Pacific Gas and Electric Company

Natural Gas Underground Storage Facility
Monitoring Plan
Facility: Pleasant Creek

Previous Submittal: October 10, 2018
Revised: June 19, 2024

Title 17 California Code of Regulations (CCR) Division 3, Chapter 1, Subchapter 10, Article 4, Subarticle 13 Section 95668(h)(1)&(2)
Natural Gas Underground Storage Facility Monitoring Requirements

For Submittal to:
California Air Resources Board

CONFIDENTIALITY STATEMENT

This document is furnished to the California Air Resources Board (CARB) for compliance with Title 17 California Code of Regulations (CCR), Division 3, Chapter 1, Subchapter 10, Article 4, Subarticle 13, Section 95668(h)(1)&(2). This document contains confidential information regarding Pacific Gas and Electric Company's (PG&E's) underground gas storage facilities. PG&E has marked all documents containing confidential information regarding PG&E's facilities as "CONFIDENTIAL". All pages labeled "CONFIDENTIAL" should not be copied or distributed in any manner except among CARB personnel and California local air district personnel involved with enforcement of the applicable regulatory requirements, without prior notification and approval from PG&E.

Table of Contents

1. Introduction and Purpose

The following protocol outlines PG&E's monitoring plan for the Pleasant Creek Underground Gas Storage Facility (herein referred to as "Pleasant Creek UGSF" or "the Facility") as required by the CARB Greenhouse Gas Emission Standard for Crude Oil and Natural Gas Facilities, referred to as the CARB Oil and Gas Rule, promulgated under 17 CCR, Division 3, Chapter 1, Subchapter 10, Article 4, Subarticle 13 (the Subarticle), Section 95668(h)(1)&(2).

Pleasant Creek UGSF is located at 27094 County Road 32A, Winters, California with the Yolo-Solano Air Quality Management District (YSAQMD) as the local air district. The Facility receives natural gas via pipeline and operates a compressor that injects gas into underground geological formations where the gas is stored.

The monitoring plan addresses the following three key areas, as outlined under as specified in Section 95668(h)(4) of the Subarticle:

(A) Continuous Ambient Monitoring
(B) Daily or Continuous Leak Screening
(C) Well Blowout Procedures

PG&E received approval from CARB for the most recent version of the Pleasant Creek UGSF monitoring plan in June 17, 2021. PG&E is now submitting this updated monitoring plan to CARB by July 1, 2024, in accordance with Section 95668 (h)(1)(B) of the Subarticle.

Within 180 days of CARB's approval of this updated monitoring plan, and consistent with Section 95668(h)(3) of the Subarticle, PG&E will begin monitoring the Pleasant Creek UGSF according to this updated monitoring plan. PG&E will continue to monitor the Facility in accordance with the previously approved monitoring plan while awaiting CARB's approval for this updated monitoring plan

2. Continuous Ambient Monitoring

2.1 Location of Ambient Air Monitors

As required by Section 95668(h)(4)(A)(1)(a) of the Subarticle and approved by CARB in June 2021, the Pleasant Creek UGSF operates two ambient air monitors, one at the predominant upwind location (South Monitoring Station) and one at the predominant downwind location (North Monitoring Station). Additionally, PG&E also installed a meteorological station to monitor the meteorological properties at the Facility. Figure 1 below identifies PG&E's South Monitoring Station and North Monitoring Station locations for the ambient monitors and the meteorological station located at the Pleasant Creek UGSF. The monitoring locations were initially proposed in the monitoring plan submitted in 2017 and the location approved in 2019. The meteorological station was previously approved to be located at the South Monitoring Station; however, PG&E inadvertently installed the meteorological station at the North Monitoring Station. Given that the Facility is relatively flat, PG&E determined that the location of the installed meteorological station is representative to monitor the Facility's meteorological properties. In August 2019, PG&E requested CARB's approval for the installed location of the meteorological station, co-located at the North Monitoring Station. Approval for this request was received from CARB in September 2019. These monitors are placed at ground level.

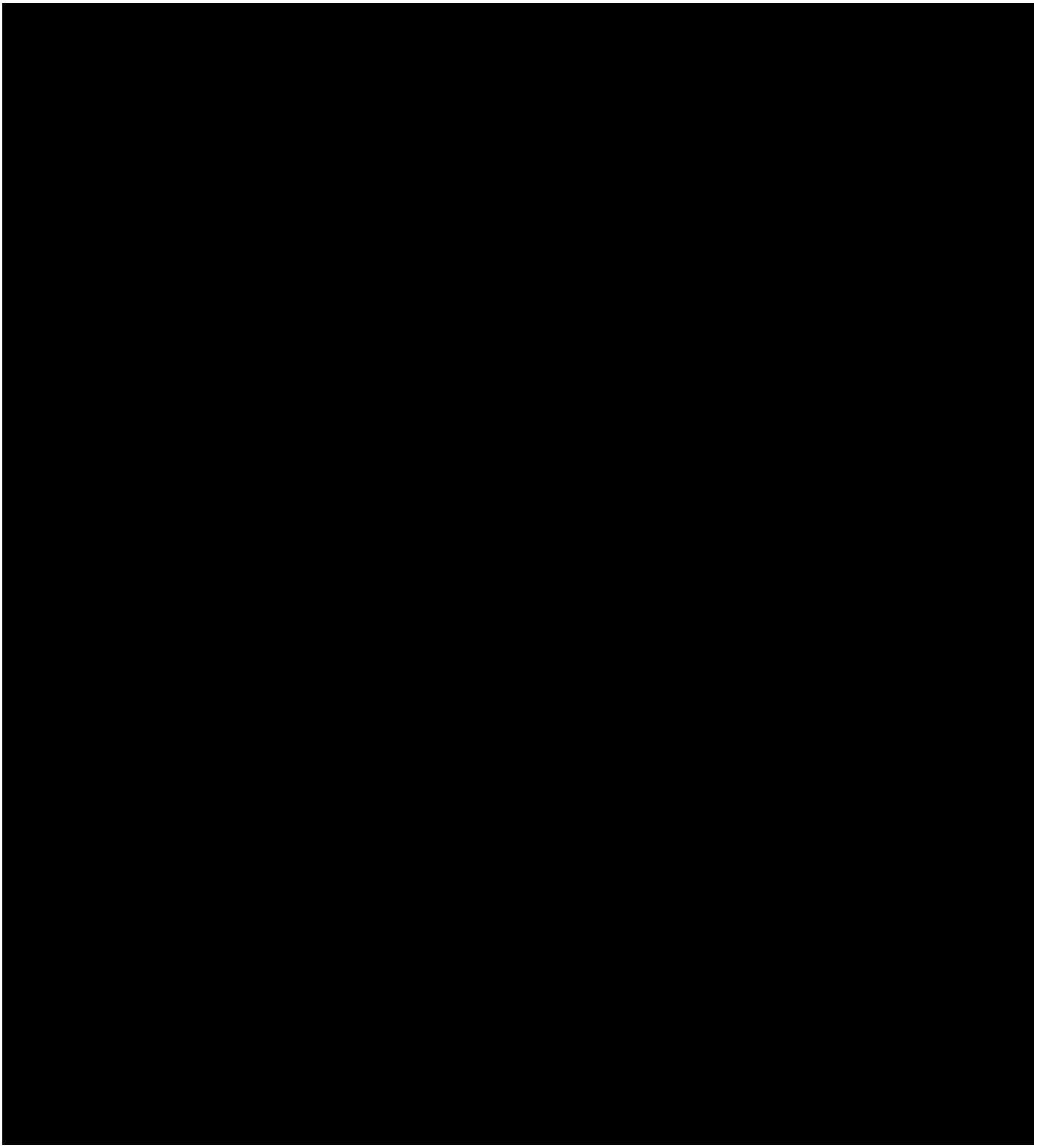


Figure 1: Location of Ambient Monitors at Pleasant Creek UGSF

The ambient monitoring locations were chosen to meet the requirements of Section 95668(h)(4)(A) of the Subarticle as well as the monitor site selection guidance presented in 40 CFR Part 58, Appendices A & E and EPA's Meteorological Monitoring Guidance for Regulatory Modeling Applications. The monitoring locations are of suitable terrain features/obstructions and meet the requirements for obtaining representative air quality measurements and right-of-way access to the site. The meteorological station is located at a distance which is beyond the influence of obstructions such as buildings and trees. Section 2.1.1 of this monitoring plan discusses supporting documentation on the locations of the ambient monitors.

2.1.1 Supporting Geographical Information and Wind Data

The Pleasant Creek UGSF is located on the western edge of California's Central Valley, near Winters, California. The area surrounding the facility is a flat agricultural space. The predominant geological features nearby are small foothills about half a mile west of the Pleasant Creek UGSF. PG&E believes that the location of the ambient monitors (as outlined in Figure 1) allows representative measurement of background methane concentration at the Facility.

When PG&E was first determining the locations for the ambient monitors in 2017, several databases were reviewed to find representative meteorological stations to establish predominant wind flow patterns for the Facility. Wind roses provided in Figure 1 were produced using data collected in 2016 by the National Weather Service (NWS) at University Airport near Davis, California and Vacaville Nut Tree Airport in Vacaville, California. The locations of the meteorological stations are provided below:

- University Airport: 38.5315, -121.7865, 18.9 kilometers east of Pleasant Creek.
- Vacaville Nut Tree Airport: 38.3776, -121.9585, 19.3 kilometers south of Pleasant Creek.

The wind roses in Figure 1 indicated that the prevailing wind direction at the Pleasant Creek UGSF is from the south, south-southwest, and north.

The South Monitoring Station is located south-southwest of Well Pad 3-2 upwind of all emission sources associated with the Pleasant Creek UGSF. The North Monitoring Station is located north of an orchard which surrounds the Pleasant Creek UGSF's Well Pad 4-2, adjacent to a maintenance road. The wind rose from the University Airport shows predominant winds at the Facility are from the south followed by the south-southwest and north. When broken into seasonal wind patterns, as seen in Figures 2 and 3, the primary wind patterns are more defined as being out of the south during the summer and out of the north during the winter. Vacaville wind roses show predominant winds out the southwest and south-southwest, followed by south and north. When split into seasonal patterns the predominant winds remain out of the southwest for all seasons except winter which is dominated by winds out of the north. As such, the locations of the monitoring locations at the Facility are appropriate for capturing predominant winds out of the north and south.

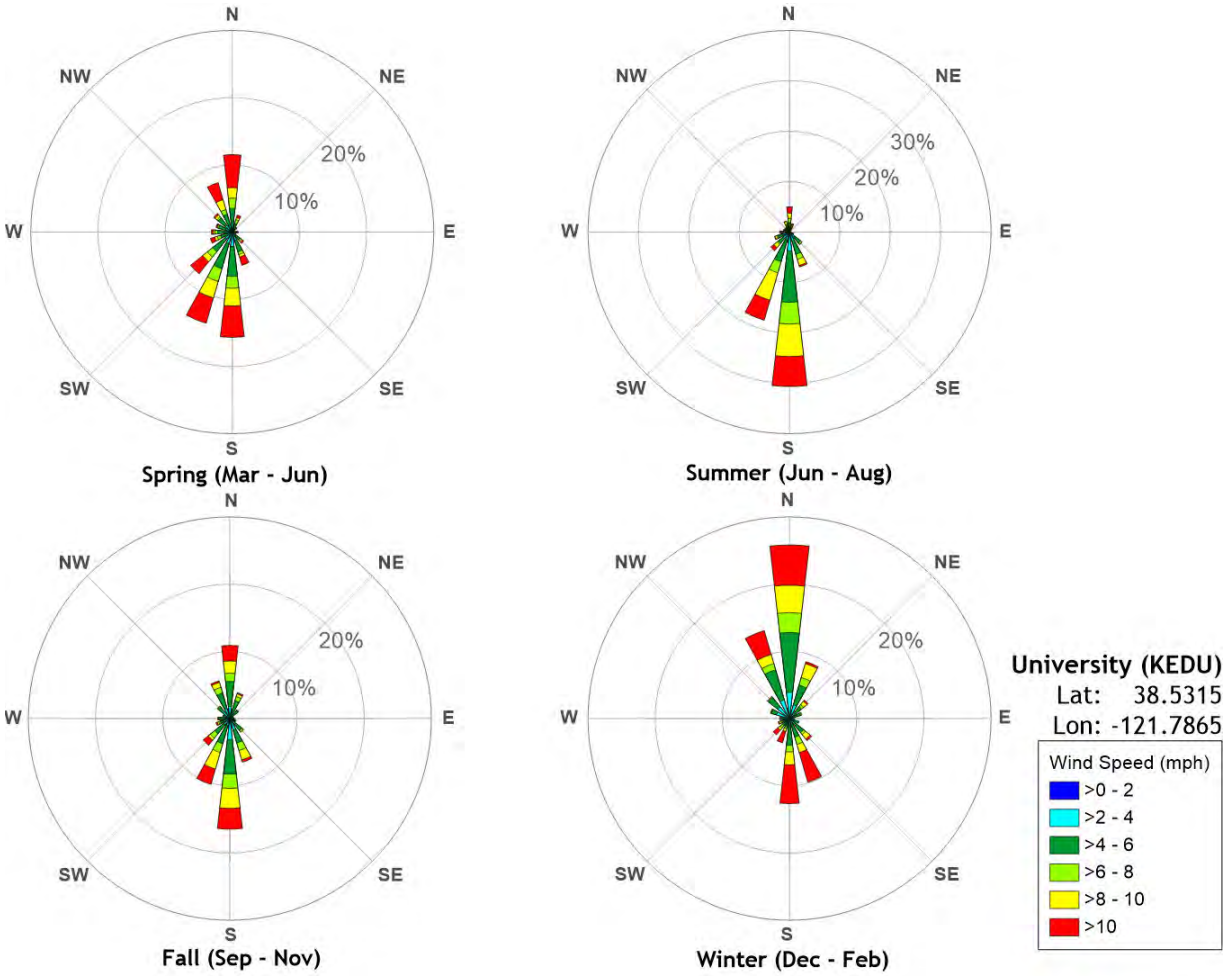


Figure 2: Seasonal Wind Roses for University Airport Meteorological Station

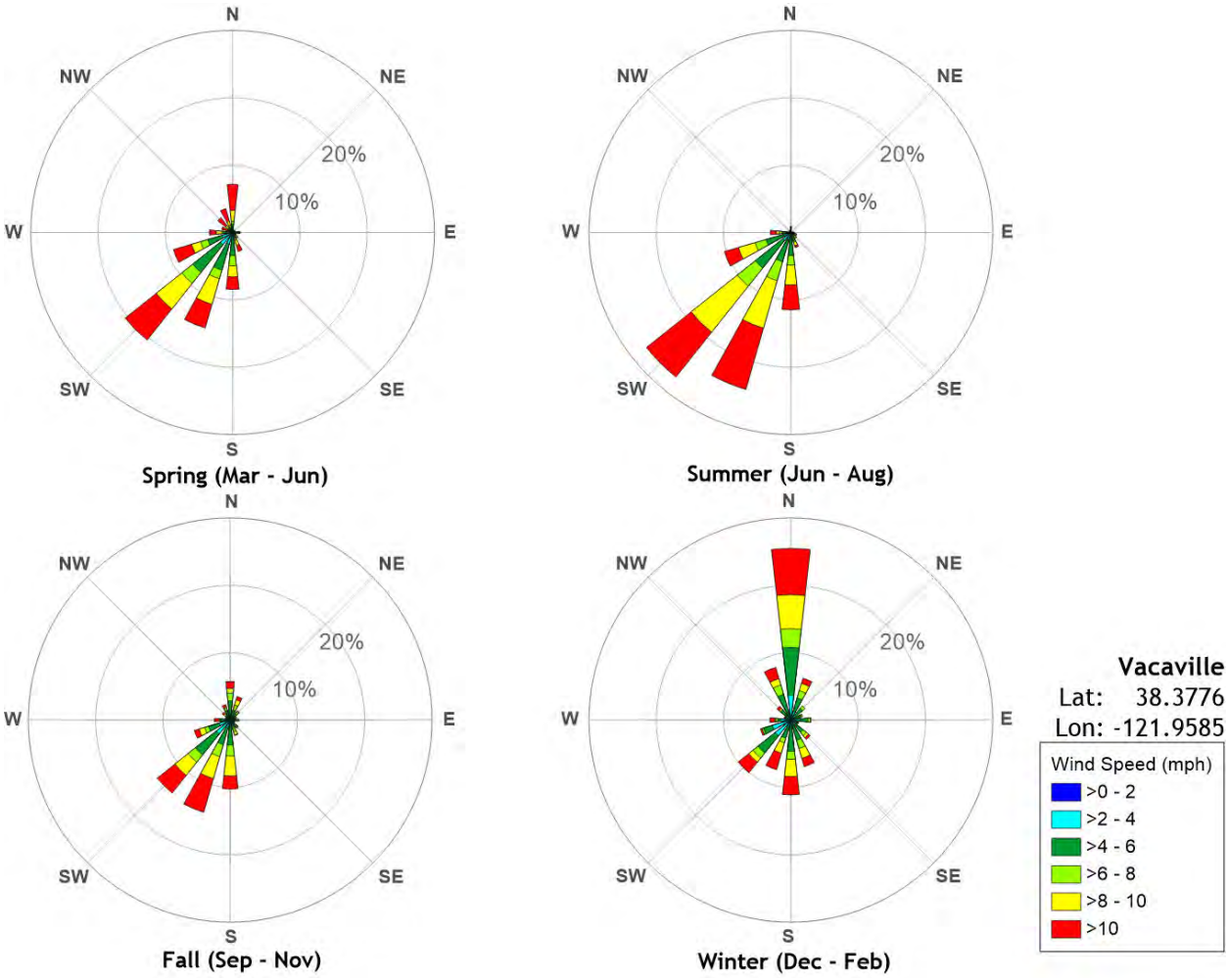


Figure 3: Seasonal Wind Roses for Vacaville Nut Tree Airport Meteorological Station

2.2 Ambient Air Monitor Technology and Operation

2.2.1 Technology

The ambient monitoring instruments are capable of measuring the ambient methane concentrations at a minimum accuracy of 250 ppb with data resolution of one minute. PG&E uses the LGR MicroPortable analyzer ambient monitors along with supporting instrumentation that provides automated zero/span verifications. These monitors provide a minimum methane detection level of 10 ppb which exceeds the 250-ppb accuracy requirement required by the CARB Oil and Gas Rule. Detailed instrument specifications have been provided in Appendix C.

PG&E's sampling inlet heights on the ambient monitors are approximately 8-12 feet above ground level. Given that methane is lighter than air during normal atmospheric conditions, PG&E

believes this height captures representative methane releases. Additionally, per 40 CFR Part 58, Appendix E, *Ambient Air Quality Surveillance – Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring*, microscale ambient monitors are required to have an inlet probe height two to seven meters (6.6 - 23 feet) above ground level, which is consistent with PG&E's sampling inlet height.

2.2.2 Operation

As required by Section 95668(h)(4)(A)(1)(b) of the Subarticle, PG&E will continue to calibrate the ambient air monitors at least once annually, which is more frequent than the manufacturer's recommendation. PG&E will continue to repair or replace any defective air monitors within 14 calendar days from the date of calibration or discovery of malfunction. In the event that parts or equipment needed to complete the necessary repairs are unavailable within this timeframe, PG&E will request a delay of repair from the CARB Executive Officer in accordance with Section 95670.1 of the Subarticle.

