LongPath Emissions Sensing Network™ Technology: ≤2 kg/hr Fugitive Methane Emission Monitoring

1. Scope and Application

1.1 Scope

This method is an alternative test method (ATM) for determining compliance with the procedures in 40 CFR §60.5398b for fugitive emissions components affected facilities and compliance with inspection and monitoring requirements for covers and closed vent systems, specifically demonstrating compliance through periodic screening per 40 CFR §60.5398b(b), as approved, per 40 CFR §60.5398b(d). Applicable sites include single wellhead only well sites, small well sites, multi-wellhead only well sites, well sites with major production and processing equipment, centralized production facilities, and compressor stations.

1.2 Applicability

1.2.1 The application of LongPath Emissions Sensing Network™ technology is per the Environmental Protection Agency's 40 CFR part 60 New Source Performance Standards (NSPS): Subparts OOOO, OOOOa, and OOOOb, and Emissions Guidelines (EG): OOOOc, for the Oil and Natural Gas Source Category.

1.2.2. The test method is Broadly Applicable Across Sector to methane (CH_4, CAS #: 74-82-8) emissions from oil and natural gas facilities. This method can be used, as approved by the Administrator, in lieu of the applicable fugitive monitoring requirements in either §60.5397a or §60.5397b and inspection and monitoring of covers and closed vent systems in either §60.5416a or §60.5416b. This test method may be used for fugitive monitoring requirements in §60.5397c and monitoring of covers and closed vent systems under §60.5416c when a state, local, or tribal authority incorporates the model rule (i.e. OOOOc) for the emission guidelines as part of their State Implementation Plan (SIP) or elsewhere approved as applicable.

1.2.3. The test method is a performance-based method to determine whether facility level emissions remain below prescribed thresholds.

1.3 Method Sensitivity

The sensitivity of this method is a 2 kg/hr alerting threshold. The instrument's Minimum Detection Limit (MDL) is 0.6 kg/hr. The spatial resolution of follow-up required for this method is facility-level per §60.5398b(b)(5)(ii).

1.4 Data Quality Objectives

Adherence to the requirements of this method will ensure the data supporting the technology's objective will be accurate and of quality. The technology's objective is to screen for fugitive emissions from an oil and gas site that exceed 2 kg/hr and provide an alert to an operator that triggers a leak detection and survey response.

2. Summary of Method

2.1 Emissions Quantification Principles

This method involves the measurement of atmospheric methane concentrations, the collection of atmospheric meteorological parameters, and use of atmospheric inversion modeling to determine the presence, rate(s) and location(s) of methane emissions from the fugitive emissions components at oil and gas infrastructure sites. The atmospheric concentration of methane gas measured at a sensor downwind of a site, $CH_{4\ ATMOS}$, is influenced by methane emissions occurring on the site, including the contributions of fugitive emissions, x_{FUG}, and non-target (non-fugitive) emissions, x_{NTE}, as well as the contribution of incoming background methane molecules, $CH_{4\ BG}$. A is a function linking emission sources, x, to changes in atmospheric methane concentrations, ΔCH_4.

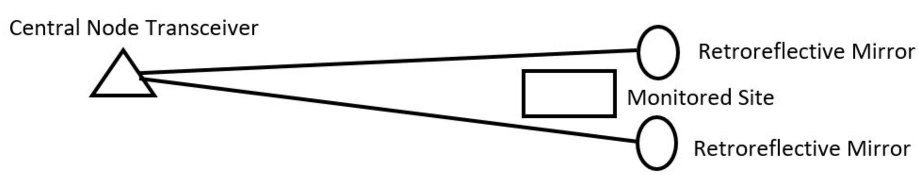
$$CH_{4\ ATMOS} = A(x_{NTE} + x_{FUG}) + CH_{4\ BG} = \Delta CH_4 + CH_{4\ BG}$$

In this method, the background ($CH_{4\ BG}$) is measured, and total emissions (ΔCH_4) are solved directly (Coburn et al., 2018; Alden et al., 2019), for comparison with alerting thresholds.

2.2 Data Collection

Atmospheric concentrations are measured using long-range open-path laser spectroscopy, in which the absorption of the laser light at wavelengths resonant with quantum transitions of methane is recorded and converted into an integrated methane concentration along the beam path. Data that contribute to a periodic screening Fugitive Emission Screening Assessment are collected when a clean background is measured by one or more beam paths and an enhanced methane signal is measured by one or more beam paths.

Figure 2.2 Example map (plan) view of central node transceiver and two retroreflective mirrors arrayed around one monitored site.



2.3 Data Delivery and Storage

Fugitive Emissions Screening results are shared with the operator. The requirements for owner and operator monitoring and response are found and referenced in 40 CFR §60.5398b(b). A draft monitoring and response plan is included as Appendix II.

3. Definitions of Method

3.1 Definitions

3.1.1 *Alerting Threshold* is the minimum detection threshold requirement associated with the screening frequencies in tables 1 and 2 of this subpart. These values are used as alerting thresholds, where an exceedance of the minimum detection threshold listed in table 1 and 2 of the subpart of the periodic screening emission rate estimate measured in this method is an alert.

3.1.2 *Anemometer* means a sonic sensor used to measure instantaneous wind speed along different axes by measuring the influence of wind on sound waves traveling between pair(s) of transducers.

3.1.3 *Beam Path* means the pathway through the atmosphere of laser light between a *Transceiver* and a *Retroreflective Mirror*. Distances cited are one-way distances (not round-trip, although the laser light does perform a round trip, from *Transceiver* to *Retroreflective Mirror* and back).

3.1.4 *Central Node* means the location of the *Transceiver*, *Laser Spectrometer*, *Gimbal*, controls, computing devices and *Anemometer*. One *Central Node* can monitor one to many sites.

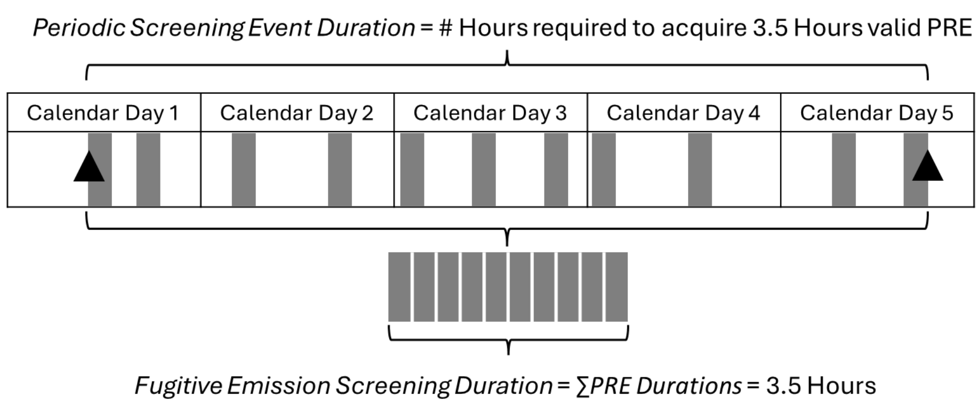
3.1.5 *Concentration Measurement* means one sample, or measurement of the atmospheric concentration of methane gas along a *Beam Path* from *Transceiver* to *Retroreflective Mirror*.

3.1.6 *Detection Threshold* is the minimum detection threshold requirement associated with the screening frequencies in tables 1 and 2 of this subpart.

3.1.7 *Fugitive Emission Screening Assessment* means the result from the *periodic screening*. The primary result of the screening is a *periodic screening emission rate estimate* and a determination of either Alert (rate above threshold) or No Alert (rate at or below threshold).

3.1.8 *Fugitive Emission Screening Duration* means the sum of the *preliminary real-time estimate duration* values for all *preliminary real-time estimates* (PRE) obtained during a single *periodic screening event.* The *fugitive emission screening duration* is defined as 3.5 hours. In the below graphic, the *fugitive emission screening duration* is the sum of the durations of, in this example, the 11 gray vertical bars that indicate *preliminary real-time estimate* timing and duration.

Figure 3.1.8 Information graphic demonstrating the durations of different defined elements of the method. The black triangles show the time of the *periodic screening event* start and end. The grey bars indicate the timing and duration of *PRE* collected during the *periodic screening event*.



3.1.9 *Gimbal* means a device that rotates about one axis or two orthogonal axes, enabling the controlled pointing of the laser transceiver toward retroreflective mirrors.

3.1.10 *High-Rate Concentration Measurement* means the concentration data collected at a > 1 Hz rate which is processed to generate one *Concentration Measurement*.

3.1.11 *Laser Spectrometer* means a device that generates and detects laser light, including the laser control computer that converts raw laser energy to methane concentration data and *Quality Assurance Quality Control* metrics.

3.1.12 *Meteorological Data* refers to wind speed, wind direction, turbulence, moisture, and temperature data.

