

**Sensirion Connected Solutions Nubo Sphere: Periodic Fugitive Methane Emission Monitoring**

**1 Scope and Application**

**1.1 Scope**

This method is applicable for demonstrating compliance with the procedures in 40 CFR §60.5398b for fugitive emissions components affected facilities and compliance with periodic inspection and monitoring requirements for covers and closed vent systems, specifically demonstrating compliance through periodic screening in 40 CFR §60.5398b(b), as approved, per 40 CFR §60.5398b(d). Affected facilities could include but are not limited to, single wellhead only sites, small well sites, multi-wellhead sites, well sites with major production and processing equipment, centralized production facilities, and compressor stations.

**1.2 Application**

1.2.1 The application of Sensirion Connected Solutions (SCS) Nubo Sphere laser-based photoacoustic methane sensing 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. SCS is the sole provider of this technology.

1.2.2 The test method is applicable to methane (CH<sub>4</sub>, CAS No. 74-82-9) emissions from oil and gas facilities. This method can be used, as approved by the Administrator, in lieu of the applicable fugitive monitoring requirements in either 40 CFR §60.5397a or §60.5397b and inspection and monitoring of covers and closed vent systems in either 40 CFR §60.5416a or §60.5416b. This test method may be used for fugitive monitoring requirements in 40 CFR §60.5397c and monitoring of covers and closed vent systems under 40 CFR §60.5416c when a state, local, or tribal authority incorporates the model rule (i.e., EG 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 1, 2, 3, 5, 10, or 15 kg/hr alerting threshold. The device's Minimum Detection Limit (MDL) is 0.1 kg/hr. Operators will select the alerting threshold based on their specific site characteristics and operator practices and will define the appropriate threshold in their monitoring plan (see Appendix II for an example monitoring plan). The spatial resolution of follow-up required for this method is facility-level per 40 CFR §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. Technology's objective is to screen fugitive emissions rates detected at the specified screening frequencies defined in Tables 1 and 2 and to provide an alert to an operator that triggers a leak detection and survey response.

**Table 1. Method Detection Limits and Screening Frequencies – Oil and Gas Multi-wellhead Sites, Well Sites with Major Production and Processing Equipment, Centralized Production Facilities, and Compressor Stations**

Method Detection Limit	Screening Frequency
1 kg/hr	Quarterly
2 kg/hr	Bimonthly
5 kg/hr	Monthly
10 kg/hr	Bimonthly
15 kg/hr	Monthly

**Table 2. Method Detection Limits and Screening Frequencies – Oil and Gas Single Wellhead Sites and Small Well Sites**

Method Detection Limit	Screening Frequency
1 kg/hr	Semiannual
2 kg/hr	Triannual
5 kg/hr	Quarterly
10 kg/hr	Triannual
15 kg/hr	Bimonthly or Quarterly

## 2 Summary of Method

- 2.1 Methane concentration data measured by a point-sensor network are combined with wind data and an inversion plume dispersion [1] model to detect, localize and quantify methane emissions on oil and gas sites. Localization is only for modeling the methane emission rate and providing an estimate of the likely origin of the emission.
- 2.2 The sensor nodes of the point-sensor network and the anemometer(s) are positioned at the fence line around the site and at selected positions on the site.
- 2.3 Local methane concentrations are measured using a laser-based photoacoustic methane sensor using a laser source emitting infrared radiation with a wavelength specific to a methane absorption line.
- 2.4 Methane emissions rates are determined using a human-supervised plume dispersion and inversion algorithm.
- 2.5 To perform periodic screening, methane emission data, atmospheric conditions and system health information are recorded for the periodic screening period and transmitted via wireless communication to the cloud.
- 2.6 QAQC checks as described in section 9 are performed to determine if the periodic screening is “valid”.

- 2.7 If all quality checks are passed (“valid screening”), the average site emission rate estimate is calculated for the periodic screening period.
- 2.8 An alert is generated if the Average Site Emission Estimate is above the applicable alerting threshold.
- 2.9 In case of an alert, the owner or operator must conduct a facility-wide follow up survey using OGI or Method 21.
- 2.10 Initial sensor placement including positioning and determination of the number of sensors is performed using SCS’s siting procedure contained in Appendix I – Siting Procedure.

### **3 Definitions of Method**

#### **3.1 Definitions**

- 3.1.1 **Alerting Threshold:** the minimum detection threshold associated with the screening frequencies in Tables 1 and 2. These values are used as alerting thresholds, where an alert is issued when the Average Site Emission Rate Estimate measured during the periodic screening event exceeds the applicable minimum detection threshold listed in Table 1 and 2.
- 3.1.2 **Average Site Emission Rate Estimate:** is a single data point resulting from the periodic screening event. This rate is defined as the total amount of methane emitted during the periodic screening event divided by the duration of the periodic screening event. The total amount of methane is calculated by summing the amount of methane emitted for all emission events detected from the site.
- 3.1.3 **Coverage Area:** area covered by the plume from an emission source. The coverage area depends on the emission rate, wind speed, and the wind direction. It is used in the coverage QAQC check to determine if an emission source is covered by the Nubo Sphere monitors.
- 3.1.4 **Device Health:** system status of the Nubo Sphere monitor including battery charging status, sensor status, and connectivity.
- 3.1.5 **Emission Event:** period during which methane concentrations exceed the atmospheric background of 2 ppm by 0.6 ppm, triggering the subsequent localization and quantification of the emission. For every emission event, a start and stop time, an emission source, an emission rate time series, and the total amount of methane emitted are determined.
- 3.1.6 **Fugitive emissions screening assessment:** 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).
- 3.1.7 **GNSS sensor:** global navigation satellite system sensor on every Nubo Sphere monitor to determine the position of the device.
- 3.1.8 **Initial Siting:** process to determine the number and positions of Nubo Sphere monitors before the installation of the monitors.

- 3.1.9 **Minimum Detection Limit:** the Nubo Sphere's 90% probability of detection emission rate.
- 3.1.10 **Nubo Sphere monitor:** sensor node hardware including the photoacoustic methane sensor.
- 3.1.11 **Photoacoustic methane sensor:** methane sensor used in the Nubo Sphere monitoring system based.
- 3.1.12 **Sensor cartridge:** removable part of the Nubo Sphere monitor which contains the photoacoustic methane sensor and a temperature and humidity sensor. This allows for easy maintenance in case a sensor replacement is required.
- 3.1.13 **Siting:** procedure to determine the number of Nubo Sphere monitors on a site as well as their positioning to ensure coverage of all emission sources on the site.
- 3.1.14 **System health:** system status of the Nubo Sphere methane monitoring system to ensure valid methane measurements. It includes the status of the Nubo Sphere monitors, the connectivity, and data transfer and processing.
- 3.1.15 **Wind rose:** Average wind speed and frequency as a function of wind angle over a 1-year period visualized on a circle (wind rose).

## 3.2 Abbreviations

- 3.2.1 **2G:** second generation, referring to the second-generation of mobile telecommunications technology.
- 3.2.2 **AH:** absolute humidity
- 3.2.3 **GNSS:** Global Navigation Satellite System
- 3.2.4 **IR:** Infrared
- 3.2.5 **ISO27001:** international standard for information security
- 3.2.6 **LTE:** long-term evolution is a standard for wireless broadband communication
- 3.2.7 **MDL:** Minimum Detection Limit
- 3.2.8 **QAQC:** Quality Assurance Quality Control
- 3.2.9 **RH:** relative humidity
- 3.2.10 **SCS:** Sensirion Connected Solutions

## 4 Method Interferences and Envelope of Operation

**Table 3. Summary of SCS Nubo Sphere Method Interferences and Envelope of Operation**

Condition	Summary	Mitigation
Trace gases	Natural gas contains multiple gases at various concentrations that exhibit unique mid-infrared (IR) absorption profiles	Use of a sensor designed to operate in the mid-IR absorption band that maximizes methane absorption to minimize cross-sensitivity with other trace gases present
Sensor placement and source coverage	Nubo Sphere monitors must be placed such that all potential emission sources are covered given the prevailing wind direction and variation of wind direction on the site	Siting must follow SCS's siting protocol described in Appendix I to ensure coverage of sources under prevailing wind directions
Wind speed	Wind speeds must be between 1 m/s and 10 m/s to transport methane to sensors for detection without too much dilution	Data collected outside this envelope is not used for periodic test
Temperature	Temperatures must be between -20°C and 50°C (-4°F and 122°F)	Data collected outside this envelope is not used for periodic test
Absolute humidity	Absolute humidity must be between 0.7 g/m <sup>3</sup> and 50 g/m <sup>3</sup>	Data collected outside this envelope is not used for periodic test
Solar radiation	The location of the Nubo Sphere monitor must ensure sufficient solar radiation for regular battery charging	Siting must follow SCS's siting protocol described in Appendix I to ensure placement of monitors allows for sufficient solar charging capabilities
LTE connectivity	LTE or 2G cellular connectivity are required to transmit data from the monitors to the cloud for data processing	Periods with lost data due to lack of connectivity are not used for periodic test
Hazardous zones	Nubo Sphere monitors are not rated for use in hazardous zones	Siting must follow SCS's siting protocol described in Appendix I to ensure placement of monitors outside of hazardous zones
Ambient Noise	Photoacoustic sensor technology might be impacted by extremely high levels of ambient noise.	High noise levels are detected by the photoacoustic sensor and removed as part of the QAQC checks.

