



California Air Resources Board  
1001 I Street  
Sacramento, CA 95812

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## **Kairos Aerospace Comment on Proposed Short-Lived Climate Pollutants Strategy**

Kairos Aerospace commends the Air Resources Board on its continued leadership on air quality and climate issues, as well as on its emphasis on science-based approaches to solving these problems. We appreciate the opportunity to comment on the methane component of the proposed Short-Lived Climate Pollutants Strategy.

The emerging framework for reducing methane emissions from the oil and gas industry in California covers a wider range of facilities than any other state or federal regulations we're aware of, and involves a broad set of regulatory agencies and researchers. We also admire ARB's commitment to investing in research projects to measure methane statewide, as better data is critical to forming more effective policies. However, we think ARB misses an opportunity to shape the discussion on two important issues regarding fugitive methane emissions:

- 1) The volume of methane released into the atmosphere is the relevant metric for emissions reduction, more so than the number of emission sources. However, regulatory frameworks at both local and federal levels currently focus on the latter. California should lead the way in updating those frameworks to achieve more practical, environmentally effective, and cost-efficient regulations.
- 2) New technologies are regularly entering the market, with unique new capabilities and limitations. ARB should lay out a path for these technologies to gain regulatory acceptance, as well as provide flexibility for operators to choose the technology, or combination of technologies, that works for their circumstances (assuming the environmental and health results are comparable.) ARB should take the lead on setting performance standards against which to evaluate new technologies, which for fugitive methane emissions should be reduction in total volume of emissions.

### **Focus on Emission Volumes**

We at Kairos Aerospace believe that, given real world constraints, the best way to tackle fugitive methane emissions is to minimize the total volume of methane emitted, rather than the total number of emissions, as quickly as possible. That is, finding and stopping large leaks more frequently moves the needle more than finding and stopping every leak occasionally.

A study by the British Columbia Oil and Gas Commission measured leak rates from capped wells, and provides a helpful way to visualize the problem. Analysis of this data (Figure 1) shows that 80% of the emissions volume is coming from 6% of the leaks found, and that finding and stopping the one biggest leak is equivalent to finding and stopping 328 of the smallest leaks.<sup>1</sup>

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<sup>1</sup> Checkai, D. "Estimating Permeability Distribution of Leakage Pathways Along Existing Wellbores" MS Thesis, The University of Texas at Austin. Aug 2012.

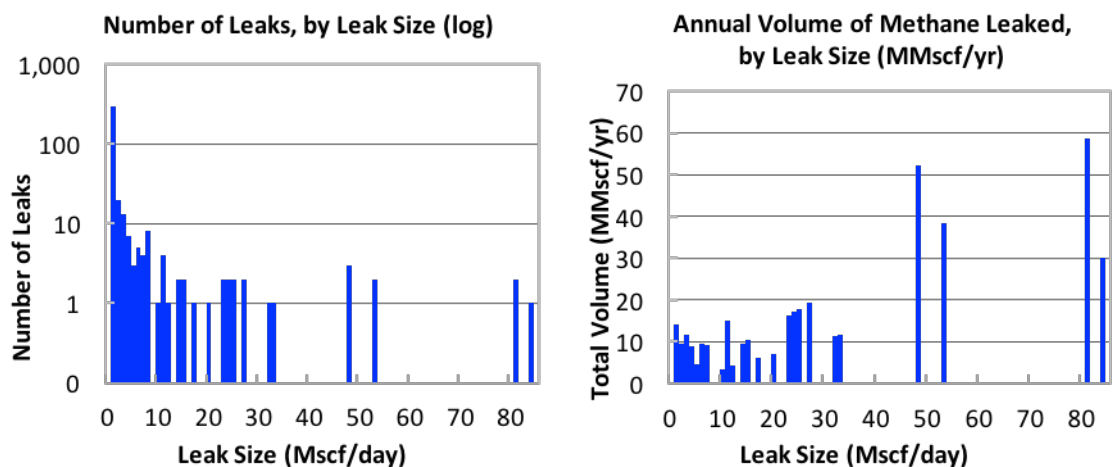


Figure 1: Data collected by the British Columbia Oil and Gas Commission shows 80% of the methane emitted comes from 6% of the leaks found, and finding one big leak is equivalent to finding hundreds of small leaks.

These calculations become even more startling in the face of mounting evidence on the prevalence of super-emitters. Several recent studies show that the distribution of leak sizes contains a larger number of extremely large leaks than previous estimates predicted, such that “a small percentage of sites—commonly labeled super-emitters—account for a majority of emissions.”<sup>2</sup> Each day that one of these large leaks is not found could be equivalent to thousands of small leaks.

Current inventories rely on emissions factors that have historically used central estimates of emission rates that do not successfully capture the impact of skewed emissions. A better understanding of the distribution translates directly into a better strategy for emissions limitation – as the authors of a 2014 *Science* paper<sup>3</sup> observe, “the heavy-tailed distribution of observed emissions rates presents an opportunity for large mitigation benefits if scientists and engineers can develop reliable (possibly remote) methods to rapidly identify and fix the small fraction of high-emitting sources.” In addition, a recent paper from Brandt et al. analyzed ~15,000 measurements from 18 prior studies and showed that “all available natural gas leakage datasets are statistically heavy-tailed, and that gas leaks are more extremely distributed than other natural and social phenomena. A unifying result is that the largest 5% of leaks typically contribute over 50% of the total leakage volume.”<sup>4</sup> The authors conclude that “performance targets for novel detection technologies can be informed by the emission distributions synthesized here... basing R&D targets on the largest dataset could possibly allow more efficient solutions to the problem (i.e., avoid ‘over-engineering’ of detector technologies.)”