3.1.13 *Minimum Detection Limit* is the instrument 90% probability of detection emission rate.

3.1.14 *Periodic Screening Emission Rate Estimate* is a single data point resulting from the *periodic screening event*. This rate is defined as the median of all *valid data* collected during a *periodic screening event*. This rate data is used in the *fugitive emission screening assessment*.

3.1.15 *Periodic Screening Event* means a discrete time period during which assessment of the presence or absence of emissions from fugitive emissions components is performed at one site. The data from a *periodic screening* is used to generate a *fugitive emission screening assessment*.

3.1.16 *Periodic Screening Event Duration* is the total duration (in hours) between the start of a *periodic screening event* and the end of a *periodic screening event* for one monitored site. A *periodic screening event duration* must be at least 3.5 hours, which is the minimum *fugitive emission screening duration*.

3.1.17 *Periodic Screening Minimum Detection Limit Value* is the minimum detection limit for the *periodic screening event*.

3.1.18 *Preliminary Real-Time Estimate* means the total event of sample collection that occurs to gather concentration data at one site for modeling of emission rate. Multiple atmospheric methane concentration measurements are made along two or more beam paths to produce one *PRE* value. Multiple *PRE* values are used in a *periodic screening*, the duration of which is defined as 3.5 hours of cumulative *PRE duration*.

3.1.19 *Preliminary Real-Time Estimate Minimum Detection Limit Value* is the minimum detection limit for one *preliminary real-time estimate* value.

3.1.20 *Preliminary Real-Time Estimate Duration* means the duration (in hours) of one *PRE* data collection event. The duration of one *PRE* is determined by the amount of time it takes to collect the requisite number of valid concentration data points.

3.1.21 *Quality Assurance Quality Control* means metrics that assess whether the system is providing information within compliance.

3.1.22 *Retroreflective Mirror* means a mirror that reflects light received back toward its source.

3.1.23 *Site* means an affected facility. Sites include single wellhead only well sites, small well sites, multi-wellhead only well sites, well sites with major production and processing equipment, centralized production facilities, and compressor stations.

3.1.24 *Transceiver* means optical componentry that sends eye-safe and invisible light through the atmosphere to a retroreflective mirror and receives the reflected laser light for processing.

3.1.25 *Valid data* refers to a PRE that has passed all QAQC requirements.

3.2 Abbreviations

3.2.1 *ETL* Extract, Transform, Load

3.2.2 *MDL* Minimum Detection Limit

3.2.3 *PRE* Preliminary Real-Time Estimate

3.2.4 *QAQC* Quality Assurance Quality Control

3.2.5 *SNR* Signal-to-Noise Ratio

4. Method Interferences and Envelope of Operation

Method interferences and envelope of operation are summarized in Table 4.1.

Table 4.1. Summary of Method interferences and envelope of operation.

Condition	Summary	Mitigation
Laser Light Return Power	Optical attenuation (e.g., from temporary physical obstruction, precipitation, or fog) of laser signal	Data is not collected unless laser light is returned to the detector; measurement is filtered
High temperature	Temperatures above 50 °C risk overheating of electronics	Temporarily suspend data collection until temperature returns to operating range
Low temperature	Temperatures below -40 °C are outside of the recommended conditions for gimbal operation	Temporarily suspend data collection until temperature returns to operating range
Low wind speed	Wind speeds below 1 m/s prevent adequate plume development, degrading measurement quality	Data collected outside this envelope is flagged and not used for periodic test
High wind speed	Wind speeds in above 10 m/s reduce plume detectability	Data collected outside this envelope is flagged and not used for periodic test
Laser Beam Angular Separation	Angular separation between laser beam paths that is too low can lead to unintentional signal acquisition from neighboring retroreflective mirrors	A minimum angular distance between adjacent retroreflective mirrors is maintained to match gimbal pointing accuracy and data is flagged and removed if signal from the wrong retroreflective mirror is acquired
Line of sight	Topographic or other features can block laser light from traveling between the transceiver and retroreflective mirror	Line-of-sight between transceiver and retroreflective mirror is confirmed during install and during re-siting as needed

Solar Power Battery Capacity	Extended periods of uncharacteristically low sunlight can lead to insufficient power for solar powered systems	Temporarily suspend system operation until solar power returns

5. Safety

This method may not address all potential safety scenarios associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method.

5.1 Field Safety

Outside of installation procedures, this method is fully automated and does not require personnel on site except in cases in which manual maintenance is required. During installation of equipment, the following safety considerations are made. System design is approved by a professional engineer to mitigate the risk of collapse or falling of the equipment holding the transceiver, anemometer and retroreflective mirrors. Equipment is installed and located so that an ample fall radius prevents possible collisions with on-site equipment. Equipment is located out of the way of oil and gas equipment, including the transceiver, which is not intrinsically safe and requires power, for example from a solar panel and/or battery. The retroreflective mirrors are intrinsically safe and do not require power. All personnel who install or maintain equipment must have appropriate Safety Certifications, use personal protective equipment, and observe standard oilfield safety protocols for gases and liquids.

5.2 Laser Safety

The laser light leaving the transceiver is Class 1, meaning it is safe for the human eye. The laser light is invisible and does not pose a risk of distracting personnel from other duties.

6. Equipment and Supplies

6.1 Tower to mount laser spectrometer and transceiver, rated to local standards for wind and hazardous conditions. The height of the laser transceiver is determined as described in Appendix I.

6.2 Laser transceiver to transmit and receive laser light from central node to reflective mirrors.

6.3 Laser spectrometer to generate laser light and signals required to perform laser absorption spectroscopy and measure methane concentrations. The spectrometer must be able to measure methane concentrations including ambient atmospheric concentrations (1.9 ppm methane) and up to +10s of ppm with a sensitivity of at least 10 ppm*m.

6.4 Gimbal to mechanically or optically steer the laser light towards the retroreflective mirrors.

6.5 Retroreflective mirrors to reflect laser light back towards the transceiver. Two or more retroreflective mirrors must be used per monitored site. The location and height of a retroreflective mirror is determined as described in Appendix I.

6.6 Anemometer to measure local meteorological data, including either high-frequency 3-dimensional directional wind speed (with precision of ± 5%) and air temperature (with a precision of ± 0.5 °C over 5 seconds and sensor drift < 0.1 °C over 30 seconds) from the 3D anemometer; or high-frequency 2-dimensional directional wind speed and air temperature (with a precision of ± 0.5 °C over 5 seconds and sensor drift < 0.1 °C over 30 seconds) from the 2D anemometer (with precision of ± 5%) with friction velocity, sensible heat flux and mixing layer height from forecast or model data. Air pressure is calculated according to altitude.

6.7 Power source to provide constant source of DC voltage.

6.8 Software and firmware to autonomously operate system and process data.

6.9 Computing and storage equipment to autonomously operate full system, aggregate data from various sensors, process data in real time, store data, and sync data with off-site database.

6.10 Network connectivity to transmit and receive data over existing network infrastructure.

6.11 GPS device to measure initial geospatial locations of tower and reflector during installation.

7. Reagents and Standards

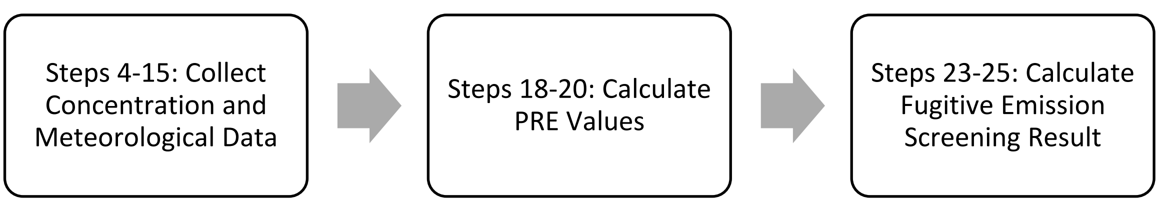
7.1 Methane Gas Reference Cell

The precision of each laser system must be validated during the manufacturing process at three conditions using commercially available static optical methane gas reference cells containing a sealed mixture of 50 Torr pure methane and 690 Torr pure nitrogen (resulting total pressure of 740 Torr) to represent measurements at column densities of 20, 3, and 0.6 ppm-km.

8. Data Collection and Method Input Sourcing

8.1 Data Collection

Data collection and management is described here in a stepwise fashion. The procedures for planning, placement and installation of the equipment needed to collect samples are described in Appendix I. The operation of equipment, collection of samples (data) and sample (data) processing take place according to the following data collection and processing procedures. First, concentration and meteorological data are collected. Second, PRE values are calculated. Third, PRE data is used to generate the final fugitive emission screening result.



All steps in this process take place automatically and at the central processing computer, unless otherwise noted.

