emissions results from LDAR-Sim modeling may vary from other modeling runs or approaches due to varying inputs.

- LDAR-Sim allows for practical considerations that vary by producer, facility, environment, and policy context, such as inspection time, snow cover, or cloud cover.

- The model allows the user to combine multiple inspection programs, such as periodic aerial surveys plus annual ground-based inspections.

c. Distributions Used

Our modeling uses emissions distributions for the Permian Basin and Barnett Shale from Sherwin et al. (2024) (the "Sherwin study"). These distributions combine Insight M emission detections in these

[14] Fox, T.A., Gao, M., Barchyn, T.E., Jamin, Y.L., Hugenholtz, C.H., (2021). An agent-based model for estimating emissions reduction equivalence among leak detection and repair programs. *Journal of Cleaner Production*, 282, 125237. https://doi.org/10.1016/j.jclepro.2020.125237

basins with modeling of small emissions below Insight M's minimum detection threshold. The Sherwin study is based on the most comprehensive aerial surveys of these regions to date, and the resulting distributions cover the full range of possible emissions, from the largest super-emitters to the smallest component-level leaks. For the Haynesville Shale, we follow the methodology laid out in the Sherwin study to build a distribution. First, we incorporate emission detections from our basinwide operations in the Haynesville in 2022. Then, due to an absence of published distributions of small emission sources for the Haynesville, we incorporate data from the Barnett Shale published by Rutherford et al., (2021)[15] as an analog to model emissions below Insight M's minimum detection threshold.

It is imperative to use accurate, measurement-based emissions distributions during modeling exercises, as the modeled efficacy of a given leak detection technology may change depending on the distribution. For example, in a hypothetical region where the vast majority of emissions occur from small sources, a highly sensitive technology such as handheld OGI might be a very effective approach to detection. Alternatively, in a hypothetical region with significant large emissions, sensitivity is less important and potentially a disadvantage, as high sensitivity, ground-based methods are often less scalable and more costly to deploy. In this scenario, rapid and frequent deployment of mid-sensitivity sensors would be a more effective method to quickly find and fix large sources across a region. In reality, regions and basins are a mix of large and small sources, and so characterizing these distributions and the relative contributions of all sources from the smallest is key to determining the best leak detection approach. These regional differences in emissions distributions underscore the importance of utilizing Texas-specific data as opposed to relying on prior modeling that used national average emission distributions.

d. Simulated Programs

We simulate and compare the efficacy of a quarterly OGI leak detection program to remote sensing surveys conducted at sensitivities ranging from 10 kg/hr to 50 kg/hr and at survey frequencies ranging from six to twelve surveys per year, with and without an additional OGI survey.

The purpose of this analysis is to demonstrate the emission reductions that result from these programs, and the potential equivalency between remote sensing programs and EPA's OGI BSER.[16] We assess each program's performance in relative emissions reductions from a baseline, rather than absolute emissions reductions, following recommendations set out in Fox et al. (2021). This is because absolute program performance is reliant on key model factors such as leak production rate, which are highly impactful but poorly constrained. Relative program performance, on the other hand, has been found to be independent of these factors and accurate across a wide range of input values.

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[15] Rutherford, J.S., Sherwin, E.D., Ravikumar, A.P., Heath, G.A., Englander, J., Cooley, D., Lyon, D., Omara, M., Langfitt, Q., Brandt, A.R., (2021). Closing the methane gap in US oil and natural gas production emissions inventories. *Nature Communications*, 12, 4715. https://doi.org/10.1038/s41467-021-25017-4

[16] EPA set a quarterly OGI BSER for compressor stations and well sites with major production and processing equipment and centralized production facilities. While not presented here, we would be happy to further support TCEQ's equivalency determinations by running similar equivalency testing using LDAR-Sim modeling against the BSERs set for wellhead sites without major production equipment.

e. Quarterly OGI Parameterization

Alternative technology programs must achieve equivalency to the EG's presumptive standard of emissions reductions achieved through quarterly OGI surveys. So it is important to appropriately model the emissions reductions that can be achieved in the Permian, Barnett, and Haynesville regions under this quarterly OGI base case.

EPA's BSER and presumptive standard assume that OGI has a 100% probability of detection at 60 g/hr.[17] The referenced 60 g/hr standard, however, was set by EPA in 2015 for the NSPS OOOOa rule and does not reflect the more recent studies like Zimmerle et al. (2020).[18] Zimmerle et al. evaluated the field performance of OGI cameras under realistic operational conditions and found that the most experienced, and therefore most effective, OGI surveyors had a 90% probability of detecting leaks at 134 g/hr, or 7 standard cubic feet per hour (scfh). The study further found that OGI surveyors detected between 40% and 80% of total site emissions, depending on surveyor experience. Moreover, additional recent studies show that OGI surveyors typically miss emissions located high off the ground such as emissions from tanks and flares.[19]

Given the gap between EPA's assumed OGI efficacy in the EG's presumptive standards and actual real-world performance of OGI surveys, we compared remote sensing programs to quarterly OGI using different OGI parameterizations. We present the most realistic and most conservative quarterly OGI model results here.

First, for a more realistic comparison of remote sensing surveys to quarterly OGI, we start with a parameterization based on Zimmerle et al.'s evaluation of the field performance of OGI cameras under realistic conditions. Zimmerle et al. found that the probability of emission detection was an order of magnitude worse under field conditions than in laboratory studies, and varied significantly by the experience level of the surveyor. We conservatively use the average performance of the "experienced" group of surveyors as a standard of comparison, even though actual field performance by other surveyor cohorts is typically significantly worse than this highest performing cadre. Lastly, we account for recent results highlighting that OGI surveys often miss emissions located high off the ground by assuming that a given OGI survey would detect 80% of possible emissions (which still represents a generous assumption based on the studies). We refer to this modeling as the "realistic OGI" case.

