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Re: bp comments on EPA non-rulemaking Docket: EPA-HQ-OAR-2021-0295

To whom it may concern,

bp's company purpose is reimagining energy for people and our planet and our ambition is to become a net-zero company by 2050 or sooner and help the world get there too.

We are committed to playing our part by delivering solutions that reduce the risks of climate change and providing cleaner, more affordable, and reliable energy. We aim to be net zero across our operations by 2050 or sooner and to actively advocate for policies that advance net zero.

bp has a 150-year history in America and is committed to the U.S. for the long-term. We have a larger economic footprint in the U.S. than in any other country - we invested more than $130 billion here between 2005 and 2020. bp's business activities support more than 125,000 American jobs and contributed about $60 billion to the national economy in 2020.

After completing a $10.5 billion acquisition of BHP’s American shale assets, bp’s U.S. onshore oil and gas business, bpx energy (“bpx”), took over operations in early 2019 of sizeable acreage positions in Texas and Louisiana. These world-class unconventional oil and gas assets are located in the Permian-Delaware and Eagle Ford basins in Texas, and the Haynesville basin in Texas and Louisiana. At the time of acquisition, bp also announced its divestment of legacy assets in Wyoming, Colorado, Oklahoma and New Mexico.

bp respectfully submits this white paper, along with the associated raw data contained in *Methane Detection Technology Raw Data* to assist the Environmental Protection Agency (“EPA”) in understanding the application, data collection, benefits, and challenges of bpx’s currently deployed methane detection technologies, including case studies, in advance of proposed regulations later this year for new, modified and existing sources.

Methane Detection Technology

bpx is a leader in understanding the challenge posed by methane emissions and is taking action to achieve significant reductions in our U.S. onshore operations. The detection and repair of emission sources is a critical success factor. To reduce our emissions, bpx deploys a host of methane measurement technologies based on operational feasibility and applicability. bpx currently uses the technologies summarized in Table 1 below to detect or quantify methane.

Table 1: Summary of bpx Deployed Methane Measurement Technology*

Technology Type	Measurement Frequency	Sensor Package	Sensor Product	Lower Detection Limit
Handheld OGI	Based on Regulatory Compliance Additional Verification	IR Optical Gas Imaging	Qualitative, Source Identification	0.8 g/hr methane
Fixed Wing - Aerial	Quarterly	Proprietary Optical Gas Imaging	Quantitative, Imagery with concentration overlay, Estimated Flow Rate	5.5 mscfd/ mph (80% probability of detection)
Drones - Aerial	Periodically	Optical Gas Imaging, Tunable Diode Laser Absorption Spectrometer (TDLAS)	Qualitative, Source Identification Images, OGI Video, Laser Reading Data	OGI: 0.8 g/hr methane TDLAS: 1 ppm-m
Continuous On-site Fenceline (trial)	Continuous (trial)	Metal Oxide Methane Sensor	Qualitative Source Direction ppm, windspeed, wind direction, estimated rate	10 kg/hr (500 scf/hr)
Satellite (trial)	Semi-annually	Depends on satellite source	Imagery with concentration overlay Estimated flow rate	100 kg/hr
Satellite - II (trial)	Semi-annually	Depends on satellite source	Imagery with concentration overlay Estimated flow rate	95 kg/hr

**The general information contained in this table are derived from bpx specific trials and do not necessarily reflect all performance characteristics for technology types by class.*

In this submission, each technology is explored in a separate section, which provides more substantive operational usage scenarios, including case studies from deployment. We are learning that these technologies have played an instrumental role in reducing emissions in our operations, and that deployment of a variety of technologies in a holistic and complementary way is critical to achieve bp's aim to deploy continuous site detection and source level measurement systems.

As the agency considers the role of methane measurement technologies, we encourage the EPA to consider:

1. An integrative approach when considering these technologies for future regulatory purposes.

2. Different technologies are better suited to different asset types, operations, and applications.

3. Technologies can be used together to improve and manage against certain temporal and spatial limitations of each technology type.

Handheld OGI

Background

Handheld optical gas imaging cameras ("OGI") are used for leak detection and repair ("LDAR") inspections – for regulatory compliance and to verify methane sources detected by other measurement technologies. We began using this technology to inspect equipment in 2006.

Data Collection

The handheld OGI surveys are conducted by trained personnel to diagnose and analyze infrared thermography. The cameras have a detection limit of 0.8 g/hr for methane and can capture real time video with the ability to switch between infrared and visual video while recording.