This is precisely what Kairos Aerospace does – identify and fix the small fraction of high-emitting sources, achieving better environmental and economic results while avoiding over-engineered

<sup>2</sup> Zavala-Araiza, Daniel, et al. “Toward a Functional Definition of Methane Super-Emitters: Application to Natural Gas Production Sites.” *Environ. Sci. Technol.* July 7, 2015. URL: <http://pubs.acs.org/doi/abs/10.1021/acs.est.5b00133>

<sup>3</sup> Brandt, Adam, et al. “Methane Leaks from North American Natural Gas Systems.” *Science*. Feb. 14, 2014. URL: [http://nature.berkeley.edu/er100/readings/Brandt\\_2014.pdf](http://nature.berkeley.edu/er100/readings/Brandt_2014.pdf)

<sup>4</sup> Brandt, Adam, et al. “Methane Leaks from Natural Gas Systems Follow Extreme Distributions.” *Environ. Sci. Technol.* Oct. 14, 2016. URL: <http://pubs.acs.org/doi/pdf/10.1021/acs.est.6b04303>

instruments. Our aerial methane detection service, LeakSurveyor, surveys large areas frequently and affordably to find and stop large methane emissions faster. LeakSurveyor:

- ...is designed to survey large areas frequently at an affordable cost – a single instrument can cover 30,000 acres in one day.
- ...is specific to methane, avoiding signal confusion from other gases like propane or steam.
- ... produces direct images of methane plumes overlaid on simultaneously captured optical imagery, allowing operators to distinguish between separate point sources of methane and differentiating LeakSurveyor from air-sampling techniques.
- ...quantifies sizes of methane emissions with a precision within  $\pm 25\%$ .
- ...is operated as a service, meaning no capital expenditures or ongoing maintenance and repair costs are incurred by customers.
- ...is operated by highly trained Kairos engineers, meaning no operator training or labor resources are required on the part of customers, and reducing the likelihood of user error.
- ...is combined with a proprietary data analysis pipeline that streamlines reporting and recordkeeping and minimizes human variation in interpreting results.

The end result is a protocol that reduces more emissions faster, at lower up-front cost. In addition, this protocol produces far fewer false positives and wasted resources, making it less burdensome to operators.

As an example of our results, the image below on the left (Figure 2) shows a methane plume over a California gas storage facility that we estimated to be leaking at a rate of roughly 440 Mscf/day. A measurement by Scientific Aviation taken on the same day estimated the leak rate to be 450 Mscf/day. The image below on the right (Figure 3) shows a methane plume from a controlled release next to a smaller, separate plume from a flooded field nearby.



Figure 2: LeakSurveyor false color image of a leak from a gas storage facility; blue represents a methane plume.

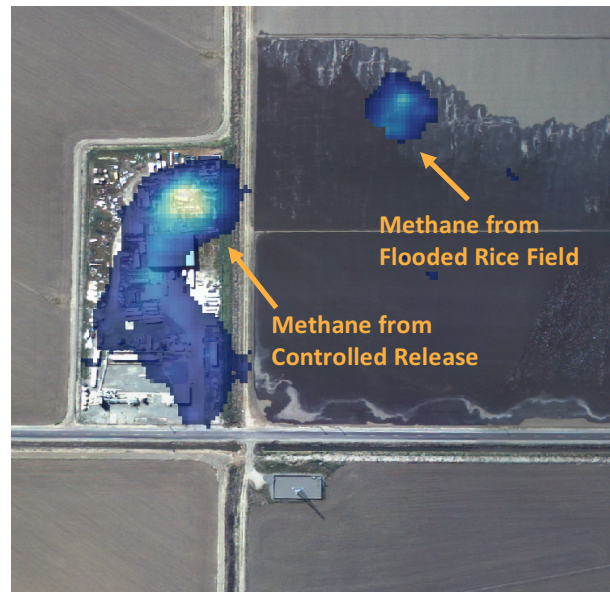


Figure 3: LeakSurveyor's direct point source methane imaging allows distinct attribution of methane between different sources.

We are happy to share more information about LeakSurveyor if it is of interest to ARB.



## **Create a Framework for Innovation**

With its large population of scientists and entrepreneurs and its history of technological innovation, California should be a natural leader in crafting the regulatory processes necessary to allow the use of new technologies for environmental monitoring and compliance. The proposed strategy does cite AB 32's mandate to "seek the maximum technologically feasible and cost-effective reductions of GHG emissions." However, there is no significant discussion of ARB's strategy for seeking out new technologies or for ensuring that its regulated community can rapidly take advantage of new technological advancements.

We believe this is an important part of a comprehensive long-term SLCP strategy. The methane leak detection technology landscape is highly dynamic, with innovation happening through efforts like ARPA-E's MONITOR project and EDF's Methane Detectors Challenge, as well as by independent start-ups such as Kairos.

As a suggestion, we think the document could benefit from a discussion of ARB's support for alternative compliance pathways that are minimally prescriptive and that specifically create an entry point for appropriately qualified technologies, which will encourage innovation in technology, reduce costs for the regulated community, and improve environmental outcomes. ARB could voice its support for demonstration and pilot projects, for example, in the various regulations that comprise the SLCP plan, as well as its support for letting operators choose from a list of approved devices or obtain approval for an equally effective device, rather than dictating technology in forthcoming rules. This would be valuable not only to oil and gas operators but also to those of us in the start-up community who are interested in contributing solutions, but don't have the long history and official regulatory approval of more established companies with older technology.

We at Kairos believe we can help the oil and gas industry reduce fugitive methane emissions by more than 40% by 2030, for less than ARB's current cost estimates. We hope to work with ARB going forward to make this a reality.

We greatly appreciate this opportunity to comment on the proposed SLCP strategy and would be happy to answer questions or discuss our comments in more detail.

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