Second, as a conservative approach, we utilize the parametrization defined by Ravikumar et al., (2018),[20] which is based on controlled release testing of an OGI camera, without considering OGI operator experience or variable field conditions. Under this parameterization, we do not discount the

[17] *See* 89 Fed. Reg. 16904. https://www.federalregister.gov/d/2024-00366/p-1072
[18] Zimmerle, D., et al., (2020). Detection limits of optical gas imaging for natural gas leak detection in realistic controlled conditions. *Environmental Science & Technology*, 54, 11506–11514. https://pubs.acs.org/doi/10.1021/acs.est.0c01285
[19] Tyner, D.R., Johnson, M.R., (2021). Where the methane is—insights from novel airborne LiDAR measurements combined with ground survey data. *Environmental Science & Technology*, 55, 9773–9783. https://doi.org/10.1021/acs.est.1c01572
[20] Ravikumar, A.P., Wang, J., McGuire, M., Bell, C.S., Zimmerle, D., Brandt, A.R., (2018). "Good versus good enough?" Empirical tests of methane leak detection sensitivity of a commercial infrared camera. *Environmental Science & Technology*, 52, 2368–2374. https://doi.org/10.1021/acs.est.7b04945

ability of OGI surveys to detect emissions based on field performance or emission height. This parameterization aligns with EPA's generous assumption that OGI can detect 100% of emissions greater or equal to 60 g/hr. We refer to this modeling as the "conservative OGI" case or "assuming ideal OGI performance."

Based on our LDAR-Sim modeling according to the methodology described above, multiple alternative technology remote sensing program options achieve the same or better emissions reductions as quarterly OGI—even under the conservative parameterization that assumes optimal OGI performance. These results are described further in the following two sections. Full results are available in Appendix A.

2. ***Compared to realistic OGI performance, six surveys per year at a detection sensitivity of 50 kg/hr outperform quarterly OGI in all tested Texas basins and plays.***

For all three regions (Permian Basin, Barnett Shale, and Haynesville Shale), our analyses confirmed that all program options tested—10 kg/hr to 50 kg/hr at 6, 8, 10, or 12 times per year, with and without annual OGI inspection requirement—outperformed quarterly OGI when tested against realistic OGI performance. We recommend further modeling to examine the potential equivalency of less frequent or less sensitive survey program options.

a. <u>Permian Basin</u>

In the Permian, our modeling shows that—assuming realistic OGI performance—a quarterly OGI monitoring program would achieve an emissions reduction of 60.8% compared to baseline emissions.

All of our tested program options (6–12 surveys per year at 10 kg/hr, 15 kg/hr, 30 kg/hr, or 50 kg/hr sensitivities, with or without annual OGI survey) exceeded the emissions reductions achieved by quarterly OGI. In fact, the least restrictive program option tested—6 surveys per year at 50 kg/hr sensitivity—outperformed quarterly OGI by 2.8% in terms of emissions reductions.

Recommendation: The results of our modeling indicate that TCEQ should, at a minimum, include a program option that allows operators in the Permian to meet OOOOc fugitive emission and CVS monitoring requirements by conducting 6 surveys per year at a sensitivity <= 50 kg/hr. We further recommend that TCEQ conduct additional modeling to determine if even less restrictive advanced technology periodic screening programs would meet the quarterly OGI BSER.

b. <u>Barnett Shale</u>

In the Barnett, our modeling shows that—assuming realistic OGI performance—a quarterly OGI monitoring program would achieve an emissions reduction of 62.2% compared to baseline emissions.

All of our tested program options (6–12 surveys per year at 10 kg/hr, 15 kg/hr, 30 kg/hr, or 50 kg/hr sensitivities, with or without annual OGI survey) exceeded the emissions reductions achieved by quarterly OGI. In fact, the least restrictive program option tested—6 surveys per year at 50 kg/hr sensitivity—outperformed quarterly OGI by 2.6% in terms of emissions reductions.

Recommendation: The results of our modeling indicate that TCEQ should, at a minimum, include a program option that allows operators in the Barnett to meet OOOOc fugitive emission and CVS monitoring requirements by conducting 6 surveys per year at a sensitivity <= 50 kg/hr. We further recommend that TCEQ conduct additional modeling to determine if even less restrictive advanced technology periodic screening programs would meet the quarterly OGI BSER.

c. Haynesville Shale

In the Haynesville, our modeling shows that—assuming realistic OGI performance—a quarterly OGI monitoring program would achieve an emissions reduction of 61.6% compared to baseline emissions.

All of our tested program options (6–12 surveys per year at 10 kg/hr, 15 kg/hr, 30 kg/hr, or 50 kg/hr sensitivities, with or without annual OGI survey) exceeded the emissions reductions achieved by quarterly OGI. In fact, the least restrictive program option tested—6 surveys per year at 50 kg/hr sensitivity—outperformed quarterly OGI by 3.2% in terms of emissions reductions.

Recommendation: The results of our modeling indicate that TCEQ should, at a minimum, include a program option that allows operators in the Haynesville to meet OOOOc fugitive emission and CVS monitoring requirements by conducting 6 surveys per year at a sensitivity <= 50 kg/hr. We further recommend that TCEQ conduct additional modeling to determine if even less restrictive advanced technology periodic screening programs would meet the quarterly OGI BSER.

3. ***Compared against the conservative OGI case that assumes ideal OGI performance, several remote sensing program options with sensitivities ranging from 10 kg/hr to 50 kg/hr would achieve equivalent emissions reductions as quarterly OGI in all tested Texas basins and plays.***

Even when assuming OGI to be 100% effective, modeling based on data specific to Texas oil and gas regions demonstrates that lower sensitivity/frequency pairs achieve equivalent performance in Texas than those outlined in the EG's matrix.