Benefits and Limitations

OGI cameras are useful in that the camera operator can in real-time qualitatively assess the severity of a methane source from the camera footage. The OGI cameras have detection limits that are more sensitive to methane sources, as compared to other technologies, allowing for visual identification of small leaks.

Due to the quantitative limitations of the OGI camera the assessment of methane detection and source identification relies on the competency of the camera operator and their ability to analyze the video footage. The camera operators can conduct up to ten OGI inspections per day due to the geographical expanse of our operations. Additionally, handheld OGI cameras are expensive to purchase and require specialized training for use. Lastly, the use of handheld OGI cameras requires an operator to drive to location. Safety is our top priority and driving has been identified as one of our biggest operational risks. Leveraging other technologies for methane detection helps bpx reduce this risk.

Fixed-Wing Aerial

Background

bpx launched fixed-wing aerial quantification surveys of our Permian Basin assets in late 2019. By August 2020, bpx began conducting quarterly surveys of our entire operations using fixed-wing aerial methane quantification technology.

Data Collection

The fixed-wing aerial methane quantification vendor uses proprietary sensors mounted to a lightweight propeller aircraft to detect the presence of methane sources greater than 5.5 mscfd/mph wind speed (80% probability of detection). The fixed-wing aircraft flies at an elevation of 3,000 feet above ground level ("AGL") and can fly over 100 square miles daily.

This technology combines infrared spectrometry, optical imagery, GPS, and inertial orientation data to produce maps with a plume overlay of methane sources. The raw data collected from the sensors is processed by the vendor's data validation algorithms, and a methane emission rate (in mcf/d) is then calculated for the methane source. Data specific to a methane source and a comprehensive report of findings are then communicated to bpx, which includes raw data files, images of methane sources, shape files for mapping, and number of detected methane sources with methane emission rates.

The data collected from fixed-wing aerial surveys is uploaded to an internal database. bpx uses this data to track performance over time, monitor corrective action response times, and identify insights that may inform improvements in our methane measurement program.

Benefits and Limitations

One of the key benefits of this technology is the aircraft's ability to cover large geographic areas, over 100 square miles of operations per day. The ability to survey an entire asset in a short amount of time resolves the spatial challenge of OGI handheld cameras and is a cost-effective way to survey a large geographic area. Flying at 3,000 feet above ground level allows for entire methane plumes to be captured and mapped, further allowing quantification of the total plume density and methane emission rate. The quantification of methane emission rate allows for the prioritization of methane sources.

Fixed-wing aerial surveys also have limitations. The ability to fly relies on weather conditions, which can cause surveillance delays. Additionally, while the technology visualizes and quantifies methane emissions, the high-altitude perspective makes it difficult to localize the source to a specific equipment component, which may require a follow-up investigation and diagnosis with a handheld OGI camera before corrective action can be taken. Fixed-wing aerial surveys also experience temporal challenges due to the nature and intermittency of some methane sources.

Case Study

The following case study and accompanying raw data, *Methane Detection Technology Raw Data.xlsx* [Fixed-Wing Aerial Raw Data], serve as a demonstration of our use of fixed-wing methane measurement technologies. In early 2021, bpx conducted a fixed-wing aerial survey of our Permian assets. Through this surveillance activity, bpx identified methane sources on 5% of sites surveyed (methane detected on 12 out of 228 wells surveyed) and dispatched operations personnel to troubleshoot and repair any issues. The survey spanned the entirety of our Permian Basin operations and typically takes one flight day to complete

The images below represent images captured through use of fixed-wing aerial surveys. The images indicate which general equipment had methane sources, such as the tank battery, but does not give specific information regarding which component may be the methane source, such as a dump valve or thief hatch. The fixed-wing aerial survey is, however, able to estimate both the methane emission rate per facility as well as the total emission rate which is used to identify insights that may inform improvements in our methane measurement program.

Image 1 & 2: Plumes captured during fixed-wing aerial surveillance flyover

Drone Aerial

Background

bpx uses drones, along with other various methane detection technologies, to provide periodic, aerial methane surveillance of our assets. Our drone aerial surveillance work began in 2017 and expanded to all bpx operations in 2019.

Data Collection

The drone is equipped with three primary components: an optical gas imaging camera (OGI), a methane laser, and a digital camera. A drone operator flies the drone around a site and uses the OGI to capture the methane source if detected. The mounted methane laser measures the methane concentrations on a per-second frequency during the flight and is capable of a detection limit of 1-50,000 ppm-m. A digital camera captures still images for each site inspected and is annotated to identify the equipment where the methane source is located. Additional images and videos are captured for methane sources detected.