The monitors will continue to operate continuously. In the event of an unplanned or unpredictable power loss and/or maintenance, daily leak screening per Section 95668(h)(4)(B)(1) of the Subarticle will adequately capture any leaks. In addition, PG&E will keep records of any time the monitoring system is inactivated and reactivated along with an explanation of reason for the system being inactivated per Section 95668(h)(4)(A)(10) of the Subarticle.

2.3 Meteorological Measurements

As required by Section 95668(h)(4)(A)(2) of the Subarticle, the ambient monitoring system includes instrumentation that allows for continuous measurement and recording of ambient temperature, ambient pressure, relative humidity, wind speed, and wind direction. PG&E utilizes one 10-meter meteorological measurement tower at the Facility to measure the aforementioned meteorological parameters. PG&E believes that one station is adequate to provide sufficient meteorological data that is representative of conditions at the Facility due to the relatively flat terrain immediately surrounding the Pleasant Creek UGSF and the same footprint of the Facility. PG&E has placed the meteorological station at the same location as the North Monitoring Station as shown in Figure 1. The meteorological monitor will operate continuously, except in the event of an unplanned or unpredictable power loss.

A summary of the meteorological instrumentation at the Pleasant Creek meteorological station located at the North Monitoring Station is presented in Table 1 below.

Table 1. Pleasant Creek Meteorological Equipment

Parameter (Manufacturer/Model)	Specified Accuracy	Sensor Resolution in System
Wind Speed Met Pak Weather Station 100-1723-1B-2-11	±2% @ 12 m/s	0.01 m/s
Wind Direction Met Pak Weather Station 100-1723-1B-2-11	±3 degrees@ 12 m/s	1 degree
Temperature Met Pak Weather Station 100-1723-1B-2-11	±0.1°C	0.1°C
Relative Humidity Met Pak Weather Station 100-1723-1B-2-11	±0.8% RH @ 23°C	0.1% RH

Parameter (Manufacturer/Model)	Specified Accuracy	Sensor Resolution in System
Barometric Pressure Met Pak Weather Station 100-1723-1B-2-11	±0.5 hPa	0.1 hPa

2.4 Data Handling

2.4.1 Data Validation and Storage

In order to validate data being captured by the ambient monitoring system, PG&E has implemented the procedures outlined in a quality assurance project plan (QAPP).

The necessary practices and procedures as stipulated in the following EPA documents are contained in the QAPP, specifically:

- *40 CFR Part 58, Appendix A – Quality Assurance Requirements for Monitors used in Evaluations of National Ambient Air Quality Standards (NAAQS);*
- *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV: Meteorological Measurements, EPA-454/B-08-002, March 2008;*
- *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II: Ambient Air Quality Monitoring Program, EPA-454/B-17-001, January 2017; and*
- *Meteorological Monitoring Guidance for Regulatory Modeling Applications, EPA-454/R-99-005, February 2000.*

The procedures outlined in the reference documents listed above represent best practices for ambient air quality monitoring and provide sound data validation protocols. The categories below represent the descriptive titles of each section that are included in the QAPP:

- Project Management Elements
  - Approvals Signatures
  - Table of Contents
  - Distribution List
  - Project/Task Organization
  - Problem Definition/Background
  - Project/Task Description
  - Data Quality Objectives and Criteria for Measurement of Data
  - Special Training/Certifications
  - Documents and Records
- Measurement and Data Acquisition
  - Sampling Process Design
  - Monitoring Equipment and Methods Description
  - Sample Handling and Custody
  - Quality Control Requirements
  - Instrument/Equipment Testing, Inspection and Maintenance
  - Instrument/Equipment Calibration and Frequency
  - Inspection/Acceptance of Supplies and Consumables
  - Data Management
- Assessment and Oversight
  - Assessments and Response Actions
  - Reports to Management
- Data Validation and Usability

- Data Review, Validation, and Verification Requirements
- Data Validation and Verification Methods
- Reconciliation with User Requirements

Unlike conventional technologies (like gas chromatography, Nondispersive Infrared Sensor [NDIR], and electrochemical sensors) for measuring gas concentrations that usually require frequent calibration, span and zero checks, and periodic bump test validation, the analyzer PG&E uses (LGR MicroPortable) is based on (cavity enhanced) high resolution tunable diode laser absorption spectroscopy. Further technical details about the LGR MicroPortable analyzer technology are included in Appendix C. Per guidance from the ambient monitor manufacturer, PG&E performs preventative maintenance and calibration of the methane analyzer annually.

Alarm system failure is determined by the ambient monitor system health metrics which monitor the temperature, pressure, optical path length, laser wavelength, and all parameters used in the analysis and that affect the measured concentration. Table 8 and 9 in Appendix C describe each warning and alarm in greater detail. If any measured parameter is outside normal bounds, a critical error or warning flag is triggered and provided in the data file and in the coil register of the Modbus output immediately.

By virtue of the selected technology and measurement method, the ambient monitor analyzer automatically performs a zero measurement every second as part of normal operation, and is inherently linear, which obviates the need for a span check. Internal system health diagnostics record, monitor and report all of the parameters that affect measurement integrity. If any of these parameters indicate operation outside prescribed normal bounds, the system will trigger flags/alarms that are instantly presented in the data files. These comprehensive health diagnostics ensure proper system oversight and, as a result, obviate the need for a bump check. Alerts are sent out instantly when the health metrics fall outside of the established threshold. These alerts are monitored, verified, and can be used to identify the need for any additional verification or adjustments. Additionally, operation of the system will be verified periodically.

To perform sampling and analysis operations consistently, standard operating procedures (SOPs) for the PG&E Pleasant Creek monitoring network were developed and included as part of the QAPP. SOPs are written documents that detail the method for an operation, analysis, or action with thoroughly prescribed techniques as well as steps and are officially approved as the method for performing routine and repetitive tasks. SOPs ensure consistent performance with organizational practices, serve as training aids, provide ready reference and documentation of proper procedures, reduce work effort, reduce error occurrences in data, and improve data comparability, credibility, and defensibility. Each SOP is sufficiently clear and written in a step-by-step format to be readily understood by a person knowledgeable in the general concept of the procedure.

Pursuant to Section 95668(h)(4)(A)(3) of the Subarticle, PG&E's ambient air monitoring system (including the meteorological station) has the ability to store at least 24 months of continuous data with the capability to generate hourly, daily, weekly, monthly and annual reports.

2.4.2 Data Reporting

Pursuant to Sections 95668(h)(4)(A)(5), 95673(a)(11) and 95673(b)(2) of the Subarticle, PG&E will continue to provide an annual report of all meteorological data and ambient air data collected at the Pleasant Creek UGSF to CARB electronically at oilandgas@arb.ca.gov with the subject line "Natural Gas Underground Storage Reporting". Additionally, PG&E will continue to make all

data collected by the monitoring system to be made available upon request from the CARB Executive Officer.

2.5 Alarm System and Monitoring Baseline Conditions

Pursuant to Section 95668(h)(4)(A)(4) of the Subarticle, PG&E has established an integrated alarm system connected to the ambient air monitors that is audible and visible continuously in the control room at the Facility and at PG&E's Gas Control Center located in San Ramon, California. Per Section 95668(h)(4)(A)(7) of the Subarticle, the alarm system will be triggered when the predominantly upwind (South) or predominantly downwind (North) ambient air monitor has a sensor failure, or when the downwind ambient air monitor reading records the 1-hour average concentration, for a full operating hour, as greater than or equal to four times the downwind ambient air monitor baseline.

Pursuant to Section 95668(h)(4)(A)(6) of the Subarticle, PG&E has established a baseline monitoring value for the Facility using 12 months of continuous monitoring data from August 6th, 2019, through August 5th, 2020. The baseline condition was established from the 98th percentile of the 12-month continuous period of 1-hour measurements. PG&E submitted the baseline data and calculation on March 17th, 2021, and received approval of the baseline concentration on June 17, 2021.

A summary of the baseline concentration at Pleasant Creek's North and South Monitoring Stations is presented in Table 2 below.

Table 2. Pleasant Creek Baseline Concentration Values

	PC – N – MET	PC – S
Approved Baseline Concentration (ppm)	2.40	2.43
Alarm Threshold (ppm)[1]	9.60	9.72

1. Alarm system is triggered when the sensor detects a reading that is greater than or equal to 4 times the baseline concentration value.

For the purposes of determining the downwind ambient air monitor 1-hour values, a full operating hour will be considered as at least 45 valid data points that will be used to calculate the hourly average. Hourly data will not include partial operating hours (any clock hour with less than 45 minutes of monitor operation) and hours when maintenance or quality-assurance activities are performed on the monitors. Pursuant to Section 95668(h)(4)(A)(9), PG&E recognizes that the upwind (PC-S) and downwind (PC-N-MET) baseline conditions may be re-evaluated every 12 months for changes in local conditions and must be approved by CARB. Note that if alarms are frequently triggered due to planned maintenance and operational activities, PG&E will submit an updated monitoring plan with revised data collection and alarming calculation procedures.

In the event that an alarm is triggered, PG&E will confirm that an alarm condition has occurred and then contact the following agencies within 24 hours of the alarm trigger in accordance with Section 95668(h)(4)(A(8):

- CARB
- California Department of Conservation Geologic Energy Management Division (CalGEM)
- YSAQMD

The following represent examples of scenarios where, if an alarm is triggered, PG&E will investigate the cause of any resultant alarms, document the cause of the alarm, and provide CARB, CalGEM, and YSAQMD a notification via email within 24 hours. PG&E will include an explanation for the alarm condition in the notification when an explanation is available:

1. Natural gas blowdown events.
2. Natural gas releases due to maintenance activities or emergency shutdowns.

3. Leak Screening, Repair, and Reporting

3.1 Daily or Continuous Leak Screening

In accordance with Section 95668(h)(4)(B)(1) of the Subarticle, PG&E has been conducting and will continue to conduct daily leak screening or inspection at each injection/withdrawal wellhead and attached pipelines using Detecto Pak-Infrared (DP-IR) with Method 21 probe, Thermo Fischer Toxic Vapor Analyzer (TVA), or alternate leak screening instruments described in Section 3.1.1 below. PG&E intends to evaluate gas detection instrumentation for continuous leak screening in parallel with completing daily leak screening surveys. Should PG&E choose to use continuous leak instrumentation to meet the requirements of Section 95668(h)(4)(B) of the Subarticle, PG&E will submit a request to CARB to amend the monitoring plan to reflect the use of this instrumentation in lieu of the daily leak survey instruments. Under the CalGEM approved leak detection protocol, PG&E currently performs daily leak screenings in accordance with its utility procedures TD-4110P-01 (provided in Appendix D). PG&E proposes to continue to use these procedures to meet the leak screening requirement under the CARB Oil & Gas Rule.

Pursuant to Section 95668(h)(4)(B)(1)(a) of the Subarticle, PG&E will report a delay of inspection if wildlife is found to be present on a component and inspection must be halted or postponed within a certain distance of the wildlife in order to comply with state and federal wildlife regulations. PG&E will report the delay of the inspection to CARB within 24 hours of discovering the wildlife. The notification will include a description of the type of wildlife and the regulations required work to be halted. Once the reason for the inspection delay is resolved, PG&E will resume inspection and notify CARB within 24 hours of resuming the daily leak inspections.

3.1.1 Leak Screening Technology

In a letter dated March 6, 2018, CARB provided PG&E approval to use the Heath Detecto Pak-Infrared (Model: DP-IR™) Intrinsically Safe Leak Detector as an EPA Method 21 instrument for the purposes of implementing the CARB's Oil and Gas Rule. The DP-IR™ instrument uses a highly advanced optical technology capable of detecting methane gas using the Infrared Controlled Interference Polarization Spectrometry method. Note that PG&E does not have any geography or access issues that compromise the capability of the instrument. Detailed specifications for the DP-IR™ can be found in Appendix E and are summarized below.

Measurement Range:

- 0 - 10,000 ppm
- 0 to 100% Gas

Sensitivity Range:

- 0 - 1,000 ppm: 1 ppm
- 1,000 - 10,000 ppm: 5 ppm
- 1 - 100% Gas: 0.5%

PG&E requested CARB's approval for the use of the Health Remote Methane Leak Detector (Model: RMLD™) Intrinsically Safe Leak Detector, as an alternate leak screening instrument that meets the requirements of Section 95668(h)(4)(B)(1) of the Subarticle, as part of the previous submittal of this monitoring plan. The previous monitoring plan was approved and as such, PG&E uses and will continue to use RMLD™ as approved by CARB. The RMLD™ uses laser technology known as Tunable Diode Laser Absorption Spectroscopy to detect methane gas. PG&E does not have any geography or access issues that compromise the capability of the instrument. Detailed specifications for the RMLD™ can be found in Appendix F and are summarized below.

Measurement Range:

- 0 – 99,999 ppm-meter (ppm-m)

Sensitivity Range:

- 5 ppm-m from 0 to 50 feet
- 10 ppm-m from 50 to 100 feet

PG&E may also choose to use Thermo Fisher's TVA2020 as an alternate leak screening instrument that meets the requirements of Section 95668(h)(4)(B)(1) of the Subarticle. The TVA2020 complies with the U.S EPA Method 21 requirements. The TVA is equipped with a flame ionization detector (FID) analyzer that allows the instrument to measure organic compounds with high sensitivity. Detailed specifications for the TVA2020 can be found in Appendix G and are summarized below.

Dynamic Measurement Range:

- 1.0 to 50,000 ppm

Repeatability:

- ±2% at 500 ppm

Accuracy:

- ±10% of reading or ±1.0 ppm whichever is greater, from 1.0 to 10,000 ppm.

3.2 Leak Detection and Repair

3.2.1 Leak Detection

In accordance with Section 95668(h)(4)(B)(3) of the Subarticle, within 24 hours of detecting a leak through the daily leak screening procedures, PG&E will perform leak measurements in accordance with EPA Method 21, excluding the use of PID instruments. Types of instruments that can be used are discussed in Section 3.1.1 above. Note that as discussed in Section 3.1.1, CARB has approved the DP-IR™ instrument as an approved instrument for conducting Method 21 leak measurements for the purposes of implementing the CARB's Oil and Gas Rule. As such, a daily leak survey completed by the DP-IR™ will be considered an EPA Method 21 measurement and will not need any additional follow-up measurements for the purposes of implementing the CARB's Oil and Gas Rule.

Pursuant to Section 95669(i) of the Sub article, the following procedures will be completed upon leak detection:

1. PG&E will affix a weatherproof readily visible tag that identifies the date and time of leak detection and the measured leak concentration to the leaking component.
    a. Minimum leak threshold concentration is 1,000 ppmv total hydrocarbon per Section 95669(h) of the Subarticle.
2. The tag shall remain affixed to the leaking component until the leaking component has been successfully repaired or replaced, after which the tag shall be removed.

a. Successful repair or replacement will be confirmed by re-measuring the component using EPA Method 21 to determine that the component is below the minimum leak threshold after repair or replacement.

3. Tags shall be removed from components following successful repair or replacement.

Leak detection instrumentation, when used by PG&E personnel, will be operated by qualified individuals that have completed the required training and have obtained the applicable PG&E Operator Qualifications (OQ). When leak detection instrumentation is operated by contracted personnel, training responsibilities will be completed by the vendor.

3.2.2 Leak Repair

After determining the leak rate using EPA Method 21, PG&E will repair the leak according to the following timelines, as outlined in Sections 95669(h) and (i) of the Sub article and Table 3 below.

Table 3. Leak Rate and Repair Timeframe

Leak Rate	Repair Time Period[1]
1,000-9,999 ppmv	First repair attempt within 5 calendar days; successful repair within 14 calendar days
10,000 – 49,999 ppmv	5 calendar days
≥ 50,000 ppmv	2 calendar days
Critical Component or Critical Process Unit Leak [1]	By next process shutdown or within 12 months, whichever is sooner

[1]Given the current use and pending sale of PG&E Pleasant Creek UGSF, as of the date of this monitoring plan, the Facility does not have any pre-approved critical components.

3.3 Leak Reporting and Recordkeeping

3.3.1 Leak Reporting

In accordance with Section 95668(h)(4)(B)(6) of the Subarticle, PG&E will report the following leaks identified during daily leak screening at each injection/withdrawal wellhead and attached pipelines to CARB, CalGEM, and YSAQMD within 24 hours:

- Any leaks measured above 50,000 ppmv total hydrocarbons
- Any leaks measured above 10,000 ppmv total hydrocarbons, if leak persists for more than 5 continuous calendar days

In accordance with Section 95668(h)(4)(B)(8) and Section 95673(a)(9) of the Subarticle, PG&E will report, on a quarterly basis, the following information required per Table 5 of Appendix A of the Subarticle, for leaks identified as a result of a Method 21 measurement performed in conjunction with the daily leak screening measurements:

- Inspection Date
- Method 21 Instrument Make and Model
- Method 21 Instrument Calibration Date
- Component Type

[1] Per Section 95669(h)(4)-(5) of the Subarticle, repair timelines may deviate due to critical component designation or delay of repair conditions.

- Component ID, if applicable
- Equipment ID or description
- Active or Idle Well, if applicable
- Initial Leak Concentration (ppmv)
- Repair Date
- Concentration After Repair (ppmv)

3.3.2 Leak Recordkeeping

In accordance with Section 95668(h)(4)(B)(7) of the Subarticle, PG&E will maintain and make available to the CARB Executive Officer, records of the initial and final leak concentration measurements for leaks identified during the daily leak screening process that are above the thresholds specified in Section 3.2. PG&E will maintain records which contain all information as specified in Appendix A, Table A5 of the CARB Oil and Gas Rule.

4. Well Blowout Procedures

During the event of a well blowout, PG&E follows the emergency response process outlined in its Gas Emergency Response Plan (GERP). PG&E has reviewed and updated its GERP to reflect the OGI leak monitoring requirements in the CARB Oil and Gas Rule.

Per Section 95667(a)(3) of the Subarticle, “blowout” means the uncontrolled flow of gas, liquids, or solids (or a mixture thereof) from a well to the surface. PG&E understands that uncontrolled, in this context, means that the release of gas cannot be predictably stopped, minimized, or otherwise harnessed due to technical infeasibility and/or exposure to unsafe working conditions. Upon confirmation of a well blowout, PG&E will respond in accordance with the GERP and activate applicable Emergency Centers to support the incident response. PG&E defines a well blowout as terminated when the release of gas is controlled.

4.1 Optical Gas Imaging (OGI) Procedures

OGI, as defined under Section 95667(46) of the Subarticle, means an instrument that makes emissions visible that may otherwise be invisible to the naked eye. For the purposes of OGI at the Pleasant Creek UGSF, PG&E will use the EyeCGas VOC camera, the FLIR GF300/GF320 camera, or an equivalent. Specifications for these types of instruments have been provided in Appendix H.