1) Necessary equipment for monitoring is installed per requirements in Appendix I.
2) A periodic screening is initiated according to the owner or operator’s monitoring plan.
3) The start of the periodic screening event is noted as a date and time.

4) The anemometer collects data continuously through time. If the installed anemometer is a 2D anemometer, then high-resolution real-time or forecast data from weather models is also synced to the central processing computer from a remote server.
5) High-frequency directional wind speed data from the anemometer (2-dimensional if 2D anemometer and 3-dimensional if 3D anemometer) and temperature data are continuously sent from the anemometer to the central processing computer where QAQC checks are applied as described in Section 9.2.
6) If the installed anemometer is a 3D anemometer, then the high-frequency directional wind speed and temperature data are continually processed to generate wind direction, wind speed and turbulence parameters, and if the installed anemometer is a 2D anemometer, then the high-frequency directional wind and temperature data, and friction velocity, sensible heat flux and mixing layer height from forecast or model data are continually processed to generate wind direction, wind speed and turbulence parameters (De Visscher, 2013). These outputs are time stamped with the UTC time of measurement and saved to the central processing computer. The high-frequency raw data is averaged to a lower frequency for long-term storage in the database.
7) The central node runs per standard operation and under automated site selection criteria.
8) When a site is selected for measurement by the automated site selection criteria, the gimbal pivots to direct the laser light toward the retroreflective mirrors assigned to the monitored site, in sequence.
9) When the laser transceiver collects data from a retroreflective mirror, the data acquisition unit sends the laser data to the central processing computer. Each high-frequency concentration laser data packet is stamped with: UTC time of measurement, unique measurement ID number corresponding to retroreflector visit, and embedded software version number.
10) The high-frequency laser data are QAQC checked, per Section 9.3.
11) The high-frequency laser data that pass QAQC are processed to generate high-frequency path-integrated methane concentration data using modeled absorbance signals.
12) The high-frequency concentration data are averaged across the time the gimbal continuously points toward a single retroreflective mirror. The averaged concentration data and associated QAQC metrics are stamped with a unique identifier of the software version (traceable and backed up with the third-party software) and saved to the computer.
13) A bottom-up sensitivity value is generated for each averaged concentration data point using the instrument precision and field conditions (equipment and sensor locations, monitored site(s) equipment and locations, meteorological conditions) logged during the time the concentration measurement was made.
14) Each concentration data point bottom-up sensitivity value is multiplied by a factor to convert from an instrument sensitivity value to an MDL value for use in calculation of the PRE MDL value.
15) The averaged concentration data is QAQC checked for use in the PRE calculation, per Section 9.4.
16) The laser transceiver continues collecting data per Steps 4-15 for the monitored site until at least one concentration measurement has been made on each bounding retroreflective mirror associated with the site.

17) Wind direction data is used to parse concentration measurements into measurements of $CH_{4\,BG}$ alone (background or ambient methane) and measurements of ΔCH_4 + $CH_{4\,BG}$ (background or ambient methane plus emitted methane).
18) At the central processing computer, final as-built GIS data, wind speed, wind direction and turbulence parameters, temperature data, ΔCH_4 measurements, and $CH_{4\,BG}$ measurements are processed in model to produce a PRE and a PRE MDL value at the monitored site for the window of time that the site was measured during steps 8-15. Data from all retroreflective mirrors monitoring the site are used to calculate a single PRE. The PRE duration is the total time of data collection of steps 8-15.
19) The minimum MDL value of the concentration data points used in the calculation of the PRE is used to generate the PRE MDL Value.
20) The PRE is QAQC checked as described in Section 9.4. All processed data are stored as a data packet with UTC time of measurement, site ID and meteorological data.
21) Steps 4-20 are repeated for the duration of the periodic screening event, which is defined as the amount of time it takes to collect 3.5 hours of valid PRE data.
22) The end of the periodic screening event is noted as a date and time.
23) The duration of all valid (not removed for QAQC or maintenance) PRE data collected since the start of the periodic screening period for the monitored site are summed to generate the fugitive emission screening duration. If the fugitive emission screening duration is at least 3.5 hours, the periodic screening event is considered valid.
24) For the purpose of this subpart, the average aggregate MDL is the average of all site-level MDL values from a single deployment of a technology, such that the periodic screening MDL value is calculated as the sensor average of the PRE MDL values during the periodic screening event.
25) The median value of all valid (not removed by QAQC checks) PRE data collected during the periodic screening event is calculated to generate the periodic screening emission rate estimate.

Table 8.1. Summary of data collected.

Instrument/Source	Variables	Use
Spectrometer	High-frequency laser data	Raw laser data processed to generate methane concentration data and QAQC metrics
3D or 2D anemometer	High-frequency directional wind speed, temperature	Meteorological data used in model for PRE
High-resolution forecast or model data	friction velocity, sensible heat flux, mixing layer height	If 2D anemometer used, then these data are used in model for PRE

8.2 Data Management

Data handling and storage of samples (data) occurs according to the following data delivery and reporting procedures.

1) Data logging occurs locally at the central processing computer, as described above.
2) Processed data is synced to the central server every minute. Data is securely transferred from the central processing computer to the central server via communications on the central node tower.
3) Once the initial Extract, Transform and Load (ETL) of raw data from the edge occurs, a secondary gateway instance is used to further ETL data as a security measure to ensure data is contained.
4) Once raw data from the edge is delivered to the initial ETL point, a secure backup of the data is created.
5) The Fugitive Emission Screening Assessment takes place automatically and data is delivered to the owner or operator as well as to LongPath for optional manual review.

Samples, which are digital data, are stored for a minimum period of 5 years at primary and secondary locations for data security and maintenance. Records are provided to the owner or operator for reporting.

9. Quality Control

Quality Assurance and Quality Control (QAQC) metrics ensure that the data supporting the method are accurate and of quality. Each subsystem requires diagnostics, frequencies that diagnostics are checked, and corrective actions, as specified in Table 9.1 below.

Table 9.1. Summary of envelope of operation, Quality Assurance and Quality Control Metrics, acceptance criteria, and corrective actions.

System	Measurement	Acceptance Criteria	Frequency Checked	Corrective Action
Siting and MDL	Angular separation between laser beam paths	Minimum angular distance	Initial siting and re-siting evaluation as needed	Re-siting evaluation
Siting and MDL	Line-of-Sight	See Spectrometer Metrics	See Spectrometer Metrics	See Spectrometer Metrics
Siting and MDL	Periodic screening MDL	MDL is equal to or below the required detection threshold	Each periodic screening event and mock periodic screening event	Re-siting evaluation
Siting and MDL	Periodic screening event duration	3.5 hours	Each periodic screening event and mock	Re-siting evaluation

			periodic screening event	
Anemometer	Wind speed accuracy	± 5% at 10 m/s	Verified at time of manufacturing by the supplier; no additional checks performed	Do not deploy
Anemometer	Wind direction accuracy	± 3° at 10 m/s	Verified at time of manufacturing by the supplier; no additional checks performed	Do not deploy
Anemometer	Temperature accuracy	± 1°C	Verified at time of manufacturing by the supplier; no additional checks performed	Do not deploy
Anemometer	Wind speed bounds	ϵϵ [0 m/s, 50 m/s]	Every measurement (5 seconds)	Filter measurement
Anemometer	Wind direction bounds	ϵϵ [0°, 360°]	Every measurement (5 seconds)	Filter measurement
Anemometer	Temperature bounds	ϵϵ [-60°C, 60°C]	Every measurement (5 seconds)	Filter measurement
Anemometer	Firmware error code	No error code	Every measurement (5 seconds)	Filter measurement
Spectrometer	Concentration precision	± 2 ppb over 10 seconds	In-house manufacturing	Do not deploy
Spectrometer	Concentration accuracy	< 5% from reference methane cells	In-house manufacturing	Do not deploy

Spectrometer	Model fit error	< 5% at column densities > 2 (ppm-km)	In-house manufacturing	Do not deploy
Spectrometer	Concentration bounds	ϵϵ [1.8 ppm, 50 ppm at 2.5 km]	Every concentration measurement	Filter measurement
Spectrometer	Optical interference	< 5% model fit error	Every concentration measurement	Filter measurement
Spectrometer	Laser intensity SNR	SNR > 25 based on baseline noise intensity	Every concentration measurement	Filter measurement
Spectrometer	Retroreflector acquisition	No error code	Every concentration measurement	Filter measurement
Spectrometer	Laser light return power	Non-zero	Every concentration measurement	Filter measurement
Spectrometer	Temperature	< 50 °C	Every concentration measurement	Temporarily suspend data collection
Preliminary real-time data	Wind Direction	< 20° off parallel from site heading from tower	Every concentration measurement	Concentration data not used for PRE
Preliminary real-time data	Wind Speed	> 1 m/s or < 10 m/s	Every PRE	PRE not used for periodic screening

Preliminary real-time data	Measurement density	> 1 concentration measurement per bounding retroreflective mirror at site	Every PRE	PRE not reported
Power system	Fault indicators	No critical faults present	Every hour	Field service required
Power system	Charging history	Has charged > 20% daylight hours	Daily	Data Analytics team triage
Power system	Battery capacity	Non-zero	Every hour	Temporarily suspend data collection
Gimbal	Movement	Movement detected	Every concentration measurement	Software or field service required
Gimbal	Temperature	> -40 °C	Every concentration measurement	Temporarily suspend data collection
Networking system	Data upload to cloud	Data upload success	Every hour	Wait for cell service to return

9.1 Siting and Detection Threshold Metrics

Initial siting and detection threshold metrics can be found in Appendix I.