Within 24 hours of the drone flight, all images and video are provided to bpx and an alert email is sent notifying bpx stakeholders of methane sources identified. The data collected from drone aerial surveys is uploaded into an internal database. Work orders are automatically generated for any methane sources detected above a pre-defined limit. bpx tracks performance over time, monitors corrective action response times, and identify insights that may inform improvements in our methane measurement program.

Benefits and Limitations

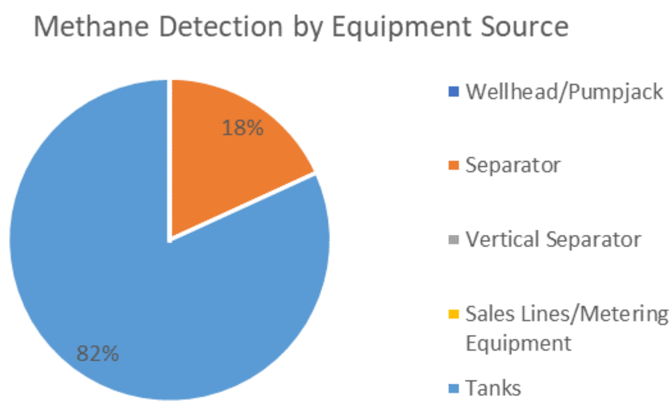
One of the benefits to deploying drone aerial surveys is the drone's ability to inspect a large geographic area per day. The drone aerial program can complete up to 40 site inspections per day. The drone surveillance delivers high resolution images, video from OGI cameras, and targeted methane detections with the laser beam which enables methane sources to be localized to specific equipment.

Similar to fixed-wing aerial surveillance, drone aerial surveillance can be impacted by inclement weather (heavy rain, high wind) which cause scheduling delays. Additionally, the drone operators require access to facilities which may conflict with other on-site operational activities resulting in surveillance delays. Drone aerial surveys also experience temporal challenges due to the nature and intermittency of some methane sources.

Due to the limitations of the drone technology's ability to quantify an estimated total rate of the detected methane sources, prioritization is based on the maximum methane concentration level detected. Therefore, all detected methane sources for a single equipment group are represented at the highest concentration rate instead of a total rate. The reported methane concentration detected is used in parallel with the imagery collected and a qualitative analysis is performed to determine corrective actions.

Case Study

The following case study, and accompanying data, *Methane Detection Technology Raw Data.xlsx* [Drone MethaneRaw, Drone MethaneStats], serve as a demonstration of drone mounted methane measurement technologies. In early 2021, bpx conducted drone aerial surveillance of our entire Permian asset over the course of 13 flight days. Through this surveillance activity, bpx identified methane sources on 8% of sites surveyed (methane detected on 9 well pads out of 108 well pads surveyed). The OGI cameras mounted to the drone identified the equipment specific source of the detected methane (7 tanks and 2 separators) and operations personnel were dispatched to troubleshoot and repair detected methane sources.



The images and comprehensive report from the drone aerial surveillance program include photos of the location, video, and OGI video footage of identified methane sources with annotations. The ability to view video footage of identified methane sources improves operation's ability to respond and repair identified methane sources.

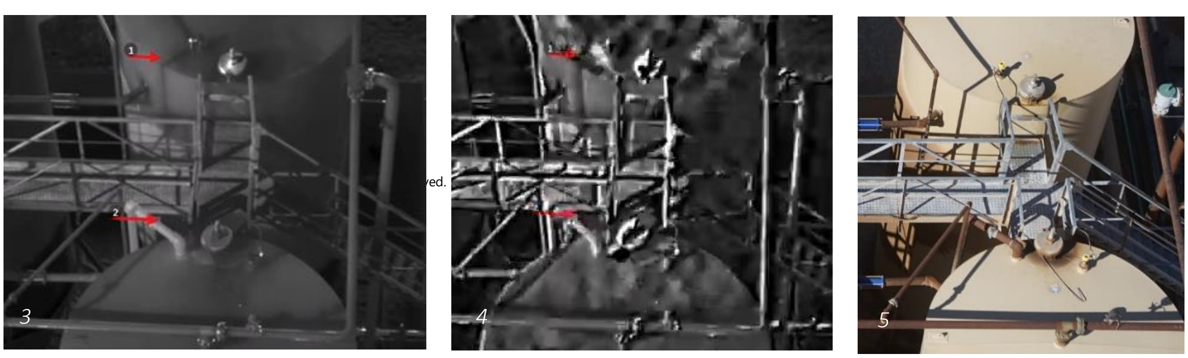


Image 3, 4, & 5: ***Left****: A still image from drone OGI video in normal mode.* ***Middle****: A still image from drone OGI video in enhanced mode.* ***Right****: Image from normal digital camera.*