## **5 Safety**

### **5.1 Disclaimer**

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.

### **5.2 Field safety**

All personnel performing installation or field maintenance must complete a Sensirion-internal safety training, follow standard safety procedures, and obtain safety certificates as required for the site where the sensor network will be installed. Nubo Sphere monitors must not be positioned within hazardous areas or where they would interfere with regular operations of the site. Ensure all monitors are mounted on poles that are properly secured against falling.

## **6 Equipment and Supplies**

### **6.1 Nubo Sphere monitor package**

Each Nubo Sphere monitor package shall include the following equipment:

- 1 sensor node that includes a preinstalled Nubo Sphere laser-based photoacoustic methane sensing cartridge
- 1 solar panel with mount and cable
- 2 pole mounts
- 4 band ties for the pole mounts

### **6.2 Wind Meter Package**

Each Nubo Sphere wind meter package shall include the following equipment:

- 1 wind meter, including cable
- 1 wind meter mounting adapter
- 1 pole mount
- 2 band ties for the pole mount

### **6.3 Wind Meter**

The wind meter must be able to measure wind direction in at least two dimensions as well as wind speed in the range of 0 m/s to 15 m/s. Wind speeds above 15 m/s exceed the Nubo Sphere operating window for this alternative test method. The accuracy of the wind meter must be 5% RMSE (root mean square error) at 12 m/s. The wind meter must be installed at least 2 meters above ground level.

### **6.4 Temperature and Humidity Sensor**

The temperature and humidity sensor must be able to measure temperature in the range of -40°C to 60°C and humidity in the range of 0%-100% relative humidity. The accuracy of the temperature and humidity sensor must be +/- 0.2°C (temperature) and +/- 2% (relative humidity).

#### 6.5 Mounting poles

Mounting poles with a height of approximately 2 to 3m (6.5 to 10ft) must be installed at positions determined in the siting procedure. The poles must be secured against tipping-over and rotation.

#### 6.6 Photoacoustic methane sensor

The sensor nodes shall be capable of measuring methane concentrations with a detection limit<sup>1</sup> of <1ppm, an accuracy<sup>1</sup> of better than +/- (20% of measured value +1ppm), a response time of <10s, a measurement frequency of >1 Hz. Accuracy specifications must be checked during manufacturing for every sensor using the reference gas mixture defined in section 7.1. The photoacoustic sensor accuracy should be valid over the temperature and humidity range specified in the operating window.

#### 6.7 Software

Software and firmware to autonomously operate system and process data.

#### 6.8 Central Server

Central server to autonomously operate full system, aggregate data from various sensors, process data in real time, and store data.

#### 6.9 Connectivity

Network connectivity to transmit and receive data over existing network infrastructure

#### 6.10 GNSS

GNSS sensor to measure geospatial locations of Nubo Sphere monitors.

#### 6.11 User Manual

To ensure proper installation and operation of the Nubo Sphere, as well as adherence to all safety precautions, it is essential to follow the instructions outlined in the Nubo Sphere User Manual.

### **7 Reagents and Standards**

#### 7.1 Methane Reference Gas Mixture

At manufacturing the accuracy of the photoacoustic sensor must be validated against a reference gas mixture with a methane concentration in the range of 50 ppm to 500 ppm (200 ppm recommended) in a humid zero air matrix (relative humidity = 50%, temperature: 25°C). The concentration of the reference gas mixture must be verified with a spectroscopy reference device.

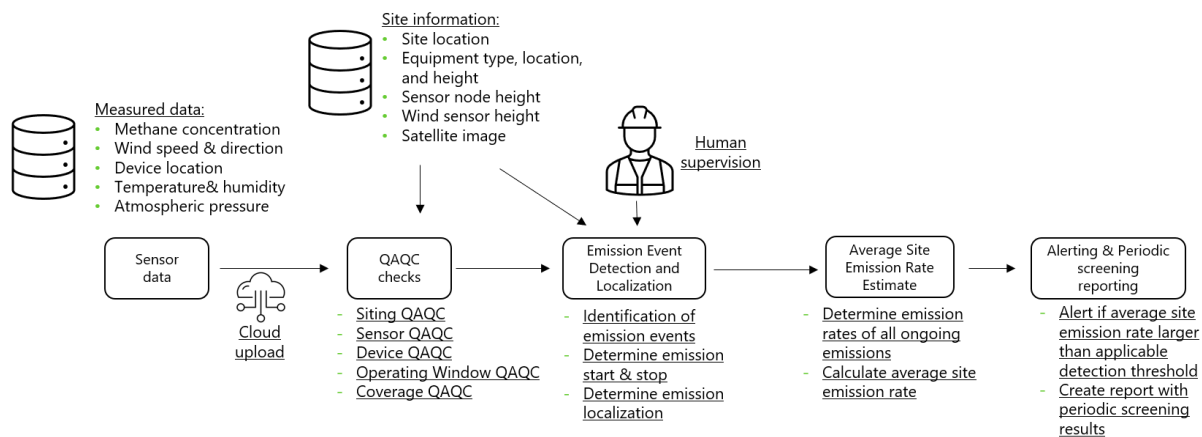
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<sup>1</sup> 3-sigma value

## 8 Data Collection and Method Input Sourcing

### 8.1 Data collection

This section describes the steps taken for data collection and data management. The specific procedures for planning, monitor placement, and installation of Nubo Sphere monitors and other necessary equipment needed to collect data are described in the siting procedure in Appendix I. The operation of monitors, collection of data, and data processing take place according to the following data collection and processing procedures.



**Figure 1.** Schematic overview of the data collection and processing workflow.

The following steps occur automatically and within the SCS platform, unless otherwise noted:

- 1) Necessary equipment for monitoring is installed per the requirements in Appendix I.
- 2) A 12h periodic screening period is determined according to the owner or operator's monitoring plan. The start of the periodic screening is noted as date and time.
- 3) Nubo Sphere methane concentration data and meteorological data (wind speed, wind direction, temperature/humidity, and atmospheric pressure) are collected continuously through time, time-stamped with UTC time of measurement and sent to the central server.
- 4) All QAQC checks are applied as described in Section 9.2.
- 5) The measurement data that passed the QAQC checks is pre-processed to generate a time series of methane concentration data points for each Nubo Sphere monitor for the periodic screening period.
- 6) In case the site coverage QAQC check for the chosen 12-hour periodic screening period fails, the screening period is extended for up to 5 days, and steps 4 and 5 are repeated until the site coverage QAQC check is passed. The stop of the periodic screening period is noted as date and time.
- 7) If the periodic screening period exceeds 5 days, the periodic screening cannot be performed, and a re-siting evaluation is triggered.



- 8) At the central server, wind speed, wind direction, and methane measurements are processed to produce emission-rate time-series for the window of time defined as the periodic screening period determined steps 2-6 for each identified emission event.
- 9) Emission events are identified, and the most likely emission source is determined following the procedure described in section 12.1.1. Specifically, the most likely location of the emission source is determined by a human reviewer in a triangulation process supported by a software tool.
- 10) The emission-rate time-series for each emission event is calculated following the procedure in section 12.1.2. The emission-rate time-series is calculated using a plume dispersion model.
- 11) The total amount of methane emitted for each emission event is calculated for the periodic screening time window.
- 12) The total amount of methane emitted for the whole site is calculated by summing methane emitted over all emission events as calculated in step 11 divided by the duration of the periodic screening to generate the facility-wide Average Site Emission Rate Estimate.

