Quarterly Report for Phillips 66 Denver Terminal Fenceline Monitoring Plan-Q3 2024

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MONTROSE AIR QUALITY SERVICES

Table of Contents

Table of Figures

Table of Tables

I. Phillips 66 Denver Terminal Fenceline Monitoring Plan Quarterly Report- Q3 2024

II. Executive Summary

This report summarizes the findings related to the Phillips 66 fenceline monitoring plan during the period of July 1st of 2024 to September 30th of 2024 (Q3 of 2024). The data collected during this period were validated following all procedures described in the Phillips 66 fenceline monitoring plan. This report includes tables with the validated and invalidated data, statistical analysis results and timeseries of the compounds of interest and meteorological parameters.

III. Contact Information

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IV. Methods

A. Site Description

Phillips 66 operates a bulk fuel storage and distribution terminal at 3960 East 56th Avenue, Commerce City (Adams County), Colorado. Gasoline, Ethanol, Jet and Diesel fuel products are received from a pipeline, stored and distributed to market by tank trucks. The principal components of the facility are as follows:

- Gasoline aboveground storage tanks
- Butane aboveground storage tanks
- Jet aboveground storage tanks
- Diesel aboveground storage tanks
- Additive aboveground storage tanks
- Ethanol aboveground storage tank
- Vapor combustor unit (VCU)

The facility lies in an industrial area near the Suncor refinery to the north and east, another bulk terminal, two asphalt plants and a wastewater treatment facility and other nearby industrial sources of Covered Air Toxics.

B. Instrument Description

1. Open-Path Monitors

The Phillips 66 Denver Terminal fenceline air monitoring system includes both open-path tunable diode laser spectrometers (TDLAS), and open-path ultraviolet Doppler optical absorption spectrometers (UVDOAS). Open-path monitors operate by projecting a beam of light through open air to retroreflectors

that reflect the light back to the monitor where spectral absorption characteristics are measured. As the light travels along the path length a certain amount of this light will be absorbed by the various chemical species present in the air. Because all gases absorb light differently according to their own unique spectral characteristics, it is possible to use measurements of absorption intensity at specific wavelengths as a proxy for measuring a target gas' concentration in the air.

Therefore, along a known path length, an absorption measurement taken at the appropriate wavelength for the target molecule can easily be used to solve for its average concentration over the length of the beam.

The Phillips 66 open-path system will consist of four analyzers at the locations shown in Figure 1 and as outlined in Table 2. The light is transmitted to a retroreflector and back to a detector co-located with the transmitter. The analyzer software will provide five-minute and hourly-average concentration measurements for each path.

- ***Open Path (OP) Ultra Violet Differential Optical Absorption Spectroscopy (UVDOAS)***

For the monitoring of benzene, the Phillips 66 Denver Terminal uses Open Path (OP) Ultraviolet Differential Optical Absorption Spectroscopy (UVDOAS). This technology quantifies concentrations of gaseous compounds by measuring the absorption of ultraviolet light by chemical compounds in the air and applying the Beer-Lambert Law. UVDOAS typically uses unique absorptions of specific wavelengths of ultraviolet light in a wavelength range of 245 to 380 nanometers (nm). Benzene peaks are found close to the 253 nm wavelength.

Open path UVDOAS instrumentation consists of a light source, transmitting and receiving optics (telescopes), a spectrometer, a reflector, a detector, and a data processing computer. A Xenon light source provides light, which is focused in a collimated beam before it is sent through a transmitting telescope and into the measurement path. A receiving telescope collects the light and directs it to the spectrometer which diffracts the light onto the detector. The detector is typically a solid-state array such as a charge-coupled device (CCD). This allows the detector to collect light of different wavelengths without moving parts. The spectra bands can be extracted from the spectrum and compared to reference spectra to determine which compounds were present along the path and at what concentrations.

Monostatic (as opposed to bistatic) open path instruments have been selected to reduce the need for substantial power at the retroreflector sites and improve detection limits by increasing effective path lengths. Thus, only the light-source/detector end of the monitoring path requires substantial power, communications equipment, and a large shelter.

The Phillips 66 Denver Terminal uses the UV Sentry Open Path Multi-Gas Analyzer (UV Sentry) manufactured by Cerex Monitoring Solutions, LLC for the monitoring of benzene. The UV Sentry uses no moving parts to wear out, it should not fail or require calibration, which keeps consumables and maintenance to a minimum. The UV Sentry has an on-board computer and saves raw spectral data independent of calibration. These spectra may be used at any time to verify real time measurements. Additionally, the UV Sentry records signal intensity and minimum detection limits (MDLs) for benzene in real time as data quality indicators. Real time MDL output supports both American Society for Testing and Materials (ASTM) and USEPA methods. The UV Sentry also has a flow through calibration cell to allow for regular QA audits and bump tests.

- ***Open Path (OP) Tunable Diode Laser Absorption Spectroscopy (TDLAS)***

For the monitoring of Hydrogen Sulfide and Hydrogen Cyanide[1], an Open Path (OP) Tunable Diode Laser Absorption Spectroscopy (TDLAS) is used. OP-TDLAS offers some significant operational and cost

[1] These two compounds are neither used nor stored at, nor are they emitted from the Phillips 66 Denver Terminal. Therefore, the facility does not have the potential to emit either of these compounds,

advantages over other measurement technologies such as Fourier Transform Infrared Spectroscopy (FTIR). Tunable diode lasers (TDL) are designed to focus on single absorption wavelengths specific to a compound of concern in the gaseous form. They are capable of achieving low detection limits and are generally interferent-free. Similar to UVDOAS, quantitative measurements in direct gas phase laser absorption spectroscopy are based on the Beer-Lambert Law. A TDL uses a diode to generate light within a narrow frequency range that contains a relatively unique absorption wavelength of the chemical of interest. The laser frequency is "tuned" by changing the temperature of the diode or the current being fed to the diode or both so that it matches the spectral absorption line of interest.

Similar to the UVDOAS system, the OP-TDLAS system consists of a light source, a spectrometer, a reflector, a photodiode detector, and a data processing computer. Monostatic (as opposed to bistatic) open path instruments have once again been selected to reduce the need for substantial power at the retroreflector sites, and improve detection limits by increasing effective path lengths.

The Phillips 66 Denver Terminal uses the LasIR™ Fence Line Monitoring Gas Analyzer manufactured by Unisearch Associates Inc. for the monitoring of Hydrogen Sulfide and Hydrogen Cyanide.[1] The LasIR™ allows one laser to send beams at two different wavelengths down each path length (one for each compound). Additionally, the beam can be split allowing it to monitor two path lengths with one laser. The controller uses a near infrared (NIR) Tunable Diode Laser Absorption Spectrometer System utilizing a single mode laser mounted in a thermoelectric cooler. A Windows based software package displays the data on a host laptop PC. The LasIR™ also has a flow through calibration cell to allow for regular QA audits and bump tests.

2. Meteorological Monitors

The meteorological instrumentation are installed on a 10m, heavy-duty aluminum tower. The 3-sided, open latticework tower is fabricated using a high-strength aluminum alloy in three, 10-foot sections and is engineered for the specified wind load per EIA RS-222G. The tower is designed not to twist, rotate or sway, providing a rigid platform for mounting the sensors. It features hinged base leg brackets that permit the tower to be pivoted down into a horizontal position for easy servicing of the sensors. The tower incorporates a lightning rod with a full height ground cable and ground rod.

The meteorological monitoring tower is located at the west end of the Phillips 66 property. This tower is outfitted with high quality meteorological instruments, as outlined in Table 1, and are capable of making accurate real time measurements continuously. All sensors will be connected to a datalogger which will store the data, as well as broadcast it out to a cellular modem so that data can be viewed or downloaded at any time, from anywhere. The specific meteorological instruments chosen meet EPA specifications for accuracy, range and resolution (Table 1) and have been deemed appropriate for use in the fenceline monitoring system. Data from these sensors will be used to calculate 1-hour rolling averages updated every five minutes.

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which comprise "Covered Air Toxics" under HB21-1189. Therefore, in the event an Alert Threshold (Table 1-2 of the Fenceline Monitoring Plan) for either of these compounds is monitored, the monitored concentrations will be assigned a NS qualifier code and attributed to one or more of the near-by facilities described in Section 2.1 and Table 2-1 of the Fenceline Monitoring Plan, titled, "Other Industrial Facilities near the Phillips 66 Facility" .

Table 1: Performance Specifications for Installed Meteorological Sensors

Parameter	Sensor Make and model	Reporting units	Accuracy	Range
Horizontal wind speed	Met One 010C	Meters per second (m/s)	± 0.1	0 to 55
Horizontal wind direction	Met One 020D	Degrees (°)	± 3	0 to 360
Temperature	Met One 065	Degrees of Celsius (°C)	± 0.15	-30 to +50
Relative humidity	Met One 083F/0/35	Percentage (%)	± 2	0 to 100
Barometric pressure	Met One 0192	Atmospheres (atm)	± 0.001	0.3 to 1.09

C. System Design

The fenceline monitoring system utilizes four primary shelters to house the open path analyzers, identified as the orange and blue pins in Figure 1. Each orange pin shelter houses one (1) monostatic open-path tunable diode laser 4-channel H_2S (TDL) analyzer, one (1) monostatic open-path tunable diode laser 4-channel HCN (TDL) analyzer, and two (2) monostatic open-path ultraviolet differential optical absorption (UV-DOAS) analyzers. Each blue pin shelter houses one (1) fiber optic line from the monostatic open-path tunable diode laser 4-channel H_2S (TDL) analyzer in the orange pin shelter, one (1) fiber optic line from the monostatic open-path tunable diode laser 4-channel HCN (TDL) analyzer in the orange pin shelter, and one (1) monostatic open-path ultraviolet differential optical absorption (UV-DOAS) analyzer.

Each open-path analyzer location has multiple paths identified numerically 1 through 6. At the end of each path there is a retroreflector opposite the analyzer. For example, the line from the analyzer shelter to the retroreflector forms the path. The specific locations for all open path equipment were selected to provide coverage of all facility emission sources within the constraints of the facility footprint.