Continuous Monitoring

Background

bpx methane measurement technologies include trialling continuous monitoring ("CM") technologies. The trialling of continuous monitoring systems began in 2017. bpx expanded the pilot to our Permian Basin and Midstream assets in 2020, and then to all bpx operations areas in 2021.

Data Collection

The CM sensor units are mounted to poles on the perimeter of the facility. Typically, four sensor units are deployed on a site – one for each side of the facility. The sensor units collect high frequency methane concentration data, humidity, windspeed, and wind direction and are averaged on a per minute basis. The vendor creates georeferenced polygons that cover specific equipment or equipment groups on the facility. Methane concentration readings and weather data are then combined in a data model that detects methane for each of the identified equipment polygons defined on the site.

If an anomalous reading is detected (two standard deviations from the base methane levels), an alert is sent to bpx. Once an alert is sent, our operations team can access Google Earth images of the site with overlays of the sensor locations, wind cones, and equipment polygons. This information is used to verify findings and take any corrective actions necessary. This CM sensor data is refreshed every fifteen minutes.

Benefits and Limitations

The primary benefit of CM is that high frequency, continuous observations resolve the temporal challenges posed by other methane detection methods and increase the probability of detecting intermittent methane sources. The sensors will also capture a methane source for its entire duration, addressing temporal limitations of other methane detecting technology.

While we continue to pilot CM technologies, one of the early challenges we have identified is the infrastructure necessary to collect data and create detection alerts may be limited in some locations since most CM technologies rely on cellular or fiber network coverage. Additionally, we are finding certain sensors may produce inaccurate information, due to malfunctioning sensor placement or interference from weather. Lastly, the use of data analytics to approximate the location of the methane source makes it difficult to localize the source to specific equipment, which requires follow-up on-site investigation and diagnosis with a handheld OGI camera prior to implementing corrective action. Finally, installing CM on every well pad may be cost prohibitive.

CM surveillance is a maturing technology, not readily available for full field use, and is still in development. The accuracy of methane detection is also still under evaluation.

Case Study

The following case study, and accompanying data *Methane Detection Technology Raw Data.xlsx* [CM 15Min, CM 1Min], serve as a demonstration of bpx use of CM technologies on one location in the Permian Basin. We installed four CM sensors along the perimeter of the facility in November 2020. This location experienced a detection level greater than two standard deviations from the baseline of methane in early February 2021.

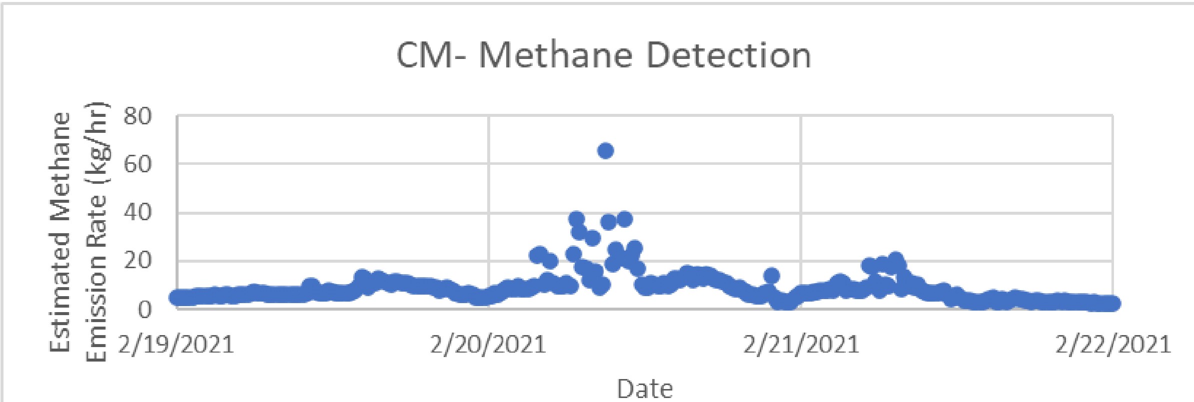


*Image 6, 7, & 8: **Left**: Wind-cone overlay. Blue cones represent wind direction. **Middle**: Plume captured during aerial flyover. **Right**: Plume captured during satellite imaging.*

Notably, both fixed-wing aerial surveillance and satellite imagery were conducted during the same period and captured imagery with corresponding evidence of methane sources. The use of technology in tandem has validated the methane detection capabilities of each and further supports an integrative approach to deploying technology.