## 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 every Nubo Sphere monitor as described in section 8.1.
- 2) Processed data is synced to the central server every 15 minutes. Data is securely transferred from each Nubo Sphere monitor to the central server via LTE communications on each monitor. Up to 15 hours of measurements data is stored on each Nubo Sphere monitor to avoid data loss in case of a temporarily unavailable LTE connection.
- 3) Data is processed on the central server in multiple steps following the procedure in section 8.1.
- 4) The Fugitive Emissions Screening Assessment takes place automatically and data is delivered to the owner or operator as well as to Sensirion Connected Solutions.
- 5) All digital data transferred to the central server (measurement data, processed data) is stored indefinitely at redundant locations for data security following ISO27001 standards.
- 6) Records are provided to the owner or operator for reporting as described in section 18.3.

### Table 14. Summary of Data Collected

Instrument/Source	Variables	Use
Photoacoustic sensor	Methane concentration data	methane data to calculate emission rates and QAQC metrics
Anemometer	2D directional wind speed	Meteorological data to calculate emission rates and QAQC checks
Temperature/humidity sensor	Temperature/humidity data	Temperature/humidity compensation of methane concentration signal
GNSS sensor	Position	Device position QAQC check
Satellite image	Satellite image	Siting procedure

## 9 Quality Control

Quality Assurance and Quality Control (QAQC) metrics ensure that the data supporting the method is accurate and of quality. Each subsystem requires diagnostics, frequencies that diagnostics are checked, and corrective actions, as specified in Table 5 below.

**Table 5** - Summary of Quality Assurance and Quality Control Metrics, Acceptance Criteria, and Corrective Actions

System	Measurement	Acceptance criteria	Frequency checked	Corrective action
Siting	All potential emission sources covered	full site coverage for all 5-day periods of a year	Initial siting and re-siting evaluation as needed	Re-siting evaluation
Siting	# of sensors and position of sensors	According to siting procedure	Initial siting and every periodic screening	Re-siting evaluation
Wind sensor	Wind speed accuracy	+/- 5% at 12m/s	Verified at time of manufacturing by the supplier; no additional checks performed	Do not deploy
Wind sensor	Wind direction accuracy	+/- 4° at 12m/s	Verified at time of manufacturing by the supplier; no additional checks performed	Do not deploy
Wind sensor	Wind speed bounds x and y direction	0-60 m/s	Every measurement	Filter measurements

System	Measurement	Acceptance criteria	Frequency checked	Corrective action
Wind sensor	Wind sensor time since first deployment	<10 years	Every periodic screening	Replace wind sensor
Wind sensor	Monthly average wind speed compared to nearest meteorological station	difference between subsequent months: <30% difference between the same month 1 year ago: <30%	Every periodic screening	Trigger service event
Photoacoustic sensor	Concentration accuracy	Better than 5.25% of measured value at 200ppm	In-house manufacturing	Do not deploy
Photoacoustic sensor	Sensor error code	No error code	Every measurement	Filter measurement
Photoacoustic sensor	Sensor time since first deployment	<6 years	Every periodic screening	Replace sensor cartridge
Photoacoustic sensor	sensor noise error code	No error code	Every concentration measurement	Filter measurements for 30s
Photoacoustic sensor	methane concentration values	>1.5ppm	Every measurement	Filter measurement
RH/T sensor	Relative humidity accuracy	+/- 2% (typ.)	Verified at time of manufacturing by the supplier; no additional checks performed	Do not deploy
RH/T sensor	Temperature accuracy	+/- 0.2 °C (typ.)	Verified at time of manufacturing by the supplier; no additional checks performed	Do not deploy
RH/T sensor	Comparison with secondary RH/T sensor	difference (monthly average) temperature: <4°C;	every periodic screening	Trigger service event

System	Measurement	Acceptance criteria	Frequency checked	Corrective action
	on photoacoustic sensor cartridge	absolute humidity: < 40% of measured value		
Operating window	Wind speed	1m/s - 10m/s (rolling average over 30min)	Every measurement	Filter measurement
Operating window	temperature	-20°C – 50°C	Every measurement	Filter measurement
Operating window	Absolute humidity	0.7g/m <sup>3</sup> – 50g/m <sup>3</sup>	Every measurement	Filter measurement
Nubo Sphere Monitor	Data gaps	>10% of data points over 24h	every measurement	Trigger service event
GNSS	Position accuracy	Position within +/- 4m of target position	After installation, repositioning, and before every periodic screening	Trigger Service event
Coverage	Site coverage	20min of valid data within 12h for all potential emission sources	Every periodic screening	Extend periodic screening period up to a maximum of 5 days. Trigger a re-siting evaluation if 5 days are exceeded.

## 9.1 Siting

### 9.1.1 Initial Siting

Initial siting metrics can be found in Appendix I. The owner or operator is required to inform SCS any time a change is made to the facility layout (e.g. additional equipment is added).

### 9.1.2 Site Coverage

During the periodic screening window, all potential emission sources on the site must be adequately covered. A site is considered covered if all potential emission sources are covered during the periodic screening period.

A potential emission source is considered covered if more than 240 data points (corresponding to 20min of data per emission source) measured by any Nubo Sphere monitor are within the covered area of this

source. The emission source coverage calculation is performed according to the following the step-by-step procedure.

- 1) Determine the time series for wind speed and direction as measured by the on-site anemometer.
- 2) For each potential emission source:
  - a) Calculate the area covered by the plume (coverage area) corresponding to the minimum detection threshold applicable for this method using the wind time series and the parameters of the plume dispersion model for each data point in time of the periodic screening.
  - b) Determine the number of data points for which a Nubo Sphere monitor is within the coverage area and the data point has passed all QAQC checks in Table 5Table .
  - c) If the number of data points is equal to or exceeds 240, the emission source is covered. If all potential emission sources on a site are covered, the site is considered covered and the coverage QAQC check is passed.

#### 9.1.3 Root-Cause and Re-Siting Evaluation

Periodic screening failure root cause and re-siting must take place in the case of a QAQC failure of the following metrics:

- Periodic screening period greater than 5 days
- Re-positioning of Nubo Sphere monitors
- Equipment requiring monitoring is added to, removed from, or repositioned on the site

Re-siting evaluation procedures must be undertaken until such point as the next periodic screening demonstrates achievement of the QAQC metrics. The re-siting evaluation procedure follows the steps below.

- 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 temporary meteorological conditions, the re-siting evaluation is considered complete, and a new periodic screening is initiated.
- 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) If the desktop analysis indicates that the number of Nubo Sphere Monitors or the positions of monitors needs to be adjusted, a new initial siting procedure is triggered.
- 6) 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 Quality Checks

- 9.2.1 Anemometer measurement QAQC metrics include checking for sensor lifetime, data to be within reasonable bounds and, specifically also include a check that wind speed measurements in x and y directions return a number.
- 9.2.2 If the check fails, the data is not used. If a re-siting evaluation indicates that replacement or service is required, a field-service event is triggered.
- 9.2.3 In addition, on-site wind speed data is compared to the nearest meteorological station and a check for significant differences between the on-site anemometer data and the meteorological station data is performed.
- 9.2.4 If the check fails, a service event is triggered. If a re-siting evaluation indicates that replacement or service is required, a field-service event is triggered.
- 9.2.5 As part of the re-siting analysis, the internal error status register of the anemometer will be evaluated to support the root-cause analysis.
- 9.2.6 In case the maximum sensor lifetime is exceeded, a field service event is triggered, and the sensor is replaced.

## 9.3 Temperature/Humidity Sensor Quality Check

- 9.3.1 Temperature/Humidity measurement QAQC metrics include checking for data to be within reasonable bounds and for consistency between 2 redundant RH/T sensors in the Nubo Sphere monitor and the sensor cartridge.
- 9.3.2 If either check fails, the data is not used. If a re-siting, evaluation indicates replacement or service, a field service event is triggered.

## 9.4 GNSS sensor Quality Checks

- 9.4.1 GNSS sensor QAQC metrics include checking for the position of each Nubo Sphere monitor to be within reasonable bounds of the target position as defined in the siting procedure.
- 9.4.2 If the check fails, a service event is triggered.