9.1.1 Minimum Angular Separation

A minimum angular separation between laser beam paths must be maintained, including during any re-siting of equipment.

9.1.2 Line-of-Sight

Line-of-sight between the laser transceiver and retroreflective mirrors must be maintained, including during any re-siting of equipment. Failure and corrective actions for this QAQC metric are described Section 9.3.2 and Table 9.1.

9.1.3 Minimum Detection Threshold Requirements

For each periodic screening event and mock periodic screening event, the periodic screening MDL value is compared with the minimum detection threshold requirements. Failure of the periodic screening event MDL value to meet the required thresholds triggers a re-siting evaluation.

9.1.4 Re-Siting Evaluation

Periodic screening failure root cause and re-siting evaluation ("re-siting evaluation") must take place in the case of a QAQC failure of the following metrics: periodic screening MDL, mock periodic screening MDL, periodic screening duration greater than 168 hours (7 days), mock periodic screening duration greater than 168 hours (7 days), minimum angular separation between laser beam paths, or line-of-sight between laser transceiver and retroreflective mirror(s). A re-siting evaluation is also performed if equipment requiring monitoring is added to the site or moved to a different location on the site. Re-siting evaluation procedures must be undertaken until such point as the next periodic screening or mock periodic screening demonstrates achievement of the QAQC metrics. The re-siting evaluation procedure follows these steps.

1) A desktop analysis of measurement conditions must be performed to determine the likely cause(s) of failure.
2) If the desktop analysis indicates that the conditions for failure were due to meteorological or temporary physical or visual blockages of the laser beam path, then the re-siting evaluation is considered complete.
3) If the desktop analysis indicates that settings or configuration attributes may be adjusted to achieve QAQC metrics via remote intervention, then adjustments are made remotely and the re-siting evaluation is considered complete.
4) If the desktop analysis indicates that hardware adjustment, repair or replacement are required, then hardware adjustment, repair or replacement is made, and the re-siting evaluation is considered complete.
5) Repeat failure of QAQC metrics requires re-initiation of the periodic screening failure root cause and re-siting evaluation until QAQC metrics are met.

9.2 Anemometer Data Quality Checks

Anemometer measurement QAQC metrics include checking for 1) error flags provided by the manufacturer's firmware and 2) for data to be within reasonable bounds (see Table 9.1). If either check fails, the data is not used. If re-siting evaluation indicates replacement or service is required, a field service event is triggered.

9.3 Laser Spectrometer Quality Checks

9.3.1 In-house Manufacturing Validation

Each laser spectrometer is manufactured in-house by LongPath Technologies. Prior to deployment, the precision and accuracy of each spectrometer is validated using three methane gas reference cells described in Section 7.1. Spectrometers that fall outside of the bounds for precision, accuracy and spectroscopic fit error specifications set in Table 9.1 are not deployed.

9.3.2 Operational Checks of Concentration Data

9.3.2.1 The signal to noise (SNR) ratio of the detected laser signal intensity to noise must exceed a minimum threshold as shown in Table 9.1.

9.3.2.2 The fit error between model and measured data must not exceed 5% fit error, based on integrated absorbance area, as shown in Table 9.1.

9.3.2.3 A measured concentration value must pass QAQC checks for averaged fit error, measurement signal-to-noise ratio, and out of bound concentration values, as described in Table 9.1.

9.3.2.4 During periods of optical attenuation from rain, snowfall, or fog, the system will not produce concentration measurements until the conditions improve.

9.3.2.5 If concentration measurements of one retroreflective mirror continuously fails SNR QAQC checks specified in Table 9.1, as indicated by re-siting evaluation, then technicians are notified to diagnose the failure mechanism. If the failure mechanism is identified to be poor signal SNR, a field service event is triggered to either clean or replace the retroreflective mirror.

9.3.2.6 If concentration measurements for multiple retroreflective mirrors continuously fail fit error QAQC checks specified in Table 9.1, as indicated by re-siting evaluation, then technicians are notified to diagnose the failure mechanism. If the cause of the elevated fit error cannot be addressed remotely, a field service event is triggered to undertake the characterization and validation steps outlined in Section 10.0 and/or replace the laser system.

9.4 Preliminary Real-Time Estimate Data Quality Checks

PRE data must pass QAQC checks, summarized in Table 9.1 and detailed below.

9.4.1 Wind Speed Inputs

Measurements made when wind speed is below 1 m/s are not used in the periodic screening dataset, because of standard recommendations regarding dispersion models' ability to accurately parameterize atmospheric pollutant transport at wind speeds less than 1 m/s (De Visscher, 2013). Measurements made when wind speed is above 10 m/s are not used in the periodic screening dataset, because of reduced plume detectability.

9.4.2 Wind Direction Inputs

Upon installation, each site is designated a fixed range of wind directions under which PRE data collection is considered successful per Appendix I. If all measurements during the PRE are outside of the acceptable bounds, then a PRE is not calculated.

9.4.3 Concentration Data Inputs

A minimum of one concentration reading per bounding retroreflective mirror at a given site is required to produce a PRE. If this threshold is not met, a PRE is not calculated.

9.5 System Status Checks

Table 9.1 lists acceptance criteria and corrective actions for the functioning of the power, gimbal, and networking subsystems.

In the event of internet failure, the system will continue to independently operate until the internet has been restored, at which point the system will sync any measurements recorded during the internet service lapse.

10. Calibration and Standardization

10.1 Calibration Procedures

10.1.1 Spectrometer Calibration Procedures

The equivalent calibration procedures are described in Section 7.1 and Section 9.3.1. All procedures are undertaken in the laser manufacturing facilities of LongPath Technologies. These encompass the initial procedures, follow-up and periodic procedure, which are triggered by initial manufacturing and by failure of QAQC checks described in Section 9.3.2.

Failure of these checks leads to an instrument not being deployed for use with this method and/or removal from use with this method. A spectrometer may be removed from the field and taken back to a testing facility, where the laser performance may be recharacterized and validated against known sample conditions.

10.1.2 Anemometer Calibration Procedures

Sonic anemometers are wind tunnel tested and calibrated by the instrument manufacturer, per the manufacturer's specifications, and do not require further calibration or ongoing recalibration because there are no moving parts to produce wear.

Repeated failure of an anemometer to meet the QAQC metrics results in the removal of the instrument from the field.

10.2 Threshold Metrics for As-Needed Calibration

The threshold metrics for as-needed calibration of the laser spectrometer are the Laser Intensity SNR and the Model Fit Error, which are described in Table 9.1. The repeated failure of these metrics across multiple retroreflective mirrors, as indicated by re-siting evaluation, is the threshold for as-needed calibration.

The frequency of as-needed calibration of the spectrometer systems is extremely rare and averages well below once per year per instrument.

10.3 Standardization: Training Requirements

Only specialized and trained LongPath personnel are allowed to manufacture and calibrate LongPath spectrometers. The training procedures, requirements and standard operating procedures are held by LongPath.

11. Analytical Procedure

[Reserved]

12. Detection and Alerting

12.1 Detection

For the purposes of this ATM, detection is defined as the exceedance of measured emissions above the alerting threshold value. Discrete windows of data collection produce PRE data points. The median of all preliminary real-time data points across the minimum 3.5-hour duration of all data collected during a periodic screening event produces a periodic screening emission rate estimate. Ambient methane concentrations are removed by sampling representative air masses moving onto the measured site ("background" methane concentrations) as well as representative air masses moving off from the measured site (air masses with signals of potential methane emissions embedded in the methane concentration measurement).

A periodic screening emission rate estimate that is at or below the relevant alerting threshold (2 kg/hr) is a non-detection. A periodic screening emission rate estimate that is above the relevant alerting threshold (2 kg/hr) is a detection.

12.2 Alerting

Once a sufficient length of data collection has occurred (≥ 3.5 hours of combined duration of PREs), the data is input into the Fugitive Emissions Screening Assessment. The outcome of the Fugitive Emissions Screening Assessment is binary: either Alert or No Alert.

An *Alert* result is generated if the periodic screening emission rate estimate is above the defined alerting threshold.