For the hydrogen cyanide[2] and hydrogen sulfide[2] northwest path (Path 6) and northeast path (Path 1), laser light is transmitted from the most local orange pinned shelters under or above ground via fiber optic cable to the blue pinned shelters then transmitted above ground to monitor the northwest path (Path 6) and northeast path (Path 1). The laser light reflects back to a telescope mounted on the northwest path (Path 6) and northeast path (Path 1) instrument shelters then transmitted back underground to the detector in the most local orange pinned shelter that the laser light originated from.

This monitoring program also includes meteorological monitoring as required in HB21-1189. Meteorological monitoring allows for the characterization of wind patterns for understanding the movement of the three covered air toxics and potential sources of emissions, and whether they are from the Phillips

[2] These two compounds are neither used nor stored at, nor are they emitted from the Phillips 66 Denver Terminal. Therefore, the facility does not have the potential to emit either of these compounds, which comprise “Covered Air Toxics” under HB21-1189.

66 bulk terminal or a neighboring facility. Since the Phillips 66 Denver Terminal does not store, emit or have the potential to emit hydrogen cyanide or hydrogen sulfide, in the event concentrations of those covered air toxics are detected by the Phillips 66 fenceline monitoring system, the source of the detected emissions will necessarily indicate hydrogen cyanide or hydrogen sulfide emissions from a neighboring facility or source. A 10-meter meteorological tower will be installed near the Path 6 instrument shelter (Figure 1), so that power can be shared.

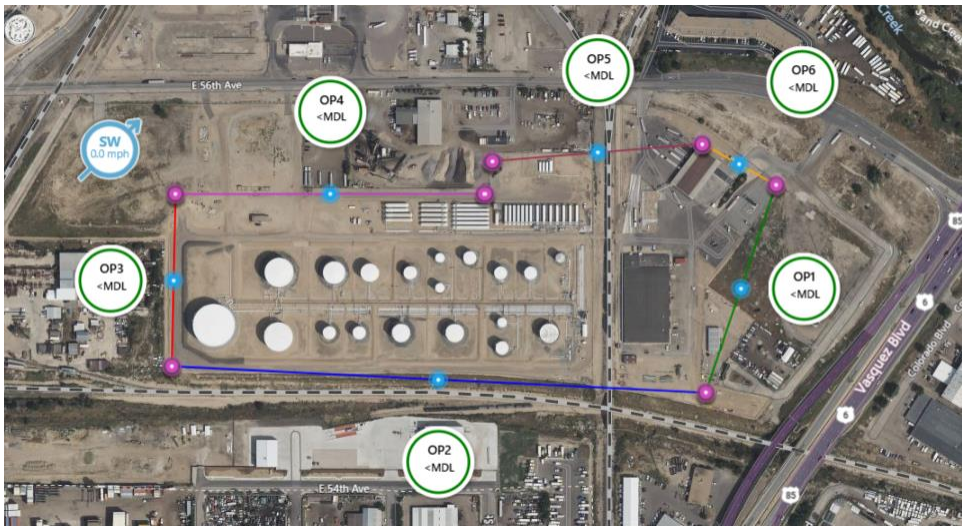

Figure 1: Approximate Layout of the Open-Path Analyzers, Retroreflector Locations, and Meteorological Station

Table 2: Descriptions of Each Individual Path

Path	Path Length	Compounds
1	226 meters	Hydrogen sulfide Hydrogen cyanide Benzene
2	550 meters	Hydrogen sulfide Hydrogen cyanide Benzene
3	165 meters	Hydrogen sulfide Hydrogen cyanide Benzene
4	315 meters	Hydrogen sulfide Hydrogen cyanide Benzene

5	222 meters	Hydrogen sulfide Hydrogen cyanide Benzene
6	138 meters	Hydrogen sulfide Hydrogen cyanide Benzene

D. Data Validation and QA/QC Procedures

-Automated Quality Control Procedures

Many Quality Control procedures for the fenceline monitoring network are integrated directly into the AirSense data platform and are outlined as follows. These automated procedures allow for the ability to screen data not suitable for public display due to atmospheric or operational issues. These automated quality control checks include:

- Inspection of daily reports generated by the AirSense platform which summarize data recovery for each analyzer/sensor and suspect data flags;
- Monitoring of real time alerts and daily reports generated by the AirSense data platform that flag:
  - No data;
  - Data sticking – if values are repeated for a number of sampling intervals (does not apply to data below the detection limit);
  - Range exceedances – if values are outside a reasonable minimum or maximum value;
  - Data recovery;
  - Monitoring instrument parameters that may indicate equipment degradation / failure or a need for maintenance and / or cleaning;
  - Signal intensity (open path instruments);
  - Instrument or sensor alarms or error codes;
  - Analyzer and shelter temperatures; and
  - Laser parameters (TDL instruments)

Table 3: List of automated quality control parameters and corresponding evaluation criteria

Instrument	Automated Quality Control Parameter	Definition	Units	Evaluation criteria
UV-DOAS	MDL	Minimum detection limit	PPB	< 25% of alert threshold

	R^2	Percentage peak match	%	> 64
	Signal intensity	Signal intensity at full scale	%	> 40
	UV spectrometer temperature		^oC	35
TDL	MDL	Minimum detection limit	PPB	< 25% of alert threshold
	Absolute Signal	Detector Signal	mA	> 0.1
	Laser temperature stability	Absolute value of (laser temperature- laser temperature in long average) *100/ laser temperature in long average	%	< 5
	R	Peak correlation		> 0.8

-Instrument Quality Control Checks

Both the UV-DOAS and TDL systems are designed to require only modest service and maintenance. Section 5.4 of the FLMP summarizes the UV-DOAS and TDL maintenance activities as recommended by the manufacturer. These activities will help ensure data integrity and maximize up-time. For the UV-DOAS system, a calibration verification bump test is performed on a quarterly basis using a flow through cell. For the UV-DOAS system, precision is calculated by evaluating the variance of pollutant concentrations during a period of low atmospheric variability. Five-minute data are selected when concentrations are well above the minimum detection limit (MDL) during periods of low variability. The precision can then be determined by calculating the coefficient of variation (CV). For the UV-DOAS, robustness can be determined by calculating the desired signal intensity in order for the benzene minimum detection limit to be lower than 25% of the notification threshold. If the measured signal intensity is found to be below the desired value, corrective action will be required (e.g., replace light source, instrument alignment, etc.). The QC checks for the UVDOAS are summarized in Table 4.

Table 4: UV DOAS QC Checks

QA/QC Check	Frequency	Acceptance Criteria
Accuracy and precision (Bump Test)	Quarterly	Accuracy: ≤ 30% of reference gas value Precision: ± 25%

Baseline Stability	Continuous	± 5%
Signal intensity	Continuous	>60%
Robustness	Continuous	Compound MDL lower than 25% of notification threshold

For the TDL system, a calibration verification bump test is performed on a quarterly basis. The bump test simulates system-observed gas content at the required path average concentration and is used to verify that the system can detect concentrations at or below the levels of concern. For the TDL system, precision will be calculated by evaluating the variance of pollutant concentrations during a period of low atmospheric variability. Five-minute data will be selected when concentrations are well above the minimum detection limit during periods of low variability. The precision can then be determined by calculating the coefficient of variation (CV). If there are no periods of low variability with concentrations above the minimum detection limit, bump test data will be used for the precision determination. For the TDL system, robustness can be determined by calculating the desired signal intensity for the hydrogen sulfide and hydrogen cyanide minimum detection limit to be lower than 25% of the corresponding notification thresholds. If the measured signal intensity is found to be below the desired value, corrective action will be required (e.g., replace laser, instrument alignment, etc.). The QC checks for the TDL are summarized in the table as follows.

Table 5: TDL QC Checks

QA/QC Check	Frequency	Acceptance Criteria
Accuracy and precision (Bump Test)	Quarterly	Accuracy: ≤ 30% of reference gas value Precision: ± 25%
Baseline Stability	Continuous	± 5%
Signal intensity (Absolute Power)	Continuous	>0.1 mA
Robustness	Continuous	Compound MDL < 25% of notification threshold

Wind speed, wind direction, temperature, relative humidity and barometric pressure measurement systems will be aligned, tested and calibrated at the time of installation and at six-month intervals thereafter using test equipment traceable to NIST or other authoritative standards and following standard operating procedures. Calibrations are performed immediately following scheduled semi-annual meteorological audits and performance of scheduled preventive and/or corrective maintenance for the monitoring instruments. Following initial startup calibrations and continuing throughout the monitoring program, the field operator performs quarterly site checks on the meteorological monitoring systems. In the course of these checks, sensors will be observed for proper operation. The monitoring instruments and support equipment are visually inspected to confirm operational integrity. The current data logger readings are assessed for agreement with prevailing conditions.

-Data Quality Assurance

All continuous data from the monitoring equipment are transferred to the cloud-based servers every five minutes. Each business day, a data technician checks the data files to ensure that all data were successfully transmitted and stored in the database. If data are missing, they are manually retrieved from the computers that control each piece of equipment or the on-site data logger for the meteorological equipment. This data is the raw data collected from the instrument computers or data logger and is considered “Level 1” data. These data are used to monitor instrument operations on a regular basis but are not used for reporting until subject to further review and validation. Level 1 (raw) data files are kept intact and unedited. These data are not subject to reduction or reformatting.

“Level 1” data are “raw” data; i.e., data obtained directly from the instrument computers or data logger that have not yet been subjected to quality assurance review. Electronic files of the raw data record are archived "as is"; no alteration is made to the raw data files. All data processing, editing and validation work is accomplished by working with copies of the raw data files produced by the data management system software upon request. Level 1 data are manually reviewed for reasonableness and completeness. Initial (daily) review of the data occurs no more than four days after sample acquisition because of weekends and holidays. Daily data review includes checking for status or event flags, reasonableness of reported averaged data values (out-of-range, inconsistent or excessive transition values) and any missing data periods. The operating status of each instrument is also reviewed (e.g., sample flow rates; other internal operating parameters). Meteorological data are reviewed for agreement with local seasonal and prevailing conditions and internal consistency. These daily reviews support “Level 2” validation of the data and provide a decision basis for investigative actions, instrument adjustment and calibration. The data analyst annotates the separate data processing file (i.e., an electronic copy of the original raw data file) and produces a summary report of any suspect data or out-of-tolerance operating conditions. Any situation requiring investigative and/or corrective action is immediately brought to the attention of the Project Manager and Technical Lead. A “Non-Conformance / Corrective Action” (NC/CA) report documenting all pertinent information regarding suspect data, a non-conformance event or out-of-tolerance operating condition is generated and updated with further information as it becomes available until the problem is fully resolved.