## 9.5 Photoacoustic Laser Spectroscopy Sensor Quality Checks

### 9.5.1 In-house Manufacturing Validation

Each photoacoustic laser-spectroscopy sensor is manufactured in-house by Sensirion. Prior to deployment, the accuracy of each sensor is validated. Sensors that fall outside of the bounds for accuracy specifications set in **Table** Table 5 are not deployed.

### 9.5.2 Functional Check

The functional QAQC for the photoacoustic sensor includes checking for the sensor error flag provided by the sensor manufacturer's firmware. If the functional check fails, the data is not used. If re-siting evaluation indicates replacement or service, a field-service event is triggered.

As part of the re-siting analysis, the internal error status register of the photoacoustic sensor will be evaluated to support the root-cause analysis. In case the maximum sensor lifetime is exceeded, a field service event is triggered, and the sensor cartridge is recalibrated or replaced.

## 9.6 Data Quality Checks

9.6.1 Data quality QAQC metrics include a check for sensor noise and a check for the measured methane concentration to be within reasonable bounds.

9.6.2 If the methane concentration value is below 1.5 ppm, the data is not used.

9.6.3 If the noise of the photoacoustic methane measurements indicates a high noise level, the data for the next 30s is not used.

9.6.4 If the noise QAQC check of a photoacoustic methane sensor continuously fails, as indicated by a re-siting evaluation, a field service event is triggered to investigate and potentially replace the photoacoustic sensor cartridge.

## 9.6.5 Operating window

For every measured concentration value, the measured atmospheric parameters (wind speed, temperature, humidity) must be within the operating window described in **Table** Table 5. If any of the parameters are outside the operating window, the data is not used.

## 9.7 Nubo Sphere Monitor Checks

9.7.1 The Nubo Sphere monitor QAQC checks continuously for data gaps in the past 24 hours. If the amount of missing data within 24 hours exceeds 90%, a re-siting evaluation is triggered. If re-siting indicates that repair or replacement is required, a field-service event is triggered.

9.7.2 As part of the re-siting analysis, the internal error status register of the Nubo Sphere monitor will be evaluated to support the root-cause analysis.

9.7.3 In the event of LTE data transmission failure or downtime of the cloud infrastructure, the system will continue to independently operate and store data for a minimum duration of 15h. As soon as connectivity or cloud infrastructure is working, the system will sync any measurements recorded during the service lapse.

## 10 Calibration and Standardization

### 10.1 Calibration Procedures

#### 10.1.1 Photoacoustic Methane Sensor

The laser-based sensor is factory calibrated. No field calibration or bump testing are required during the first 6 years of operation due to the inherent long-term stability of the laser-spectroscopy sensing principle in combination with long-term drift compensation algorithms. After this period, the photoacoustic sensor needs to be recalibrated or replaced to maintain reliable performance (see section 18.2).

#### 10.1.2 Wind Meter

The wind meter is factory calibrated by the manufacturer and does not require any regular field calibration nor maintenance for 10 years as per manufacturer requirements. After this period, the wind sensor needs to be recalibrated or replaced to maintain reliable performance. The functionality of the anemometer is verified by a QAQC check for every measurement.

### 11 Analytical Procedure

[Reserved]

### 12 Detection and Alerting

#### 12.1 Detection

An Average Site Emission Rate Estimate that is above the applicable alerting threshold is a detection. An Average Site Emission Rate Estimate that is at or below the applicable alerting threshold is a non-detection.

The Average Site Emission Rate Estimate is calculated as described below.

- 1) Detect all emission events during the periodic screening period.
- 2) Determine the emission source location as well as the start and stop time for each emission event.
- 3) Calculate the emission rate time-series for each emission event.
- 4) Calculate the Average Site Emission Rate Estimate.

##### 12.1.1 Emission event detection and localization

An emission event is detected when a consistent pattern of methane concentrations exceeding the photoacoustic sensor detection limit is measured after subtracting the ambient methane concentration of 2 ppm. This determines the start time of the emission event.

The most likely source location of the emission event is determined (“localization”) by a triangulation process, correlating elevated methane concentration data points with the coverage area for each Nubo Sphere monitor.

To support this process, an internal software tool provides a site map with sensor locations, potential emission sources, and real-time wind and methane concentration data. Visual cones indicate each sensor's coverage area based on wind direction and speed, helping specialists correlate methane patterns with potential emission sources. By integrating these visual aids with data from multiple sensors and tracking the event timeline, human specialists determine the most likely origin of the emission.



Localization is only used to convert methane concentrations to emission rates.

The emission event is closed when, after subtracting ambient methane concentrations, a consistent pattern of methane concentrations below the photoacoustic sensor detection limit is measured by a Nubo Sphere Monitor that is in the covered angle of the emission source.

#### 12.1.2 Calculation of Average Site Emission Rate Estimate

In this process step, the Average Site Emission Rate Estimate is calculated. The output is one average emission rate estimate for the whole site which is used as input in the alerting procedure.

The Average Site Emission Rate Estimate is calculated over the duration of the periodic screening. Only data points that have passed all QAQC checks are used. An emission rate time-series is calculated for every emission event using methane concentration data, wind data, and the estimated emission source location determined in the previous step.

For periods of time of an emission event for which no valid emission rate value can be determined, because no sensor is in the covered angle of the source or there is an insufficient amount of data that has passed the QAQC checks, an ongoing emission with the last calculated emission rate value is assumed.

Step-by-step, the Average Site Emission Rate Estimate calculation is performed as follows:

- 1) For each emission event, calculate the emission rate time series as follows:
  - a. For time periods for which a valid emission rate estimate is available, use this value.
  - b. For time periods for which no valid emission rate estimate is available, assume an ongoing emission with the last calculated emission rate
- 2) For each emission event, calculate the total amount of methane emitted over the periodic screening period by summing up all emission rate values of the time series obtained in step 1.
- 3) Calculate the Average Site Emission Rate Estimate by summing up the total amount of methane for all emission events and dividing it by the duration of the periodic screening.

#### 12.2 Alerting

Once enough data collection has occurred, such that the site coverage test is passed, the data is input into the Fugitive Emissions Screening Assessment. The result of the Fugitive Emissions Screening Assessment is: "Alert" or "No Alert".

- Alert: If the Average Site Emission Rate Estimate is above the applicable detection threshold, then an alert is generated.
- No Alert: If the Average Site Emission Rate Estimate is at or below the applicable detection threshold, then no alert is generated.

A confirmed detection generates an alert which requires a whole facility follow up inspection as required in 40 CFR §60.5398b(b) by the owner or operator.

Any additional information provided by Sensirion, outside of what is included in this method, (e.g., localization information) 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

Sensirion 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 Sensirion localization data alone to limit the scope of a full-site follow-up; additional credible information from another source is required.

## 13 Method Performance

### 13.1 Validation of Method Sensitivity

Third-party controlled release testing in a field-like setting at METEC [2] has demonstrated a detection threshold of <1 Kg/h at a 90% probability of detection. The experimental design included single- and multi-emissions. The corresponding data set is shown in Figure 2. **Error! Reference source not found..** These results are confirmed by field tests on operated oil and gas sites across different basins in the US.