A *No Alert* result is generated if the periodic screening emission rate estimate is at or below the defined alerting threshold.

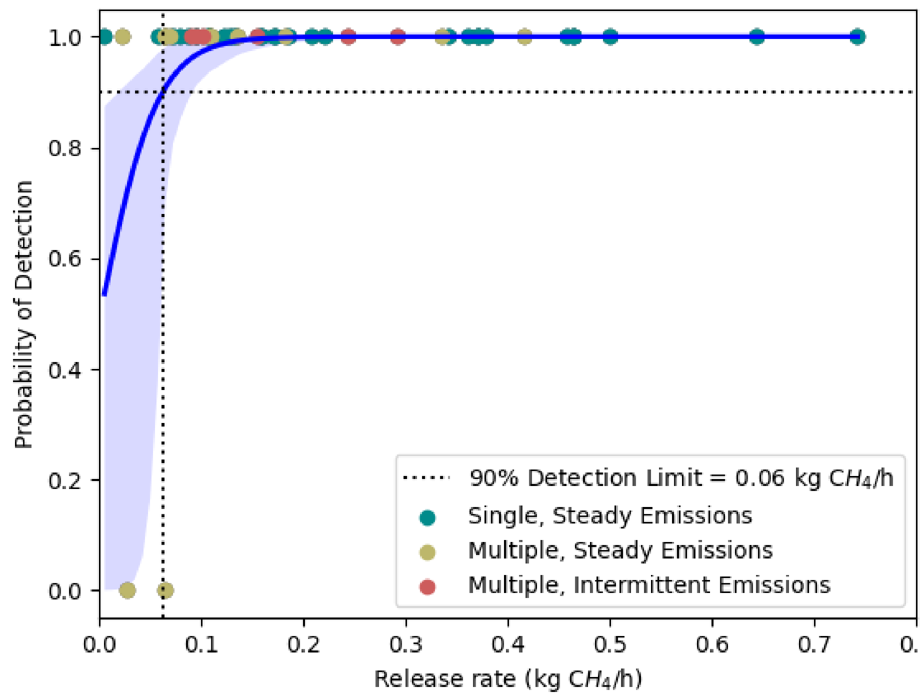
An Alert outcome necessitates a full facility follow up per §60.5398b(b) by the owner or operator. Any additional information provided by LongPath, outside of what is included in this method, (e.g., localization information, expected versus allowed emissions) may be used by the owner or operator to support decisions related to the full facility follow up at the risk of the owner or operator. However, the additional information provided by LongPath must not be the only information used to make decisions related to facility wide follow ups. For example, the owner or operator may not use LongPath localization data alone to limit the scope of a full-site follow up, and the owner or operator may not use modeled allowable emissions provided by LongPath alone to conduct a desk assessment and determine OGI follow up is not required; additional credible information from another source is required.

13. Method Performance

13.1 Validation of Method Sensitivity

In third-party blind testing at METEC, the LongPath measurement system had a 100% success rate in detecting the presence and absence of leaks for single steady emission points (Alden et al., 2019) and a 100% success rate in detecting the presence and absence of leaks greater than 0.096 kg/hr (5 scfh) for more complex combinations of multiple and intermittent emissions sources. generate a probability of detection curve that shows a 90% probability of 0.06 kg/hr, including all levels of emissions complexity: steady, intermittent, single point, and multiple point emission sources.

Figure 4.3 Probability of detection curve with individual tests by complexity.



13.1.1 Validation of Method Quantification

In third-party blind testing at METEC, the quantification of emission rate was accurate, on average, to ± 27% for single steady emission sources ± 40% for multiple, low-rate, and intermittent emissions (Alden et al., 2019). Blinded field trials on active oil and gas pads provide further demonstration of quantification capabilities. Across 29 tests, spanning metered rates from 0.6 to 243 kg/hr and across 4 different basins in the US, the LongPath Emissions Sensing Network™ system demonstrated an average quantification accuracy of ± 10%. Repeat, long-term measurements at an underground natural gas storage facility show excellent agreement between LongPath (ground-based) and aircraft-based methods (Alden et al., 2020).

13.2 Validation of Method Envelope of Operation

Method interferences and envelope of operation are summarized in Table 4.1 in Section 4. Discussion and data in support of the method's field-validated envelope of operation is discussed here.

13.2.1 Laser Light Return Power

Optical attenuation (e.g., from temporary physical obstruction, precipitation, or fog) can occlude the laser signal and reduce signal return to the detector. The required mitigation of this limitation is to continue attempting measurements until sufficient return power is obtained.

13.2.2 Temperature Range

Temperatures above 50 °C risk overheating of electronics. Temperatures up to 44 °C have been robustly demonstrated in field conditions. Temperatures below -40 °C are outside of the recommended conditions for gimbal operation. Temperatures as low as -34 °C have been robustly demonstrated in field conditions.

13.2.3 Wind Speed Range

Wind speed must be at or above 1 m/s to ensure successful modeling. This limitation is drawn from the recommendation of De Visscher, 2013. Wind speed must be at or below 10 m/s to ensure successful modeling. The highest wind speed measured during blind field validation testing of the method was 10 m/s. The required mitigation of this limitation is to flag data collected outside this envelope and not use for periodic test.

13.2.4 Laser Beam Path Location

Angular separation between laser beam paths that is too low can lead to unintentional signal acquisition from neighboring retroreflective mirrors. The required mitigation of this limitation is to ensure that installed systems have a minimum angular distance between adjacent retroreflective mirrors that matches gimbal pointing and accuracy, and to flag data during real-time data collection if the installation and siting have failed to prevent this occurrence.

13.2.5 Line of Sight

Topographic or other features can block laser light from traveling between the transceiver and retroreflective mirror. The required mitigation of this limitation is to confirm line-of-sight between transceiver and retroreflective mirror during planning, installation, and re-siting.

13.2.6 Solar Power Battery Capacity

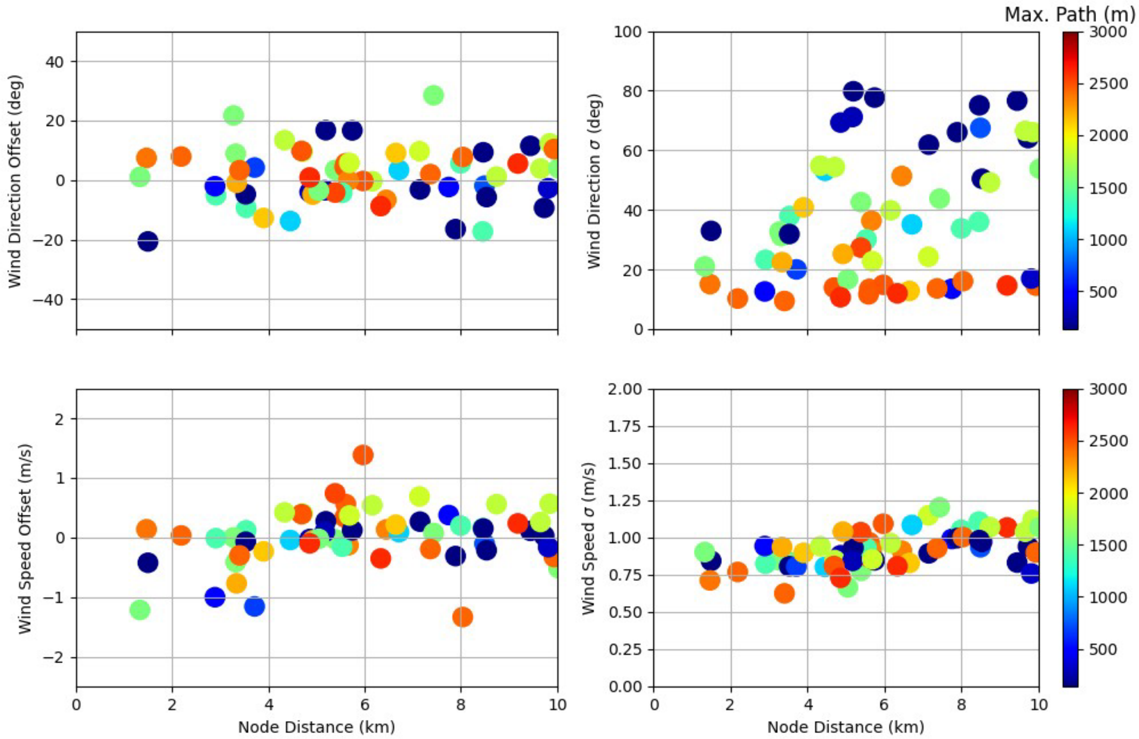
Extended periods of uncharacteristically low sunlight can lead to insufficient power for solar powered systems. The required mitigation of this limitation is to temporarily suspend system operation until solar power returns.