Recommendation: If TCEQ feels compelled to determine the equivalency of advanced technology alternatives as compared to idealized OGI performance assumptions that reflect those utilized by EPA in its modeling in support of the EG, we recommend that TCEQ include the following program options for advanced periodic screening programs:

- Permian:
  - 6 surveys per year with a sensitivity <=10 kg/hr, with 1 annual OGI survey
  - 8 surveys per year with a sensitivity <=10 kg/hr
  - 8 surveys per year with a sensitivity <= 30 kg/hr, with 1 annual OGI survey
  - 10 surveys per year with a sensitivity <=15 kg/hr
  - 10 surveys per year with a sensitivity <= 50 kg/hr, with 1 annual OGI survey
- Barnett:
  - 8 surveys per year with a sensitivity <= 50 kg/hr, with 1 annual OGI survey
  - 10 surveys per year with a sensitivity <=10 kg/hr
  - 12 surveys per year with a sensitivity <=15 kg/hr
- Haynesville:
  - 6 surveys per year with a sensitivity <=10 kg/hr, with 1 annual OGI survey

- 8 surveys per year with a sensitivity <=15 kg/hr
- 8 surveys per year with a sensitivity <= 30 kg/hr, with 1 annual OGI survey
- 10 surveys per year with a sensitivity <= 50 kg/hr, with 1 annual OGI survey
- 12 surveys per year with a sensitivity <=30 kg/hr

We did not test any frequencies below 6 times per year. Based on the above results, we recommend further analysis to see if 10 kg/hr surveys with annual OGI might achieve equivalency with the conservative OGI case at a lower frequency.

The equivalency of these program options with the quarterly OGI BSER (conservative case) is presented in more detail below by region. For each of tables presented in the following sections, the cell highlighted in blue represents the target equivalency—the percent of total emissions reduced through a quarterly OGI program assuming ideal OGI performance. The cells highlighted in green or purple represent survey program results that meet or exceed the emissions reductions achieved through the quarterly OGI program. Cells bolded and highlighted in green indicate the least restrictive sensitivities for a given survey frequency/OGI coupling. To reduce complexity in the presentation of these results tables, we omitted program options that either (a) did not meet quarterly OGI equivalency, or (b) represented higher frequency program options at sensitivities that already met OGI equivalency at a lower frequency.

a. Permian Basin

In the Permian, our modeling shows that—assuming ideal OGI performance—a quarterly OGI monitoring program would achieve an emissions reduction of 71.3% compared to baseline emissions under a no-monitoring scenario.

Of the advanced remote sensing technology program options that we evaluated under the same modeling, program options at 10 kg/hr and 15 kg/hr sensitivities, with and without annual OGI, would achieve the same or greater emissions reductions as quarterly OGI. The modeling results also demonstrate that program options at 30 kg/hr and 50 kg/hr sensitivities, combined with an annual OGI survey, would achieve the same or greater emissions reductions as quarterly OGI. The least restrictive (and generally most cost-effective) program options for the Permian are highlighted in green in Table 1, below.

Sitewide Monitoring Program			**Percent Emissions Reduction Achieved through Program**
Advanced Tech Detection Limit (kg/hr)	**Advanced Tech Surveys/Year (Days between surveys)**	**OGI Surveys/Year**	
n/a	n/a	4	71.3
10	**8 (45)**	**0**	**72.8**
10	**6 (61)**	**1**	**71.7**
15	**10 (36)**	**0**	**71.3**
15	8 (45)	1	73.4
30	**8 (45)**	**1**	**71.3**
50	**10 (36)**	**1**	**71.4**

Table 1. Permian advanced technology emissions monitoring program options compared to quarterly OGI BSER assuming ideal OGI performance.

b. Barnett Shale

In the Barnett, our modeling shows that—assuming ideal OGI performance—a quarterly OGI monitoring program would achieve an emissions reduction of 72.7% compared to baseline emissions under a no-monitoring scenario.

Of the advanced remote sensing technology program options that we evaluated under the same modeling, program options at 10 kg/hr and 15 kg/hr sensitivities, with and without annual OGI, would achieve the same or greater emissions reductions as quarterly OGI. The modeling results also demonstrate that program options at 30 kg/hr and 50 kg/hr sensitivities, combined with an annual OGI survey, would achieve the same or greater emissions reductions as quarterly OGI. The least restrictive (and generally most cost-effective) program options for the Barnett are highlighted in green in Table 2, below.

Sitewide Monitoring Program			
Advanced Tech Detection Limit (kg/hr)	**Advanced Tech Surveys/Year (Days between surveys)**	**OGI Surveys/Year**	**Percent Emissions Reduction Achieved through Program**
n/a	n/a	4	72.7
10	**10 (36)**	**0**	**73.8**
10	8 (45)	1	75.1
15	**12 (30)**	**0**	**72.7**
15	8 (45)	1	74.6
30	8 (45)	1	73.3
50	**8 (45)**	**1**	**72.7**

Table 2. Barnett advanced technology emissions monitoring program options compared to quarterly OGI BSER assuming ideal OGI performance.

c. Haynesville Shale

In the Haynesville, our modeling shows that—assuming ideal OGI performance—a quarterly OGI monitoring program would achieve an emissions reduction of 71.4% compared to baseline emissions under a no-monitoring scenario.

Of the advanced remote sensing technology program options that we evaluated under the same modeling, program options at 10 kg/hr, 15 kg/hr, and 30 kg/hr sensitivities, with and without annual OGI, would achieve the same or greater emissions reductions as quarterly OGI. The modeling results also demonstrate that a program option at a 50 kg/hr sensitivity, combined with an annual OGI survey, would achieve greater emissions reductions than quarterly OGI. The least restrictive (and generally most cost-effective) program options for the Haynesville are highlighted in green in Table 3, below.