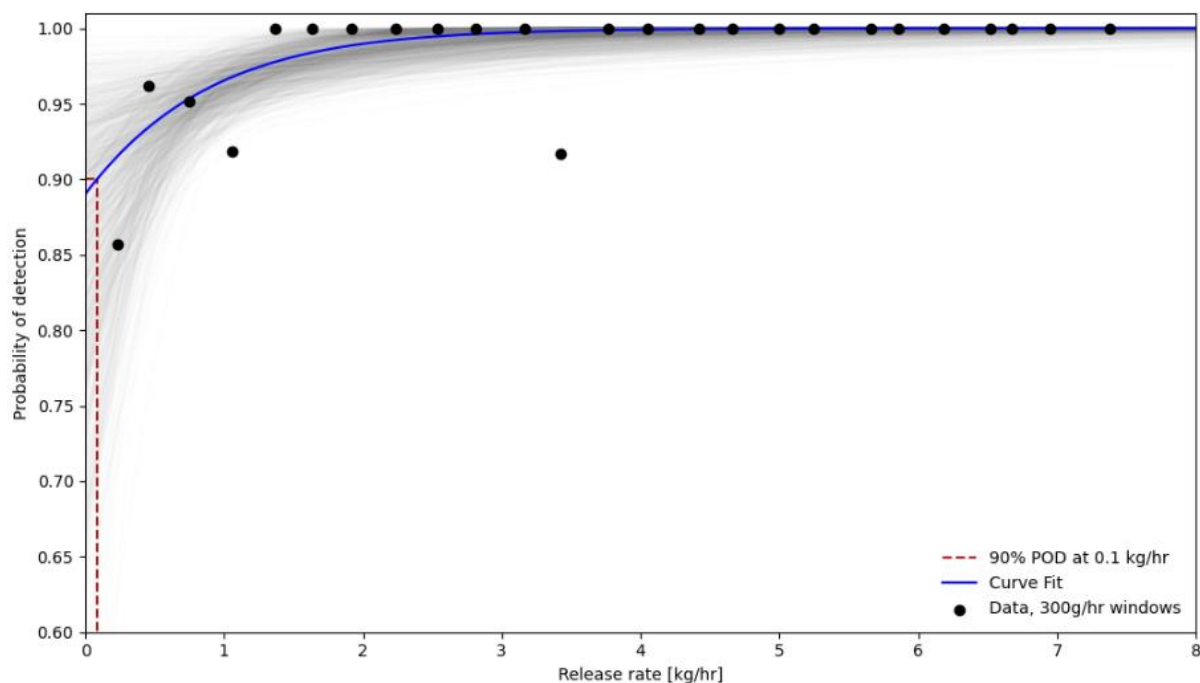


Figure 2 - Detection threshold validation data. We show the reported emissions (black dots), the best fit probability of detection curve based on a logistic regression (blue line) and alternative fitted curves based on random sampling of the data set (grey lines). Black circles datapoints are the ratio between True positives and False negatives clustered in bins of 300 g/h emission rate. Based on the best fit logistic regression, we extract a 90% POD at 0.1 Kg/h (red dashed line).

### 13.2 Validation of Method Envelope of Operation

#### 13.2.1 Wind Speed Range

Blind test validation demonstrates that the detection threshold of <1 Kg/h is achieved for wind speeds in the range from <1 m/s to 10 m/s. The required mitigation of this limitation is to flag data collected outside this envelope and not use it for the periodic test.

The limitation at low wind speeds is determined by the applicability of the transport model used in this method (plume dispersion). At wind speeds above 10 m/s, the performance of the method has not been verified.

#### 13.2.2 Temperature Range

The temperature operating window for this method is -20°C to +50°C. Accuracy of the photoacoustic methane sensor has been verified in the temperature range from -20°C to +60°C. In addition, robust operation in field conditions has been demonstrated for temperatures below -20°C. The required mitigation of this limitation is to flag data collected outside this envelope and not use it for the periodic test.

#### 13.2.3 Humidity Range

The humidity operating window for this method is 0.7g/m<sup>3</sup> to 50 g/m<sup>3</sup> (absolute humidity). The accuracy of the photoacoustic methane sensor has been verified in the humidity range from 0.7 g/m<sup>3</sup> to 50 g/m<sup>3</sup>. The required mitigation of this limitation is to flag data collected outside this envelope and not use it for the periodic test

#### 13.2.4 Solar Power Battery Capacity

Extended periods of uncharacteristically low sunlight or snow coverage of the solar panels 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.

#### 13.2.5 Connectivity

Extended periods of insufficient connectivity can lead to delay in data transmission or loss of data if the local data buffering time of the monitor is exceeded. The required mitigation of this limitation is to temporarily extend the periodic screening period or trigger a field-service event.

### 14 Pollution Prevention

[Reserved]

### 15 Data Management and Recordkeeping

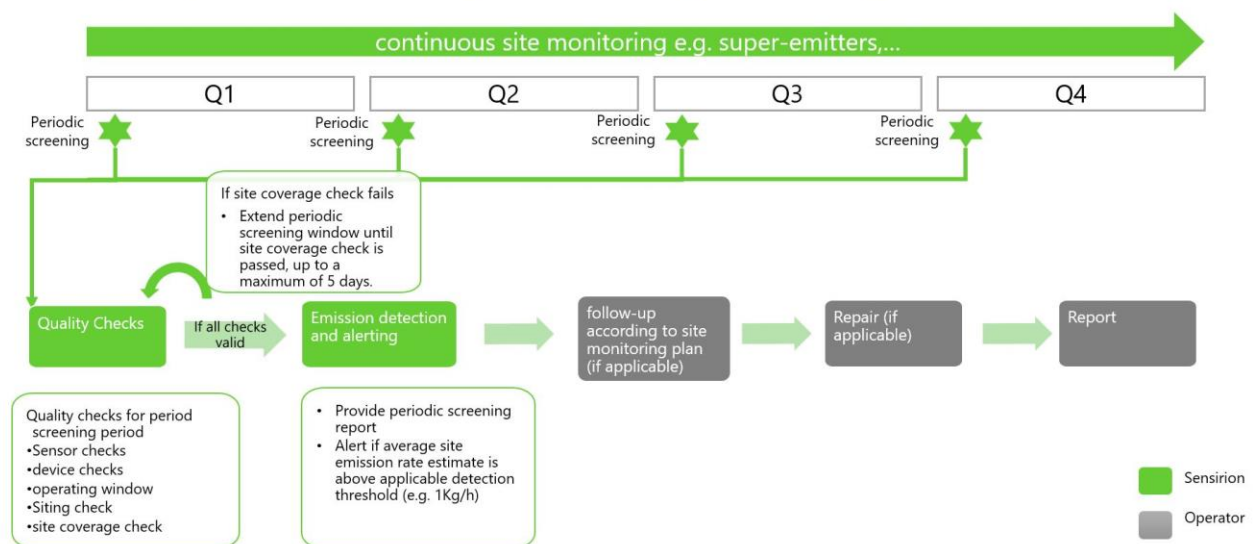
15.1 Photoacoustic sensor data and meteorological data, as well as system diagnostics, are collected by the Nubo Sphere monitors and securely transmitted via LTE to a central server. Data processing occurs on the central server. All data at every stage of processing is stored in multiple redundant locations. All information-security aspects are handled according to the ISO27001 standard. Figure 3 outlines the specific data that is collected, the processing steps, and reporting procedures.

15.2 The results of every periodic screening are provided to the operator in the form of a periodic screening report including the presence of an alert or non-alert, and other metadata described in the site monitoring plan. The report is created automatically within a maximum of 5 days after the periodic screening is completed. The report is sent via email and available for download via the

Nubo Sphere web application. An example periodic screening report is included in the appendix – Site Monitoring Plan.

- 15.3 Raw and processed data is maintained for a period of 5 years to be consistent with the recordkeeping requirements as specified in 40 CFR §60.5420b(c).
- 15.4 Figure 3 provides a workflow for the periodic screening using this test method, using the 1 kg/hr threshold as an example.

## Exemplary Workflow: 1Kg/h Quarterly Screenings



**Figure 3.** Workflow for periodic screening using the Nubo Sphere solution

## 16 References

- [1] A. S. Monin and A. M. Obukhov, "Basic laws of turbulent mixing in the surface layer of the atmosphere," *Tr. Akad. Nauk. SSSR Geophys. Inst.*, vol. 24, no. 151, p. 163–187, 1954.
- [2] C. Ilonze, E. Emerson, A. Duggan and D. Zimmerle, "Assessing the Progress of the Performance of Continuous Monitoring Solutions under a Single-Blind Controlled Testing Protocol," *Environmental Science & Technology*, vol. 58, no. 25, pp. 10941-10955, 2024.
- [3] Sensirion Connected Solutions, *Nubo Sphere User Manual*, 2025.

## **17 Tables, Diagrams, and Flow Charts**

[Reserved]

## **18 Appendices**

### **18.1 Initial Siting Procedures**

SCS utilizes a proprietary siting tool to determine the number and position of Nubo Sphere monitors for each site. The following steps are required to ensure adequate coverage of the site. Adequate coverage in this context means that all potential emission sources on the site are covered as defined in section 9.1.2 for all 5-day periods of a year.