All data reporting forms and activity logs completed during the previous month are stored in Montrose’s local Denver office and are reviewed against the electronic data record on a monthly basis in support of data processing and validation. Monthly review of the field monitoring documentation will include:

- All completed routine site check forms;
- Documentation of the QC tests performed on the monitors during the previous month;
- Documentation of any maintenance activities performed on the monitors during the previous month;
- Documentation of any quality assurance audits performed on the meteorological sensors during the previous month; and
- Documentation of any Non-Conformance/Corrective Action (NC/CA) events that occurred during the previous month.

During “Level 2” data validation, the data file of each continuously-monitored parameter is processed at monthly intervals to develop an initial data report to be reviewed for completeness and correctness. Any corrections or additions to the raw “Level 1” data file are annotated in the processing data file with explanatory comments. Any hours incorporating a test, calibration or other quality control check, corrective

or preventive maintenance, instrument malfunction, power failures, weather event, etc. are removed from the data set and annotated with the appropriate null data code (for detail on null data codes and corresponding descriptions see Table 11 of Appendix F). Results of this review, including any data losses equal to or greater than one hourly block average, are documented and dated by the data technician in "Level 2" data files. The data technician enters and annotates any null data codes or corrections required in the "Level 2" electronic data file. When all entries or corrections are complete, the data are designated as "Level 2 - Final" data, and are archived for subsequent final data validation review.

"Level 3" data validation review is performed by senior project personnel other than the data processing analyst. During the Level 3 data validation process, data losses due to activity or instrument malfunction are corroborated against documentation noted by the station field operators on completed field forms. The field form record identifying data affected by these activities and events are inter-compared with corresponding status flags entered by the operator in the digital data record. Documented results of QA/QC checks performed on each analyzer are evaluated with respect to relevant acceptance and performance criteria outlined in the fenceline monitoring plan. Reports documenting unacceptable operating conditions or non-conformance/corrective action (NC/CA) events that may have adversely impacted data quality are also reviewed. If discrepancies or questionable data values are identified during the validation process, the entire data record is reviewed (including all annotated corrections made for Level 2 data). Any additional corrections or revisions made to the data report file during the data validation review are documented, dated and signed by the validation reviewer. The corrections are then entered into the electronic data file and re-processed. A separate file containing the corrections is checked for accuracy against the documented corrections. When all corrections are complete and checked, a final "Level 3 - Validated" data file is produced.

V. Results

A. Monthly Data Summary

Table 6: Monthly Data Summary

Month	Path	Compound	Number of Exceedances[1]	0th[2]	25th[2]	50th[2]	75th[2]	100th[2]	Avg	Pct Detect[3]	Pct Valid[4]	Median 1hr DL[5]
Jul-24	1	Benzene	0	0.07	0.17	0.27	0.43	3.3	0.33 ppb	2.26%	78.80%	0.36 ppb
Aug-24	1	Benzene	0	0.13	0.31	0.42	0.57	50.7	0.53 ppb	0%	86.60%	0.58 ppb
Sep-24	1	Benzene	0	0.17	0.34	0.45	0.6	6.66	0.52 ppb	0%	90.90%	0.62 ppb
Jul-24	1	H2S	0	0.42	5.8	11.3	23.7	118.4	16.1 ppb	0.26%	69.40%	16.1 ppb
Aug-24	1	H2S	0	0.67	8.2	13.9	21.8	54.6	15.9 ppb	0%	77.90%	19.9 ppb
Sep-24	1	H2S	0	0.79	8.56	13.8	21.6	58.9	16.1 ppb	0.11%	85%	19.6 ppb
Jul-24	1	HCN	0	0.01	0.16	0.35	0.77	6	0.61 ppb	0.20%	97.90%	0.49 ppb
Aug-24	1	HCN	0	0.02	0.28	0.67	1.32	11.65	1.04 ppb	0.20%	92%	0.95 ppb
Sep-24	1	HCN	0	0.01	0.08	0.11	0.18	3.1	0.16 ppb	0%	89.90%	0.16 ppb
Jul-24	2	Benzene	0	0.05	0.18	0.27	0.46	3.6	0.40 ppb	0.20%	99.60%	0.37 ppb
Aug-24	2	Benzene	0	0.07	0.22	0.34	0.71	4.84	0.56 ppb	0%	99.80%	0.48 ppb
Sep-24	2	Benzene	0	0.09	0.26	0.36	0.6	3.9	0.53 ppb	0%	94.60%	0.52 ppb
Jul-24	2	H2S	0	0.52	6.28	14	25.8	55.2	17.1 ppb	0.09%	89.20%	20 ppb
Aug-24	2	H2S	0	0.25	5.8	11.9	22.4	61.3	15.3 ppb	0.05%	93.10%	16.8 ppb
Sep-24	2	H2S	0	0.7	8.2	15.8	26.4	54.8	18.2 ppb	0.04%	84.70%	22.5 ppb
Jul-24	2	HCN	0	0.004	0.03	0.05	0.09	3.3	0.14 ppb	0.69%	98.80%	0.07 ppb
Aug-24	2	HCN	0	0.004	0.04	0.07	0.12	3.44	0.15 ppb	0.25%	99%	0.09 ppb
Sep-24	2	HCN	0	0.004	0.03	0.06	0.13	2.07	0.16 ppb	0.07%	86.10%	0.09 ppb
Jul-24	3	Benzene	0	0.11	0.22	0.3	0.43	235.4	1.6 ppb	0.49%	99.70%	0.40 ppb
Aug-24	3	Benzene	0	0.18	0.38	0.47	0.66	250.5	1.4 ppb	0%	100%	0.67 ppb
Sep-24	3	Benzene	0	0.22	0.38	0.48	0.64	7.9	0.6 ppb	0%	92.90%	0.68 ppb
Jul-24	3	H2S	0	1.1	9.4	18.9	26.6	75.5	18.9 ppb	0.76%	77.40%	24.7 ppb
Aug-24	3	H2S	0	2.1	13.2	21.4	30.6	59.1	22.7 ppb	0.01%	63.80%	31.8 ppb

Sep-24	3	H2S	0	1.5	15	22.9	31.7	100.7	23.9 ppb	0.02%	61.70%	34.8 ppb
Jul-24	3	HCN	0	0.005	0.19	0.32	0.64	10.7	0.61 ppb	0.08%	98.20%	34.8 ppb
Aug-24	3	HCN	0	0.02	0.24	0.46	0.91	7.07	0.7 ppb	0.17%	89%	0.65 ppb
Sep-24	3	HCN	0	0.007	0.17	0.31	0.68	10.6	0.84 ppb	0.24%	85.70%	0.44 ppb
Jul-24	4	Benzene	0	0.09	0.32	0.5	0.82	35.8	0.79 ppb	0%	97.70%	0.71 ppb
Aug-24	4	Benzene	0	0.23	0.56	0.75	1.07	6.66	0.92 ppb	0%	99.75%	1.05 ppb
Sep-24	4	Benzene	0	0.19	0.55	0.72	0.95	4.47	0.82 ppb	0%	99.30%	1.02 ppb
Jul-24	4	H2S	0	0.24	8.4	13.1	19.9	53	15.3 ppb	0.02%	86%	18.7 ppb
Aug-24	4	H2S	0	0.07	11.8	18.8	26.9	55	19.8 ppb	0.10%	88.50%	27.1 ppb
Sep-24	4	H2S	0	2.03	15.8	24.3	37.2	88.3	26.7 ppb	0.04%	44.50%	35.4 ppb
Jul-24	4	HCN	0	0.02	0.29	0.63	1.2	6.4	0.85 ppb	2.64%	98.70%	0.88 ppb
Aug-24	4	HCN	0	0.03	0.52	1.07	1.8	5.7	1.28 ppb	0.00%	99.80%	1.51 ppb
Sep-24	4	HCN	0	0.03	0.56	1.55	2.74	18.4	2.01 ppb	0.41%	86.20%	2.19 ppb
Jul-24	5	Benzene	0	0.15	0.33	0.44	0.65	5.5	0.57 ppb	0.72%	98.80%	0.59 ppb
Aug-24	5	Benzene	0	0.13	0.24	0.32	0.43	3.93	0.38 ppb	0.66%	92.80%	0.44 ppb
Sep-24	5	Benzene	0	0.12	0.24	0.32	0.42	3.6	0.36 ppb	0.64%	98.60%	0.44 ppb
Jul-24	5	H2S	0	0.34	6.99	15.5	28.6	126.9	18.7 ppb	1.14%	75.10%	22.4 ppb
Aug-24	5	H2S	0	1.75	9.03	13	19	57.3	15.3 ppb	0%	75.40%	57.3 ppb
Sep-24	5	H2S	0	1.9	8.1	12.1	18.07	55.1	14.32 ppb	0%	90.50%	12.13 ppb
Jul-24	5	HCN	0	0.25	1.78	2.9	5.2	157.2	5 ppb	0.87%	86.70%	4.02 ppb
Aug-24	5	HCN	0	0.34	1.8	2.76	4.19	26.7	3.27 ppb	0.06%	91.70%	3.9 ppb
Sep-24	5	HCN	0	0.1	0.92	1.43	2.24	17.06	1.84 ppb	0.11%	90.40%	2.02 ppb
Jul-24	6	Benzene	0	0.07	0.19	0.35	0.88	8.58	0.74 ppb	17.80%	98.06%	0.42 ppb
Aug-24	6	Benzene	0	0.13	0.29	0.42	0.83	9.84	0.84 ppb	12.90%	91.70%	0.56 ppb
Sep-24	6	Benzene	0	0.19	0.35	0.48	0.8	9.59	0.79 ppb	8.96%	98.70%	0.64 ppb
Jul-24	6	H2S	0	1.81	16.5	27.5	38.2	78.1	27.7 ppb	0.76%	40.20%	42.3 ppb
Aug-24	6	H2S	0	2.88	18.3	28.3	38.3	59.2	28.4 ppb	0%	31.60%	42.8 ppb
Sep-24	6	H2S	0	2.5	12.5	21	31.7	57.7	22.7 ppb	0%	61.30%	31.5 ppb
Jul-24	6	HCN	0	0.009	0.1	0.24	0.63	11.9	0.73 ppb	0.18%	98.30%	0.33 ppb
Aug-24	6	HCN	0	0.014	0.14	0.25	0.43	15.6	0.42 ppb	0.22%	92%	0.35 ppb
Sep-24	6	HCN	0	0.005	0.11	0.27	0.69	11.8	0.74 ppb	0.89%	97.10%	0.38 ppb