Per Section 95668(h)(4)(C) of the Subarticle, PG&E will direct a qualified technician (with training in basic thermal science, OGI camera operation and safety, and OGI inspections) to obtain daily OGI video footage of a leak resulting from a well blowout according to the following timeline:

- Within forty-eight (48) hours of PG&E Gas Operations confirming that a well blowout event has occurred at the Pleasant Creek UGSF or as soon as reasonably possible, a qualified technician will collect 10 minutes of OGI video footage of the leak resulting from the well blowout. The forty-eight (48) hour time period will allow PG&E to:
    - Ensure that the safety of PG&E staff and/or contractors at the well blowout site is adequately evaluated and addressed. This would include:
        - Determining the radius around the well blowout site that is considered safe for operation of the OGI equipment.
        - Mobilizing technicians (including PG&E staff and/or contractors) to arrive safely at the well blowout site. Note that a well blowout may occur at any time such that

nearby technicians may need to travel from non-worksite locations and navigate around potentially dangerous obstructions to reach the well blowout site.
    - Mobilize OGI equipment to the well blowout site, considering the fact that the first available OGI camera may have been damaged or become inaccessible due to the well blowout event.
- The qualified technician will continue to record OGI video footage of the leak for a minimum of 10 minutes every four (4) hours throughout the course of the blowout incident until the gas has been controlled and the PG&E emergency centers have been deactivated.
- Within one business day after the qualified technician has recorded OGI video footage, PG&E will post the video footage on a public internet website maintained by PG&E. The one business day will allow PG&E to:
    - Provide adequate time to transfer video footage from the OGI camera to PG&E databases in the event that wireless transmission is not possible from the well blowout site due to power loss, unavailability of internet connectivity, or unsafe working conditions during the well blowout.
    - Ensure trained communications staff review the video footage for liability concerns prior to posting the video on a public internet website.

Pursuant to Section 95668(h)(4)(C)(3) of the Subarticle, PG&E will provide OGI video footage to the CARB Executive Officer upon request, for publication on an CARB maintained public internet web site.

5. Ambient Monitoring Plan Revision History

Table 4. Ambient Monitoring Plan Revision History

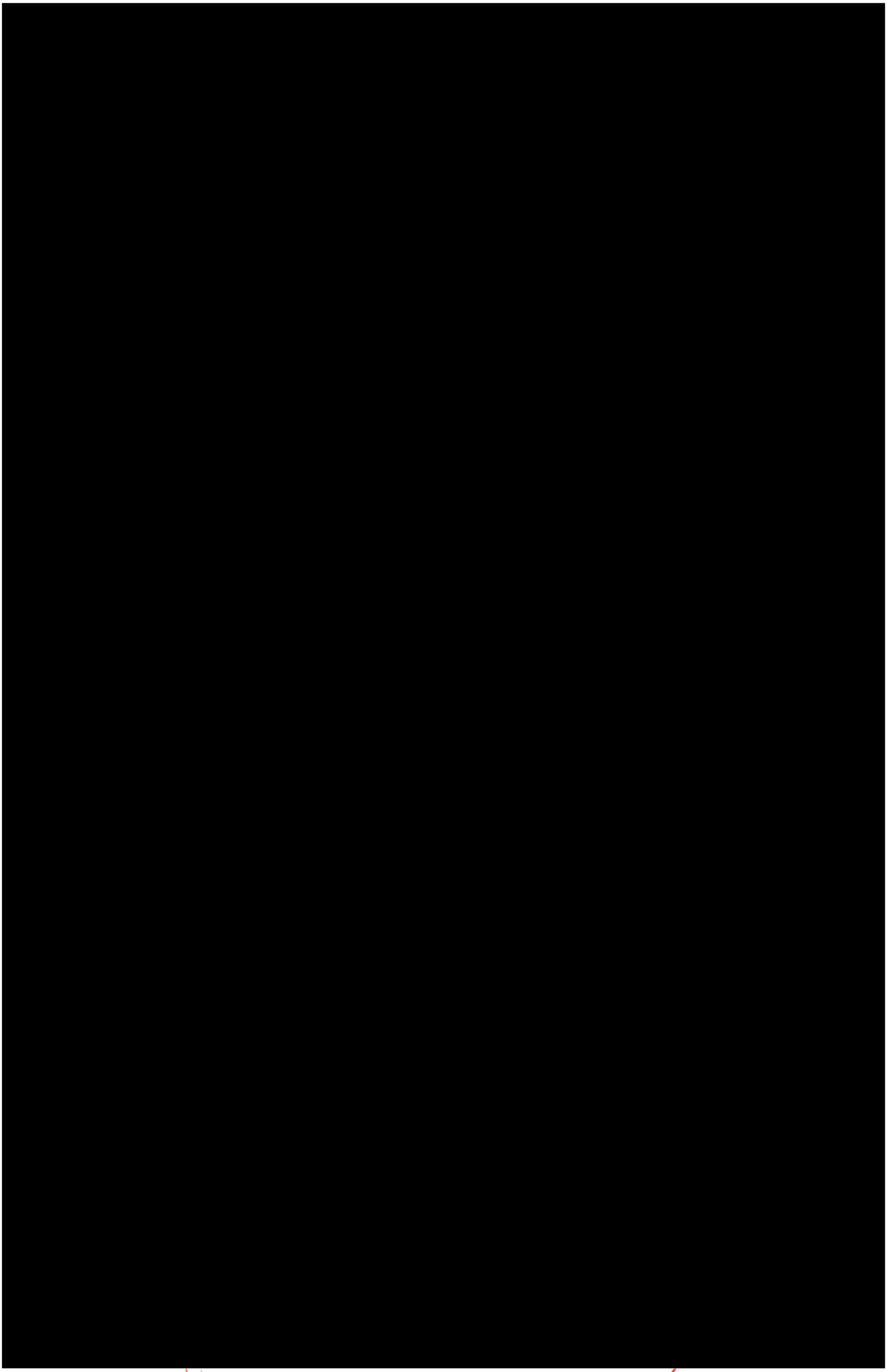
Revision Number	Revision Date	Revision Notes
1	December 18, 2017	Initial draft of the Ambient Monitoring Plan. CARB conditional approval received on February 7, 2019.
2	October 10, 2018	Revision following CARB conditional approval. CARB approval received on June 17, 2021.
3	June 19, 2024	Revision to align with amendments to the CARB O&G Rule (effective 4/1/2024).

Appendix A – List of Wellhead Sites

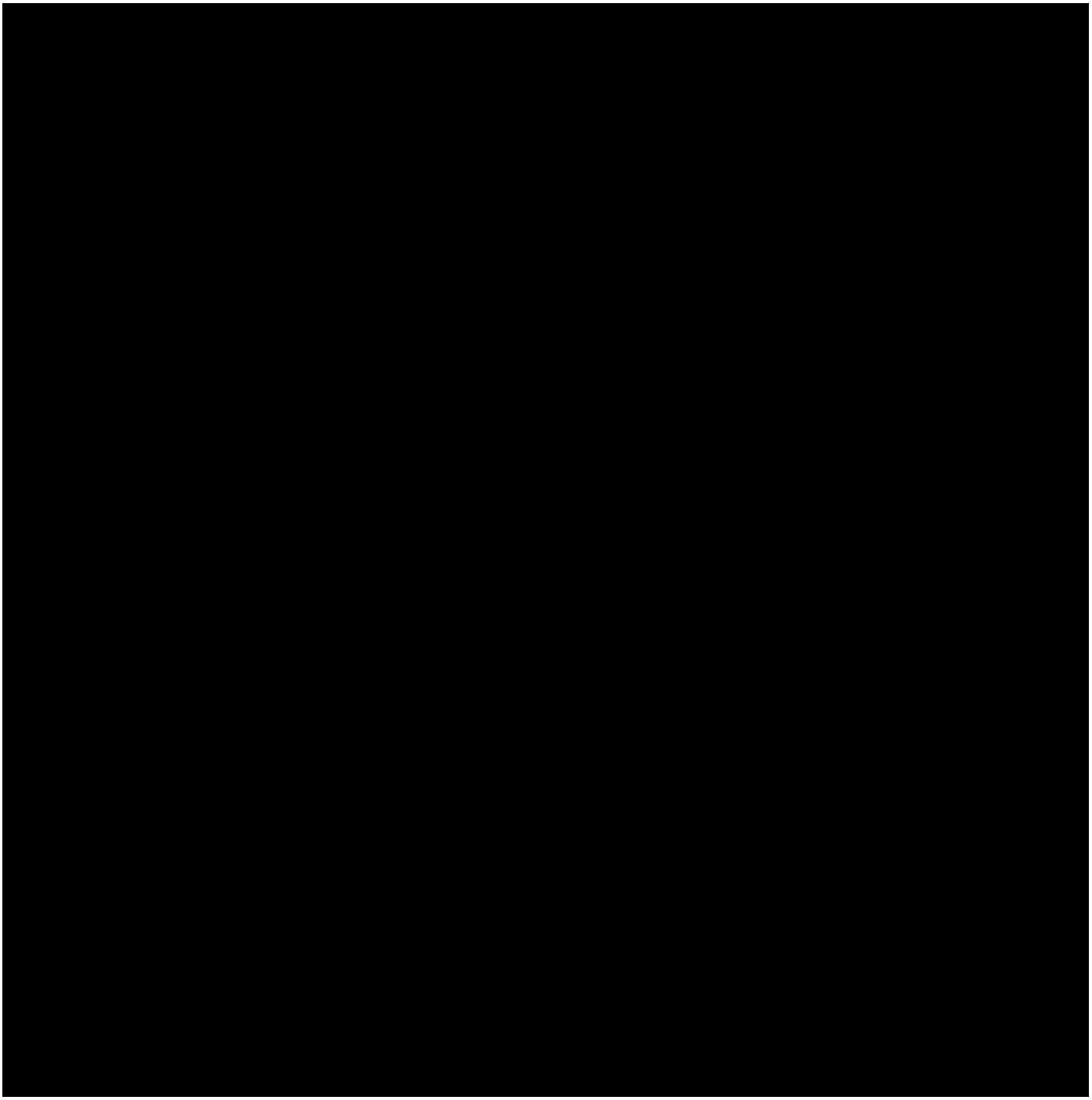
Pleasant Creek Storage Field Well List

API #	Station Name	Well Name
11300063	Pleasant Creek	3-1
11320192	Pleasant Creek	3-2
11320193	Pleasant Creek	3-3
11320194	Pleasant Creek	3-4
11321279	Pleasant Creek	3-5
11320195	Pleasant Creek	4-2

Appendix B – CONFIDENTIAL: Map of Pleasant Creek UGSF & Wellhead Sites



CONFIDENTIAL



Pleasant Creek Gas Storage Facility - Regional Map

Appendix C – Ambient Air Monitor Specifications

LGR MicroPortable Analyzer Technical Description

The LGR MicroPortable analyzer utilizes a narrow-bandwidth diode laser that is tuned/scanned in wavelength continuously over a selected absorption feature of the target gas to be measured (methane, in this case) and the entire (methane) absorption feature/line shape is recorded. Since the laser is much narrower in width compared with the measured line shape, the line shape is not convoluted or instrument broadened). The analysis routine running on the internal computer in the analyzer then automatically fits the measured line shape to a known profile that is unique to the target gas (methane) and calculates the area under this methane line shape from which, along with the measured gas temperature and pressure in the cell and the measured optical path length (from the measured ringdown time), the gas concentration is determined using Beer's Law. Since all of the internal measurements (gas temperature, pressure, path length) are absolute (ultimately traceable to a standard reference), this method of determining the gas concentration is inherently absolute and, in principle, does not require calibration. Also, since the spectra is obtained by scanning the laser over the entire line shape, which is unique (a spectroscopic fingerprint) and known a priori, the measurements are inherently linear (via Beer's Law). Furthermore, the system automatically performs a zero-offset measurement during every laser scan over the wavelength region containing the target absorption feature so, if methane is zero, the measured integrated area under the line shape is zero; i.e. there is essentially no offset.

Find natural gas leaks now

NEW

- ppb sensitivity
- battery powered
- 10-Hz data rate
- small size

Microportable Greenhouse Gas Analyzer (CH_4, CO_2, H_2O)

Features and Benefits

- 5.8 kg (12 lbs) w/ 2-hr battery
- Continuous measurements
- CH_4 reported at 10 Hz with ppb sensitivity
- Ideal for natural gas leak detection while walking; also, for chamber flux and soil studies, emissions monitoring
- Extremely wide range: ppb to %
- Extended Range option allows CH_4 measurements up to 1%
- Species specific - no cross interferences
- Operates directly on DC power
- Extremely fast time response (1 Hz with internal pump)
- Record data within 20 seconds after power on

LGR's new Microportable Gas Analyzer (μGGA) reports measurements of methane, carbon dioxide and water vapor simultaneously in a package that is compact, crushproof and travels anywhere. Small enough to be hand carried (even on-board aircraft) and requiring less than 35 watts, the μGGA offers opportunities to measure GHG and natural gas leaks anywhere. As with all LGR instruments, the μGGA is fast and simple to use which makes it ideal for natural gas leak detection and other field studies, compliance monitoring, air quality studies and soil flux studies, and wherever measurements of methane, carbon dioxide and water vapor are needed quickly and sensitively.

The μGGA begins recording data within 20 seconds after power on so you don't have to wait for a long warm-up period for the system to thermally equilibrate.

Furthermore, LGR's "Extended Range" option provides accurate methane measurements at levels up to 1% (without dilution) without reducing precision and sensitivity at typical ambient levels - a unique capability to LGR. Moreover, only LGR's analyzers provide reliable measurements at concentrations greater than 10,000 times ambient levels.

LGR's patented technology, a fourth-generation cavity enhanced absorption technique, has many advantages (simpler, easier to build and operate, more rugged) over older, conventional and delicate cavity ringdown spectroscopy (CRDS) and direct absorption techniques. As a result, LGR Analyzers provide higher performance and reliability at lower cost.

LGR Analyzers have an internal computer (Linux OS) that can store data practically indefinitely on a hard disk drive and send real time data to a iPhone, iPad, Android Tablet, or other WiFi device.

[L G R] Los Gatos Research

ABB - Los Gatos Research, Inc.
3055 Orchard Drive
San Jose, CA 95034

Phone: +1 650-965-7772
Fax: +1 650-965-7074
sales@lgrinc.com

www.lgrinc.com

Microportable Greenhouse Gas Analyzer (CH_4, CO_2, H_2O)

Performance Specifications

Precision (1σ, 0.1 sec / 1 sec / 10 sec):
- CH_4: 9 ppb / 3 ppb / 1 ppb
- CO_2: 6 ppm / 2 ppm / 1 ppm

Measurement Rates:
0.01 – 10 Hz (user selectable)

Measurement Ranges (meets all specifications):
- CH_4: 0.01 – 1000 ppm (standard range)
- CH_4: 0.01 – 10,000 ppm (extended range)
- CO_2: 100 ppm – 10%

Operational Range
(external calibration may be required):
- CH_4: 0 – 4%
- CO_2: 0 – 10%
- H_2O: 0 – 70000 ppm (0 – 98% relative humidity)

Sampling Conditions:
- Sample Temperature: -40 – 50 °C
- Operating Temperature: 0 – 50 °C
- Ambient Humidity: 0 - 98% RH non-condensing

Flow time response:
1 second (1/e)

Data Outputs:
- WiFi, USB

Power Requirements:
- 35 watts (10-30 VDC)

Dimensions:
- 13.4"× 11.6"× 6"

Weight:
- 12 pounds (5.4 kg) with internal 2-hour battery

Ordering Information

Model: 909-0050 (Analyzer includes control and analysis software)

Accessories (optional)

Gas sampling wand

Shoulder strap

Tablet - Android Nexus or Apple iPad

Tablet harness (for hands-free operation)

Larger internal battery - for 4 hour operation

Smart external battery charger

Shoulder strap

Mirror Cleaning Kit

[L G R] Los Gatos Research

ABB - Los Gatos Research
3055 Orchard Drive
San Jose, CA 95134

Phone: +1 650-965-7772
Fax: +1 650-965-7074
Sales@lgrinc.com

www.lgrinc.com

Table 8 Channel 5 Temperature Warnings/Alarms

Warning / Alarm	Current (mA)	UI Display 4–20 mA Alarm Status	Detected Problem
Alarm	4 ± 0.1	Cavity Heater	Cavity temperature is too high or too low
Alarm	5 ± 0.1	Expansion heater	Expansion chamber temperature is too high or too low
Alarm	6 ± 0.1	Bulkhead temperature (Only on Bulkhead option)	Bulkhead temperature is too high or too low
Alarm	7 ± 0.1	Filter temperature	Filter temperature is too high or too low
Alarm	8 ± 0.1	Orifice temperature	Orifice temperature is too high or too low
Alarm	9 ± 0.1	Inlet Tubing temperature	Inlet tubing temperature is too high or too low
Alarm	10 ± 0.1	Analyzer temperature	Ambient temperature is outside of alarm set-point range
Warning	12 ± 0.1	Cavity temperature	Cavity temperature is above or below normal
Warning	13 ± 0.1	Expansion temperature	Expansion chamber temperature is above or below normal
Warning	14 ± 0.1	Bulkhead temperature (Only on Bulkhead option)	Bulkhead temperature is above or below normal
Warning	15 ± 0.1	Filter temperature	Filter temperature is above or below normal
Warning	16 ± 0.1	Orifice temperature	Orifice temperature is above or below normal
Warning	17 ± 0.1	NaN reading	Not a Number (NaN). Faulty random number/character result being displayed
Warning	18 ± 0.1	Inlet Tubing temperature	Inlet tubing temperature is above or below normal
No issue	20 ± 0.1		No warning/alarm

Table 9 Channel 6 Analyzer Warnings/Alarms

Warning / Alarm	Current (mA)	UI Display 4-20 mA Alarm Status	Detected Problem
Alarm	4 ± 0.1	Data Health (A)/(B)	Laser A and/or B goodness of fit is poor
Alarm	5 ± 0.1	Pressure	Pressure is not in operating range
Alarm	6 ± 0.1	HD Space	Hard drive (HD) space is low, deleting oldest files
Alarm	7 ± 0.1	Mirror Health (A)/(B)	Mirror health has degraded, clean mirrors
Alarm	8 ± 0.1	Linelock (A)/(B)	Laser A and/or B peak position is outside of control range, contact customer support
Alarm	9 ± 0.1	Signal Power (A)/(B)	Laser A and/or B power has degraded, contact customer support
Alarm	10 ± 0.1	Maintenance	Maintenance is needed on system now
Warning	12 ± 0.1	Data Health (A)/(B)	Laser A and/or B goodness of fit is not optimal
Warning	13 ± 0.1	Pressure	Pressure is noisy
Warning	14 ± 0.1	HD Space	HD space is low
Warning	15 ± 0.1	Mirror Health (A)/(B)	Mirror health is degrading, clean mirrors soon
Warning	16 ± 0.1	Linelock (A)/(B)	Laser A and/or B peak position is moving very fast
Warning	17 ± 0.1	Signal Power (A)/(B)	Laser A and/or B power is degrading, contact customer support soon
Warning	18 ± 0.1	Maintenance	Maintenance is needed on system soon
No issue	20 ± 0.1		No warning/alarm

NOTE

If the analyzer power is deactivated for more than 10 minutes, allow the heaters to reach the set temperature before CH5 and CH6 start porting 20 mA values.

An analyzer not equipped with a gas-expansion heater, orifice heater, or inlet-tube heater, does not have the associated color flags in the *Alarm Status* display screen.

Unique Technology

All LGR analyzers utilize a unique laser absorption technology called Off-Axis Integrated Cavity Output Spectroscopy (OA-ICOS). This technique, which was patented by LGR, offers superior performance, value and reliability as compared to any other technology.