#### **18.1.1 Planning**

- 1) Sites are identified by the owner/operator for monitoring.
- 2) Coordinates of potential emission sources are determined based on a satellite image of the site. The satellite image of the site should not be older than 1 year. The identification and localization of potential emission sources must be reviewed by a SCS specialist. In case only satellite images older than 1 year are available, the location of potential emission sources must be confirmed by the owner/operator of the site.
- 3) Historical wind data with a time resolution of 1h for the location of the site is obtained via API from World Weather Online for the most recent 12 months period. Based on this data, SCS generates a wind rose to determine the predominant wind directions and speeds as well as to calculate the site coverage for the initial siting proposal.
- 4) The number and positions of Nubo Sphere monitors are determined by a Sensirion specialist using an internal software tool following the procedure described in the following section.
- 5) A deployment file is generated that specifies the coordinates at which the Nubo Sphere monitors will be installed.
- 6) The owner or operator must verify all potential leak sources are present on the satellite image. If the owner or operator identifies missing sources, step 4 is repeated.
- 7) The owner or operator must inform SCS any time a change is made to the facility layout. Any change to the facility layout must result in a re-siting evaluation conducted by SCS (section 9.1.3).
- 8) The owner or operator must retain an updated copy of the deployment file that specified the coordinates of the Nubo Sphere monitors and the locations of all potential leak sources.

#### **18.1.2 Determination of Nubo Sphere Monitor Positions**

The following iterative process is used to determine the number and position of Nubo Sphere monitors for a site based on the information obtained in the planning steps 2 and 3. This process is performed by an SCS specialist with the support of a software tool.

- 1) Determine the initial number of monitors and potential locations within the software tool based on the following conditions:
  - a. Sensors should be positioned preferentially around the perimeter of the site (fenceline). Positions within the perimeter of the site can be chosen if positioning at the fenceline is not sufficient to cover all potential emission sources (e.g., large-area sites) provided monitors are not located in hazardous areas or other areas excluded by the operator.
  - b. Monitors should be placed such that for each potential emission source, a Nubo Sphere monitor is within range of 5m to a recommended maximum distance defined in **Table 2** Table I-1 from the source in the downwind direction for the prevailing wind directions on the site. The recommended maximum distance is defined as distance from a detection threshold emission rate at which the methane concentration is 0.6 ppm above ambient methane concentrations while still within the covered area of the emission source.
  - c. Location of existing infrastructure for mounting should be noted because the monitors can be mounted on existing infrastructure such as light poles or fences, which facilitates installation for the customer.
- 2) Calculate site coverage based on the software tool output for the number and location of monitors by determining whether all potential emission sources on the site are covered for all 5-day periods of the year.
- 3) If site coverage is determined to 100% for all 5 days periods over one year, then finalize monitor placement and prepare the siting proposal for approval and installation.
- 4) If site coverage is determined to be less than 100% of all 5 days periods over one year, then adjust the number and/or placement of sensors within the software tool until site coverage meets the specifications in step 2a of this process.
- 5) After choosing the optimal monitor placement, the anemometer is typically installed on the same pole as one of the Nubo Sphere monitors upwind of the prevailing wind direction based on the wind rose developed in step 3 of the planning process. If placement of the anemometer is not possible upwind of the prevailing wind direction, the placement on the pole of a Nubo Sphere monitor with obstacle clearance when the wind is blowing from the predominant direction is preferred.
- 6) The anemometer must be installed at a minimum height of 1.5m. The anemometer must be installed at a minimum distance of 20m from any nearby structure which might influence the wind pattern. The anemometer must be oriented according to the procedure described in the SCS Nubo Sphere User Manual.
- 7) Prior to installation, the siting proposal is submitted to the site operator for review to ensure that the proposed positions of the Nubo Sphere monitors do not interfere with site operations.

**Table 2I-1** Recommended maximum Source-Sensor Distance used in the siting procedure for different detection thresholds

Minimum detection threshold	Recommended maximum source-sensor distance for coverage
1 Kg/h	70m
2 Kg/h	90m

5 Kg/h	150m
10 Kg/h	220m
15 Kg/h	300m

### 18.1.3 Installation

The following installation procedures are example procedures but may change as needed for different locations. All installation procedures must be approved by SCS specialists.

- 1) Once the siting proposal is approved by the site operator, installation of the Nubo Sphere monitors and anemometer is completed following the installation instructions provided in the SCS Nubo Sphere User Manual [3].
- 2) Install pole mounts at predetermined locations on the site. The pole mounts should have a height of 2-3m and must be able to withstand the expected wind forces at the location, as well as support the weight (approx. 6.5 Kg) of the Nubo Sphere monitor.
- 3) Fix the Nubo Sphere monitor to the pole using the mounting plates provided with each Nubo Sphere monitor.
- 4) Connect the solar panel to all Nubo Sphere monitor. Connect the anemometer where applicable.
- 5) Connecting the solar panel will trigger the start-up procedure of the Nubo Sphere monitor indicated by a yellow blinking LED indicator. Once the device is working correctly, the LED will turn solid green.

If a Nubo Sphere monitor needs to be moved to another location at a later point in time, the procedures outlined under “Determination of Nubo Sphere Monitor Positions” must be repeated and site coverage must meet the criteria in step 2a of those procedures after the repositioning of the monitors.

### 18.2 Field Calibration Check

This is an optional procedure to check if a photoacoustic methane sensor is still properly calibrated. Field calibration checks of the photoacoustic methane sensor must be performed by trained Sensirion personnel or other similarly trained persons. To perform a field calibration check, the step-by-step instructions described below must be followed.

- 1) Calibration gas: a mixture of dry synthetic air with a reference concentration of 100 ppm.
- 2) Use a pressure regulator to provide a flow rate in the range from 0.1l/min to 0.5l/min through a 6mm (0.236 inches) diameter tube.
- 3) Connect a suitable mechanical adapter provided by Sensirion Connected Solution to the tube.
- 4) The photoacoustic sensor should be exposed to a defined reference concentration of methane for 10min at a flow rate in the range from 0.1l/min to 0.5l/min using the calibration gas mixture defined above. The opening of the sensor cartridge should be fully covered by the mechanical adapter to avoid any gas mixing with ambient air.
- 5) To pass the field calibration check, the measured methane concentration after 10min reported by the photoacoustic sensor should be in the range from 75 ppm to 125 ppm.

A failure of the field calibration check triggers a service event and a re-calibration of the sensor or a sensor replacement.

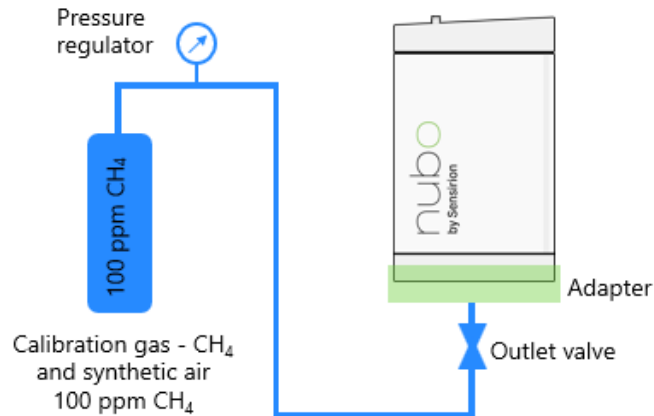


Figure 4 – Experimental setup for the field calibration test.

### 18.3 Site Monitoring Plan

This monitoring plan provides owners and operators adopting this test method, “Sensirion Connected Solutions Nubo Sphere: Periodic Fugitive Methane Emission Monitoring”, with the recommended steps necessary in response to confirmed detections during periodic screening surveys. This monitoring plan can be incorporated into the required monitoring plan that owners and operators maintain as required in 40 CFR 60.5398b(b)(2).

#### a. Site Information

Table II-1 identifies each site covered by this monitoring plan and that will be monitored through periodic screening using the approved test method for “Sensirion Connected Solutions Nubo Sphere: Periodic Fugitive Methane Emission Monitoring”. This table contains the name of each individual site, the site type, site monitoring category (regulatory frequency for OGI/AVO), latitude, and longitude coordinates in decimal degrees to an accuracy and precision of at least four decimals of a degree using the North American Datum of 1983.



**Table II-1. Sites Covered in this Monitoring Plan using SCS Nubo Sphere**

Site Name	Site Type	Site Monitoring Category	Latitude	Longitude
[site name]	[single wellhead, multi-wellhead, small well site, well site with major equipment, compressor station]	[Required OGI/AVO monitoring frequencies]	[latitude]	[longitude]

**b. Alternative Screening Procedure**

Table II-2 identifies the periodic screening frequency and detection threshold that will be implemented by the operator for the sites listed in Table II-1. Use Tables II-3 and II-4 to determine the appropriate screening frequency and detection threshold to aid in completion of this Table II-2.