[1] number of 1-hour measurements above the notification threshold value
[2] data quartiles = the value at which a defined percentage of data existing below this value (valid data only)
[3] the percentage of hourly averages above the detection limit (DL) as compared to the total possible hourly averages (excluding data collected during QA/QC activities, calibration, or maintenance).
[4] the proportion of the 1h measurements that pass all data verification measures compared to the possible hourly averages.
[5] the median 1-hr detection limit observed across validated measurements per compound for the month specified.

B. Summary of Invalidated Data

The invalidated data can be found in file “P66 FLMP Data Packet_Q3 2024”. All 5min data have been validated based on the procedures described in the P66 fenceline monitoring plan.

C. Discussion of Invalidated Data

The data was validated based on the procedures mentioned in the fenceline monitoring plan. During this first quarter of the fenceline monitoring program operation, there was a high data invalidation rate for H2S, mainly for paths 4 and 6. The reason was related to the TDL instruments not being optimized during the first months of operation. More specifically, the H2S data that was invalidated could not meet the criteria for the detection limits (minimum detection limit was more than 25% of threshold). The higher-than-expected detection limits were related to the increased signal noise that was observed in most of the paths due to the instrument’s operational parameters not being optimized. Montrose worked on optimizing the instrument operational parameters to decrease the signal noise and thus the detection limits. During the instrument optimization, additional construction took place in Phillips 66 to resolve some retroreflector structure vibration issues that were observed.

D. Discussion of Results

As shown in the summary plots, the concentration of the three compounds of interest was below detection limit in most cases. There were no threshold exceedances during the first quarter of the fenceline monitoring for any of the compounds. For benzene the average MDL value was around 0.5 ppb, for H2S the average MDL value was approximately 50 ppb, and for HCN the corresponding average MDL was around 0.5 ppb. As discussed in Section C, the higher H2S MDL values are related to the interferences of this compounds with water and CO2 which can cause increased signal noise levels. Phillips 66 does not store nor emit H2S and HCN.