Cavity enhanced absorption was first developed as an ultra-sensitive detection method by LGR founder Anthony O'Keefe in 1988 (Review of Scientific Instruments (ISSN 0034-6748), vol. 59, Dec. 1988, p. 2544-2551) in the form of cavity ringdown spectroscopy (CRDS). While innovative, unfortunately this first-generation technique requires sub-nanometer alignment of its internal optics, which translates directly into limitations in terms of high cost, and vulnerability to vibrations and temperature/pressure changes. To overcome these drawbacks, scientists at LGR developed a fourth-generation cavity enhanced laser absorption technology called OA-ICOS. This approach delivers superior performance, yet is orders of magnitude less sensitive to internal alignment of components. As a result, OA-ICOS is ideal for use in commercial instruments for even the most demanding applications in remote locations.

The inherent advantages of OA-ICOS technology make LGR trace gas and stable isotope analyzers the best choice, whatever the application.

Superior Performance

All LGR analyzers deliver superior performance (in terms of accuracy, precision, sensitivity, linearity and dynamic range) and ease of use compared to any competitive technology.

That's because all LGR trace gas and isotope analyzers are based on our unique and patented OA-ICOS technology. This fourth-generation cavity-enhanced laser absorption method offers several inherent advantages over older, multipass and cavity based (e.g., conventional CRDS) methods. For instance, OA-ICOS provides the same optical path lengths (20 km or longer) as conventional CRDS but without the expense and vulnerability of a sub-nanometer opto-mechanical setup. This enables it to easily deliver parts per billion precision (or better) quickly and in an easy to use package. And, because OA-ICOS directly measures absorption rather than only a cavity decay time, it offers a linear response over a significantly wider dynamic range than conventional CRDS, e.g., up to 100% mole fraction for some gases.

LGR trace gas and stable isotope analyzers deliver the world's best performance for applications such as climate research, water cycle studies, petrochemical exploration, and emissions compliance monitoring.

Unmatched Reliability

All LGR analyzers combine state-of-the-art performance with robust operation and unmatched reliability, enabling continuous operation in challenging environments, as well as in mobile (truck, ship, aircraft) and remote applications.

LGR achieves this exceptional reliability because all our trace gas and isotope analyzers are based on our patented OA-ICOS technology. This fourth-generation, cavity-enhanced laser absorption method offers several inherent advantages

over older, multipass and cavity based (e.g. conventional CRDS) methods. In particular, the performance of an OA-ICOS instrument is not dependent on hyper-critical optical alignment, whereas older cavity-based techniques require sub-nanometer optical component alignment. This makes these older techniques very vulnerable to degraded performance due to vibrations, small physical shocks, and changes in temperature and pressure. But, because OA-ICOS performance is orders of magnitude less sensitive to internal alignment, our rugged instruments are incredibly robust and reliable. And designed with simplicity in mind, in the rare instance that repair is necessary, LGR instruments may be easily serviced on site by minimally trained personnel.

For these reasons, LGR trace gas and stable isotope analyzers deliver state-of-the art precision and unmatched reliability whether in the laboratory, in a helicopter, or at an unmanned arctic monitoring site.

Exceptional Value

All LGR analyzers deliver exceptional value by providing superior performance over any other technology, while still remaining an economical instrument.

This is possible because LGR trace gas and isotope analyzers are based on our patented OA-ICOS technology. This fourth-generation, cavity-enhanced laser absorption method offers several inherent advantages over older, multipass and cavity (e.g., conventional CRDS) methods. In particular, the performance of OA-ICOS is not dependent on hyper-critical optical alignment, whereas older, conventional CRDS techniques require sub-nanometer optical component alignment. This necessitates the use of expensive electro-mechanical components and complex feedback loops as well as very time-consuming cleanroom assembly and elaborate testing. But with LGR's instruments, the analyzer's performance is completely unaffected by any minor shifts in optical alignment. This enables the use of simpler, lower-cost components and fewer feedback control systems, as well as simplifying our assembly process.

By employing this simpler, more robust and less-delicate technology, LGR trace gas and stable isotope analyzers deliver state-of-the art precision and accuracy for a cost that is approximately half that of the nearest competitor.

Simple Field-Maintenance

All LGR analyzers are designed for simple field maintenance, avoiding the factory return that all competitive instruments require, even for simple optics cleaning.

When measuring gas samples with any type of optical analyzer, there is the small but finite chance that dust or other contaminants may deposit on the optics over a long period of time. While some manufacturers may claim (in very carefully chosen words) that this can never happen, LGR offers a solution for the rare situation where it actually does happen. With instruments based on older cavity techniques, such as conventional CRDS, even a small speck of dust or a microscopic droplet of liquid on an optic ALWAYS requires a factory return and extended downtime. In contrast, LGR analyzers utilize LGR's patented OA-ICOS technology, an approach that does not require ultra-precise optical alignment. This means that a minimally trained user can easily remove a cavity mirror, if necessary, and then clean and replace it in only minutes, with no impact on performance.

LGR analyzers reduce the downtime impact of accidental optics contamination to only minutes rather than the days or weeks required by conventional CRDS systems. Furthermore, in LGR instruments, the laser beam spot pattern covers practically the

entire cavity mirror, in contrast to convention CRDS, which only uses a small area in the center of the mirror. As a result, LGR instruments are much less affected by the presence of dust than conventional CRDS systems and thus require less frequent maintenance.

True Wavelength Scanning

All LGR analyzers employ a unique laser absorption technology called Off-Axis Integrated Cavity Output Spectroscopy (OA-ICOS). Unlike older laser-based methods, such as cavity ringdown spectroscopy (CRDS), this approach utilizes true wavelength scanning to record fully resolved detailed absorption lineshapes, which are presented to the user in real time, a critical advantage that delivers several considerable benefits including:

- Unmatched specificity
- Superior accuracy
- Widest linear dynamic range
- Enhanced capabilities, e.g., multiple isotopes
- Greater simplicity and higher value
- Stable isotope calibration

After LGR's founder, Anthony O'Keefe, Ph.D., pioneered the development of CRDS [*ref], scientists at LGR went on to develop OA-ICOS as an alternative cavity-based technique. Specifically, this method was created to achieve the same or better sensitivity, but without the hyper-critical alignment and laser wavelength control requirements. OA-ICOS has delivered on this goal by enabling the development of robust, rugged and portable instruments in a lower-cost platform that effectively spans the entire range of wavelengths that tunable lasers are available. But just as important, OA-ICOS also permits true continuous wavelength scanning that delivers a host of other advantages.

* Anthony O'Keefe; David A.G. Deacon (1988). "Cavity ring-down Optical Spectrometer for absorption measurements using pulsed laser sources". *Review of Scientific Instruments* 59: 2544.

With first generation cavity techniques like CRDS, the laser wavelength has be matched and stabilized to one of the resonant modes of the cavity. In operation the laser wavelength is controlled to one part in 10^9, and successively stepped to record data at a small finite number of these resonant cavity modes. In contrast, OA-ICOS does not require mode matching and, as a result, the laser wavelength is smoothly and repetitively scanned over the entire spectral region of interest - see figure 1 - to yield fully resolved absorption spectra that is always presented to the user.

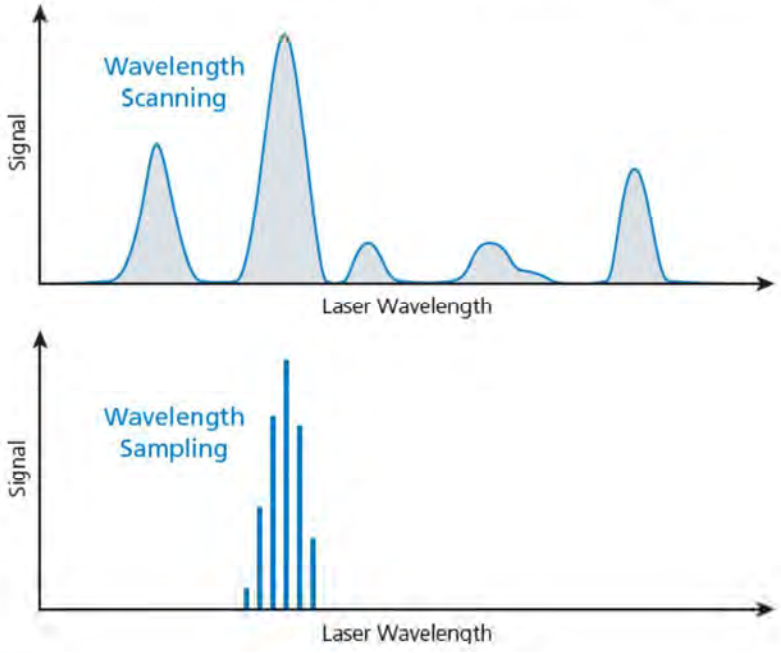


Figure 1. (top) True continuous wavelength scanning capabilities of OA-ICOS allow direct measurements of fully resolved absorption lineshapes. (bottom) Discrete wavelength sampling measurements recorded using CRDS do not provide detailed absorption lineshapes. As a result, OA-ICOS instruments report measurements with higher accuracy and linearity, and are much less susceptible to cross interferences and errors due to contaminants.

Unmatched specificity. Most real samples contain multiple chemicals that can potentially absorb laser light within the probed spectral region. Any spectral overlap between absorption line(s) of other molecules can cause crosstalk by changing the shape and intensity of the target absorption line. In addition, variations in the concentrations of a gas with a permanent dipole (like CO_2) can even cause subtle changes in the shape of a non-overlapped line, for example CH_4 — a well-known effect called pressure broadening. Having a continuous scan of an extended spectrum at a few MHz resolution (as opposed to 300 MHz resolution for CRDS wavelength stepping) allows the instrument's analysis software to identify and precisely correct for both spectral overlap and/or broadening and for the presence of interferences. As a result, OA-ICOS delivers excellent specificity and is much less susceptible to crosstalk or effects of contamination than CRDS. Moreover, with OA-ICOS the entire spectrum is continuously displayed, enabling the user to unambiguously check for other species present in the sample. For example, LGR's Spectral Contamination Identifier software can accurately correct for the presence of contaminants in liquid water samples, whereas other methods that rely on insufficient spectral resolution cannot.

Superior accuracy. All cavity-based laser absorption methods deliver parts per billion precision or better. But in many applications, instrument precision is of limited value unless it's accompanied by absolute accuracy. True continuous wavelength scanning means that the precise height and fully resolved shape of target absorption lines can always be measured, even in the presence of varying ratios of other gas components. That's why OA-ICOS consistently delivers superior accuracy in independent comparisons. For example, LGR's Enhanced Performance series of instruments can provide absolute accuracy of 0.03% (or better) of measured mole fraction for several target species, even in complex flows containing many gases.

Extended linear dynamic range. Unlike CRDS, OA-ICOS records fully resolved absorption lineshapes continuously in real time and without the need for expensive high bandwidth photodetectors. In contrast, CRDS measures the ringdown time to infer absorption. While CRDS can be effective if the ringdown time is sufficiently long, when mole fraction of the target gas gets high, the ringdown time becomes too short to reliably measure. OA-ICOS directly measures absorption and thus can provide accurate measurements at very high concentrations. The inherently higher dynamic range ofOA-ICOS (see specific product datasheets for details) is also extremely linear as a result of true continuous wavelength scanning. That's because subtle spectroscopy effects, such as pressure broadening, that are dependent on gas concentrations of all molecules in the sample, are specifically measured in detail. Techniques, no matter how stable, that rely on measurements at only a few discrete wavelengths in a scan cannot accurately measure these subtle effects and thus have limited linear range.

Enhanced capabilities — multiple species. Because the wavelength of the tunable laser can be scanned at high resolution over an extended region, an OA-ICOS instrument can simultaneously report detailed complex spectra that contain many lineshapes associated with several different molecules (e.g., CO_2, CH_4, CO) or from several different isotopologues (e.g., three types of nitrous oxide, ^{15}NNO, $N^{15}NO$, $NN^{18}O$) easily. For instance, an Industrial Emission Analyzer from LGR configured for monitoring gas from syngas reactors, steel manufacturing facilities and other high temperature flows can simultaneously report accurate mole fractions for nine separate gases in real time. In contrast, CRDS instruments, which only measure at a limited number of wavelengths, cannot provide detailed measurements of many gases, isotopologues or isotope ratios.

Greater simplicity and higher value. True continuous wavelength scanning enables simpler, lower-cost instruments for two reasons. In earlier technologies like CRDS, wavelength sampling requires a high precision and costly internal wavemeter to accurately measure the laser wavelengths at all times. (This is done to avoid measuring the wrong absorption line). Because OA-ICOS instruments from LGR scan an

extended spectrum (and always display the measured spectrum to the user), there is no possibility of scanning the wrong line, eliminating the complexity and cost of an integrated custom wavemeter. In addition, for applications requiring simultaneous measurement of multiple species, a single laser can usually reach quantitative absorption lines for these different molecules, further enhancing instrument simplicity and value. For example, one version of LGR's Industrial Emissions Analyzer configured for measurements in syngas generators and steel manufacturing facilities uses a single laser source to simultaneously measure nine different gases: CO_2, H_2S, H_2O, CO, CH_4, NH_3, C_2H_4, OCS, and HCN. In contrast, a CRDS instrument based on wavelength sampling will usually need multiple lasers to measure multiple gases, greatly increasing instrument cost and complexity.

Stable Isotope Calibration. Any stable isotope measurement instrument requires periodic calibration, whether based on mass spectrometry or optical absorption. In the case of isotopic water, an independent comparative study confirmed that the calibration curve for an LGR instrument was constant and stable over time. In contrast, the calibration curve of a competitive CRDS-based isotopic water vapor analyzer kept changing, necessitating frequent re-measurement of this curve. The stability of the OA-ICOS isotope calibration curve is another consequence of true wavelength scanning, enabling the instrument to automatically correct for changes in sampling conditions and for variations in other non-measured gases.

[L G R] Los Gatos Research

Los Gatos Research, Inc.
67 East Evelyn Avenue, Suite 3
Mountain View, CA 94041-1529

Phone: +1 650–965–7772
Fax: +1 650–965–7074
Sales: sales@lgrinc.com

www.lgrinc.com

Appendix D – Utility Procedure TD-4110P-01

Leak Survey Process

SUMMARY

This utility procedure provides the process and instructions for performing, monitoring, and documenting gas leak surveys for Pacific Gas and Electric Company (PG&E or Company) gathering, transmission, and distribution pipeline facilities.

Level of Use: Informational Use

TARGET AUDIENCE

Personnel who manage, perform, or document leak surveys including, but not limited to, personnel in gas leak survey, gas pipeline operations and maintenance (GPOM), mapping, quality management (QM), un-crewed aerial system (UAS) operations and helicopter operations personnel, and gas asset strategy personnel (see Utility Standard TD-4110S, "Gas Leak Survey and Detection Program," for roles and responsibilities).

Personnel that do not perform specific leak survey tasks but must be aware of the steps detailed in this utility procedure include maintenance and construction (M&C) personnel, pipeline engineers, integrity management (IM) personnel (distribution integrity management program [DIMP], transmission integrity management program [TIMP], and facility integrity management program [FIMP] personnel), and regulatory compliance, quality control, and compliance desk personnel.

SAFETY

Hazards and abnormal operating conditions (AOCs) impacting this work include, but are not limited to:

- Explosive gases
- Dangerous animals
- Environmental surroundings, tripping and slipping, and traffic conditions
- Vegetation, including poison oak

BEFORE YOU START

1.1 Dog Bite Prevention

1. Follow Utility Standard SAFE-1038S, "Dog Bite Prevention Standard," whenever working in locations where a dog might be present.

2. The following dog bite prevention tools are available for purchase through the Supplies and Solutions (S&S) group:

   - Bulli Ray baton, S&S part number 2881241
   - Certified dog repellent, S&S part number 2721442
   - Dog Dazer II Ultrasonic Dog Deterrent, S&S part number 2824173

Leak Survey Process

BEFORE YOU START (continued)

1.2 **Operator Qualifications (OQs):** This procedure contains covered tasks requiring qualifications. For covered task information, including date available and effective dates, please consult the *Guide to Operator Qualifications* in the Technical Information Library (TIL) or contact the Gas Qualifications department.

1.3 **Tools:** See Utility Procedure TD-4110P-21, "Calibration Verification for Leak Survey Instruments," and Gas Design Standard (GDS) M-58, "Leak Survey and Leak Investigation Tools and Equipment," for approved leak survey tools and equipment. The *Leak Survey Field Guide* also has recommended additional materials the line of business has identified to be used while performing leak survey.

1.4 **Training:** See the Academy training curriculum for most up-to-date available courses.

1.5 **Personal Protective Equipment (PPE):** Personnel performing this procedure must have the minimum PPE per the Gas Operations PPE Matrix and PG&E's *Code of Safe Practices (CSP)*.

TABLE OF CONTENTS

Leak Survey Process

PROCEDURE STEPS

1 Overall Process Steps

NOTE
Performing gas leak surveys of PG&E assets is required per federal code and State of California requirements. Leak survey frequency is also governed by these requirements.

1.1 The major steps of completing leak survey are:

1. Prepare.
    a. Understand your surroundings and requirements for designated areas and special leak survey
    b. Determine type of leak survey
2. Perform leak survey and rechecks.
3. Document.

1.2 Leak survey personnel perform all steps in this process, unless otherwise specified.

1.3 If at any time the leak survey map does not align with field conditions, leak survey personnel complete Form TD-4460P-11-F01, "Gas Map Correction," per Utility Procedure TD-4460P-11, "Gas Map Corrections," to ensure the geographic information system (GIS) is updated. Create a Corrective Action Program (CAP) notification and submit Form TD-4460P-11-F01 to mapping personnel.

- Do not submit a map correction to alter leak survey boundary. Leak survey map boundaries are updated based on Asset Strategy quarterly/annual reviews, updates without proper review may create missed compliance due dates.

2 Leak Survey Frequency and Schedule

2.1 Complete leak surveys at the following intervals (see Table 1 for frequency by asset):

1. Quarterly: Four times each calendar year, at intervals not greater than 4½ months, to the date.
2. Semi-Annually: Twice each calendar year, at intervals not greater than 7½ months, to the date.
3. Annually: Once each calendar year, at intervals not greater than 15 months, to the date.
4. 3-Year: Once every three calendar years, at intervals not greater than 39 months, to the date.
5. 5-Year: Once every five calendar years, at intervals not greater than 63 months, to the date.

Leak Survey Process

2.2 As a best practice, PG&E schedules the accelerated 5-year survey within 3 years, meeting the California Public Utilities Commission (CPUC) leak abatement commitment.

Table 1. Leak Survey Frequency

Facility Types[1]	Description	Survey Frequency
Distribution	Business districts and public assemblies	Annually
	Buried metallic facilities not under cathodic protection and not covered by an annual requirement	3 Years
	All copper facilities	3 Years
	Balance of underground distribution facilities	5 Years
Transmission	Department of Transportation (DOT) all odorized transmission (including non-HCA pipe within Class III and Class IV locations)	Semi-Annually
Unodorized DOT Transmission and Unodorized DOT Gathering	Class I, Class II, and Class III	Semi-Annually
	Class IV	Quarterly
Gathering (odorized)	Class I, Class II, Class III, and Class IV	Annually
Transmission Stations	Class I, Class II, and Class III	Semi-Annually
Electric Substations	Any existing facilities within 150 feet of the structure	Annually (PG&E Best Practice)

1. See Utility Procedure TD-4125P-10, "Identifying Gas Transmission Assets."

2.3 Semi-annually, typically in June and December, leak management (LM) personnel ensure a supplemental gas leak survey analysis is performed to identify facilities that have become operational since the previous annual analysis.