13.3 Validation of Data Quality Indicators

All data quality indicators cited in Section 9 are derived from successful operation of field systems across all major US basins and geographies according to the specified requirements of the method.

13.4 Validation of Meteorology Data Extrapolation

The LongPath Emissions Sensing Network™ System uses one anemometer at the central node location to represent meteorology at all sites monitored by that node. Data comparisons between geographically adjacent anemometers operated as part of the LongPath network show that as topography supports longer path lengths, wind data is more strongly correlated across longer distances. Offset is defined as the difference in wind speed and wind direction between neighboring anemometers, with the distance between the anemometers shown on the x-axis and the maximum pathlength of a beam on the node shown on the color bar.



The wind speed and wind direction offsets differences between anemometer locations center strongly around zero and have high R values (0.91 and 0.98, respectively), indicating that high agreement and no bias emerges from extrapolating wind information across large distances. The finding that longer pathlengths are associated with smaller offsets in wind differences further supports the extrapolation of wind information across larger distances where topography allows longer beam paths.

Wind Speed Average Offset (m/s)	-0.02	Wind Direction Average Offset (deg)	-1.91
Wind Speed Std of Offset (m/s)	0.89	Wind Direction Std of Offset (deg)	18.45
Wind Speed R Value of Offset	0.91	Wind Direction R Value of Offset	0.98

This analysis demonstrates that meteorological information for up to 10 km away may be used for parameterization of atmospheric transport models for individual oil and gas sites.

14. Pollution Prevention

[Reserved]

15. Data Management and Recordkeeping

Spectrometer and anemometer data, as well as system diagnostics, are collected and stored at the central processing computer (located at the central node). Data processing occurs at the central processing computer. Processed data is securely transferred from the central processing computer to a central server via communications on the central node.

Data transferred to the owner or operator includes the results of the fugitive emission screening: the presence of an alert or non-alert, and other metadata described in the site monitoring plan. This data is transferred to the owner or operator via secure cloud transfer.

Processed data that is transferred to the central server is maintained for a period of 5 years to be consistent with the recordkeeping requirements as specified in §60.5420b(c).

16. References

1. Alden, C., Ghosh, S., Coburn, S., et al., (2018). Bootstrap inversion technique for atmospheric trace gas source detection and quantification using long open-path laser measurements. Atmospheric Measurement Techniques, 11, 1565-1582. https://doi.org/10.5194/amt-11-1565-2018
2. Alden, C. B., Coburn, S., Wright, R. J., et al. (2019). Single-blind quantification of natural gas leaks from 1 km distance using frequency combs. Environmental Science & Technology, 53(5), 2908–2917. https://doi.org/10.1021/acs.est.8b06259
3. Alden, C. B., Wright, R. J., Coburn, S. C., et al. (2020). Temporal variability of emissions revealed by continuous, long-term monitoring of an underground natural gas storage facility. Environmental Science & Technology, 54(22), 14589-14597. https://dx.doi.org/10.1021/acs.est.0c03175
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5. Coburn, S., Alden, C. B., Wright, R., et al. (2020). Long distance continuous methane emissions monitoring with dual frequency comb spectroscopy: deployment and blind testing in complex emissions scenarios. https://arxiv.org/abs/2009.10853
6. Cole, R. K., Makowiecki, A. S., Hoghooghi, N., & Rieker, G. B. (2019). Baseline-free quantitative absorption spectroscopy based on cepstral analysis. *Optics express*, *27*(26), 37920-37939. https://doi.org/10.1364/OE.27.037920
7. De Visscher, A. Air Dispersion Modeling: Foundations and Applications; John Wiley & Sons: New York, 2013.
8. Rieker, G. B., Giorgetta, F. R., Swann, W. C., et al., (2014). Frequency-comb-based remote sensing of greenhouse gases over kilometer air paths. Optica, 1, 290-298.

17. Tables, Diagrams, and Flow Charts

[Reserved]

Appendices

I. Siting Information

Planning

1. Sites are identified by the owner/operator for monitoring.
2. A site survey is scheduled to locate equipment groups, identify site boundaries, identify site equipment, identify potential leak sources, and to measure equipment heights.
3. Site information is used along with other imagery or map products available to generate a geodatabase of planned locations and heights of tower and retroreflectors by taking the 3D site survey locations and heights and running an optimization algorithm to produce ideal and feasible locations and heights.
4. Equipment locations are manually checked and adjusted as needed to ensure that planned laser beam locations bound all applicable fugitive emissions sources.
5. Heights of all equipment are confirmed to be within county and state regulations for structure heights and permits are acquired if necessary.
6. A deployment file is created that specifies the GPS coordinates for the equipment that will be installed.

Installation

The following installation procedures are example procedures but may change as needed for different locations and tower heights. All installation procedures must be approved by engineers

1. The central node location is verified using GPS coordinates from the deployment file.
2. A concrete slab is placed where the tower will be located.
3. The tower is anchored to the concrete slab base by drilling holes into the concrete base, inserting wedge anchors, and securing them with impact drivers. Guy lines are connected to the tower to stabilize it.
4. Spectrometer and anemometer are set up, including securing cables, mounting the gimbal and telescope, installing the cell antenna, and mounting the anemometer.
5. The use of a 2D or 3D anemometer is noted so that model or forecast data can be used in the case of a 2D anemometer installation.
6. Concrete blocks are stacked for mounting the solar panels. The battery box is mounted to the tower base, and batteries are installed following precise wiring instructions. Solar panels are mounted and wired, ensuring they are positioned for optimal sun exposure.
7. The system is powered on.
8. Cement blocks are placed on retroreflector mirror site locations based on the deployment file and reflectors are mounted.
9. Line-of-sight between retroreflective mirrors and transceiver is verified.
10. Angular distances between laser beams are verified.
11. Laser beam path distance measurement accuracy is verified.
12. Final “as built” deployment waypoints are used to generate the “as built” geodatabase.
13. The “as built” geodatabase is used to initialize model parameters in the atmospheric inversion.

14. The acceptable wind directions for a site are determined by modeling the concentration response to a methane leak in intervals of 5 degrees from 0 to 360 degrees on all retroreflector beam paths and selecting wind directions that have a minimum threshold sensitivity. This information is stored in software configuration files.
15. Once installed and collecting data, a mock periodic screening is performed. The results of the mock periodic screening are analyzed to determine whether the system, as installed, can meet the required detection threshold for the frequency of screening. Failure to achieve the required threshold triggers the re-siting evaluation described in Section 9.1. The results of the mock periodic screening are also analyzed to determine whether the system, as installed, can collect 3.5 hours of valid PRE within a 168-hour (7 day) period. Failure to achieve a periodic screening event duration of 7 days or less triggers the re-siting evaluation described in Section 9.1.

II. Site Monitoring Plan

This site monitoring and response plan ("monitoring plan") outlines the response actions that the owner/operator is recommended to perform in response to a periodic screening result from Alternative Test Method: Detect and Localize Methane Emissions using LongPath Emissions Sensing Network™ Technology.

All procedures for periodic screening must be followed as described in Alternative Test Method: Detect and Localize Methane Emissions using LongPath Emissions Sensing Network™ Technology.

1. Response Requirements for use of Alternative Test Method: Detect and Localize Methane Emissions using LongPath Emissions Sensing Network™ Technology

   LongPath will deliver the results of the fugitive emission screening and assessment within 5 days of the end of the periodic screening event. The Fugitive Emissions Screening Assessment result includes the following information.

Variable	Units	Description
Screening Result Recommendation	Either Alert or No Alert	A Yes/No indicator of the likelihood of a detection
Periodic Screening Emission Rate Estimate	[kg/hr]	A numerical value of median total site-wide emissions during the screening window
Screening Threshold Value	[kg/hr]	A numerical value of the screening threshold per table 1 or 2 to this subpart, based on the required frequency for conducting monitoring surveys in § 60.5397b(g)(1)(i)-(v)

Screening Start Date / Time	Date / Time	Start date and time of the periodic screening event
Screening End Date / Time	Date / Time	End date and time of the periodic screening event
Periodic Screening Event Duration	[Days, Hours, Minutes]	Total duration from start to end of screening event
Fugitive Emission Screening Duration	[Hours, Minutes]	Cumulative duration of valid measurements in screening event
90% PoD	[kg/hr]	A numerical value of the 90% Probability of Detection value representative of the screening event

The following meta data will be maintained in LongPath records for each monitored site, with availability to operator as needed.

Variable	**Units**	**Description**
Retroreflective Mirror(s) latitude	List of latitude coordinates	Latitude of all mirrors used in monitoring the site
Retroreflective Mirror(s) longitude	List of longitude coordinates	Longitude of all mirrors used in monitoring the site
Retroreflective Mirror(s) height above ground	List of heights	Height of all mirrors used in monitoring the site
Mock Periodic Screening Threshold Value	[kg/hr]	Value of the most recent mock periodic screening 90% PoD threshold value

The owner/operator further has access to the time history of daily emissions data at the monitored site as measured by LongPath, including a heat map of emissions locations and relative rates.