E. Summary Plots

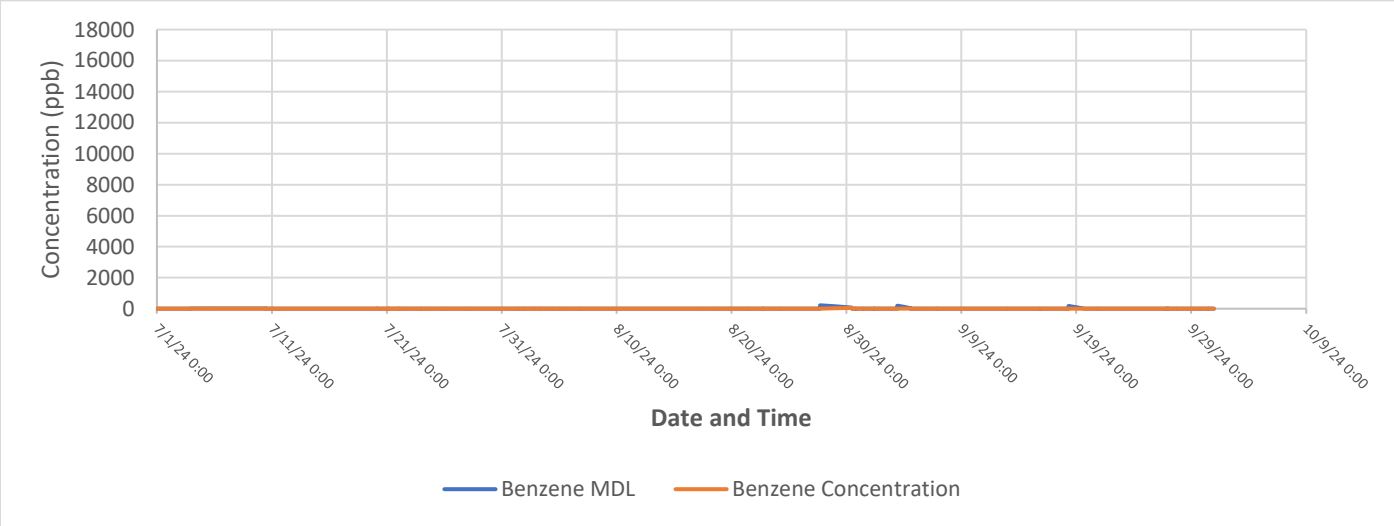

Figure 2. Timeseries of Benzene Path 1

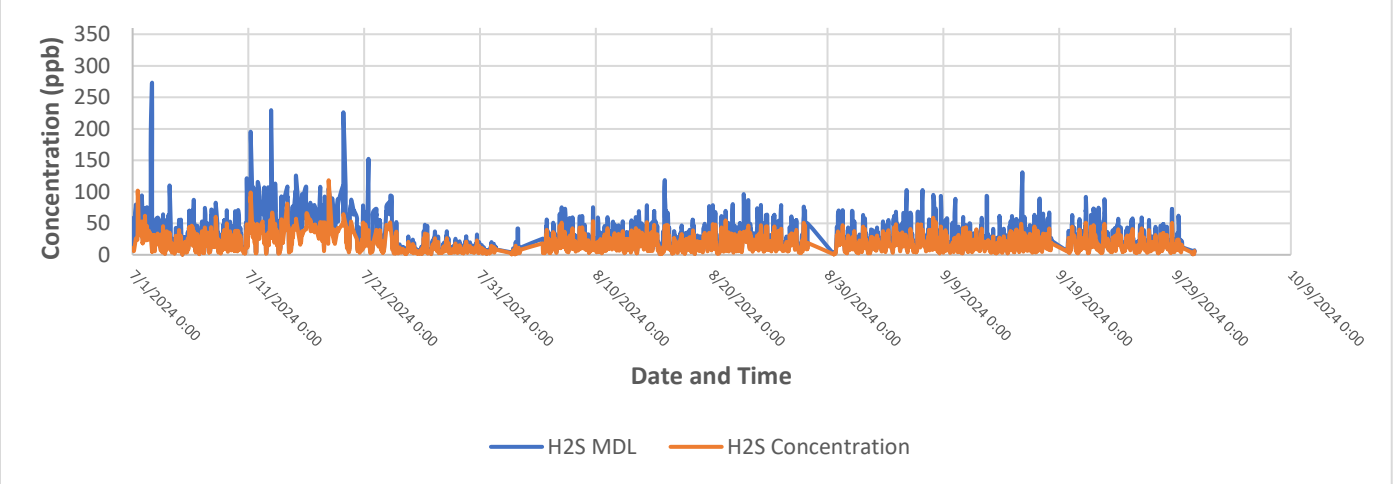

Figure 3. Timeseries of H_2S Path 1

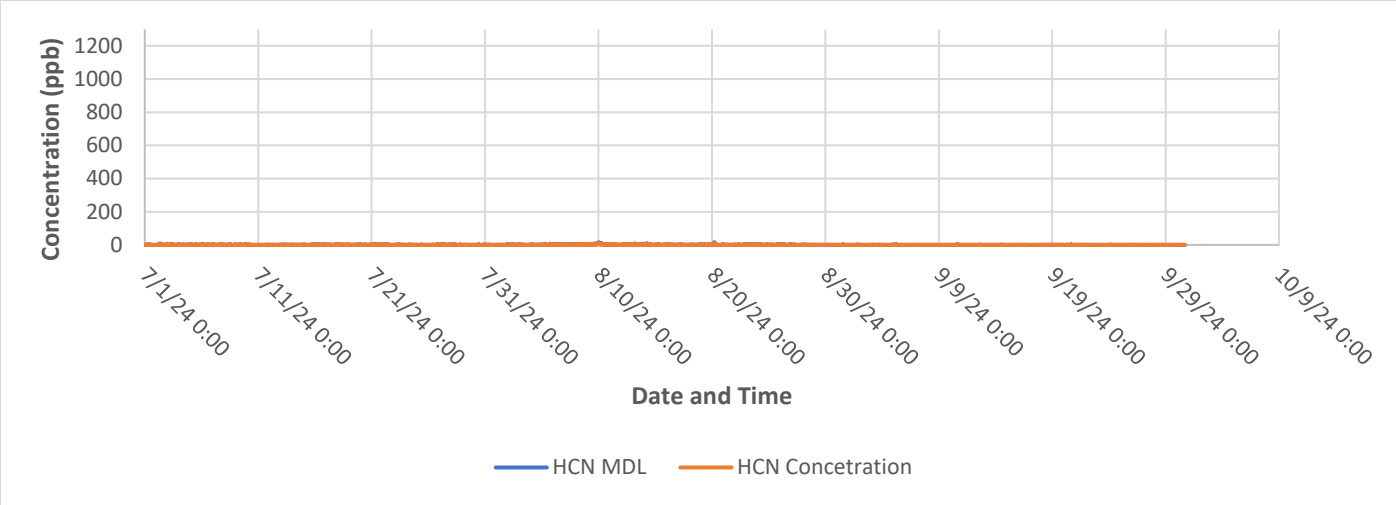

Figure 4. Timeseries of HCN Path 1

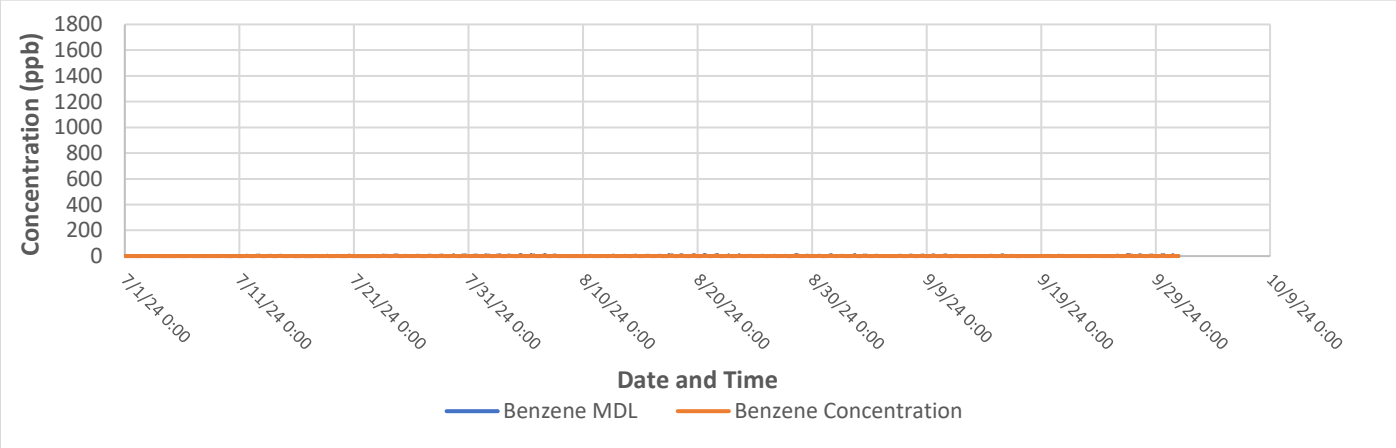

Figure 5. Timeseries of Benzene Path 2

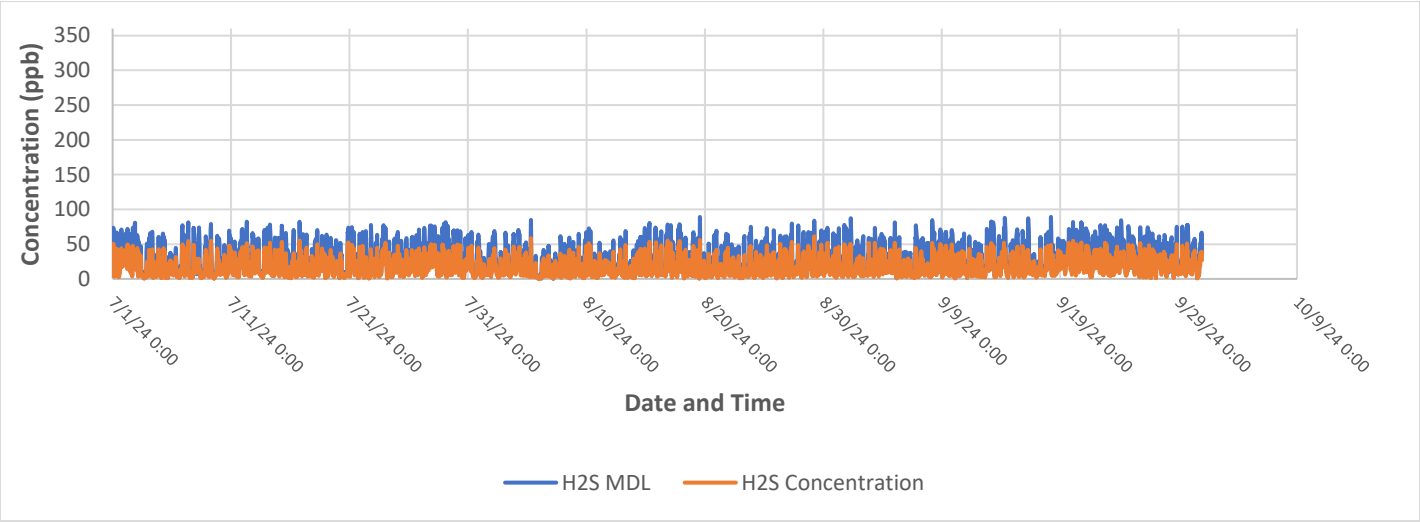