2.4 LM personnel perform semi-annual review of gas distribution (GD) GIS plat to ensure all plats have one-year and three-year maintenance plans.

3 Leak Survey Preparation

3.1 Ensure leak survey instrument is entered into SAP with maintenance plans to schedule calibration. See Utility Procedure TD-4007P-02, "Measurement and Test Equipment Process," for additional instrument tracking steps.

1. Ask asset strategist to add new instruments in SAP via the request for work (RW) process.

3.2 Capture leak survey documentation electronically. The leak survey supervisor and mappers review documentation per the internal process plan.

1. Use tech down paper forms only when an approved electronic device is unavailable.

NOTE

Leaks cannot be closed in SAP until all required daily check log information has been provided electronically.

2. Ensure the following forms are available and printed before leak survey for when electronic device is unavailable:

   a. Form TD-4110P-01-F01, "Daily Leak Survey Log"

Leak Survey Process

3.2 (continued)

b. Form TD-4110P-01-F02, "Map Stamp Checklist," printed on the back of all printed distribution leak survey maps

c. Form TD-4110P-01-F03, "Leak Survey CGI Log"

d. Form TD-4110P-01-F04, "Gas Transmission Leak Survey Log"

e. Form TD-4110P-01-F05, "Gas Transmission Station Leak Survey Report (GT Backbone)"

f. SAP-generated leak recheck work ticket

3.3 Leak survey supervisor reviews maps assigned for leak survey.

1. Maps for scheduled leak surveys may be printed by distribution mapping personnel, excluding exceptions for specific DIMP leak surveys (see Step 6.2), or may be provided electronically on an approved electronic device.

   a. Print the most current survey map. Print the distribution leak survey map within 30 days before survey date to ensure map information is up to date when surveyed.

   b. Mapping personnel post all open leaks on maps to be surveyed.

   c. For tech down, check that Form TD-4110P-01-F02 is printed on the back of all printed distribution leak survey maps.

   d. Transmission maps (aerial and gas transmission [GT] GIS) are created by a transmission analyst and either printed by distribution mapping personnel or provided electronically on an approved electronic device.

3.4 The leak survey supervisor assigns recheck work tickets for each open leak on the specific plat scheduled to be surveyed.

1. All open leaks identified must be surveyed.

2. SAP recheck work tickets must be generated within 30 days of a scheduled leak survey.

NOTE

Recheck work tickets allow the surveyor to recheck any open leaks that are within the scope of the routine leak survey and prevents the duplication of leak number assignments and entry into SAP.

3.5 Surveyor compares recheck work ticket to open leaks identified on map to ensure the recheck work ticket includes all known leaks.

Leak Survey Process

3.6 The leak surveyor receives and reviews the survey documentation and facilities assigned by the leak survey supervisor. Survey documentation and facility description includes:

1. A distribution leak survey with all Company distribution facilities identified for the survey up to and including the customer's meter or end of pipe (such as a distribution service stub).

2. A transmission leak survey identifying transmission lines for leak survey and service taps from the main up to the outlet of a transmission farm tap regulator set. The transmission leak survey includes transmission pipelines, distribution feeder mains, and gathering pipelines with limitations for subsurface vaults and aboveground facilities.

3. For subsurface vaults, a leak survey performed at the surface and vents without opening lid. Further investigation is required when a leak indication is found (refer to Utility Procedure TD-4110P-09, "Leak Grading and Response").

4. Transmission station survey that includes all piping within the station fence line, excluding fuel lines (see Step 5.5).

3.7 LM personnel ensure all leak survey tasks are documented and archived in SAP, **except** can't get in (CGI) follow-up (see Step 7.12).

1. If electronic data entry is unavailable, use tech down forms (see Step 3.2).

2. Mapping personnel ensure tech down data is uploaded in electronic system as soon as possible so that data is available to PG&E personnel who perform required tasks after leak survey is complete (e.g., data review, repair, and scheduling rechecks).

3.8 Obtain the following additional required documentation for transmission leak survey, if not available electronically:

- Frequency table
- Overview map
- Aerial plat

3.9 To plan an efficient survey route, review the maps to evaluate the footage of the main and condition of the area being surveyed (e.g., vegetative cover, water crossings, offsets, distance to headquarters, growth season, and residential and commercial areas).

1. It is also recommended to drive the route before performing leak survey to ensure access to all areas, plan walking route, and determine areas of high traffic.

2. See Section 4 for safe work practices when performing leak surveys in high-traffic areas.

3.10 Use only an approved leak survey instrument (refer to GDS M-58 and Utility Procedure TD-4110P-21) to perform a leak survey.

Leak Survey Process

4 Working Safely in High-Traffic Areas

4.1 See Utility Standard SAFE-1050S, "Short Duration and Mobile Operations Work – Traffic Control Environments," for guidance on working in roadways, including visibility vest requirements.

4.2 When work is required in high-traffic areas, create a work safety plan considering best options for each situation, and review with the leak survey supervisor to determine which traffic safety method is best for the location being surveyed.

4.3 Do not enter a public roadway without the use of proper temporary traffic control.

4.4 When walking in a roadway, face traffic to maintain situational awareness.

4.5 Use tools and equipment as appropriate to reduce exposure to traffic (e.g., mobile system to survey main in roadways).

4.6 With leak survey supervisor, review options for performing survey during hours when traffic is lighter.

4.7 When necessary, use a mobile leak survey or remote methane leak detector (RMLD) per Utility Procedure TD-4110P-21.

4.8 Use traffic control or additional personnel to ensure visibility and personal safety.

1. In residential areas, place signs to notify motorists that work is occurring in the roadway.
    a. It is recommended to work in pairs, starting on opposites sides and moving towards each other, and to place signs at the starting position of each survey location.
2. If desired, use appropriately colored or marked vehicles with high-intensity rotating, flashing, oscillating, or strobe lights in place of signs. Vehicles must be near the personnel performing the work.
    a. Use when performing stationary work such as leak investigation.
3. A shadow vehicle may be used when walking in a roadway.
    a. Consult responsible supervisor before using a shadow vehicle.
    b. Shadow vehicle must have operating light bar or arrows.

5 Survey in Specifically Designated Areas

5.1 GD GIS and mapping personnel perform annual review of PG&E plat maps, updating with new annual assets using programmatic methodology.

1. Distribution mapping personnel create RWs and maintenance items and provide the date the plat map became a valid annual asset for leak survey, providing the date in a timely fashion within the compliance window.

2. Asset strategy manages the maintenance plans and processes the RW.

5.2 For public assemblies (schools, hospitals, and churches):

1. Perform a survey near identified public building locations, including tests of the atmosphere in gas, electric, telephone, sewer, and water system manholes, at cracks in pavement and sidewalks, and at other locations that provide an opportunity for finding gas leaks. Refer to CPUC General Order (GO) 112-F, § 143.1, "Leakage Surveys and Procedures."

2. For distribution facilities, a public building survey must include:

   a. All Company facilities feeding the public building assembly.

   b. Service lines, including stubs, branch services, and all connected branch services to a customer meter.

   c. Services and main per Table 2.

   d. Leak surveyors can identify main and service line lengths in the field by using maps, installation records, and drawings as references.

Table 2. Public Assembly Survey Actions for Distribution Facilities

Condition	Action
Service Line (200 feet or less)	Survey entire service line[1] and 50 feet of main in each direction
Service Line (greater than 200 feet)	Survey entire service line[1] and tee
Service Line in Known Casing	Survey entire service line[1], pausing at each suspected casing opening
Distribution Main Lines	Survey any main within 25 feet of structure

1. Service line includes stubs and branch services.

NOTE

New public buildings may also require extension of business district boundaries.

3. Survey any new public building locations. Complete Form TD-4460P-11-F01, create a CAP notification, and submit it to mapping personnel to update GIS.

Leak Survey Process

5.3 For business districts:

1. A leak survey must include both main and service lines in the building districts identified on leak survey map.
2. Survey any new business districts.
   a. Whenever map does not reflect observed conditions, complete Form TD-4460P-11-F01 and create a CAP report to submit to mapping personnel to update GIS.

WARNING

Injury or death could result from unknown electric hazards in a substation. The presence of qualified electric personnel (electrician or higher) reduces the risk.

5.4 For designated enclosed electric substations and switching stations:

1. Request qualified electrical worker (QEW) support before performing leak survey at substation. Qualified electric personnel (electrician or higher) must accompany leak surveyor whenever entering a substation.
2. At frequency per Table 1, perform a leak survey at the following locations:
   a. Sub/switching station building foundation line
   b. Any existing gas facilities located within 150 feet from the outermost edges of the structure
   c. Nearest electric substructures

5.5 For transmission station survey:

1. If necessary, contact GPOM to obtain access into station.
2. Survey all facilities within fence line except fuel lines. Fuel lines (from regulation to compressor) are not included in station survey.

NOTE

Buried piping connects regulator and monitor facilities with remote terminal unit (RTU) facilities.

5.6 For supervisory control and data acquisition (SCADA) and electronic recorder (ERX) facilities:

1. Survey all venting locations around SCADA and ERX facilities located next to transmission and distribution regulator stations for leaks.

Leak Survey Process

NOTE

Waterways may also be leak surveyed using a drone, per Step 6.6.

5.7 For inaccessible facilities under waterways:

1. Operators of PG&E watercraft must successfully complete a boating safety course approved by the California Department of Boating and Waterways (CDBW). It can take up to six weeks to receive an operator certificate after the boating safety course has been completed.

2. Ensure watercraft speed does not exceed 3.9 knots (4.5 mph).

3. Maintain the height of a RMLD to the waterline at 6 feet or less and maintain the height of the laser on a background target to the waterline between 12 inches (minimum) and 24 inches (maximum), as shown in Figure 1.

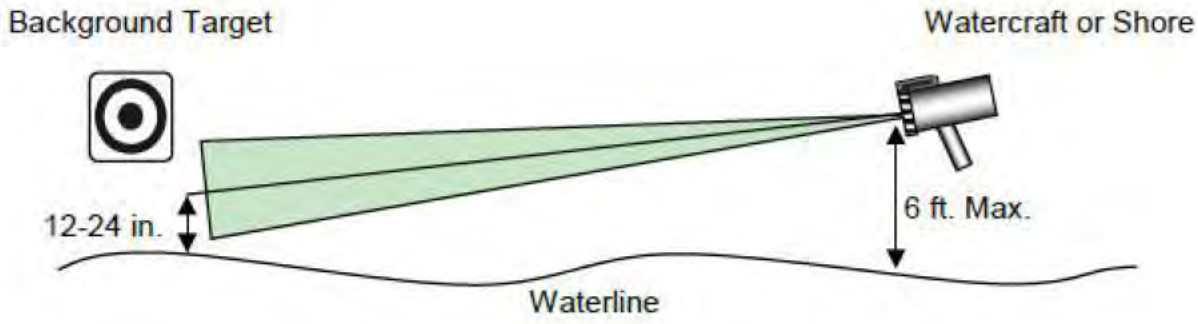


Figure 1. Maximum Laser Light

4. For surveys less than 75 feet long, where the shoreline is flat and background reflection is not possible, use a second person to hold a background target.

5. For surveys between 75 feet and 120 feet long, use the RMLD at a distance of 75 feet (maximum) from the watercraft to a shoreline OR background target. Two people may be required, with one on shore and one in the watercraft.

6. For surveys greater than 120 feet, use the RMLD to shoot watercraft-to-watercraft or shore-to-watercraft. Shooting distance must be 75 feet or less. At least two people are required, with one on shore and one in the watercraft OR watercraft to watercraft.

7. Any leaks found must be confirmed with Detecto Pak-Infrared (DP-IR) or visually (bubbles) and graded per Utility Procedure TD-4110P-09.

Leak Survey Process

6 Types of Leak Survey

NOTE

Visual inspection and vegetation leak surveys are **not** Company-approved leak survey methods.

6.1 Use only the Company-approved gas leak survey methods listed below. Refer to Utility Procedure TD-4110P-21 for approved tools and calibration steps for each method.

- Mobile
- Foot
- Aerial (with or without drone)
- Picarro

6.2 For Integrity Management (IM) Planned and Leak Abatement Order Institute Rulemaking (OIR) leak:

1. Determine leak survey areas through IM internal process per Utility Procedure TD-4850P-01, "Gas Distribution Integrity Management Program."
   a. Determine planned survey by periodic risk assessment.
   b. Request any additional fusion failure survey through IM recommendation.
   c. Identify leak survey areas through IM internal process.
   d. Mapping personnel print plats and provide open leak work tickets for leak survey.
   e. For any changes to regular leak survey locations or public assembly points, follow the map correction process. See Utility Procedure TD-4460P-11.

6.3 For Special Leak Survey and Ad Hoc Requests:

1. Assigned personnel (from engineering, IM, PG&E leadership, etc.) determine the need for special leak surveys, typically after an extraordinary event.
2. For digital maps, the appropriate supervisor provides special leak survey maps. For tech down, mapping personnel provide maps.
   a. **Exception:** Leak survey or GPOM supervisor may print tech down maps for events occurring outside of core business hours.
3. Personnel submit special leak survey requests via email to: SpecialLeakSurveyNotification@PGE.com.

Leak Survey Process

6.3 (continued)

4. Perform special leak surveys in the following situations:

   a. Before any scheduled street work is performed.

   b. Before, during, and after maximum allowable operating pressure (MAOP) uprates of gas distribution facilities. Refer to Utility Procedure TD-4125P-03, "Revising the MAOP of Pipelines Operating at 60 psig or Less."

   c. Following exposure of the gas facilities to unusual stresses caused by significant events (see Step 6.4).

   d. When requested by IM or electric substations personnel.

5. Whenever performing special leak surveys requested by IM or electric substations personnel, survey near designated PG&E substations and known third-party electric substations where transformers and switching equipment are located inside an enclosed building.

   a. **Exclude** control buildings inside fenced substations.

6.4 For leak survey after significant events:

1. Significant events are natural or manmade occurrences (earthquakes, floods, mudslides, wildfires, etc., as determined by IM) that could have a potentially large impact on PG&E facilities.

2. IM may request additional patrolling to determine if an additional leak survey is required.

3. Refer to Gas Emergency Response Plan (GERP) for instructions and post-event emergency action plans.

4. For blasting:

   a. Ensure a 500-foot (minimum) blast area before and after any blasting is completed.

   b. IM determines if an additional survey is required beyond 500 feet. Submit special leak survey requests via email to SpecialLeakSurveyNotification@PGE.com.

   c. IM informs leak surveyor of blasting area and additional leak survey requirements.

   d. Leak surveyor schedules any leak survey before blasting and the post-blast survey immediately following the operation and after the area has been restored to normal conditions.

Leak Survey Process

6.4 (continued)

5. For building explosions:

   a. Conduct a survey of the area closest to safely accessible gas lines (within 300 feet of the outside of the debris perimeter) OR the survey area as determined by IM personnel or LM personnel.

   b. IF source of explosion is unknown after 24 hours of explosion AND explosion is potentially gas related, is in wet conditions, and cannot be barholed or instrument has no gas readings potentially due to saturated soil.

      THEN contact M&C to consider isolation, shut in to make safe, and begin alternate process for leak identification (such as pressure test).

6. For earthquakes:

NOTE

The Dynamic Automated Seismic Hazard (DASH) system automatically generates rapid, facility-specific damage estimates for use in prioritizing initial PG&E post-earthquake facility inspections. After an earthquake, DASH reports are distributed automatically via company email to subscribers and are archived to the DASH website.

   a. A leak survey is performed after any earthquake registering a magnitude of 6.0 or greater. IM personnel determine survey area.

   b. A leak survey may also be performed after any earthquake registering a magnitude of less than 6.0, as determined by IM personnel.

7. Capture data as soon as possible after a structure fire (CPUC-reportable incident). Data collected after a reportable event is used in legal proceedings. Refer to Utility Procedure TD-4413P-01, "Procedure for Reportable Gas Incidents," to determine if an incident is reportable to CPUC.

   a. Whenever regulatory compliance personnel request a special post-event survey, survey must be performed within 24 hours of request.

   b. Perform a leak survey of the following facilities for any reportable event or if instructed by regulatory compliance personnel.

      - All facilities within approximately 150 feet in every direction.
      - The gas service (including any branch) supplying the damaged structure.
      - Any other gas facilities on the residential parcel.

Leak Survey Process

6.4 (continued)

- Any nearby Company gas facilities that could have potentially contributed as a leak source.

c. See Utility Procedure TD-4110P-09 for support and actions to access all facilities.

6.5 For an aerial leak survey, do the following.

1. LM personnel confirm that any third-party leak survey pilot holds current (non-expired) OQ status before performing an aerial survey.

2. LM personnel identify gas transmission facility segments requiring aerial leak survey (facilities not already assigned to other survey type), including facilities listed below, AND create a list of transmission facilities to be surveyed by aerial method.

   - Transmission facilities in Class 1, 2, and 3 locations
   - Distribution feeder mains (DFMs)
   - Gas gathering lines

3. Do not survey the following facilities by aerial method.

   - Farm tap services
   - High-pressure regulator (HPR) sets
   - Facilities under waterways
   - Transmission lines in Class 4 locations
   - Distribution lines
   - Controller-operated stations

4. LM personnel prepare to assign aerial portion of the leak survey to third party contractor.

   a. Create and provide supplemental transmission sign-off sheets, or electronic equivalent, as applicable, for all pipeline segments to be surveyed.

   b. Before any scheduled aerial leak survey, notify local M&C or GPOM supervisors to ensure resources are available for follow up and repair.

   c. Contact Company helicopter operations AND complete all required documentation before aerial leak survey, per Utility Manual TRAN-4004M, *Helicopter Operations Field Manual*.

Leak Survey Process

6.5 (continued)

5. The aerial leak survey vendor must complete the following daily tasks.

   a. Generate an aerial survey report that includes:

      - Completed tech down or electronic version of Form TD-4110P-21-F08, "Aerial Leak Survey Instrument Calibration"
      - Listing of each methane indication with GPS coordinates
      - Observed pipeline AOCs with GPS coordinates
      - GPS coordinates of assigned pipeline sections or segments leak surveyed and those that could not be surveyed with aerial

   b. Provide a daily aerial survey report to LM personnel by the close of the next business day from end of flight.

6. LM personnel review data and completed maps, assigning leak indications for investigation by the close of the next business day.

7. Complete all leak survey follow-up within two calendar days of leak investigation assignment.

8. Survey 250 feet (minimum) in each direction along the facility path from the recorded GPS coordinates and document the survey either electronically or on tech down forms per this procedure.

   a. Leak indications identified by an aerial leak survey may be located some distance from the recorded GPS coordinates.

   b. Expand the survey depending on the proximity to any distribution facility, as it may be the source of the leak indication.

6.6 Survey with drone as follows.

1. Use approved instrument for use with drone per GDS M-58.

2. Ensure instrument is calibrated per Utility Procedure TD-4110P-21.

   a. IF instrument needs to be calibrated,

      THEN give instrument to leak management personnel to complete calibration.