Sitewide Monitoring Program			Percent Emissions Reduction Achieved through Program
Advanced Tech Detection Limit (kg/hr)	**Advanced Tech Surveys/Year (Days between surveys)**	**OGI Surveys/Year**	
n/a	n/a	4	71.4
10	8 (45)	0	73.1
10	**6 (61)**	**1**	**72.3**
15	**8 (45)**	**0**	**71.4**
15	8 (45)	1	74.4
30	**12 (30)**	**0**	**72.2**
30	**8 (45)**	**1**	**72.6**
50	**10 (36)**	**1**	**71.6**

Table 3. Haynesville advanced technology emissions monitoring program options compared to quarterly OGI BSER assuming ideal OGI performance.

E. Providing a Broader Set of Equivalent Alternative Survey Program Options Will Allow Operators to Meet Regulatory Requirements in the Most Cost-Effective Manner.

In its OOOOc state plan rulemaking, TCEQ has the opportunity to craft a regulation that supports cost-effective methane mitigation, which is key to promoting global competitiveness of Texas energy production and keeping costs down for consumers. Importantly, fugitive emission and CVS monitoring programs that utilize advanced leak detection technologies—especially lower-sensitivity aerial technologies—offer significant cost savings compared to quarterly OGI monitoring, particularly for operators with more than a handful of assets. Accordingly, the cost-benefit analysis here is extremely straightforward: as described above, various remote sensing program options achieve the same or greater emissions reductions as quarterly OGI and, as further detailed below, all offer significant economic benefits relative to costly quarterly OGI monitoring programs.

1. Summary of Methods

To demonstrate how different survey program options compare in terms of economics, we utilize a predictive modeling tool that Insight M developed to help oil and gas companies identify the evidence-based methane strategy in each basin or formation best suited to their business goals. The modeling tool leverages robust region and operator-specific methane emissions data as well as other toggleable operator inputs to predict the economic outcomes of different survey program options for a specific operator.

Our tool models methane emissions by combining a given leak distribution, a number of observed emissions above a given sensitivity, and a set of LDAR strategies. It then estimates the efficacy of those strategies, and iterates 10 million times to measure their average performance under cases with different emissions outcomes. Emissions distributions used in this model are identical to those used in the LDAR-Sim analyses described in Section II.D.1., above.

The tool also allows a user to set a number of parameters to evaluate the cost effectiveness of a given LDAR program. Togglable parameters include OGI survey cost ($/site), price of gas sold ($/MCF), average repair timeframe (days from emission detection), average repair cost ($/repair), and actionability rates for emissions of different sizes. For the analyses here, we used industry average estimates for each of these parameters, and we would be happy to accommodate specific inputs from TCEQ in subsequent runs.

For each tested program option, the tool outputs:

- Emissions counts, including the number expected to be detected and number that can be mitigated;
- Total costs, including total advanced technology survey costs and annual OGI cost (if applicable), total OGI followup costs, and total repair costs;
- Recaptured revenue from mitigated emissions; and
- A summary of the results, combining the revenue and costs results into a measure of total profit or loss.

2. Sample Selection

For purposes of this submission, we ran analyses for a small sample of medium and large operators in the Permian, Haynesville, and Barnett regions. We selected operators based on the following criteria:

- Previous Insight M survey coverage well above 60% of the operator's assets, to ensure that detected emissions were adequately representative of the operator's overall emissions profile in that basin or play.
- A count of detected emissions that was roughly in line with the average number of emissions per asset in the region for operators of a similar size.
- Operator size
  - Large operator by production: generally within the 85th-99th percentile, by BOE production, of operators with at least 50 BOE/day production. In addition to production, we selected operators with a total asset count around the median (50–60th percentile) of large operators in the region (~600–1100 assets) as asset count is a key input to survey costs.
  - Medium operator by production: generally within the 60–75th percentile, by BOE production, of operators with at least 50 BOE/day production. In addition to production, we selected operators with a total asset count around the median to third quartile of medium operators in the region (~80–400 assets) as asset count is a key input to survey costs.

Using these criteria, we selected six operators to run as example analyses. To meet the above criteria, we selected a second medium operator from the Permian in lieu of a medium operator from the Barnett. Key characteristics of the six selected operators are highlighted in Table 4 below.

Operator ID	Region	Relative Asset Count (quartile)	Asset Coverage Completeness	No. Emissions Detected
P-Large	Permian	~median	90%	14
H-Large	Haynesville	~median	94%	8
B-Large	Barnett	~median	68%	14
P-Medium-A	Permian	~3rd quartile	94%	6
P-Medium-B	Permian	~median	78%	4
H-Medium	Haynesville	~median	87%	4

Table 4. Summary of operator sample used in economic modeling analyses.

3. *Results*

The summary results from our predictive modeling for the six sampled operators, presented in full in Appendix B, highlight several important takeaways relevant to TCEQ's rulemaking. For purposes of this section, and unless otherwise stated, we will examine the economic modeling results for the survey program options that would meet EPA's equivalency standard when compared against the conservative OGI case (*i.e.*, assuming perfect OGI detection capabilities, as described in Section II.D.3, above).

1) **Quarterly OGI comes with significant costs that are typically not recouped through revenue from mitigated emissions, but advanced technology survey program options are generally profitable for operators.**

   The first key result evident in the six sample analyses is that the costs of complying with quarterly OGI survey requirements typically exceed the economic return that operators can obtain from finding and fixing emissions via that type of survey program.

   In all but one case (P-Medium-B), quarterly OGI amounted to a net loss for the sampled operators. For the large Haynesville operator sampled, the loss from complying with OOOOc using quarterly OGI would exceed $1.7 million per year.