Figure 6. Timeseries of H_2S Path 2

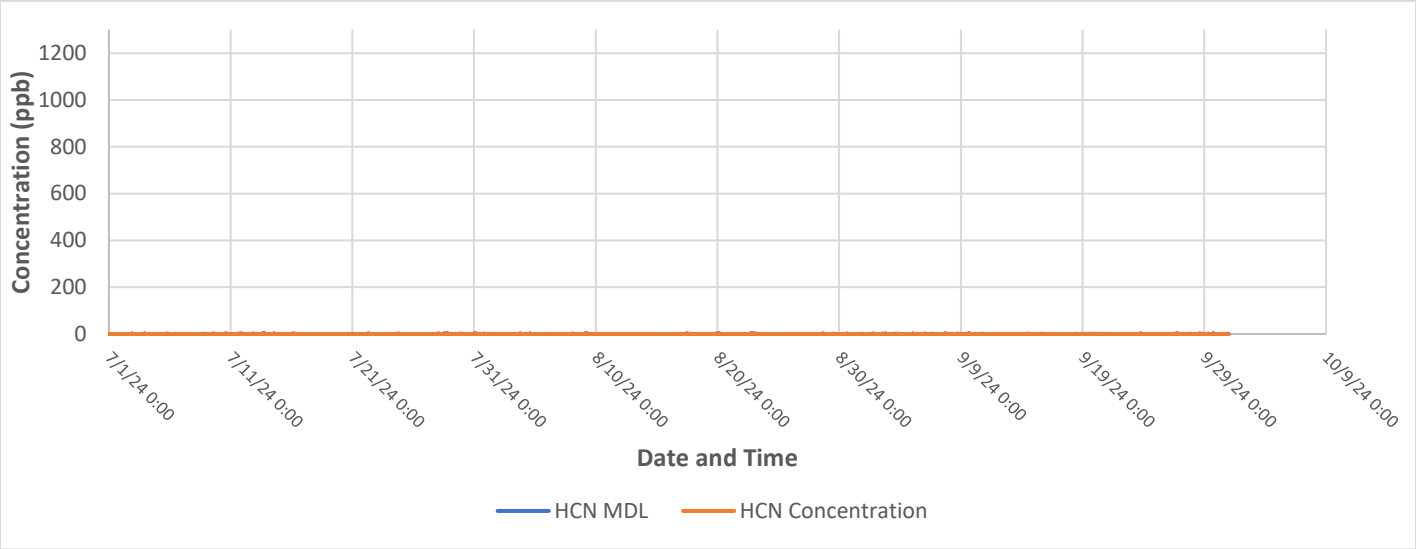

Figure 7. Timeseries of HCN Path 2

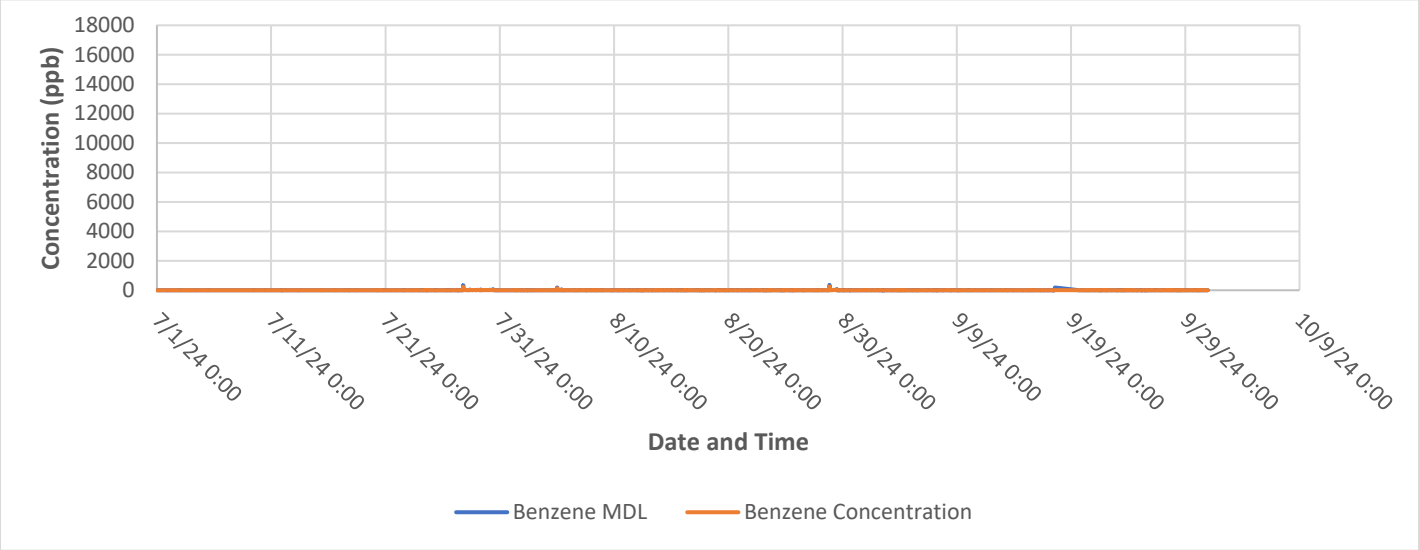

Figure 8. Timeseries of Benzene Path 3

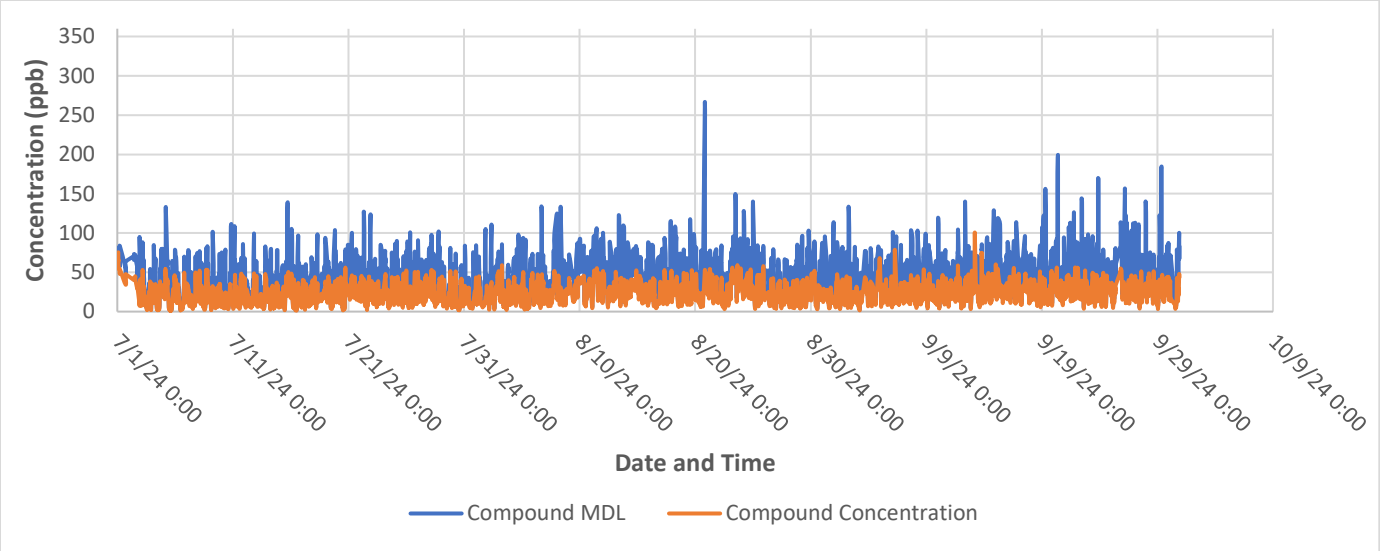

Figure 9. Timeseries of H_2S Path 3

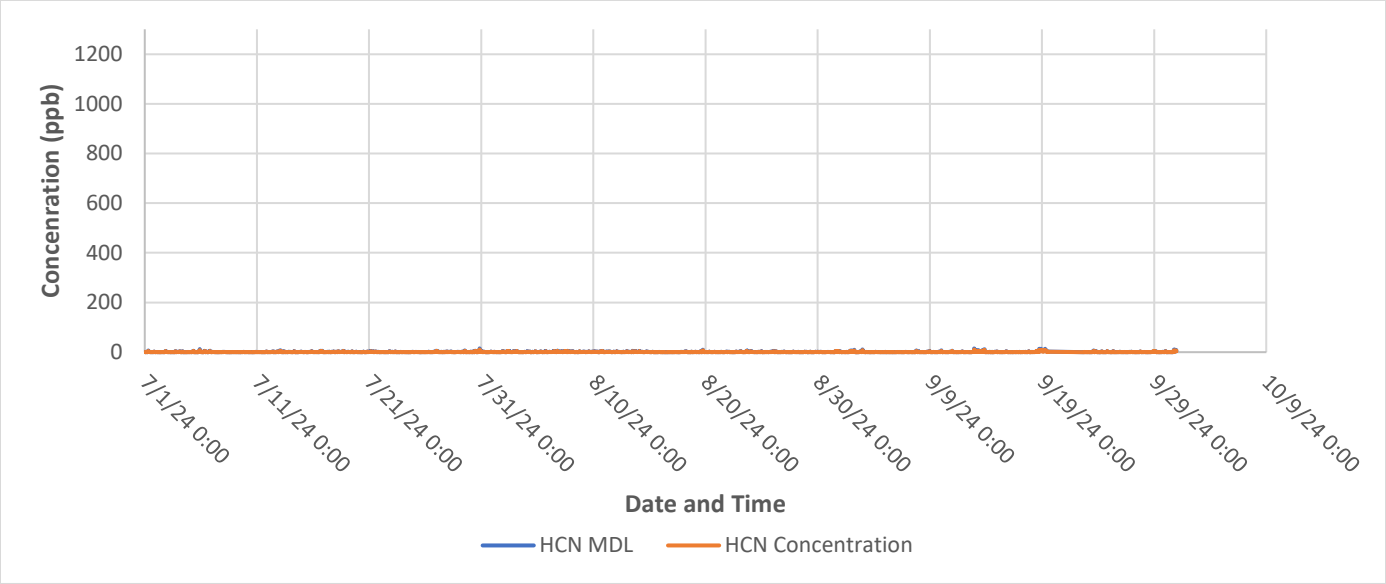

Figure 10. Timeseries of HCN Path 3

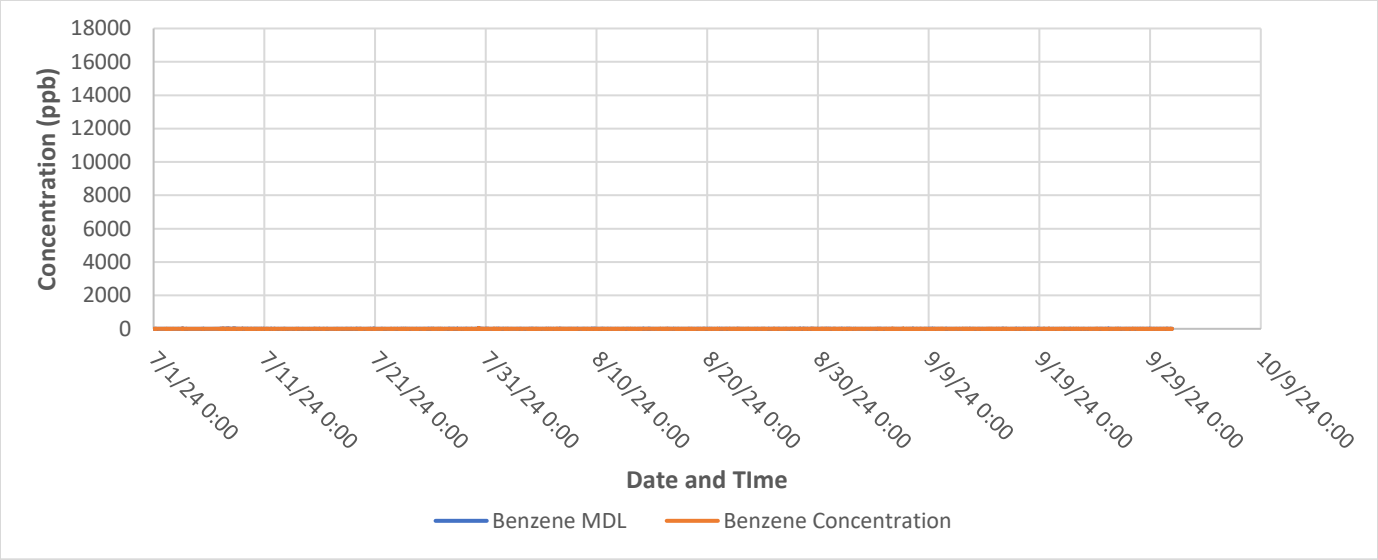