“Alert” indicates a full site methane periodic screening emission rate estimate above the alerting threshold defined in the ATM; “No Alert” indicates a full site methane periodic screening emission rate estimate below the defined methane threshold. At the request of the owner or operator, LongPath may also provide supplemental documentation that may be helpful for finding leaks or contextualizing leak types. These supplemental documents are not part of the EPA validated ATM and must not be used to limit the full site follow up. If an alert is triggered, a facility-level follow up is required §60.5398b(b)

<u>In the case of a No Alert result:</u>

The owner/operator is recommended to log a non-detection for the screening. The operator would then have any further responsibilities in Section 1 of this monitoring plan and may move on to Sections 2-11 of this monitoring plan for recordkeeping and reporting.

<u>In the case of an Alert result:</u>

The owner/operator is recommended to investigate a possible detection finding.

An Alert necessitates a full facility follow up per §60.5398b(b) by the owner or operator. Any additional information provided by LongPath, outside of what is included in this method, (e.g., localization information, expected versus allowed emissions) may be used by the owner or operator to support decisions related to the full-facility follow up at the risk of the owner or operator. However, the additional information provided by LongPath must not be the only information used to make decisions related to facility wide follow ups. For example, the owner or operator may not use LongPath localization data alone to limit the scope of a full-site follow up, and the owner or operator may not use modeled allowable emissions provided by LongPath alone to conduct a desk assessment and determine OGI follow up is not required; additional credible information from another source is required.

If the owner/operator confirms a detection finding, then the facility-level follow-up requirements described in §60.5398b(b) must be employed.

2. **Site Listing**

Please identify the scope of this monitoring plan:

_____ Site-Specific

_____ Multiple-Site

The below table lists the site(s) that will be monitored with periodic screening, including latitude and longitude coordinates of the site in decimal degrees to an accuracy and precision of at least four decimals of a degree using the North American Datum of 1983.

Site Identification	Latitude	Longitude

Optionally, a CSV with site identification and latitude and longitude may be appended to the owner or operator's monitoring plan.

3. **Contact Information**

The following table identifies the entities that will be performing periodic screenings.

Entity Identification	Entity Contact Information

4. **Screening Frequency**

The following screening frequencies will be used on the following sites.

Site Identification	Screening Frequency

Optionally, a CSV with site identification and screening frequency may be appended to the owner or operator's monitoring plan.

The below tables may used for reference.

Site Type	Periodic Screening Reference Matrix
Single Wellhead Only	Matrix 2
Small Wellsite	Matrix 1
Multi Wellhead Only	Matrix 2
Other Production Facility	Matrix 1
Compressor Station	Matrix 1

Matrix 1: Screening Frequencies for Larger Production Facilities and Compressor Stations.	
Minimum Screening Frequency	**Minimum Detection Threshold (kg/hr)**
Quarterly	≤1
Bi-Monthly	≤2
Bi-Monthly + Annual OGI	≤10
Monthly	≤5
Monthly + Annual OGI	≤15

Matrix 2: Screening Frequencies for Wellhead Only Facilities and Small Wellsites.	
Minimum Screening Frequency	**Minimum Detection Threshold (kg/hr)**

Semi-Annually	≤1
Tri-Annually	≤2
Tri-Annually + Annual OGI	≤10
Quarterly	≤5
Quarterly + Annual OGI	≤15
Bi-Monthly	≤15

5. **Annual OGI/Method 21 Surveys**

Yes / No : Some or all of the sites in this monitoring plan have an Annual OGI/Method 21 Requirement.

If "Yes" is circled, then the information in this section must be filled in for those sites for which an Annual OGI/Method 21 Survey is required. If "No" is circled, then move on to the next section and leave the remainder of this section blank.

The below table shows OGI/Method 21 screening frequency, technique, and manufacturer and model number for each relevant site.

Site Identification	**OGI/Method 21 Screening Frequency**	**Technique for Determining Fugitive Emissions (Method 21 or OGI)**	**Manufacturer and model number of equipment**

Optionally, a CSV with site identification and OGI screening frequency, technique, and manufacturer and model number may be appended to the owner or operator's monitoring plan.

A set of procedures and timeframes for identifying and repairing fugitive emissions components from which fugitive emissions are detected, including timeframes for fugitive emissions components that are unsafe to repair, may be appended to the owner or operator's monitoring plan.

A set of procedures and timeframes for verifying fugitive emissions component repairs may be appended to the owner or operator's monitoring plan.

A description of records that will be kept and the length of time records will be kept may be appended to the owner or operator's monitoring plan.

Verification that any OGI equipment to be used meets specifications may be appended to the owner or operator's monitoring plan.

Verification that any Method 21 equipment to be used meets specifications may be appended to the owner or operator’s monitoring plan.

A set of procedures for demonstrating that OGI surveys used will ensure that all fugitive emissions components are monitored during each survey may be appended to the owner or operator’s monitoring plan.

A set of procedures and plans for demonstrating that Method 21 surveys used will ensure that all fugitive emissions components are monitored during each survey may be appended to the owner or operator’s monitoring plan.

6. **Follow-Up OGI/Method 21 Monitoring Surveys**

In the case of follow-up OGI/Method 21 in response to a confirmed detection from an owner/operator’s review of a fugitive emission screening assessment, the following procedures may be used for conducting monitoring surveys. The below table shows the techniques, and manufacturers and models that may be used.

Technique for Determining Fugitive Emissions (Method 21 or OGI)	Manufacturer and model

Optionally, a CSV with techniques, and manufacturers and models number may be appended to the owner or operator’s monitoring plan.

Verification that any OGI equipment to be used meets specifications may be appended to the owner or operator’s monitoring plan.

Verification that any Method 21 equipment to be used meets specifications may be appended to the owner or operator’s monitoring plan t.

A set of procedures for demonstrating that OGI surveys used will ensure that all fugitive emissions components are monitored during each survey may be appended to the owner or operator’s monitoring plan.

A set of procedures and plans for demonstrating that Method 21 surveys used will ensure that all fugitive emissions components are monitored during each survey may be appended to the owner or operator’s monitoring plan.

7. **Procedures and Timeframes for Identification and Repair**

Procedures and timeframes for identifying and repairing fugitive emissions components, covers, and closed vent systems for which emissions are detected may be appended to the owner or operator’s monitoring plan.

8. **Procedures and Timeframes for Verifying Repair**

Procedures and timeframes for verifying repairs for fugitive emissions components, covers, and closed vent systems may be appended to the owner or operator's monitoring plan.

9. **Reporting**

The information submitted in reports for this Monitoring Plan, per the periodic screening requirements in § 60.5424b(b), are described here.

Information to be submitted in each annual report, per §60.5424b(b)		
Requirement Source	**Requirement Summary**	**Demonstration of Compliance**
§60.5424b(b)(1)	Date of each periodic screening during the reporting period (start and end date) and date that the results were received	Annual Report Template 1: Periodic Screenings Performed (see below)
§60.5424b(b)(2)	Alternative test method and technology used for each screening and spatial resolution	Annual Report Template 1: Periodic Screenings Performed (see below)
§60.5424b(b)(3)	Any deviations from the Monitoring Plan or statement that there were no deviations	Annual Report Template 1: Periodic Screenings Performed (see below)
§60.5424b(b)(4)	Results from the periodic screening	Annual Report Template 1: Periodic Screenings Performed (see below)
§60.5424b(b)(4)(i)-(iv)	Information about each confirmed detection	Annual Report Template 2: Confirmed Detection Additional Information (see below)
§60.5424b(b)(4)(iv)(A)-(D)	Information about each fugitive emission or emission or detect of a cover or closed vent system	Annual Report Template 3: Confirmed Detection Additional Information (see below)
§60.5424b(b)(5)(i)-(iv)	Information about annual OGI surveys or OGI surveys that replace a periodic screening event	Annual Report Template 4: Annual or Periodic OGI Surveys (see below)

The information in the below table, “Annual Report Template 1: Periodic Screenings Performed”, will be included in each annual report, satisfying the requirements in §60.5424b(b)(1)-(4).

Annual Report Template 1: Periodic Screenings Performed							
Site Identification	**Screening Event ID**	**Start Date of Periodic Screening**	**End Date of Periodic Screening**	**Alternative Test Method and Technology Used**	**Spatial Resolution of the Screening**	**Deviations from Monitoring Plan or Statement of No Deviations**	**Results of Periodic Screening (detect or no detect)**

Each periodic screening event will be assigned a unique identifier (Screening Event ID), which can be used to index the results of each screening and all required follow-up actions.