**Table II-2. Alternative Test Method Information – Screening Frequency and Detection Threshold**

Site Name	Screening Frequency	Detection Threshold	Spatial Resolution
[site name from Table II-1]	[periodic screening frequency]	[detection threshold generating alert]	[Facility-level]

**Table II-3. Screening Frequencies for Well Sites with Major Equipment 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

**Table II-4. Screening Frequencies for Wellhead Only Well Sites and Small Well Sites**

Minimum Screening Frequency	Minimum Detection Threshold (kg/hr)
Semiannually	≤1
Tri-Annually	≤2
Tri-Annually + Annual OGI	≤10
Quarterly	≤5
Quarterly + Annual OGI	≤15
Bi-Monthly	≤15

**c. Contact Information**

The following contact information specifies the entities performing the periodic screenings. SCS is the sole proprietor deploying the Nubo Sphere as specified in this test method and is responsible for conducting the periodic screening and providing alerts to the owner and operator implementing this test method.

**Table II-5. Contact Information of Company Conducting Periodic Screenings**

<b>Name of Company Conducting Screenings</b>	Sensirion Connected Solutions
<b>Address of Company</b>	
<b>Responsible Individual</b>	
<b>Phone</b>	
<b>E-mail</b>	

**d. OGI Surveys**

Yes / No - Some or all of the sites covered by this monitoring plan must conduct annual OGI surveys.

Yes / No - Some or all of the sites covered in this monitoring plan might choose to replace a periodic screening survey with a facility-level OGI survey.

The information contained in this section must be completed by the owner/operator if an annual OGI survey is required for the screening frequency and detection threshold chosen in this test method, if the owner/operator plans to replace a periodic screening survey with an OGI survey, or if OGI is used for the follow-up monitoring following a confirmed detection using this test method for periodic screening.

**OGI Equipment Information:**

Manufacturer:

Model Number:

Verification of the OGI equipment meets the following specifications:

- OGI equipment is capable of imaging gases in the spectral range for the compound of highest concentration in the potential fugitive emissions.
- OGI equipment is capable of imaging a gas that is half methane, half propane at a concentration of 10,000 ppm at a flow rate of  $\leq 60$  g/hr from a quarter inch diameter orifice.

Insert link to manufacturer, facility, or third-party verification:

**Procedure for a daily verification check (performed once daily or when camera has been restarted if powered off during the monitoring day):**

**Procedure for determining the maximum viewing distance from equipment and ensuring the distance is maintained (performed at each individual site before beginning the survey):**

**Procedure for determining the maximum wind speed during which monitoring can be performed and ensuring monitoring occurs only at wind speeds below this threshold:**

**Procedures for conducting OGI surveys:**

- How will the camera operator ensure an adequate thermal background is present to view potential fugitive emissions?
- How will the camera operator deal with adverse monitoring conditions, such as wind?
- How will the camera operator deal with interferences (e.g., steam)?

**Description of training and experience required prior to performing OGI surveys:**

**Procedures for calibration and maintenance of the OGI equipment:**

**Procedures for identifying fugitive emissions from fugitive emissions components, including ensuring that all fugitive emissions components, except buried yard piping and associated components (e.g., connectors), are monitored during each facility-level survey:**

**Procedures for repairing fugitive emissions from fugitive emissions components and verifying successful repairs:**

**Repair timelines for fugitive emissions components**

General Timeline:

In addition to the information provided above, all repairs of fugitive emissions components must be completed as follows:

- **Within 30 days of detection of fugitive emissions:** Complete the first attempt at repair.
- **Within 30 days of the first attempt at repair:** Complete the final repair and complete the resurvey to verify successful repair.

Delay of Repair:

Delay of repair beyond the timelines above requires justification that at least one of the following conditions are true:

- Repair is technically infeasible;
- Repair requires a vent blowdown;
- Repair requires a compressor station shutdown, a well shutdown, or well shut-in; or
- Repair would be unsafe to repair during operation of the unit.

Where one of the above conditions is justified, the repair will be completed during one of the following events, whichever is earliest:

- The next scheduled compressor station shutdown for maintenance;
- The next scheduled well shutdown or scheduled well shut-in;
- After the next scheduled vent blowdown; or
- Within 2 years of detecting the fugitive emissions.

Delay of repair for replacement parts requires justification that are least one of the following conditions are true:

- The valve assembly supplies had been sufficiently stocked but are depleted at the time of the required repair; or
- A replacement fugitive emissions component or part of a component requires custom fabrication.

Where one of the above conditions is justified, the repair will be completed as follows:

- Replacement components/parts will be ordered no later than 10 calendar days after the first attempt at repair.
- Repair will be completed as soon as practicable, but no later than 30 calendar days after receipt of the replacement component, unless the repair requires a compressor station or well shutdown.
- If a compressor station or well shutdown is required, the repairs will be completed during the next scheduled compressor station shutdown for maintenance or the next scheduled well shutdown.

**e. Follow-up Monitoring and Repair Procedures**

The monitoring procedures discussed in this section apply to the follow-up monitoring surveys that occur when periodic screening detects emissions at a site covered by this monitoring plan. Where there is specific overlap, this section refers to the information provided in Section II.d (OGI Surveys).

The procedures in this section apply when OGI is used for the follow-up survey of confirmed detections from SCS Nubo Sphere periodic screenings.

### **Delivery of Periodic Screening Results**

SCS provides the results of periodic screenings no later than 5 calendar days after the screening event occurs. These results are provided with a **facility-level** spatial resolution.

### **Follow-up OGI Survey Requirements**

All fugitive emissions components located within the site will be monitored with OGI, following the specific procedures described in Section II.d of this monitoring plan.

### **Repair Timelines for Fugitive Emissions Components**

All fugitive emissions components identified with emissions during the follow-up OGI survey will be repaired according to the procedures and timelines described in Section II.d of this monitoring plan, except as follows:

- All repairs will be completed **within 30 days** of receiving the results of the periodic screening.
- The resurvey to verify successful repair will also be completed **within 30 days** of receiving the results of the periodic screening.
- The delay of repair provisions in Section II.d will also apply, as applicable.

### **Inspections of Covers and Closed Vent Systems**

All storage vessel covers, and all closed vent systems located on the site will be inspected. This cover and closed vent inspection includes the following:

- An inspection of the cover(s) and closed vent system(s) using OGI to ensure there are no identifiable emissions. Emissions imaged by OGI will be reported as a deviation of the no identifiable emissions standard until an OGI inspection determines the cover or closed vent system operates with no identifiable emissions.
- A visual inspection of the cover(s) and closed vent system(s) to identify any defects.

*Covers:* Possible defects on covers include, but are not limited to, visible cracks, holes, or gaps in the cover, or between the cover and the separator wall; broken, cracked, or otherwise damaged seals or gaskets on closure devices; and broken or missing hatches, access covers, caps, or other closure devices. For storage vessels that are partially or entirely buried underground, the inspection will only be conducted on the portion of the cover that extends above the ground surface, and those connections that are on this portion of the cover (e.g., fill ports, access hatches, gauge wells, etc.) and that can be opened to the atmosphere. Emissions detected by visual inspection will be reported as a deviation of the no identifiable emissions standard until a visual inspection determines the cover operates with no identifiable emissions.

*Closed Vent Systems:* Possible defects on closed vent systems include, but are not limited to, visible cracks, holes, or gaps in piping; loose connections; liquid leaks; or broken or missing caps or other closure devices. Emissions detected by visual inspection will be reported as a deviation of the no identifiable emissions standard until a visual inspection determines the closed vent system operates with no identifiable emissions.

### **Repair Timelines for Covers and Closed Vent Systems**

#### General Timeline:

All covers and closed vent systems with identified emissions during the follow-up OGI survey will be repaired according to the procedures and timelines described in Section II.d of this monitoring plan, except as follows:

- All repairs will be completed **within 30 days** of receiving the results of the periodic screening.
- The resurvey to verify successful repair will also be completed **within 30 days** of receiving the results of the periodic screening.

#### Delay of Repair:

Delay of repair will be allowed on covers and closed vent systems as follows:

- If repair is technically infeasible without a shutdown
- If it is determined that emissions resulting from immediate repair would be greater than the emissions likely to result from delay of repair.
- Repairs that are delayed using the justifications above must be completed by the end of the next shutdown.