   By contrast, programs utilizing advanced remote sensing technologies offer a range of profitable options for each of the six sampled operators. Even in the one tested case where quarterly OGI could be expected to yield some profit for the operator, the most profitable advanced technology survey program was 3.3 times more profitable.

   Indeed, all advanced survey programs tested were profitable for five of the six sampled operators. For the one exception (H-Large), a number of advanced technology survey program options would still be profitable for the operator. Additionally, even for advanced technology survey program options that would incur a loss, those losses were 1 to 3 orders of magnitude smaller than the expected loss from running a quarterly OGI program.

   These results underscore the importance of the recommendation presented in Section II.B., above, to ensure that operators can meet regulatory survey requirements via alternative programs that make use of advanced methane detection technologies as these options unlock the potential to meet regulatory requirements at a profit.

2) **Operators should have the flexibility to select from a range of compliance options and the opportunity to choose the option that best meets operator-specific goals beyond compliance.**

Another key result highlighted by the sampled operator analyses is there are usually a wide range of advanced technology survey program options that are profitable for operators. In some cases the difference between profitability for program options at different sensitivities is not very substantial. B-Large and P-Medium-B provide good examples of this phenomenon. For B-Large, the most profitable survey option returned is 10 kg/hr at 10 times per year, but BSER-equivalent options at 10, 15, and 30 kg/hr offer almost the same profitability. Likewise for P-Medium-B, the most profitable survey option overall is 30 kg/hr at 8 times per year, with an annual OGI screening, but, again, options at 10–50 kg/hr sensitivities offer a similar degree of profitability. These results are summarized in Figure 1 below.

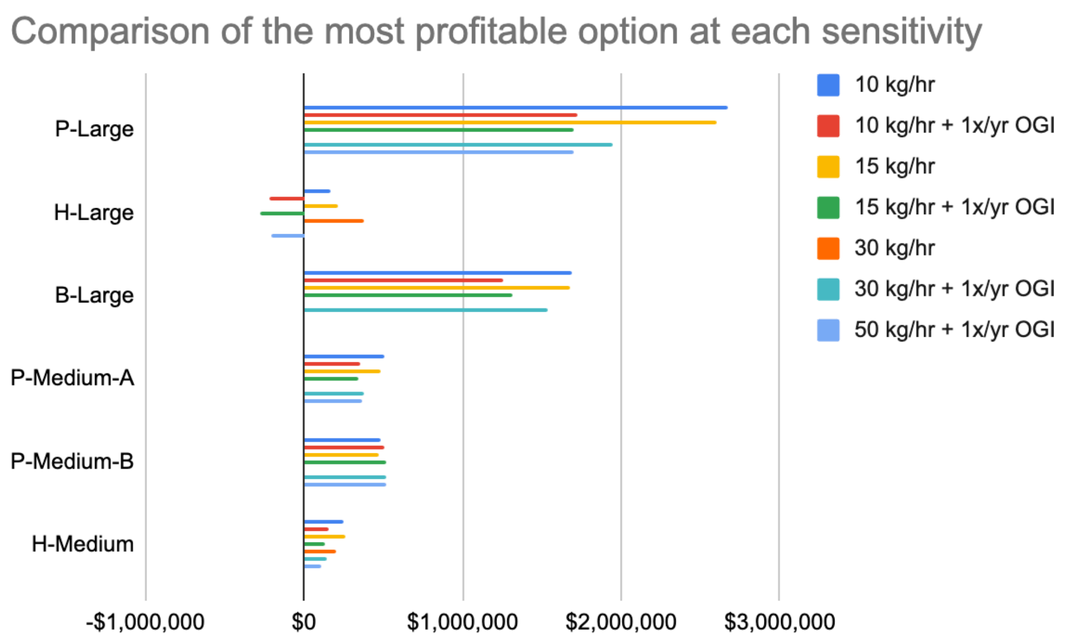

Figure 1. This chart depicts the profit or loss from different survey program options for each of the six sampled operators. For each sensitivity option (e.g., 10 kg/hr and 10 kg/hr with annual OGI), the chart depicts expected profit or loss from deploying the most profitable survey program option (at whatever frequency that may be). Program options were constrained to those that meet the equivalency standard of quarterly OGI assuming ideal OGI performance. As shown, most program options offer some amount of profit. In many cases, several program options offer profits in the range of the most profitable option, and in some cases such as Permian-B, all sensitivities offer a similar level of profitability.

The fact that many options are profitable is important because the most profitable option may not be the optimal one, once all operator-specific goals are considered. Notably, these final economic results capture both survey costs and expected survey revenue in one value. While not shown here, the cost component alone can be an important motivating factor for operators. In general, the costs for 50 kg/hr aerial surveys will be appreciably lower than 10 kg/hr surveys, holding all else equal, with costs declining on a gradient from 10 to 50 kg/hr. These differences are generally attributable to greater operational efficiencies from being able to conduct surveys at higher altitudes as sensitivity decreases. Accordingly, even if a 30 kg/hr survey program option offers a given operator slightly lower profitability compared to a more sensitive survey option, that operator might still select the 30 kg/hr survey program option if minimizing upfront costs is a goal they are trying to meet. Meanwhile, a different operator might select another less profitable option for other reasons. To support this type of operator flexibility, TCEQ should include as wide of a range of supported advanced technology survey options as possible.

Providing an expansive range of compliance options is also important to ensure that operators like H-Large are able to utilize a profitable, or at least a loss-minimizing, option. In the case of H-Large, 30 kg/hr surveys without annual OGI would offer the largest profits—substantially higher than other sensitivity options. In the Haynesville, our conservative LDAR-Sim modeling supported a 30 kg/hr survey option, without annual OGI, as equivalent to quarterly OGI (30 kg/hr, 12 times per year). This 30 kg/hr program option would offer H-Large a reasonably profitable compliance option, while most other options would entail a loss. H-Large's results underscore how important it is to include a wide range of equivalent survey program options for Texas operators to choose from.