Figure 11. Timeseries of Benzene Path 4

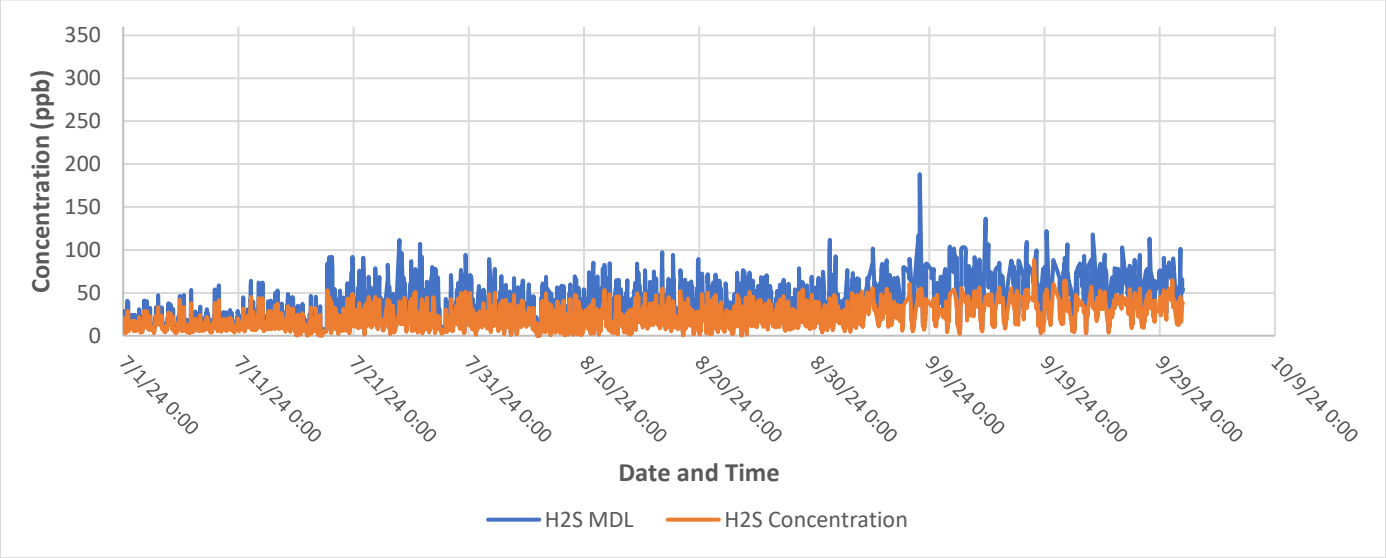

Figure 12. Timeseries of H_2S Path 4

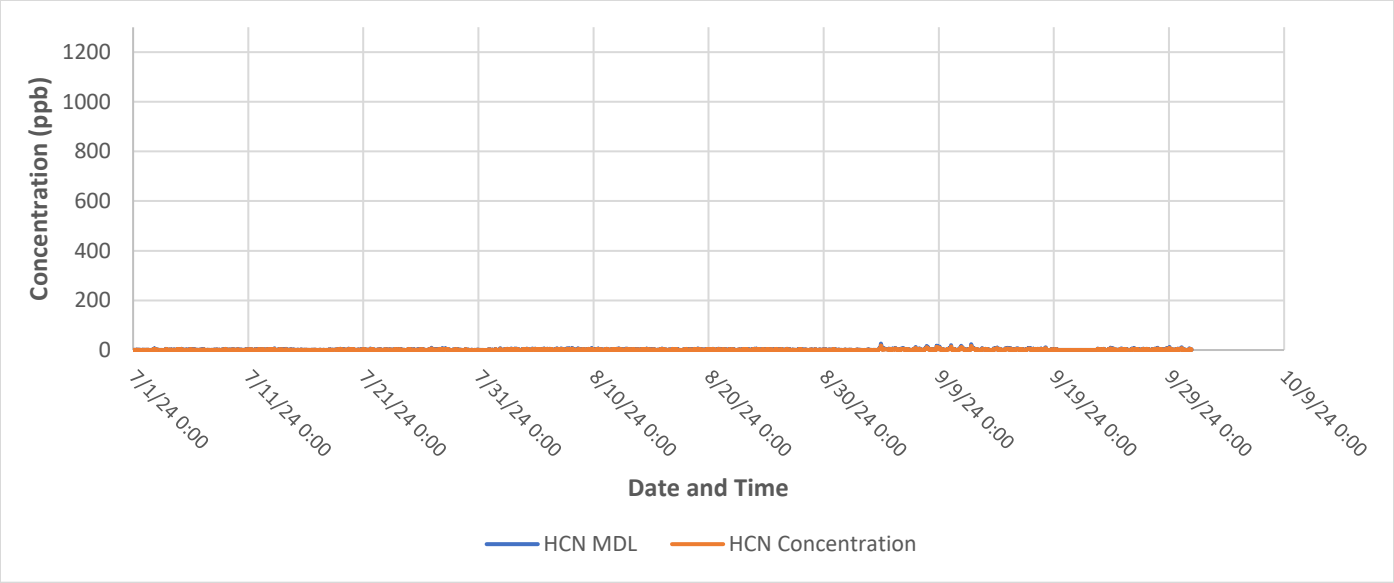

Figure 13. Timeseries of HCN Path 4

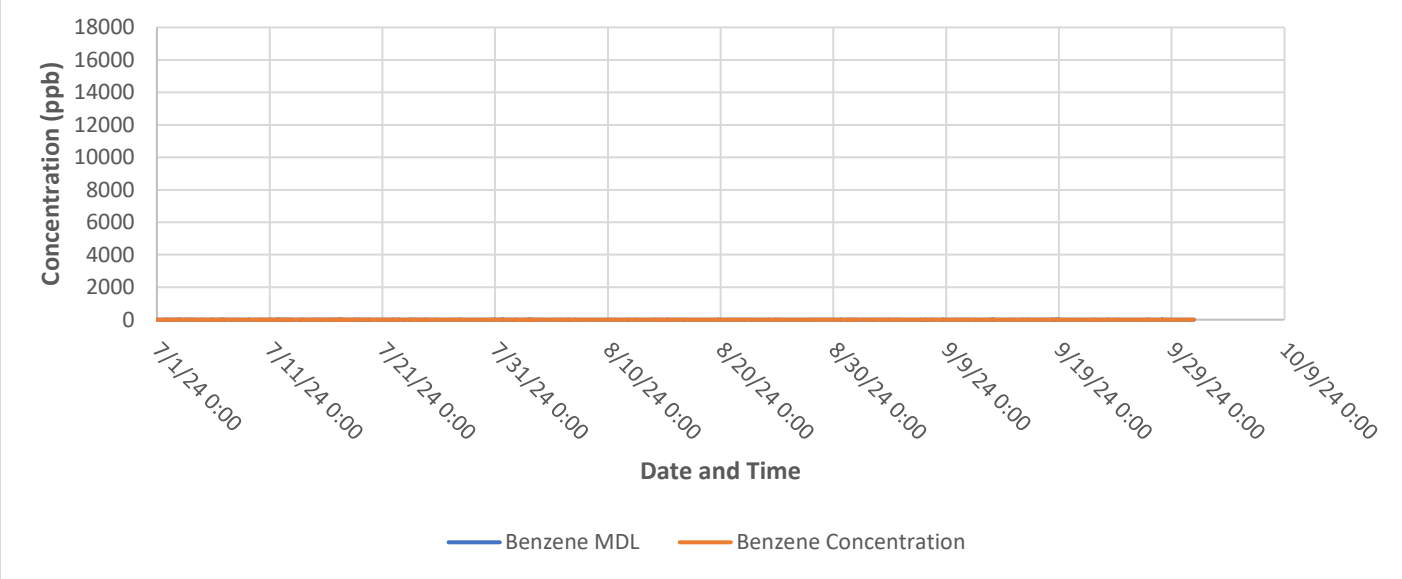

Figure 14. Timeseries of Benzene Path 5

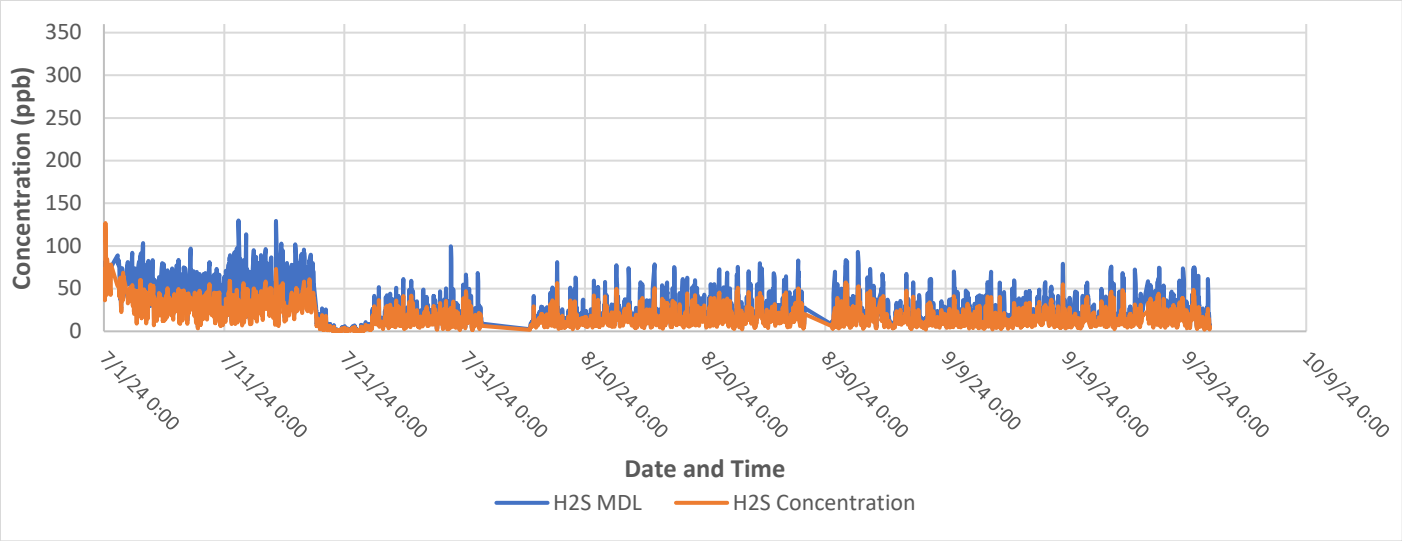

Figure 15. Timeseries of H_2S Path 5