3. Drone must be configured and operated by trained (instrument and drone) and qualified personnel (for drone leak survey).

   a. All UAS flights are flown in accordance with UAS Operations Manual AVI-4001M, *Uncrewed Aircraft Systems*.

Leak Survey Process

6.6 (continued)

4. Leak survey management provides a list of the areas to be surveyed to the remote pilot in command (RPIC). The list includes the pipeline GPS coordinates.

5. RPIC performs the following before the flight:

   a. Plan the drone flight. Before leak survey, submit flight plan to the PG&E UAS Operations and Helicopter Operations Department.

      (1) See Step 6.6.6 for flight path steps.

   b. Connect instrument to the drone to ensure readings are being captured.

   c. Perform instrument daily inspection per Utility Procedure TD-4110P-21.

   d. Perform preflight check and confirm flight path is clear.

   e. Obtain wind speed and direction using approved anemometer.

      (1) Do **not** begin leak survey unless wind speed is 15 mph or below at ground level.

6. Follow the flight path by completing the following steps.

   a. RPIC determines best pattern to fly based on site conditions at time of survey (lawn mower or figure-eight pattern). See Figure 2 and Figure 3 for flight pattern examples.

   b. Perform at least 3 passes (up and back) downwind of the pipeline.

   c. Fly within 20 ft adjacent to pipeline and over the water or span.

   d. For spans, ensure the flight path covers air to soil transition of pipeline on both ends of the span or bridge.

7. RPIC looks for AOCs while performing leak survey and reports to appropriate group to address. Examples:

   a. Missing marker or damaged marker.

   b. Bubbles in water indicating a leak.

   c. Indication of damage or corrosion to pipeline.

      (1) Immediately notify gas control personnel and your supervisor of any hazardous AOCs such as blowing gas.

6.6 (continued)

Figure 2. Example of Lawn Mower Flight Pattern

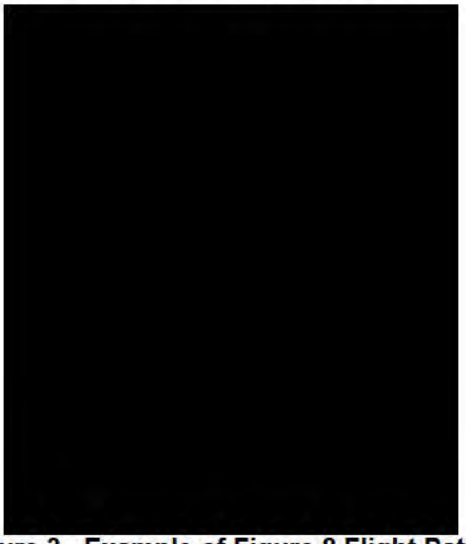


Figure 3. Example of Figure 8 Flight Pattern

8. After leak survey is complete, RPIC downloads and reviews the data for potential leak indications.

9. Whenever a leak indication is found, RPIC performs a subsequent flight to sweep area and determine maximum concentration location, by using lawn mower pattern in a roughly 50 ft x 50 ft square area with initial indication location at the center of the square. See Figure 2 for example.

   a. Download and review the data again from initial survey and sweep survey.

   b. Send completed files to leak management personnel.

6.6 (continued)

10. Leak management personnel assign leak investigation for the waterway or span using boat survey method per Step 5.7 or alternate leak investigation methods that use RMLD or DP-IR.

7 Performing Leak Survey

7.1 Before performing a leak survey, do the following:

1. Review the area for gas facility locations to be surveyed and plan the survey route accordingly (see Section 3 and Section 4).

2. Take wind speed readings at the survey location using an approved wind meter.

   a. Take wind speed meter readings at the height the leak survey instrument will be used, approximately 3 feet from ground level.

   b. If wind speed exceeds 15 mph, **do not** perform leak survey. Discontinue any leak survey already started.

7.2 Take a second wind reading at approximately the mid-point of the leak-survey day, typically after lunch.

WARNING

Personal injury may result from entering premises where dogs are present.

7.3 Perform leak survey of all identified facilities, even if not shown on map.

1. When a facility is found that is not included on map, complete Form TD-4460P-11-F01 and create a CAP notification for mapping personnel to update GIS.

7.4 To survey vaults, the vault lid does not need to be removed. If any indication of a leak is found, grade the leak per Utility Procedure TD-4110P-09.

7.5 Use survey wand or laser path of the leak survey instrument on ground at locations where gas might vent, including:

- Gas, electric, telephone, sewer, and water manholes.
- Cracks in pavement and sidewalks.
- Other locations providing an opportunity for finding gas leaks (venting locations). See Field Guide FG-4110, *Leak Survey Field Guide*, for an extensive list of examples.

Leak Survey Process

7.5 (continued)

WARNING

Unexpected, induced, or stray voltage can cause death or injury to personnel who touch piping or metallic facilities conducting voltage greater than 15 volts (V).

7.6 Before making physical contact with a riser, valve, regulator, meter, or similar metallic Company facility, use a non-contact voltage tester (NCVT) to determine if stray voltage is present, per GDS M-84, "Non-Contact Voltage Tester."

1. Rubber bellows of the survey probe may contact the facility without testing with the NCVT.

2. Report any AOC that may potentially energize the asset, such as improper grounding.

7.7 Pause for 3 seconds where leaks are commonly found (such as risers, valves, tees, service tie-ins, and transitions). See the *Leak Survey Field Guide* for an extensive list of examples.

WARNING

Injury may result from contact with aboveground wiring.

NOTE

The extension wand does not resolve difficult-to-reach AC inspections. Facilities must be visible to perform atmospheric corrosion (AC) inspections per Utility Procedure TD-4188P-01, "Atmospheric Corrosion Inspection of Customer-Connected Risers and Meter Sets."

7.8 For CGI locations resulting from difficult to reach places, and if facility is visible, an extension wand may be used to complete the leak survey under the following conditions.

- Care must be taken when using the probe, to avoid damage to property and injury from aboveground wiring.
- Extension wand may be used only with DP-IR instruments.
- A flow check must be performed before each time the probe is used (at each CGI location) to ensure a leak-free sample is being taken.
- Extension wand may be used only when standard wand cannot reach the facility, up to the meter and the meter.

Leak Survey Process

7.8 (continued)

- The wand must be used in locations where it can be physically observed (where placement of the cone can be seen).
- The extension wand is not allowed for regular walking leak survey.
- Extension wand must be set to pause for 6-10 seconds before it is used.

7.9 When leak-surveying a meter, use a smooth and sweeping motion of the probe or laser not more than 12 inches from the aboveground piping, including the base of customer piping. Keep RMLD transceiver a minimum of 3 feet from the facility being surveyed.

7.10 For atmospheric corrosion (AC) inspections:

1. Perform AC inspections per Utility Procedure TD-4188P-01.
2. Document AC inspection completion by using the check box on Form TD-4110P-01-F02 or electronic equivalent.
3. Electronically record excessive corrosion as an AOC to assign to appropriate work group for remediation.

7.11 For AOCs:

1. Document AOCs electronically to assign to appropriate work group for remediation. Ensure a photo of the AOC is attached for further evaluation.
   a. For tech down, use other corrective work process (OCW) to report AOCs.
2. Immediately notify gas control personnel and your supervisor of any hazardous AOCs.

NOTE

A CGI is a location that cannot be surveyed at the time the map is worked.

7.12 For can't get in (CGI) process:

1. Whenever a facility is identified as CGI, the data is entered into the CGI Tracker using **Inspect** data or Form TD-4110P-01-F03.
   a. It is recommended, if location cannot be surveyed within 10 business days after the last day the rest of the map was completed, that documentation be submitted to close map in SAP. The data is automatically available from Inspect for scheduling by CGI team.
   b. Do not enter CGI data in **Inspect** until it is ready to be uploaded to CGI Tracker (this may take, for example, 10 business days).

Leak Survey Process

7.13 (continued)

2. Highlight all AC CGIs on paper maps.

    a. On an annual or special leak survey, do not report AC CGIs electronically in the **Inspect** section. PG&E AC compliance is captured on the three-year leak survey per this utility procedure.

3. On the leak survey map, document any facility (services, meter, etc.) that could not be surveyed.

    a. Complete Form TD-4110P-01-F03 or electronic equivalent.

    b. Circle in green CGI for leak survey and AC locations that were not completed.

    c. Circle in orange locations that are only AC CGI.

4. Leak survey personnel work in partnership with CGI team to resolve all CGIs before any compliance deadline.

5. Through customer communications (e.g., letters, emails, and calls), the CGI team schedules appointments to perform leak surveys and AC inspections.

6. Company leak survey and AC inspection personnel perform required inspections and electronically document all inspections in an approved electronic device (e.g., FAS, ProntoForms). Neither **Inspect** nor plat maps are required for these follow-up CGI inspections.

    a. AOCs must be documented in Inspect.

    b. Qualified and trained GSRs may perform leak survey at CGI inside meter sets on aboveground piping.

    c. Leak survey of belowground facilities must be completed by a qualified leak surveyor.

    d. If belowground piping is found during leak survey, then GSR requests leak surveyor, through Dispatch personnel, to respond same day to perform the belowground survey. GSR must remain on site until leak survey arrives.

    e. For inside meter sets, default wind speed to zero, because wind is not a factor inside a structure.

7. When the necessary inspection is completed (leak survey, AC inspection), close CGI record in the CGI Tracker.

    a. The CGI team and leak management personnel report all completed leak survey and communicate any non-compliance to regulatory compliance personnel for reporting to CPUC.

Leak Survey Process

7.13 Perform leak surveying after inclement weather as follows.

CAUTION

Standing water interferes with detecting small amounts of gas and may cause damage to leak survey instruments.

1. **Do not** perform a leak survey when standing water is present over the facility or if the area is unsafe to walk (for example, diminished visibility in area or roadway).

NOTE

Rain rechecks are used to determine whether leaks can be found with the instrument on the surface (not in a barhole).

2. Before survey begins, choose a rain recheck location.

   a. If possible, choose an open belowground leak in the general survey area with a reading from 1%– 5% gas in air is present. Do not select a leak on a valve or inside a substructure.

      (1) If there are no open leaks at reading 5% or less, expand to 6%–10%.

   b. Choose a rain recheck location with similar soil type and saturation conditions as the survey area.

   c. One recheck may be used for multiple maps, as necessary, if the above conditions are met.

   d. When there are no open leaks available or no open leaks are found, per above, it is recommended that the supervisor select an alternate area to be surveyed that meets criteria above, until conditions change.

3. IF there is a concern that a compliance due date may not be met,

   THEN leak management personnel decide when leak survey begins after inclement weather.

7.14 Always perform a recheck of any open leaks on the map and recheck work ticket.

7.15 Grade and document leaks per Utility Procedure TD-4110P-09.

Leak Survey Process

8 Leak Survey Documentation

8.1 All leaks found are graded per Utility Procedure TD-4110P-09 and entered either electronically into SAP or on paper tech down form for subsequent entry into SAP.

1. For Grade 1 leaks, when repair crew does not have access to SAP, provide a paper Form TD-5100P-01-F01, "Leak Repair, Inspection, Gas Quarterly Incident Report (A-Form)" directly to the assigned crew to ensure they have information to begin leak repair.

2. M&C personnel submit tech down form to mapping personnel.

8.2 When recording leak survey results, record completed leak survey, all leaks, and AOCs at the time of discovery either electronically or on tech down forms.

- Submit completed tech down forms daily.

8.3 Review documentation before submittal to ensure all information is accurate and complete.

8.4 Document the following (either electronically or on tech down form):

1. Survey type.
   - Transmission or distribution
   - Frequency (annual, 3-year, 5-year, etc.)
2. Survey area (distribution), survey date and surveyor LAN ID; for transmission, survey area when multiple days, surveyors, or instruments are used on the same map.
3. Approved instrument used, including serial number (see Utility Procedure TD-4110P-21) and calibration information.
4. CGI locations (leak survey and AC inspections).
5. Number of services and length of main (in feet).
6. Completed AC inspection notation of any excessive AC found.
7. AOCs found.
8. Wind speed in mph.
9. Completed recheck work tickets.
10. Aerial leak survey documentation and follow-up survey.

8.5 Provide all other applicable information (electronic and paper).

1. Provide map correction form (electronic or paper) to mapping personnel.

2. Provide A-Form (Form TD-5100P-01-F01) that documents all leaks found.

9 Record Retention and Close Out

9.1 Mapping personnel conduct review of completed paper tech down leak survey documentation, upload data to SAP, and complete SAP notification with exception below.

1. IM personnel manage the IM and OIR specific leak survey records retained for compliance purposes per Utility Procedure TD-4850P-01.

   a. Mapping personnel provide originals to IM personnel.

   b. IM personnel track and archive the leak survey data for these surveys.

9.2 LM personnel ensure record retention policy is followed.

END of Instructions

DEFINITIONS

Abnormal Operating Condition (AOC): A condition identified by the operator that may indicate a malfunction of a component or deviation from normal operations that may indicate a condition exceeding design limits or result in a hazard(s) to persons, property, or the environment.

Blasting: Underground use of explosives to remove dirt and rock, including, but not limited to, quarry operations, gas exploration, and construction.

Business District: The principal business areas of a community, where the vast majority of the buildings are used for commercial, industrial, religious, educational, health, or recreational purposes.

Can't Get In (CGI): A location where an attempt has been made to access a gas facility for maintenance purposes without success. CGIs are often accessed by making customer contact or re-attempting access at another time.

Class Locations: Locations defined and classified by criteria set forth in Code of Federal Regulations (CFR) Title 49, Transportation, Part 192—Transportation of Natural and other Gas by Pipeline: Minimum Federal Safety Standards, Subpart A – General, Section 192.5, "Class locations." Class locations apply to transmission lines only.

Distribution Line: Refer to Utility Procedure TD-4125P-10, "Identifying Gas Transmission Lines."

High Consequence Area (HCA): Refer to Utility Procedure TD-4127P-05, "Criteria for Identifying High Consequence Areas."

Leak Survey Process

DEFINITIONS (continued)

Leak Grade: The classification of a leak, based on leak readings, public exposure, and location.

Leak Recheck: Any leak survey performed with a leakage detection instrument in the area of an existing Grade 2, or Grade 3 leak.

Leak Survey: A search for gas leakage in any area where Company gas facilities exist or where a gas leak is reported or suspected.

Public Assemblies: Buildings used for public gatherings. For leak survey purposes, public assemblies include the following:

- Schools – University, community college, high school, middle, elementary, and licensed day care
- Hospitals – General hospitals, emergency hospitals
- Churches – Church, synagogues, temple, mosque, monastery

Service: A pipeline that serves as the common source of supply to an individual customer, to two adjacent or adjoining residential or small commercial customers, or to multiple residential or small commercial customers served through a meter header or manifold.

Station: For the purpose of leak surveying, all transmission gas pipes and appurtenances within the company property lines, including:

- Compressor stations
- Terminals
- Storage holder facilities
- Transmission to transmission pressure regulator stations
- Other gas operating installations

Transmission Line: Refer to Utility Procedure TD-4125P-10, "Identifying Gas Transmission Assets."

Vegetation Survey: A gas leakage survey conducted by observing the conditions of the soil and the vegetation along the gas facilities. This type of survey is not an approved method.

IMPLEMENTATION RESPONSIBILITIES

This utility procedure is a complete rewrite of leak survey procedures as part of a content simplification effort. LM will communicate the leak survey simplification effort, new information location, and process changes. As part of this effort, a new field guide is being created that provides additional information about performing leak surveys such as examples, scenarios, pictures, and step by step details.

Leak Survey Process

IMPLEMENTATION RESPONSIBILITIES (continued)

PG&E Academy will update the curriculum with process changes. OQ will update impacted evaluations. QM will update impacted assessments.

The leak survey simplification effort also impacts leak investigation guidance which, in turn, impacts field services, M&C, and GPOM. LM will work with leaders from these groups to ensure impacted personnel are aware of the revised procedures and process changes.

GOVERNING DOCUMENT

Utility Standard TD-4110S, "Gas Leak Survey and Detection Program"

COMPLIANCE REQUIREMENT / REGULATORY COMMITMENT

Code of Federal Regulations (CFR) Title 49, Transportation, Part 192—Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards, Section (§) 192.197, "Control of the pressure of gas delivered from high-pressure distribution systems."

49 CFR § 192.614, "Damage prevention program."

49 CFR § 192.615, "Emergency plans."

49 CFR § 192.621, "Maximum allowable operating pressure: High-pressure distribution systems."

49 CFR § 192.706, "Transmission lines: Leakage surveys"

49 CFR § 192.709, "Transmission lines: Record keeping"

49 CFR § 192.723, "Distribution systems: Leakage surveys"

49 CFR § 192.933, "What actions must be taken to address integrity issues?"

California Public Utilities Commission (CPUC) General Order 112-F, § 143.1, "Leakage Surveys and Procedures"

Records and Information Management:

Information or records generated by this procedure must be managed in accordance with the Enterprise Records and Information (ERIM) Policy, Standards and Enterprise Records Retention Schedule (ERRS). Refer to GOV-7101S, "Enterprise Records and Information Management Standard," and related standards. Management of records includes, but is not limited to:

- Integrity
- Storage
- Retention and Disposition
- Classification and Protection

Leak Survey Process

REFERENCE DOCUMENTS

Developmental References:

Bulletin 289, "Substation Special Leak Survey"

Utility Procedure TD-4110P-03, "Performing and Documenting Leak Survey"

Utility Procedure TD-4110P-08, "Performing Leak Survey After Significant Events"

Utility Procedure TD-4110P-20, "Leak Survey of Inaccessible Pipelines Under Waterways"

Utility Procedure TD-4110P-30, "Aerial Leak Survey"

Supplemental References:

PG&E's *Code of Safe Practices*

Form TD-4460P-11-F01, "Gas Map Correction"

Form TD-5100P-01-F01, "Leak Repair, Inspection, Gas Quarterly Incident Report (A-Form)"

Gas Design Standard M-58, "Leak Survey and Leak Investigation Instruments and Tools"

Gas Design Standard M-84, "Non-Contact Voltage Tester"

UAS Operations Manual AVI-4001M, *Uncrewed Aircraft Systems*

Utility Manual TRAN-4004M, Helicopter Operations Field Manual

Utility Procedure TD-4007P-02, "Measurement and Test Equipment Process"

Utility Procedure TD-4110P-09, "Leak Grading and Response"

Utility Procedure TD-4110P-21, "Leak Survey Instruments and Calibration"

Utility Procedure TD-4125P-03, "Revising the MAOP of Pipelines Operating at 60 PSIG or Less"

Utility Procedure TD-4125P-10, "Identifying Gas Transmission Assets"

Utility Procedure TD-4188P-01, "Atmospheric Corrosion Inspection of Customer-Connected Risers and Meter Sets"

Utility Procedure TD-4188P-02, "Atmospheric Corrosion Inspection of Metallic Piping Systems"

Utility Procedure TD-4413P-01, "Procedure for Reportable Gas Incidents"

Utility Procedure TD-4460P-11, "Gas Map Corrections"

Leak Survey Process

REFERENCE DOCUMENTS (continued)

Utility Procedure TD-4850P-01, "Gas Distribution Integrity Management Program"

Utility Standard TD-4127S, "Class Location and High Consequence Area Determination and Compliance"

APPENDICES

NA

ATTACHMENTS

Form TD-4110P-01-F01, "Daily Leak Survey Log"

Form TD-4110P-01-F02, "Map Stamp Checklist"

Form TD-4110P-01-F03, "Leak Survey CGI Log"

Form TD-4110P-01-F04, "Gas Transmission Leak Survey Log"

Form TD-4110P-01-F05, "Gas Transmission Station Leak Survey Report (GT Backbone)"

DOCUMENT RECISION

Utility Procedure TD-4110P-01, Rev. 2, "Leak Survey Process," published 09/18/2019

NOTE

Document Approver, Owner, and Contact might change after publication. Current personnel are in the Gas Standards and Procedures Responsibility List.