Finally, including a broad set of compliant alternative survey program options will generally help operators keep costs down by enabling more competition in the market for survey providers with compliant offerings.

3) **The addition of an annual OGI survey requirement generally significantly increases the cost of compliance compared to programs at the same sensitivity but without OGI.**

We typically see program options without annual OGI inspections outperforming program options at the same sensitivity with annual OGI inspections in terms of profitability. For five of the six sampled operators, program options without annual OGI were always more profitable (or would result in less loss) than the option at the same sensitivity and frequency but with an annual OGI screening. Annual OGI inspections add to overall survey costs, but those costs are generally not offset by recaptured revenue from emissions detected and mitigated via the additional OGI survey. Accordingly, expanding Texas's OOOOc advanced technology fugitives monitoring matrix to include the widest range of BSER-equivalent options *without* annual OGI inspections is imperative to providing most operators with the most cost-effective compliance options.

That said, in some cases, as demonstrated by the results for P-Medium-B, incorporating annual OGI inspections can be more profitable than running a survey program at the same sensitivity and frequency without annual OGI. We tend to see this type of result for operators with lower total asset counts and higher average emission counts per asset. Because survey options with annual OGI can sometimes offer highly cost-effective compliance for some operators, we recommend that the State include all equivalent options outlined in Section II.D., above, rather than selecting just a handful of options.

4) **Lower sensitivity options (ranging from 10 kg/hr to 50 kg/hr, depending on the operator) generally offer a more profitable pathway to OOOOc compliance than high sensitivity advanced technology program options.**

   For purposes of this submission, we did not test whether advanced technology surveys at sensitivities below 10 kg/hr are equivalent with EPA's BSER for Texas basins at any frequency (see Section II.D.). EPA's EG, however, sets out 2 kg/hr surveys six times per year and 5 kg/hr surveys 12 times per year as equivalent to quarterly OGI based on EPA's modeling.[21] Ratcheting up sensitivity requirements tends to push operators toward lower program profitability or overall losses as (a) higher sensitivity surveys tend to find an increasing rate of operational emissions as opposed to mitigable fugitives and (b) the additional small fugitive emissions found typically will not yield significant savings in terms of recaptured revenue.

We recognize that the discussion here is limited to a very small sample of operators, particularly once broken down by region. We would be happy to explore expanding this analysis to more anonymized operators or potentially to a basin level to support TCEQ further during this rulemaking. Although we would lose the operator-to-operator variation by running a similar analysis at a basin level, we hope that this small sampling adequately highlighted and supported the points around the need to provide a wide range of options to provide differently situated operators with an array of cost-effective compliance options.

F. TCEQ Can Reduce Administrative Burdens by Allowing the Use of Advanced Technologies That Have Been Approved by EPA as Alternative Test Methods under OOOOb.

Insight M's advanced methane detection technology has been approved by EPA as a broadly applicable alternative test method that may be used by oil and gas operators to meet fugitive emissions and CVS monitoring requirements for facilities subject to 40 C.F.R. part 60, Subparts OOOOa and OOOOb.[22] Our test method is currently approved for use in periodic screening programs at 10 and 15 kg/hr sensitivities.[23] The technology approval is based on a thorough evaluation of the performance of Insight M's technology and its ability to reliably detect emissions at 10 and 15 kg/hr sensitivity thresholds, with a facility-level resolution.

Recommendation: We recommend that TCEQ reduce administrative burden by allowing for EPA technology approvals to be applied more broadly under certain circumstances. First, we recommend that TCEQ work with EPA to ensure that technology approvals may also be utilized for any lower sensitivity program options (e.g., 30 kg/hr or 50 kg/hr) that may be incorporated into the state plan. We further recommend that EPA's current approval automatically extend to any 10 and 15 kg/hr survey program options under Texas's state plan—including those without annual OGI or at frequencies lower than set out in the OOOOb rule. While our technology may currently be used according to the requirements set out in 40 C.F.R. 5398b, the approved alternative test method itself is not contingent on the use of Insight M's technology at any specific frequency or in combination annual OGI screenings.

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[21] 89 Fed. Reg. 17218, Table 2.
[22] *See* https://www.epa.gov/system/files/documents/2025-01/final_approval_methane-atm_insight-m_signed.pdf.
[23] *Id.*

III. CONCLUSION

To summarize, we encourage TCEQ to consider five key recommendations as it develops alternative survey program options equivalent to the presumptive OGI survey standards for fugitive emissions components and the monitoring of covers and closed vent systems:

1. Maintain a matrix of alternative compliance options for fugitive emissions surveys and CVS monitoring. Periodic screening using advanced technologies is a proven and cost-effective approach that provides important flexibility for operators.

2. Include a 30 kg/hr program option, as was supported by EPA's own modeling in support of the final EG as well as modeling conducted by other stakeholders including EDF.

3. Determine the equivalency of alternative advanced technology periodic screening program options with the Emission Guideline (EG)'s presumptive standards by conducting modeling that relies on emissions data specific to oil and gas producing regions in the State of Texas.

4. Maximize operator flexibility and unlock more cost-effective compliance options by including a greater variety of advanced technology survey options—wherever equivalency with the EG's BSER is supported by Texas-specific modeling—including 30–50 kg/hr sensitivities and additional 10–30 kg/hr options that do not require annual OGI screenings.

5. Minimize administrative burden in the advanced technology approval process by coordinating with EPA to allow EPA approvals to cross-apply to deployments of the approved technology in alternative survey program options allowed under the state plan, even where they differ from those under OOOOb (as long as the sensitivity of deployment is no higher than the sensitivities at which the technology has already been approved).