Satellite Imagery

Background

bpx is trialling short-wave infrared ("SWIR") satellite imaging. The trial of satellite technologies took place during the first half of 2021 with engagement with several satellite vendors. The initial trial surveillance area covered our Permian Basin assets.

Data Collection

SWIR satellite imagery is based on a single exposure of the sensors to electromagnetic radiation (EMR) at SWIR wavelengths. The output of the satellite imagery analysis, which is conducted using data analytics, machine learning, and algorithms, is a map with images of detected methane sources, location of the source and estimated rates. Detection limit ranges between 95 kg/hr to 100 kg/hr depending on vendor, conditions, and imaging equipment capabilities. Satellite images can capture areas up to 100 square miles enabling entire basins to be surveyed in a short time span.

Benefits and Limitations

Each satellite image is typically 100 square miles which is beneficial in detecting methane sources over a large area. Satellite imagery can capture the entirety of methane sources and identify a release point of the source. Another benefit is being able to apply data analytics models to available satellite imagery and the ability to continuously improve the algorithms for methane detection.

Satellite imagery surveillance experiences some of the same temporal challenges of other aerial surveillance technologies, and due to the processing time, the methane source may be resolved before the data is received. Image capture is also dependent on weather conditions and can be negatively affected by clouds, humidity, or haze due to methane absorption occurring at similar wavelengths that water is absorbed in SWIR bands. Windier conditions also affect analysis due to dilution of the methane sources. The accuracy of analysis can also be impacted by geographic characteristics such as heterogeneity or high latitude. Adverse weather and geographic characteristics increase the lower detection limit from 100 kg/hr to 200 kg/hr. Satellite imagery for methane detection can also be capital intensive.

Satellite imagery surveillance is a new technology that is still in development. The accuracy of methane detection using this technology is also still under evaluation. Currently, satellite technologies primarily serve as a complement to the aforementioned technologies. The use case for satellite technologies is constrained due to the time intensiveness of transmitting and translating the data. We believe this technology will mature over time.

Case Study

The following case study, and accompanying data *Methane Detection Technology Raw Data.xlsx* [Satellite Raw Data], serve as a demonstration of bpx use of satellite imaging technologies. In early 2021, satellite imagery and analysis were conducted on our Permian Basin assets. Through this surveillance, bpx identified methane sources on 2% of well sites surveyed with "high" confidence (methane detected on 2 well sites out of 98 well sites surveyed). Operations receives alerts of methane source detection which includes estimated emission rates and associated maps with methane plumes overlayed.

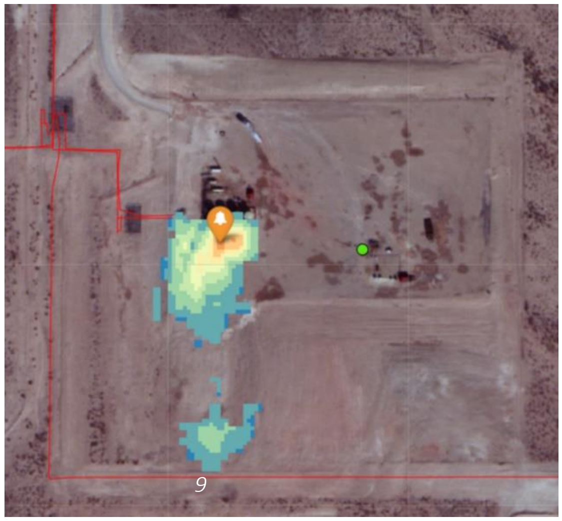


Image 9: Satellite image capture of emission plume.

Conclusion

bp supports the direct federal regulation of methane for new and existing sources. We are pleased to submit these comments to EPA's rulemaking process.

Should you have any questions, please contact Downey Magallanes at Downey.Magallanes@bp.com, Isabel Mogstad at Isabel.Mogstad@bp.com and Sam Knaizer at Sam.Knaizer@bpx.com.

Sincerely,

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