DOCUMENT APPROVER

[redacted] Principal Gas Program Manager, Leak Survey Region 5 - Central Valley

DOCUMENT OWNER

[redacted], Principal Engineer, Standards Engineering

DOCUMENT CONTACT

[redacted], Senior Gas Methods and Practices (M&P) Specialist, Work Practices and Innovations (WPI)

Leak Survey Process

REVISION NOTES

Where?	What Changed?
Revision 3a	
Form TD-4110P-01-F02	Last column: • Changed from "AC Inspection completed" TO "# of AC Inspections Completed" • Deleted checkbox
Revision 3	Publication Date: 12/21/2022 Effective Date: 03/01/2023
Step 1.3	Added clarifying language for map correction submittals to ensure leak survey boundaries are not changed without proper asset strategy review.
Step 3.10	Added reference to M-58 for approved leak survey instruments.
Step 4.1	Added new step to reference SAFE-1050S and deleted former Step 4.6 with Figure 1 showing class III vest. Per SAFE-1050S the class III vest requirements are not dependent on roadway speeds. SAFE-1050S provides visibility vest requirements.
Step 5.7	Added note that waterways may be surveyed using a drone with a reference to drone survey Step 6.6.
Step 6.4.5	Added bullet for when there is an explosion and leak investigation may be hindered by severe wet conditions and saturated soil, to address Dallas, Texas incident and NTSB recommendations.
Definitions	Revised the business district definition to align with mapping programmatic process of assigning business district to leak survey maps.
Document approvers and contact	Updated to current document approver and contact.
Form TD-4110P-01-F02	• Changed title from "Map Stamp" to "Map Stamp Checklist." • Removed header fields **Schedule Month/Year**, **Previous Start Date**, and **Current Start Date**. This data is maintained in SAP; transferring it to the paper form is redundant. • Removed column **Sample of Color**. The color for documentation is often one color; line items are distinguished by the survey area number in the first column. • Updated table note 1 to remind personnel to compare front- and back-page map number, in case pages are printed separately • Added abbreviations for instruments that align with SAP data entry (I for DPIR, R for RMLD, O for OMD). Also, added IRwin as a type of infrared instrument. • Removed gas mapping reviewer LAN ID and date. Gas mapping does not review electronic version so for consistency is not required to review the paper version.

Appendix E – DP-IR™ Equipment Specifications

DP-IR™

A new look in survey

HEATH CONSULTANTS

Your Safety...Our Commitment

The **HEATH** Detecto Pak-Infrared (DP-IR™) is a highly advanced technology capable of detecting methane without false alarming on other gases. The DP-IR is the latest generation of leak survey instruments from **HEATH** that will greatly improve the productivity and safety of a walking/mobile survey.

The DP-IR functions by using an infrared optical gas detection system. This instrument is intended to replace current surveying equipment using the traditional Flame Ionization with technology utilizing a simple light beam, eliminating the need for expensive gas cylinders and refill systems. It is designed to be selective to detecting methane only, and will not false alarm on other hydrocarbon gases.

The DP-IR operates under a variety of environmental conditions including cold or hot weather. Its rugged design will stand up to normal field use and operating conditions.

The DP-IR has built-in Self-test and Zero functions that will assure that the instrument is operating properly. Using the internal calibration cell, the operator can perform the self-test as part of a daily start up routine. While in operation, the DP-IR continuously monitors several parameters to ensure that the instrument is functioning properly. Should any of these parameters go outside of the operational limits, an audible alarm will sound and a Fault/Warning error message will be displayed.

See back for specifications and ordering instructions

DP-IR

DP-IR Kit includes: Carrying case, battery charger, shoulder strap, survey probe, bar hole probe, dust filters, water filter and CD manual.

Detection Method:	Infrared Controlled Interference Polarization Spectrometer		
Measurement Range:	0 to 10,000 PPM 0 to 100% Gas		
Display Range:	**Auto Ranging:** PPM: 0-10,000 %Gas: 1-100%	**Manual Ranging:** PPM scale: 0-10,000 %Gas scale: 0-100%	
Sensitivity:	0-1000 PPM: 1 PPM	1000-10,000 PPM: 5 PPM	1-100%Gas: 0.5%
Accuracy:	Greater of +/-.5% or +/-10% of reading (typical, std condition) (% gas on manual mode)		
Detection Alarms Modes:	Digital Methane Detection (DMD): Audible tone when detection threshold exceeded. Adjustable Alarm Level from 1 to 9,000 PPM Tick: Continuous audio tone relative to concentration		
System Fault Warning:	Audible tone and indication on the display		
Self Test & Calibration:	Built in Self Test and Calibration function verifies operation and adjusts calibration for maximum sensitivity. Test gas cell integrated within the instrument.		
Compliance:	EN 61326-1 Conducted Emissions Class B Radiated Emissions Class B ANSI C63.4 Class B FCC 47 CFR Part 15 Class B	EN 61326-1 EN 61000-4-2 4kV/8kV EN 61000-4-3 3 V/M	
Dust Filter:	Replaceable filter provides dust protection. Easy change out quick disconnect filter cap.		
Display:	Large easy to read backlit LCD (.75" Numeric)		
Operating Temperature:	0 to + 122 F (-17 to 50 C) (nominal battery voltage)		
Humidity:	5 to 95% RH, non-condensing		
Enclosure:	IP54 (Water splash and Dust resistant)		
Instrument Weight:	5.6 lbs.		
Carry Case:	13 lbs empty; 21lbs filled 24.5" x 21" x 9"		
Power Supply:	Internal rechargeable Li-ion battery or External 12vdc car battery with power conditioner		
Battery Operating Life:	8 hours at 32° F with out backlight on		
Battery Charger:	External, in-line, 110 - 240 VAC, 50 / 60 hertz. 10 hours to 90% charge		
Shoulder Strap:	Single over the shoulder padded stra		
Alarm Volume:	108 dBs @ Alarm port (A-fast)		
Survey Probe:	Quick connect fitting with locking clasp. Adjustable length from 25" to 41"		
Bar hole Probe:	Std: 20"; Optional 36"		
Intrinsic Safety:	Class I Division I Group D T3 UL 913 M and CSA 22.2 No. 157 MetLab #E112840		

Heath Consultants Incorporated operates under a continual product improvement program and reserves the right to make improvements and/or changes without prior notification.

HEATH CONSULTANTS

Your Safety...Our Commitment

Heath Consultants Incorporated
713-844-1300 • Fax 713-844-1309
1-800-HEATH-US
www.heathus.com

Pacific Gas and Electric Company

Diana Furman
Environmental Management

3301 Crow Canyon Rd
San Ramon, CA 94583

Phone: (925)270-8209
e-mail: dmwr@pge.com

December 18, 2017

Jim Nyarady
California Air Resources Board
1001 I Street
Sacramento, CA

RE: Method 21 leak measurements per Oil & Gas Rule

To Whom It May Concern:

PG&E appreciates the opportunity to work with the California Air Resources Board (ARB) to prepare for the implementation of the Greenhouse Gas Emission Standard for Crude Oil and Natural Gas Facilities herein referred to as the ARB Oil and Gas Rule, promulgated under 17 CCR, Division 3, Chapter 1, Subchapter 10, Article 4, Subarticle 13 (the Subarticle). PG&E owns and operates three (3) natural gas underground storage and nine (9) natural gas transmission compressor stations that are subject to the ARB Oil & Gas Rule

As noted in the regulation, US EPA Method 21 (Determination of Volatile Organic Compound Leaks) is required for daily leak screening of wellhead assemblies (§ 95668 (h)(5)(B)(1)), concentration measurement for leaks detected through other means (§ 95668 (h)(5)(B)(3)), and for quarterly inspection of all components (§ 95669 (g)) among other applications. Method 21 is an EPA reference method used to determine presence of volatile organic compound leaks from process equipment.

On August 16, 2017, PG&E met with ARB staff to demonstrate the Detecto Pak-Infrared (DP-IR) manufactured by Heath Consultants and present a case for using this equipment to perform Method 21 leak measurements as required by the ARB Oil and Gas Rule. After this demonstration, ARB indicated that the DP-IR instrument would be acceptable to perform Method 21 leak measurements. PG&E would like to seek written approval from ARB (prior to the January 1, 2018 effective date of the Oil and Gas Rule) to use this instrument. PG&E has been using the DP-IR since 2010 and has over 150 of the instruments across the company. Provided below is technical information for the DP-IRs and rationale supporting the use of this equipment for Method 21 leak measurements.

The DP-IRs utilize an infrared optical gas detection system, rather than the traditional flame ionization technology, which allows greater specificity to methane gas and a faster response time. Leveraging the DP-IRs within the company rather than buying a new flame ionization detector would provide substantial cost savings for PG&E. The DP-IRs meet the criteria of a Method 21 leak measurement instrument as follows:

1. Instrument shall respond to the compounds being processed.
    - *DP-IR uses infrared absorption to measure methane concentration.*
2. Instrument shall be capable of measuring the leak definition concentration specified in regulation.
    - *The regulation's threshold for a leak is between 1,000 to 50,000 ppm. DP-IR measurement range is 1 to 1,000,000 ppm gas.*

3. The scale of the instrument meter shall be readable to ±2.5% of specified leak definition concentration.
    - *2.5% of the leak definition concentration is 250 ppm. DP-IR display range is 0-10,000 ppm followed by 1-100% gas.*
4. The instrument shall be equipped with an electrically driven pump with nominal flow rate between 0.10 to 3.0 Liter/min.
    - *The flow rate of DP-IR internal pump is 1.5 Liter/min.*
5. The instrument shall be equipped with a probe for sampling not to exceed 6.4 mm (1/4 in) in outside diameter.
    - *Heath Consultants, in collaboration with PG&E, has designed a sampling probe that meets this requirement (as demonstrated to ARB in August 2017).*
6. The instrument shall be intrinsically safe.
    - *DP-IR is certified for Class 1, Division 1, Group DT3 conditions.*
7. The instrument response time shall be equal to or less than 30 seconds.
    - *The response time of DP-IR is approximately 1 second.*
8. The instrument shall be calibrated with a reference compound.
    - *DP-IR calibrates itself as part of the daily-self check which is performed by the operator with a push of a button. There is a reference calibration cell internal to the instrument.*

By equipping the current version of DP-IR with a smaller sampling probe, the DP-IR easily meets the requirements stated above. In addition, DP-IR has a reference cell filled with gas within the instrument for internal calibration which obviates the need to introduce an external gas during calibration. PG&E appreciates the opportunity to conduct a demonstration of the DP-IR at ARB's offices in Sacramento on August 16th 2017 and welcomes additional questions regarding the DP-IR. PG&E would appreciate a written response from CARB acknowledging the DP-IR as an approved instrument for Method 21.

If you have any questions about the information in this report, please feel free to call me at [redacted] or to e-mail me at [redacted]

Sincerely,

[redacted]
Environmental Scientist
Environmental Management, Transmission Facilities

Cc: [redacted]
Divya Agarwal, Trinity Consultants, LLC
Elizabeth Geller, Trinity Consultants, LLC

March 6, 2018

[redacted]
Environmental Scientist
Pacific Gas and Electric Company
3301 Crow Canyon Road
San Ramon, California 94583

Dear [redacted]

I am writing in reply to your December 18, 2017 letter, in which Pacific Gas and Electric Company (PG&E) requested written approval to use Heath Consultants' Detecto Pak-Infrared (DP-IR) instrument to conduct leak measurements, as required under the California Air Resources Board (CARB) Greenhouse Gas Emission Standards for Crude Oil and Natural Gas Facilities (Oil and Gas Regulation).

To comply with the Oil and Gas Regulation, leak measurement instruments must meet the instrument criteria of US EPA Method 21. Based on the demonstration PG&E conducted for CARB staff on August 16, 2017, and based on the information contained in your December 18, 2017 letter, CARB determined that the DP-IR, as modified by Heath Consultants with an added Method 21 probe, is an approved instrument for conducting US EPA Method 21 leak measurements.

If you have any questions, please contact me at (916) 322-7630 or via email at Elizabeth.Scheehle@arb.ca.gov, or Mr. Jim Nyarady, Manager, Oil and Gas Section, at (916) 322-8273 or via email at Jim.Nyarady@arb.ca.gov.

Sincerely,

Elizabeth Scheehle, Chief
Oil and Gas and Greenhouse Gas Mitigation Branch

cc: Jim Nyarady, Manager
Oil and Gas Section

Appendix F - RMLD™ Equipment Specifications

RMLD

Remote Methane Leak Detector

R&D 100

Award Winner

Recognized as one of the 100 most tecnologically significant products introduced to the marketplace in the past year

GMI

RMLD™ Remote Methane Leak Detector

Faster...Safer...Reliable...Efficient

Revolutionary Technology

The new, portable, reliable Remote Methane Leak Detector (RMLD™) is changing the way methane surveys are conducted.

Instead of having to walk the entire length of the service line to check for methane leaks…the RMLD can quickly and efficiently detect leaks up to one hundred feet away allowing remote detection of hard-to-reach areas and difficult terrains. Remote detection allows the user to safely survey areas that may be difficult to reach, such as busy roadways, yards with large dogs, locked gates, pipes suspended under a bridge, indoor commercial piping and other hard to access places.

For utilities and their employees, this new time-saving method represents the potential for significant productivity gains, reduced operations and maintenance costs, and a safer survey.

Tunable Diode Laser Absorption Spectroscopy

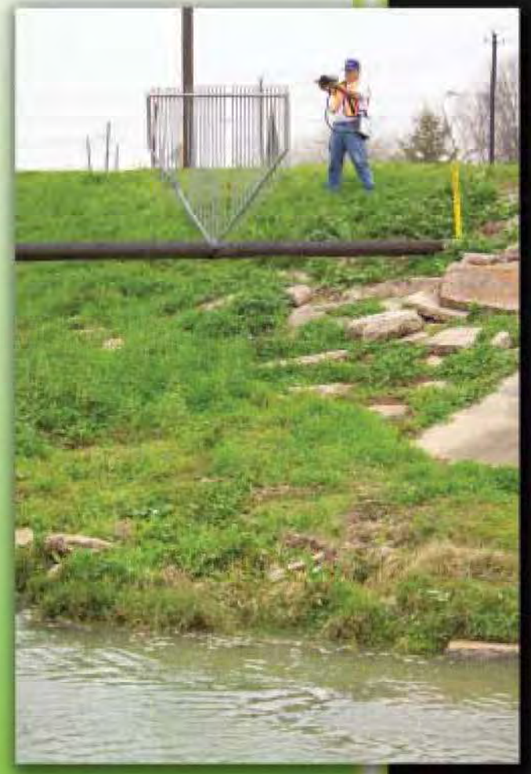
Available gas detectors that deploy technologies such as flame ionization must be positioned within the leak plume to detect the presence of methane. The RMLD does not have to be within the gas plume because it uses laser technology known as Tunable Diode Laser Absorption Spectroscopy. When the laser passes through a gas plume, the methane absorbs a portion of the light, which the RMLD then detects. This quantum leap in technology makes it possible to detect methane leaks along the sight line without always having to walk the full length of the service line.

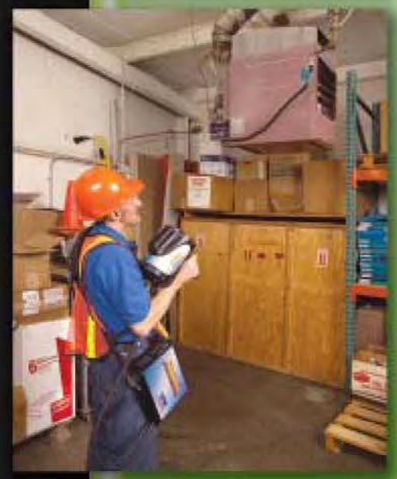
Components

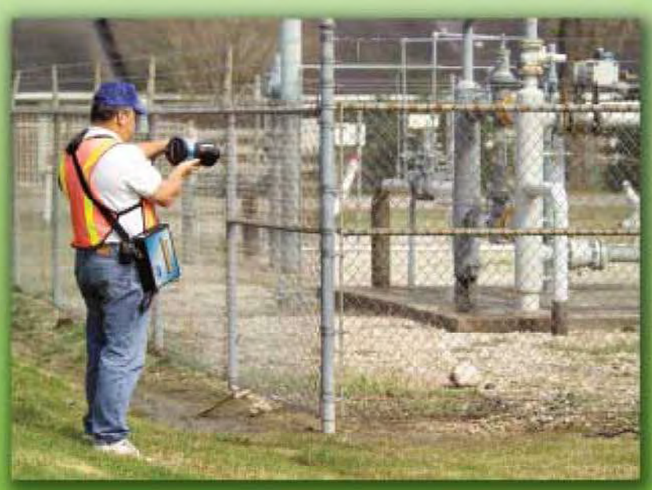
The Remote Methane Leak Detector consists of two interactive components; a transceiver subsystem and a signal processing/user interface controller. The transceiver has two lasers; an infrared laser beam that is non-visible and is continuously on while the unit is turned on. The green spotter laser is similar to those used for presentation pointers and is turned on by the operator by depressing the trigger button.

How Does It Work?

When the infrared laser beam is transmitted from the launch port some of the laser light is reflected by a normal background such as brick, concrete, grass, etc., to the detector. This reflected light is collected and converted to an electrical signal that carries the information needed to deduce the relative methane concentration. This signal is processed so that methane concentrations can be reported in parts per million meter or ppm-m. The laser has a maximum distance of up to 100 feet and is selective to methane only. It will not false alarm on other hydrocarbons.







TECHNICAL SPECIFICATIONS

Detection Method:	Tunable Diode Laser Absorption Spectroscopy (TDLAS)
Measurement Range:	0 to 99,999 ppm-m
Sensitivity:	5 ppm-m at distance from 0 to 50 ft (15 m) 10 ppm-m or better at distance from 50 to 100 ft (15 to 30 m)
Detection Distance:	100 ft (30 m) nominal. Actual distance may vary due to background type and conditions.
Beam Size:	Conical in shape with a 22" width at 100 ft (56 cm at 30 m)
Detection Alarms Modes:	Digital Methane Detection (DMD): Audible tone relative to concentration when detection threshold exceeded. Adjustable Alarm Level from 0 to 255 ppm-m Pure Tone: Continuous audio tone relative to concentration
System Fault Warning:	Unique audible tone and indication on the display
Self Test & Calibration:	Built-in Self Test and Calibration function verifies operation and adjusts laser wavelength for maximum sensitivity. Test gas cell integrated within carrying case.
Compliance:	EMC (EN61000-6-2, EN6100-6-4) Pending
Laser Eye Safety: (CDRH, ANSI and IEC)	IR Detector Laser: Class I Green Spotter Laser: Class IIIa; Do not stare into beam or view directly with optical instruments.
Display:	Large easy to read backlit LCD (.75" Numeric)
Operating Temperature:	0° to + 122° F (-17° to 50° C)
Humidity:	5 to 95% RH, non-condensing
Enclosure:	IP54 (Water splash and Dust resistant)
Instrument Weight:	9 lbs (Transceiver 3 lbs, Controller 6 lbs) (4 kg; 1.3 kg , 2.7 kg)
Carry Case:	14 lbs; 34" x 9 ½" x 14" (6.4 kg; 86 cm x 24 cm x 36 cm)
Power Supply:	Internal rechargeable Li-ion battery External Backup Battery pack with 5 C cells (Optional)
Battery Operating Life:	8 hours at 32° F without back-light on (Internal battery)
Battery Charger:	External, in-line, 110 - 240 VAC, 50 / 60 hertz universal type with charger indicator (8 hours maximum to full charge)
Shoulder Strap:	Single over the shoulder padded strap Ergonomic dual strap and belt system (Optional)

GMI **HEAD OFFICE**

Inchinnan Business Park,
Renfrew, PA4 9RG,
Scotland U.K.