Thank you for the opportunity to provide these comments. We hope that our data-informed inputs here are useful to TCEQ as it develops its OOOOc state plan. We would further like to extend an offer to provide any additional support that TCEQ may find useful, including sharing aggregate data or conducting further modeling runs for emissions equivalencies or economic comparisons. For instance, we would be happy to re-run emissions or economic model scenarios applying different assumptions that TCEQ may identify as necessary or useful to support its rulemaking. Please do not hesitate to reach out with any questions or further requests relating to these comments.

Sincerely,

V Prentice
Senior Director, Legal & Regulatory Counsel
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Appendix A - Texas Emissions Modeling Results by Region

PERMIAN

Survey Frequency	Aerial 10 kg/hr	Aerial 10 kg/hr + 1x/yr OGI	Aerial 15 kg/hr	Aerial 15 kg/hr + 1x/yr OGI	Aerial 30 kg/hr	Aerial 30 kg/hr + 1x/yr OGI	Aerial 50 kg/hr	Aerial 50 kg/hr + 1x/yr OGI	OGI 4x/yr RK	OGI 4x/yr Zim 80%
4									71.3	60.8
6	69	71.7	66.4	70.3	63.3	68.5	62.5	67.9		
8	72.8	75	69.9	73.4	66.5	71.3	65.8	70.8		
10	74	76.4	71.3	74.7	67.8	72	67	71.4		
12	75.1	77.3	72.5	75.3	68.9	72.9	68	72.4		

Table A1. Percent emissions reductions achieved with different survey program options (defined by the combination of survey modalities, sensitivity, and frequency) in Insight M's LDAR-Sim modeling for the Permian region.

HAYNESVILLE

Survey Frequency	Aerial 10 kg/hr	Aerial 10 kg/hr + 1x/yr OGI	Aerial 15 kg/hr	Aerial 15 kg/hr + 1x/yr OGI	Aerial 30 kg/hr	Aerial 30 kg/hr + 1x/yr OGI	Aerial 50 kg/hr	Aerial 50 kg/hr + 1x/yr OGI	OGI 4x/yr RK	OGI 4x/yr Zim 80%
4									71.4	61.6
6	69.8	72.3	68.1	71.1	65.8	69.1	63.6	67.5		
8	73.1	75.7	71.4	74.4	69	72.6	66.7	70.7		
10	74.9	76.7	73.2	75.4	70.4	73.3	68.2	71.6		
12	76.6	78.1	74.7	76.9	72.2	74.7	69.7	72.8		

Table A2. Percent emissions reductions achieved with different survey program options (defined by the combination of survey modalities, sensitivity, and frequency) in Insight M's LDAR-Sim modeling for the Haynesville region.

BARNETT

Survey Frequency	Aerial 10 kg/hr	Aerial 10 kg/hr + 1x/yr OGI	Aerial 15 kg/hr	Aerial 15 kg/hr + 1x/yr OGI	Aerial 30 kg/hr	Aerial 30 kg/hr + 1x/yr OGI	Aerial 50 kg/hr	Aerial 50 kg/hr + 1x/yr OGI	OGI 4x/yr RK	OGI 4x/yr Zim 80%
4									72.7	62.2
6	67.8	72.3	66.7	71.1	65	70.3	63.8	69.4		
8	72.1	75.1	70.5	74.6	68.3	73.3	67.3	72.7		
10	73.8	76.2	72.1	75.3	70.1	74.2	68.8	73.4		
12	74.2	77.3	72.7	76.4	71.2	75.2	69.7	74.2		

Table A3. Percent emissions reductions achieved with different survey program options (defined by the combination of survey modalities, sensitivity, and frequency) in Insight M's LDAR-Sim modeling for the Barnett region.

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SUMMARY OF EMISSIONS PERFORMANCE RELATIVE TO OGI

Frequency	Sensitivity	Permian	Permian (with annual OGI)	Haynesville	Haynesville (with annual OGI)	Barnett	Barnett (with annual OGI)
6	10	-2.3	0.4	-1.6	0.9	-4.9	-0.4
6	15	-4.9	-1	-3.3	-0.3	-6	-1.6
6	30	-8	-2.8	-5.6	-2.3	-7.7	-2.4
6	50	-8.8	-3.4	-7.8	-3.9	-8.9	-3.3
8	10	1.5	3.7	1.7	4.3	-0.6	2.4
8	15	-1.4	2.1	0	3	-2.2	1.9
8	30	-4.8	0	-2.4	1.2	-4.4	0.6
8	50	-5.5	-0.5	-4.7	-0.7	-5.4	0
10	10	2.7	5.1	3.5	5.3	1.1	3.5
10	15	0	3.4	1.8	4	-0.6	2.6
10	30	-3.5	0.7	-1	1.9	-2.6	1.5
10	50	-4.3	0.1	-3.2	0.2	-3.9	0.7
12	10	3.8	6	5.2	6.7	1.5	4.6
12	15	1.2	4	3.3	5.5	0	3.7
12	30	-2.4	1.6	0.8	3.3	-1.5	2.5
12	50	-3.3	1.1	-1.7	1.4	-3	1.5
4	OGI	0	0	0	0	0	0

Table A4. Summary of the emissions performance of all survey program options relative to the quarterly OGI BSER under the conservative case (assuming ideal OGI performance). Cells highlighted in white or any shade of green indicate a survey option that meets or exceeds quarterly OGI equivalency under the conservative case.

Appendix B - Texas Economic Modeling Results by Sampled Operator

The following six tables summarize the economic modeling results for six sampled operators in the Permian, Haynesville, and Barnett regions. Each cell represents a survey program option.

All advanced technology program options shown in the tables below, including the grayed out cells, represent potential survey program options that would meet quarterly OGI equivalency under our emissions monitoring, assuming realistic OGI performance.