### **Investigative Analysis for Emissions on Covers and Closed Vent Systems**

If a defect or emissions are identified on a cover or closed vent system during the follow-up OGI survey, an investigative analysis will be initiated. The goal of this investigative analysis is to determine the underlying primary and other contributing cause(s) of emissions from the cover or closed vent system. This investigative analysis will commence within **5 days of completing the inspections**. The investigative analysis will include the following:

1. A determination as to whether the system was operated outside of the engineering design analysis; and
2. Whether updates are necessary for the cover or closed vent system to prevent future emissions.

### **Investigative Analysis for Control Devices**

**19 If the periodic screening and follow-up OGI survey indicate the detection was caused by a failure of a control device used to demonstrate continuous compliance under NSPS 0000b, an**

**investigative analysis will be initiated. The goal of this investigative analysis is to determine the primary and other contributing cause(s) of the failure within 24 hours of receiving the results of the follow-up OGI inspections specified. The investigative analysis will include the following:**

1. A determination as to whether the control device is operating in compliance with the applicable requirements of 40 CFR 60.5415b and 40 CFR 60.5417b; and
2. If not operating in compliance, a determination of what actions are necessary to bring the control device into compliance as soon as possible to prevent future failures of the control device from the same underlying cause(s).

**f. Recordkeeping Requirements**

This section provides a list of the specific records that will be maintained for the sites covered by this monitoring plan. These records are specific to the periodic screenings and OGI surveys on fugitive emissions components, covers, and closed vent systems that are described in this monitoring plan. Other records that are maintained for other affected facilities are not specified in this monitoring plan. See 40 CFR 60.5420b for more details on other recordkeeping requirements outside the scope of this monitoring plan.

Records specified in this section will be maintained [onsite / field office nearby] for a period of at least **5 years**.

**Records for Fugitive Emissions Components**

The following records, required by 40 CFR 60.5420b(c)(14), will be maintained by the operator for fugitive emissions components:

**Table II-6. Records for Fugitive Emissions Components**

Reference	Description of Record
<b><i>Records related to applicability:</i></b>	
(c)(14)(i)	The date of the startup of production or the date of the first day of production after modification (for well sites)
(c)(14)(i)	The date of the startup or the date of the startup after modification (for compressor stations)
(c)(14)(ii)	For well sites – specification of the type of well site (i.e., single wellhead only, small wellsite, multi-wellhead only, or well site with major production and processing equipment)
(c)(14)(iii)	Date well site removes all major production and processing equipment from the well site and record of the well ID or centralized production facility ID where production is sent from the well site  <i>Note: This change would change the site type (i.e., becomes a wellhead only site) and could potentially change the periodic screening matrix that applies.</i>
(c)(14)(iii)	Date major production and processing equipment is added to a wellhead only well site

	<i>Note: This change would change the site type (i.e., becomes a small site or well site with major production and processing equipment) and could potentially change the periodic screening matrix that applies.</i>
<b>Records related to well closures:</b>	
(c)(14)(vii)(A)	The well closure plan developed in accordance with 40 CFR 60.5397b(l) and the date the plan was submitted
(c)(14)(vii)(B)	The notification of the intent to close the well site and the date the notification was submitted
(c)(14)(vii)(C)	The date of the cessation of production from all wells at the well site
(c)(14)(vii)(D)	The date well closure activities began at the well site
(c)(14)(vii)(E)	Each status report for the well closure activities that are reported with the annual report
(c)(14)(vii)(F)	Each OGI survey reported in the annual report, including the date, the monitoring instrument used, and the results of the survey or resurvey
(c)(14)(vii)(G)	The final OGI survey video demonstrating the closure of all wells at the site. This video must include the date that the video was taken and must identify the well site location by latitude and longitude

### Records from Periodic Screenings

The following records, required by 40 CFR 60.5424b(c), will be maintained by the operator for periodic screenings:

**Table II-7. Records from Periodic Screening Surveys and Follow-up Inspections**

Reference	Description of Record
(c)(2)	Date of each periodic screening
(c)(2)	Date that results of the periodic screening were received
(c)(3)	Name of screening operator
(c)(4)	Alternative test method and technology used during the screening
(c)(4)	Aggregate detection threshold for the technology
(c)(4)	Spatial resolution of the technology (i.e., facility-level, area-level, or component-level)
(c)(5)	Records of calibrations for the alternative technology used during the screening if calibration is required by the alternative test method
(c)(6)	Results from periodic screening
<b><i>If the results of periodic screening indicate a confirmed detection of emissions from an affected facility:</i></b>	
(c)(6)(i)	The date of the inspection of the fugitive emissions components and inspection of covers and closed vent systems
(c)(6)(ii)	Name of operator(s) performing the survey or inspection
(c)(6)(iii)	Identification of the monitoring instrument(s) used



(c)(6)(iv)	Records of calibrations of the instrument(s) used during the survey or instrument inspection, as applicable
<b><i>For each fugitive emission from a fugitive emissions component and each leak or defect from a cover or closed vent system:</i></b>	
(c)(6)(v)(A)	Location of the fugitive emissions identified using a unique identifier for the source of the emissions and the type of fugitive emissions component
(c)(6)(v)(B)	Location of the emissions or defect from a cover or closed vent system using a unique identifier for the source of the emissions or defect
(c)(6)(v)(C)	Description of any defect identified on a closed vent system, cover, or control device
(c)(6)(v)(D)	Date of repair for each fugitive emission from a fugitive emissions component or each emission or defect for each cover and closed vent system
(c)(6)(v)(E)	Number and type of fugitive emissions component and identification of each cover or closed vent system placed on delay of repair and an explanation for each delay of repair
(c)(6)(v)(F)	For delay of repair for unavailable replacement components, documentation of the: (1) date the component was added to the delay of repair list, (2) the date the replacement component or part was ordered, (3) the anticipated component delivery date (including any estimated shipment or delivery date provided by the vendor), and the actual arrival date of the component
(c)(7)	The date the investigative analysis was initiated
(c)(8)	Dates of implementation and completion of action(s) taken as a result of the investigative analysis and a description of the action(s) taken, as applicable

#### **Records from Annual OGI Surveys or OGI Surveys Replacing Periodic Screenings**

The following records, required by 40 CFR 60.5424b(c), will be maintained by the operator for required annual OGI surveys or OGI surveys that replace a periodic screening survey:

**Table II-8. Records from OGI surveys**

<b>Reference</b>	<b>Description of Record</b>
(c)(9)(i)	The date of the OGI survey
(c)(9)(ii)	Location of each fugitive emission identified
(c)(9)(iii)	Type of fugitive emissions component for which fugitive emissions were detected
(c)(9)(iv)	The date of first attempt at repair of the fugitive emissions component(s)
(c)(9)(v)	The date of successful repair of the fugitive emissions component(s), including the resurvey to verify the repair
(c)(9)(vi)	Identification of each fugitive emissions component placed on delay of repair and an explanation for each delay of repair
(c)(9)(vii)	For delay of repair for unavailable replacement components, documentation of the: (1) date the component was added to the delay of repair list, (2) the date the replacement component or part was ordered, (3) the anticipated component delivery date (including any estimated shipment or delivery date provided by the vendor), and the actual arrival date of the component

(c)(10)	Any deviations from this monitoring plan or a statement that there were no deviations from this monitoring plan
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### Records for Alternative Test Methods using Periodic Screenings

The following records, required by 40 CFR 60.5424b(c), will be maintained by the operator for alternative test methods that are used for periodic screenings:

**Table II-9. Records for Alternative Test Methods using Periodic Screenings**

Reference	Description of Record
(c)(1)	This monitoring plan
(c)(10)	Any deviations from this monitoring plan or a statement that there were no deviations from this monitoring plan
(c)(11)	Records required by the alternative test method included in Table II-10

**Table II-10. Records Provided by SCS for each Periodic Screening Survey**

Record	Description of Record
Periodic Screening and Site information	Site name, location, and type
	Periodic screening event ID
	Start and end data and time of the periodic screening event
Periodic Screening Result	Detection / No Detection
	Average Site Emission Rate Estimate
Additional Information QAQC results	Siting check result (see section 9.1.2)
	Device health check result during the periodic screening (see section 9.7)
	Operating window check result during the periodic screening (see section 9.6.1)
	Site coverage check result during the periodic screening (see section 9.1.2)
Additional Information for each Emission Event	Emission event ID
	Emission start time
	Emission stop time
	Estimated average emission rate
	Estimated emission localization