Tel: +44 (0) 141 812 3211
Fax: +44 (0) 141 812 7820

www. gmiuk.com
e-mail: sales@gmiuk.com

Appendix G – TVA2020 Equipment Specifications

thermo scientific

PRODUCT SPECIFICATIONS

TVA2020 Toxic Vapor Analyzer

Lightweight, intrinsically safe portable FID/PID detector

The Thermo Scientific™ TVA2020 Toxic Vapor analyzer is the only intrinsically safe, portable field analyzer using both Flame Ionization Detection (FID) and Photo Ionization Detection (PID) technologies.

Features

- Dual FID/PID technology
- Bluetooth enabled
- Lightweight and compact design
- Easy to service in the field
- No PC based software required

Introduction

The Thermo Scientific TVA2020 Toxic Vapor Analyzer is capable of detecting virtually all organic and inorganic compounds. The TVA2020 analyzer can be configured for use in diverse applications including U.S. EPA Method 21 monitoring, site remediation, landfill monitoring, and general area surveys.

The TVA2020 analyzer is equipped with a Flame Ionization Detector to measure organic compounds with high sensitivity. The FID technology allows for a wide dynamic and linear range that produces stable and repeatable responses. The analyzer can be configured with both FID and PID technology for simultaneous detection and enhanced analytical capabilities. This dual configuration is capable of producing a more rapid reading of organic and inorganic compounds as opposed to a single detector technology and provides more comprehensive gas coverage than comparable size devices. After performing a primary calibration, the TVA2020 analyzer can be customized by activating internal logging parameters, uploading a monitoring route, establishing a bluetooth connection, setting alarm levels, and activating response factors.

Optional bluetooth communication permits the streaming of concentration data to a handheld device containing the LDAR software database, thereby eliminating the need to transfer files post monitoring and provide a greater access to route information.

The TVA2020 analyzer is 21% lighter than earlier models and more compact than most FID stand alone instruments. The lightweight and compact design reduces fatigue for true portability. In addition, a variety of options are available such as a basic or enhanced probe, carrying case, and hydrogen refill assembly.

Thermo Scientific™
TVA2020 Toxic Vapor Analyzer

ThermoFisher SCIENTIFIC

thermo scientific

Thermo Scientific TVA2020 Toxic Vapor Analyzer

Specifications	
Accuracy	FID Instrument – ±10% of reading or ±1.0 ppm, whichever is greater, from 1.0 to 10,000 ppm. PID Instrument – ±20 % of reading or ±0.5 ppm, whichever is greater, from 0.5 to 500 ppm.
Repeatability	FID Instrument – ±2% at 500 ppm of methane PID Instrument – ±1% at 100 ppm of isobutylene
Linear range	FID Instrument – 1.0 to 50,000 ppm of methane PID Instrument – 0.5 to 2,000 ppm of isobutylene
Response time	FID Instrument – Less than 3.5 seconds for 90% of final value, using 10,000 ppm of methane PID Instrument – Less than 3.5 seconds for 90% of final value, using 500 ppm of isobutylene
Sample flow rate	1 liter/minute, nominal, at sample probe inlet
Battery	The battery operating time is 10 hours minimum at 0 °C (32 °F). Fully charged in less than 10 hours.
Hydrogen supply operating time	10 hours of continuous operation, starting from a cylinder charged up to 15.3 MPa (2200 psi)
Physical dimensions	11.5" × 9" × 4" (29.2 cm × 22.9 cm × 10.2 cm)
Weight	FID only—9.2 lbs Dual—9.4 lbs
Minimum detectable limit	The minimum detectable level is defined as seven times the standard deviation of peak-to-peak noise. FID Instrument - 0.5 ppm of methane PID Instrument - 0.5 ppm of isobutylene
Lamp life	FID Instrument - Greater than 5,000 hours PID Instrument - Greater than 2,000 hours, with normal cleaning
Data storage interval	Auto mode – 1 per second to 1 per 999 minutes, user selectable VOC or FE Mode – 2 to 30 seconds, user selectable
Relative humidity range	15 – 95%

To maintain optimal product performance, you need immediate access to experts worldwide, as well as priority status when your air quality equipment needs repair or replacement. We offer comprehensive, flexible support solutions for all phases of the product life cycle. Through predictable, fixed-cost pricing, our services help protect the return on investment and total cost of ownership of your Thermo Scientific products.

USA
27 Forge Parkway
Franklin, MA 02038
Ph: (866) 282-0430
Fax: (508) 520-2800
orders.aqi@thermofisher.com

India
C/327, TTC Industrial Area
MIDC Pawane
New Mumbai 400 705, India
Ph: +91 22 4157 8800
india@thermofisher.com

China
8/F Bldg C of Global Trade Ctr,
No.36, North 3rd Ring Road,
Dong Cheng District
Beijing, China 100013
Ph: +86 10 84193588
info.eid.china@thermofisher.com

Europe
Ion Path, Road Three,
Winsford, Cheshire CW73GA UK Ph:
+44 1606 548700
Fax: +44 1606 548711
sales.epm.uk@thermofisher.com

Ordering information

TVA2020 Toxic Vapor Analyzer

Choose from the following configurations/ options to customize your own TVA2020 Toxic Vapor Analyzer

1. Voltage options

A = 120 VAC 50/60 Hz (NA)
B = 220/240 VAC 50/60 Hz (Europe)
C = 220 VAC 50/60 Hz (China)

2. Detector

3 = Flame Ionization Detection (FID)
4 = Dual configured with FID and Photo Ionization Detection (PID)
5 = FID (Made in China)
6 = Dual (Made in China)

3. Probes

N = No probe
S = Sampling probe
A = Enhanced Probe
C = Both sampling and enhanced probes

4. Outputs

1 = None
2 = Bluetooth
3 = GPS
4 = Both bluetooth and GPS

5. Shipping

N = None
C = Transportation case
R = Hydrogen refill assembly
B = Case and refill assembly

6. Certification

2 = USA: Class I, Division 1, Groups A,B,C,D T3
Canada: Class I, Zone 1, Ex db ib IIC T3 Gb
ATEX: CE0359 Ex II 2 G Ex db ib IIC T3 Gb
IECEx: Ex db ib IIC T3 Gb
3 = NEPSI / IECEx (Made in China-Chinese Text)
4 = ATEX / IECEx (Made in China-English Text)

Your Order Code: TVA2020 -

Find out more at **thermofisher.com/tva2020**

ThermoFisher SCIENTIFIC

Appendix H – Example OGI Camera Specifications

HEATH CONSULTANTS

OPGAL
Beyond the Visible

EyeCGas®

Fugitive Emissions Detection Camera

High sensitivity to a spectrum invisible to the human eye makes EyeCGas a critical tool in fugitive gas leak detection.

Even from a distance, a user will easily see the exact location of a leak.

Field Productivity
Robust, rugged and hazardous environment certified, simplifying and broadening opportunities for use inside the facility limits without the need of a hot work permit.

No More Guesswork
The EyeCGas includes a digital CCD camera for fast recognition of the components being inspected or leaking, and GPS coordinates overlay for location assurance.

Powerful But Simple
The EyeCGas allows inspection of vast areas in a plant with an automated and simple user interface, visualizing the infrared image on a large color LCD.

Specialized
EyeCGas is an infrared camera specially designed for the Petrochemical and Gas & Oil market requirements for gas detection, Smart LDAR and EPA OOOOa compliance.

Intrinsic Safety
- UL1604, Electrical Equipment for use in Class I and II, Division 2, and Class III (Classified) Locations
- CSA C22.2 No. 213-M1987, Non Incendive Electrical Equipment for Use in Class I, Division 2 Hazardous Locations
- ANSI/ISA-12.12.01 - Non-incendive Electrical Equipment for Use in Class I and II, Division 2 and Class III Hazardous (Classified) Locations
- ATEX II 3G Ex nL IIC T6

Visual Mode

Normal Mode

Enhanced Mode

Gas leak detection equipment is vital to keeping your employees, environment and product safe. Quickly find methane and volatile organic compound (VOC) leaks. Save time searching for fugitive gas leaks, and feel confident in the knowledge that your search was far more effective that ever before possible.

A design formed by the demands of the industry.

- Specially designed for the natural gas, oil and petrochemical industries, taking into consideration the requirements of the users.
- Very sensitive and detects smaller leaks than the existing optical imagers' portable solutions.
- Certified for use in hazardous environments (Class 1, Div. 2 and ATEX II), allowing inspection of hazardous locations in the plant.
- Implements an internal video and audio recording device.
- Features a large color LCD display for image and text display.
- Rugged and durable by design to be used as a tool in the field.
- Complies with EPA's OOOOa regulation requirements.

EyeCGas - Gas Imaging Camera - Specifications

Imaging Performance	
Thermal Imager	
Thermal Sensitivity	<12mK@ 77°F (25°C)
F #	1.1
Field of View	18° with 30 mm lens
Focus Near	<0.5m
Focusing	Manual
Digital Zoom	x2, x4
Digital Video Camera	
Embedded Digital Camera	VGA, fixed focus, for situational awareness
Detector	
Type	Cooled High Sensitivity , 320x240 pixels
Spectral Range	3-4µm
Power Input	
Voltage	12 VDC
Power Consumption	14.4 W
Battery Life	4 hours continuous
Physical Characteristics	
Weight (with battery and lens)	5.5 lbs (2.5 kg)
Color	Grey and black
Size (LxHxW)	9" x 4.3" x 5.1" (230 x 110 x 130mm)
Interface	Tripod mounting UNC 1/4", rotation safe
Display	
Display Unit	3.5" Color LCD 640X480
Environmental Conditions	
Operating Temperature Range	- 4°F to 122°F (- 20°C to 50°C)
Storage Temperature Range	- 40°F to 158°F (- 40° to 70°C)
Temperature and Humidity	IEC 60068-2-30 Temp. 77°F / 104°F (25°C / 40°C) Humidity 95% RH
EMC/ EMI	FCC 47 CFR part 15 subpart B - Radiated Emissions EN 610000-6-4 : 2007 class A - Radiated Emissions EN 610000-6-2 : 2005 class A - Immunity to Electrostatic Discharge (ESD) EN 610000-6-2 : 2005 class A - Radiated Immunity to RFE EN 610000-6-2 : 2005 class A - Radiated Immunity to Power Frequency Magnetic Field
Vibration	2.4 GRMS Random Vibration
Water and Dust Protection	IP65 - Blowing Dust Test IP65 - Jetting Water
HALT - High Accelerated Life Test	Vibration level: Max temp : 55°C, Min temp : - 20°C
Safety	EN60950-1:2006
Safety	UL1604, Electrical Equipment for Use in Class I and II, Division 2, and Class III (Classified) Locations CSA C22.2 No. 213-M1987, Non Incendive Electrical Equipment for Use in Class I, Division 2 Hazardous Locations ANSI/ISA-12.12.01 - Non-incendive Electrical Equipment for Use in Class I and II, Division 2, and Class III Hazardous (Classified) Locations. 2011 edition. ATEX II 3G Ex nL IIC T6
Environmental Conditions When Packed in Carrying Case	
Free Fall (Drop) Test	ASTM-D 4169-06 Schedule A
Loose Cargo Vibration Test	ASTM-D 4169-08 Schedule F Test Method D999
Vibration	ASTM-D 4169-08 Schedule F Test Method D999
Gas Leak Detection Performance	
Operation Features	Auto and Enhanced Modes including Background selection for standard very hot background temperatures.
Includes a spectral filter of 3.2µm to 3.4µm designed for detection of	Ethylene, 1-Hexane, Propanol, Propanal, 1,3-Butadiene, 1-Butene, Methane, Propylene 1-pentene, Styrene, Toluene, Acetic acid, Xylene, 1,2-dimethyl-Benzene, Isobutylene , Isoprene, Benzene, Ethyl benzene, Ethylene oxide, Hexane, Methanol, Propylene oxide, Propylene, Ethane, Octane, Heptane, Isopropyl alcohol, MEK Methyl Ethyl Ketone 2-butanone, Propane, Butane, Pentane
Digital Video and Audio Recording	
Video, Snapshot and Audio Recording	Digital recorder built-in with connection to PC via USB 2
Snapshot Capabilities	On every video a Snapshot of the first frame will be recorded to a JPG file with identical video name
Others Features	
Connectivity	Bluetooth, USB 2
GPS	Low power, external device, Bluetooth com. to camera, accuracy <3m, 66 satelites, sensitivity up to -165dBm
Supplied Accessories	
	Batteries (3), Tri-Battery Charger, USB Cable, Headset, Neck Strap, Glare Shield, Carrying Case, GPS
OPTIONAL ACCESSORIES	
	75mm f#1.2 Lens - FOV 7.3°x 5.5°- P/N 8G9T7500A

Heath Consultants Incorporated operates under a continual product improvement program and reserves the right to make improvements and/or changes without prior notification.

FLIR GF300/GF320

Infrared Camera for Methane and VOC Detection

The FLIR GF300/GF320 is a revolutionary infrared camera capable of detecting Methane and Volatile Organic Compound (VOC) fugitive emissions from the production, transportation, and use of oil and natural gas. This camera can scan large areas and visualize potential gas leaks in real-time, so you can check thousands of components over the course of one survey. Designed with the user in mind, the GF300/GF320 is lightweight, offers both a viewfinder and LCD monitor, and has direct access to controls. Embedded GPS data helps in identifying the precise location of faults and leaks, for faster repairs.

Visualize Gas Emissions in Real-time

The FLIR GF300/GF320 is unbeatable at detecting gas emissions, with a High Sensitivity Mode that lets you visualize even the smallest leaks in real-time. Use this visual verification to pinpoint the exact source of the emissions and begin repairs immediately. In addition, the GF320 is capable of measuring temperatures up to 350 °C with ±1 °C accuracy, allowing you to note temperature differentials and improve gas plume detection.

Increase Worker Safety

Surveys performed with GF300/GF320 cameras are nine-times faster than those performed with gas sniffers. They're also safer: optical gas imaging does not require close contact with components in order to detect gas. This reduces the risk of exposure to invisible and potentially harmful chemicals. In addition, the camera can scan areas of interest that are difficult to reach using conventional methods. The ergonomic design, with a bright LCD and articulated viewfinder, takes the strain out of a full day of surveys.

Stop Leaks, Save Money, Help the Environment

By fixing gas leaks, you can save your company thousands in lost gas and lost profits, while at the same time improving regulatory compliance and protecting the environment. The FLIR GF300/GF320 complies with all current regulations for Optical Gas Imaging (OGI). See our website for a full listing.

The GF300/GF320 detects the following gases:

Methanol	Methane	Benzene	Ethane	Propylene
Ethanol	Pentane	1-Pentene	Isoprene	Butane
Ethylbenzene	MEK	Toluene	Propane	Octane
Heptane	MIBK	Xylene	Ethylene	Hexane

Specifications

Model	GF300 / GF320
Detector Type	FLIR Indium Antimonide (InSb)
Spectral Range	3.2 – 3.4 µm
Resolution	320 x 240 pixels
Detector Pitch	30 µm
NETD/Thermal Sensitivity	<15 mK @ +30°C (+86°F)
Sensor Cooling	Stirling Microcooler (FLIR MC-3)
Electronics / Imaging	
Image Modes	IR Image, visual image, high sensitivity mode (HSM)
Frame Rate (Full Window)	60 Hz
Dynamic Range	14-bit
Video Recording / Streaming	Real-time non-radiometric recording: MPEG4/H.264 (up to 60 min./clip) to memory card Real-time non-radiometric streaming: RTP/MPEG4
Visual Video	MPEG4 (25 min./clip) to memory card
Visual Image	3.2 MP from integrated visible camera
GPS	Location data stored with every image
Camera Control	Remote camera control via USB
Measurement	
Standard Temperature Range	–20°C to +350°C (–4°F to +662°F)
Accuracy*	±1°C (±1.8°F) for temperature range (0°C, to +100°C, +32°F to +212°F) or ±2% of reading for temperature range (>+100°C, >+212°F)
Optics	
Camera f/number	f/1.5
Available Fixed Lenses	14.5° (38 mm), 24° (23 mm)
Focus	Automatic (one touch) or manual (electric or on the lens)
Image Presentation	
On-Camera Display	Built-in widescreen, 4.3 in. LCD, 800 x 480 pixels
Automatic Gain Control	Continuous/manual, linear, histogram
Image Analysis*	10 spotmeters, 5 boxes with max./min./average, profile, delta temperatures, emissivity & measurement corrections
Color palettes	Iron, Gray, Rainbow, Arctic, Lava, Rainbow HC
Zoom	1-8x continuous, digital zoom
General	
Operating Temperature Range	–20°C to +60°C (–4°F to +122°F)
Storage Temperature Range	–30°C to +60°C (–22°F to +140°F)
Encapsulation	IP 54 (IEC 60529)
Bump / Vibration	25 g (IEC 60068-2-27) / 2 g (IEC 60068-2-6)
Power	AC adapter 90-260 VAC, 50/60 Hz or 12 V from a vehicle
Battery System	Rechargeable Li-ion battery
Weight w/ Battery & Lens	1.94 kg (4.27 lbs)
Size (L x W x H) w/ Lens	305 x 169 x 161 mm
Mounting	Standard. 1/4"-20

+ GF320 model only

FLIR Systems, Inc.
9 Townsend West
Nashua, NH 03063
USA
PH: +1 866.477.3687

PORTLAND
Corporate Headquarters
FLIR Systems, Inc.
27700 SW Parkway Ave.
Wilsonville, OR 97070
USA
PH: +1 866.477.3687

EUROPE
FLIR Systems
Luxemburgstraat 2
2321 Meer
Belgium
PH: +32 (0) 3665 5100

www.flir.com/ogi
NASDAQ: FLIR

CANADA
FLIR Systems, Ltd.
920 Sheldon Court
Burlington, ON L7L 5L6
Canada
PH: +1 800.613.0507

CHINA
FLIR Systems Co., Ltd
Rm 1613-16, Tower II
Grand Central Plaza
138 Shatin Rural
Committee Road Shatin
New Territories
Hong Kong
PH: +852 2792 8955

LATIN AMERICA
FLIR Systems Brasil
Av. Antonio Bardella, 320
Sorocaba, SP 18052-852
Brasil
PH: +55 15 3238 7080