Greyed out cells represent survey program options that were not found to be equivalent in terms of emissions reductions to quarterly OGI surveys assuming ideal OGI performance (conservative case). All other white or colored cells represent potential survey program options would meet the equivalency standard under our conservative OGI modeling. These cells are colored in various shades of green or red to indicate the relative profit or loss as compared to other viable options under the conservative case.

The most profitable programs that would be equivalent to quarterly OGI assuming ideal OGI performance are bolded. The most profitable programs, overall, are bolded and italicized.

P-Large

Frequency	10 kg/hr	10 kg/hr + 1x/yr OGI	15 kg/hr	15 kg/hr + 1x/yr OGI	30 kg/hr	30 kg/hr + 1x/yr OGI	50 kg/hr	50 kg/hr + 1x/yr OGI	OGI
4									-$156,432
6	$2,763,284	$1,727,763	$2,757,366	$1,778,590	$2,905,904	$1,959,838	$2,758,890	$1,830,298	-$1,517,487
8	**$2,676,914**	$1,625,124	$2,694,393	$1,700,124	***$2,908,751***	$1,947,363	$2,720,788	$1,777,776	-$2,942,504
10	$2,564,267	$1,505,555	$2,603,096	$1,601,699	$2,882,338	$1,914,053	$2,654,461	$1,704,348	-$4,404,115
12	$2,432,480	$1,369,765	$2,497,637	$1,492,030	$2,840,545	$1,868,881	$2,572,898	$1,618,847	-$5,884,022

H-Large

Frequency	10 kg/hr	10 kg/hr + 1x/yr OGI	15 kg/hr	15 kg/hr + 1x/yr OGI	30 kg/hr	30 kg/hr + 1x/yr OGI	50 kg/hr	50 kg/hr + 1x/yr OGI	OGI
4									-$1,733,206
6	$289,174	-$218,977	$323,583	-$168,841	***$511,514***	$36,919	$388,300	-$64,254	-$2,866,503
8	$162,880	-$346,499	$214,234	-$278,742	$473,454	-$1,006	$320,755	-$131,742	-$4,014,286
10	$31,187	-$477,976	$98,179	-$393,889	$429,758	-$44,552	$247,178	-$204,731	-$5,170,355
12	-$105,455	-$614,522	-$20,478	-$512,098	**$382,119**	-$91,448	$170,584	-$281,032	-$6,330,568

B-Large

Frequency	10 kg/hr	10 kg/hr + 1x/yr OGI	15 kg/hr	15 kg/hr + 1x/yr OGI	30 kg/hr	30 kg/hr + 1x/yr OGI	50 kg/hr	50 kg/hr + 1x/yr OGI	OGI
4									-$972,976
6	$1,851,884	$1,336,440	$1,899,822	$1,384,450	$2,027,143	$1,547,123	$1,842,767	$1,427,612	-$2,449,090
8	$1,778,493	$1,254,037	$1,842,411	$1,318,615	***$2,027,297***	$1,538,710	$1,811,428	$1,388,762	-$3,962,189
10	**$1,687,791**	$1,158,930	$1,765,438	$1,238,216	$2,006,879	$1,514,817	$1,760,491	$1,334,789	-$5,496,449
12	$1,582,808	$1,052,328	$1,678,685	$1,149,479	$1,975,426	$1,481,851	$1,699,004	$1,271,915	-$7,041,289

P-Medium-A

Frequency	10 kg/hr	10 kg/hr + 1x/yr OGI	15 kg/hr	15 kg/hr + 1x/yr OGI	30 kg/hr	30 kg/hr + 1x/yr OGI	50 kg/hr	50 kg/hr + 1x/yr OGI	OGI
4									-$719,843
6	$538,881	$353,046	$536,450	$365,526	***$562,169***	$392,161	$549,964	$392,618	-$1,304,989
8	**$511,953**	$327,270	$515,585	$346,461	$552,199	$383,644	$540,731	$385,364	-$1,904,888
10	$480,139	$296,739	$489,364	$321,713	$536,207	$369,130	$525,628	$372,102	-$2,513,228
12	$442,881	$261,444	$460,091	$293,748	$517,204	$351,110	$507,590	$355,315	-$3,125,788

P-Medium-B

Frequency	10 kg/hr	10 kg/hr + 1x/yr OGI	15 kg/hr	15 kg/hr + 1x/yr OGI	30 kg/hr	30 kg/hr + 1x/yr OGI	50 kg/hr	50 kg/hr + 1x/yr OGI	OGI
4									$157,442
6	$493,630	$508,811	$484,530	$515,575	$488,844	$521,847	$478,007	$519,889	$50,628
8	$486,857	$502,548	$480,955	$513,627	$488,878	***$522,976***	$479,273	$521,932	-$68,402
10	$476,313	$492,554	$473,097	$507,083	$483,952	$519,247	$474,951	$519,115	-$194,419
12	$462,382	$478,591	$463,473	$497,936	$476,546	$512,673	$468,211	$513,449	-$323,931

H-Medium

Frequency	10 kg/hr	10 kg/hr + 1x/yr OGI	15 kg/hr	15 kg/hr + 1x/yr OGI	30 kg/hr	30 kg/hr + 1x/yr OGI	50 kg/hr	50 kg/hr + 1x/yr OGI	OGI
4									-$401,180
6	$288,048	$153,103	$292,164	$167,843	***$294,905***	$172,484	$287,590	$170,729	-$746,741
8	$250,129	$115,694	**$260,471**	$136,862	$266,133	$143,710	$258,759	$143,010	-$1,101,946
10	$209,573	$75,410	$225,581	$102,382	$232,723	$111,226	$226,891	$111,583	-$1,462,670
12	$165,448	$32,108	$187,967	$65,914	$197,370	$76,558	$192,381	$77,985	-$1,826,152