The information in the below table, “Annual Report Template 2: Confirmed Detection Additional Information”, will be included in each annual report, satisfying the requirements in §60.5424b(b)(4)(i)-(iv). For any periodic screenings during the reporting period that results in a detection (“Results of Periodic Screening (detect or no detect)” column above shows “detect”), the following information will be provided.

Annual Report Template 2: Confirmed Detection Additional Information			
Screening Event ID	**Date Follow-Up OGI/Method 21 Completed**	**Date Instrument Inspections Completed**	**Date Visual Inspections Completed**

The information in the below table, “Annual Report Template 3: Confirmed Detection Additional Information”, will be included in each annual report, satisfying the requirements in §60.5424b(b)(4)(iv)(A)-(D). For each emission or defect of a cover or closed vent system identified, the following information will be provided.

Annual Report Template 3: Confirmed Detection Additional Information						
Screening Event ID	**Emission Number Label Each**	**Type of Component or Cover or Closed Vent**	**Defect Description if Needed**	**Date of Repair**	**Delay of Repair (Yes/No)**	**Explanation for Delay of Repair**

	Row 1 through (N)					

The information in the below table, "Annual Report Template 4: Annual or Periodic OGI Surveys", will be included in each annual report, satisfying the requirements in §60.5424b(b)(5)(i)-(iv). For each annual OGI survey or OGI survey performed to replace a periodic screening survey, the following information will be provided.

Annual Report Template 4: Annual or Periodic OGI Surveys						
Date of OGI Survey when Emission was Detected	**Emission Number, Label Each Row 1 through (N), Restarting at 1 for Each Unique Survey**	**Type of Component or Cover or Closed Vent**	**Defect Description if Needed**	**Date of Repair**	**Delay of Repair (Yes/No)**	**Explanation for Delay of Repair**

10. **Recordkeeping**

The list of records that will be maintained for this Monitoring Plan, per the periodic screening requirements in § 60.5424b(c), are described here.

Records that must be maintained, per §60.5424b(c)		
Requirement Source	**Requirement Summary**	**Demonstration of Compliance**
§60.5424b(c)(1)	The monitoring plan as required in §60.5398b(b)(2)	Owner or operator monitoring plan
§60.5424b(c)(2)	Date of each periodic screening and date that results were received	Records Maintained Template 1: Periodic Screenings Performed (see below)
§60.5424b(c)(3)	Name of the screening operator	Records Maintained Template 1: Periodic

		Screenings Performed (see below)
§60.5424b(c)(4)	Alternative test method and technology used and spatial resolution of screening	Records Maintained Template 1: Periodic Screenings Performed (see below)
§60.5424b(c)(5)	Records of calibrations	NA
§60.5424b(c)(6)	Results from each periodic screening	Records Maintained Template 1: Periodic Screenings Performed (see below)
§60.5424b(c)(6)(i)-(v)	Information about each confirmed detection	Records Maintained Template 2: Confirmed Detection Additional Information (see below)
§60.5424b(c)(6)(v)(A)-(E)	Information about each fugitive emission or emission or detect of a cover or closed vent system	Records Maintained Template 3: Confirmed Detection Additional Information (see below)
§60.5424b(c)(6)(v)(D)	Information about components with delayed repair	Records Maintained Template 4: Confirmed Detection Additional Information (see below)
§60.5424b(c)(7)	Date and result of investigative analysis of emissions from control device, cover or closed vent system	Records Maintained Template 5: Confirmed Detection Additional Information (see below)
§60.5424b(c)(8)	Dates of implementation and completion of action(s) taken for emissions from control devices, cover or closed vent system	Records Maintained Template 5: Confirmed Detection Additional Information (see below)
§60.5424b(c)(9)	Information about annual OGI surveys or OGI surveys that replace a periodic screening event	Records Maintained Template 6: Annual or Periodic OGI Surveys (see below)

§60.5424b(c)(10)	Deviations from monitoring plan	See below
§60.5424b(c)(11)	Any additional records required by alternative approval	NA
§60.5420b(c)(3)	Records for associated gas wells	See Regulatory Text
§60.5420b(c)(4)	Records for centrifugal compressor affected facilities	See Regulatory Text
§60.5420b(c)(5)	Records for reciprocating compressor affected facilities	See Regulatory Text
§60.5420b(c)(6)	Records for process controller affected facilities	See Regulatory Text
§60.5420b(c)(7)	Records for storage vessel affected facilities	See Regulatory Text
§60.5420b(c)(8)	Records for closed vent system inspections	See Regulatory Text
§60.5420b(c)(9)	Records for cover inspections	See Regulatory Text
§60.5420b(c)(14)	Records for fugitive emissions components affected facilities	See Regulatory Text
§60.5420b(c)(15)	Records for pump affected facilities	See Regulatory Text

The information in the below table, “Records Maintained Template 1: Periodic Screenings Performed”, will be included in each annual report, satisfying the requirements to maintain records of periodic screenings per §60.5424b(c)(6).

Records Maintained Template 1: Periodic Screenings Performed								
Site Identification	**Screening Event ID**	**Start Date of Periodic Screening**	**End Date of Periodic Screening**	**Name of screening operator**	**Alternative Test Method and Technology Used**	**Spatial Resolution of the Screening**	**Deviations from Monitoring Plan or Statement of No Deviations**	**Results of Periodic Screening (detect or no detect)**

The information in the below table, "Records Maintained Template 2: Confirmed Detection Additional Information", will be included in each annual report, satisfying the requirements in §60.5424b(c)(6)(i)-(v). For any periodic screenings during the reporting period that results in a detection ("Results of Periodic Screening (detect or no detect)" column above shows "detect"), the following information will be documented.

Records Maintained Template 2: Confirmed Detection Additional Information				
Screening Event ID	**Date Follow-Up OGI/Method 21 Completed**	**Name of operator(s) performing the survey or inspection**	**Identification of monitoring instrument(s) used**	**Records of calibrations for the instrument(s) used**

The information in the below table, "Records Maintained Template 3: Emission Detection Additional Information", will be included in each annual report, satisfying the requirements in §60.5424b(c)(6)(v)(A)-(F). For each fugitive emission and emission or defect of a cover or closed vent system identified, the following information will be documented.

Records Maintained Template 3: Confirmed Detection Additional Information							
Screening Event ID	**Emission Number Label Each Row 1 through (N)**	**Location of fugitive emission using unique identifier of source and type**	**Location of emission or defect from cover or closed vent system using unique identifier for source**	**Defect Description if a closed vent system, cover or control device is identified**	**Date of Repair**	**Delay of Repair (Yes/No)**	**Explanation for Delay of Repair**

The information in the below table, "Records Maintained Template 4: Confirmed Detection Additional Information", will be included in each annual report, satisfying the requirements in §60.5424b(c)(6)(v)(F). For each fugitive emission component placed on delay of repair for reason of replacement component unavailability, the following information will be documented.

Records Maintained Template 4: Confirmed Detection Additional Information					
Screening Event ID	**Emission Number Label Each Row 1 through (N)**	**Date component added to delay of repair list**	**Date replacement component or part ordered**	**Anticipated component delivery date**	**Actual arrival date of component**

The information in the below table, "Records Maintained Template 5: Confirmed Detection Additional Information", will be included in each annual report, satisfying the requirements in §60.5424b(c)(7). For each investigative analysis conducted in accordance with §60.5398b(b)(5)(vi)-(vii) (the confirmed detection was caused by a failure of a control device used to demonstrate continuous compliance under this subpart or was caused by an emission or defect in a cover or closed vent system), the following information will be documented.

Records Maintained Template 5: Confirmed Detection Additional Information						
Screening Event ID	**Emission Number Label Each Each Row 1 through (N)**	**Date investigative analysis initiated**	**Result of investigative analysis**	**Date of implementation of actions**	**Description of actions**	**Date of completion of actions**

The information in the below table, "Records Maintained Template 6: Annual or Periodic OGI Surveys", will be included in each annual report, satisfying the requirements in §60.5424b(c)(9)(i)-(vii). For each annual OGI survey or OGI survey performed to replace a periodic screening survey, the following information will be provided.

Records Maintained Template 6: Annual or Periodic OGI Surveys								
Date of OGI	**Emissio n Numbe**	**Locatio n of each**	**Type of Compon ent or**	**Date of first**	**Date of success**	**Date of resurvey for**	**Identificat ion of compone**	**Explanati on for**

Survey	r, Label Each Row 1 through (N), Restarting at 1 for Each Unique Survey	fugitive emission identified	Cover or Closed Vent for emissions identified	attempt at repair	ful Repair	verification	nt if placed on delay of repair	Delay of Repair

Records of any deviations from the monitoring plan must be maintained, as well as a statement of "no deviations" if there were no deviations from the monitoring plan, per §60.5424b(c)(10).