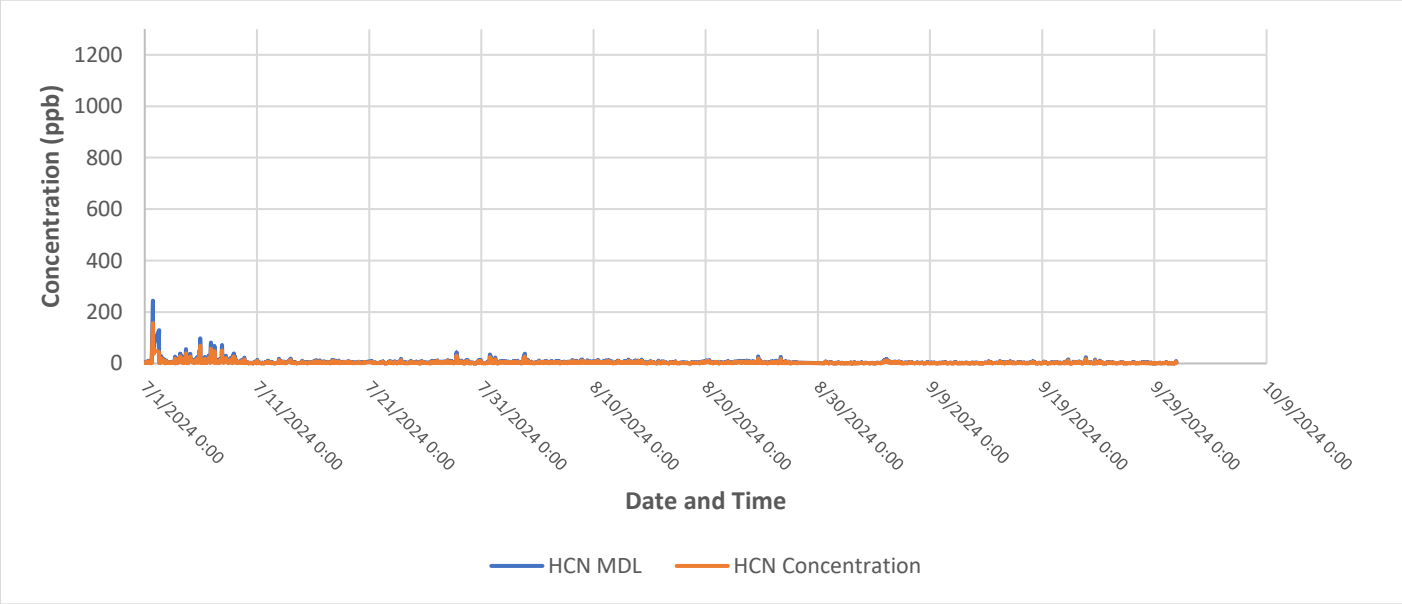

Figure 16. Timeseries of HCN Path 5

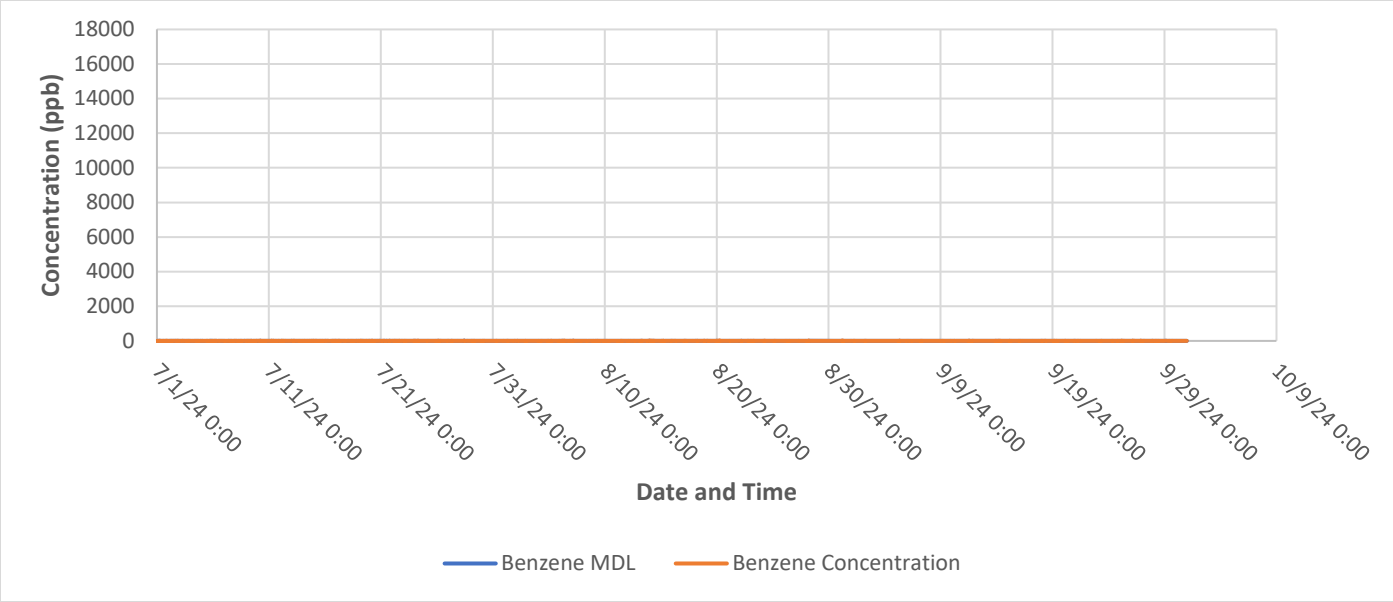

Figure 17. Timeseries of Benzene Path 6

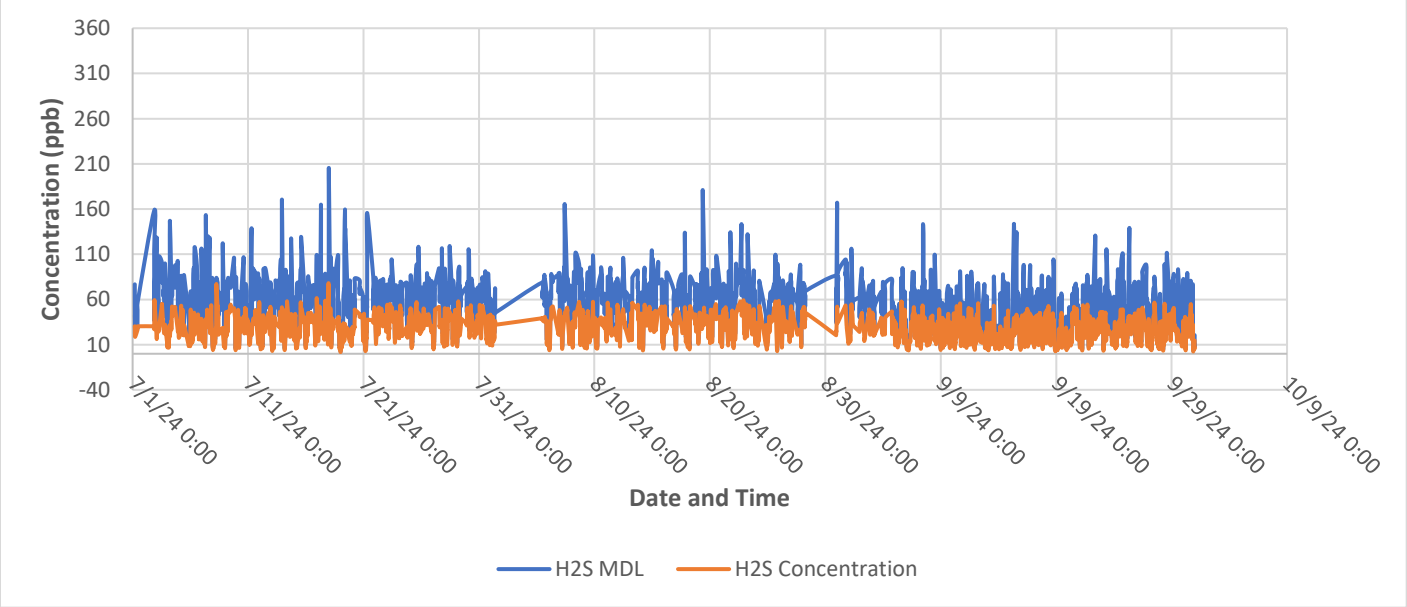

Figure 18. Timeseries of H_2S Path 6

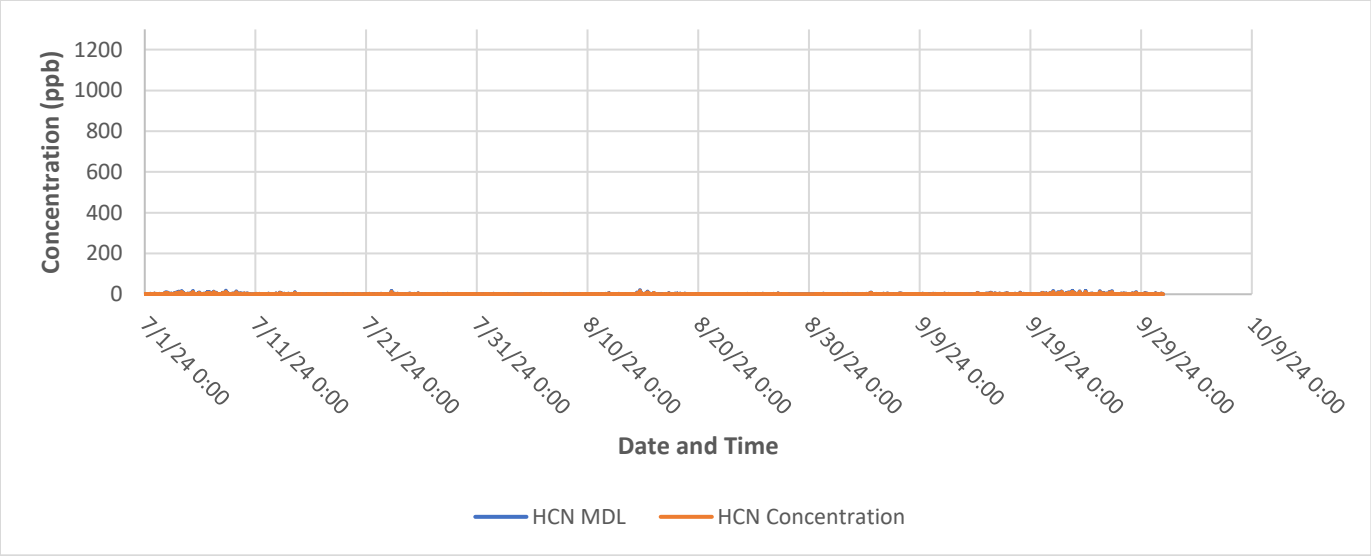

Figure 19. Timeseries of HCN Path 6

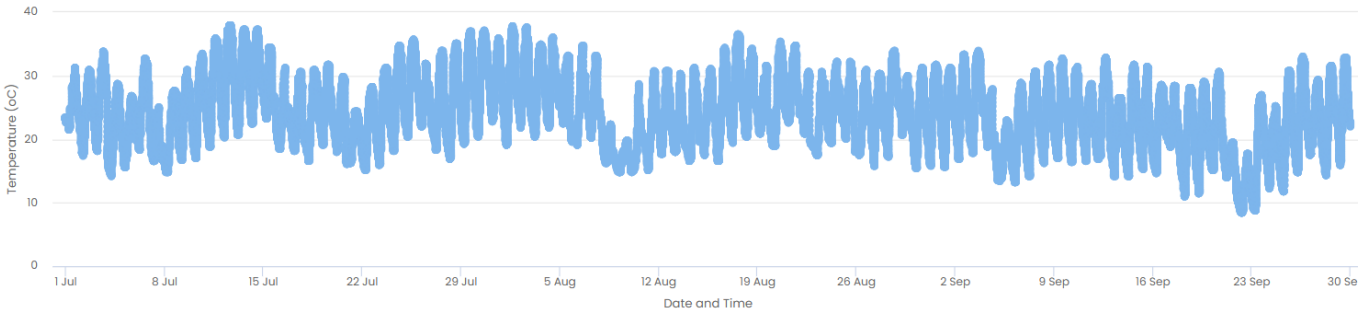

Figure 20. Temperature Timeseries

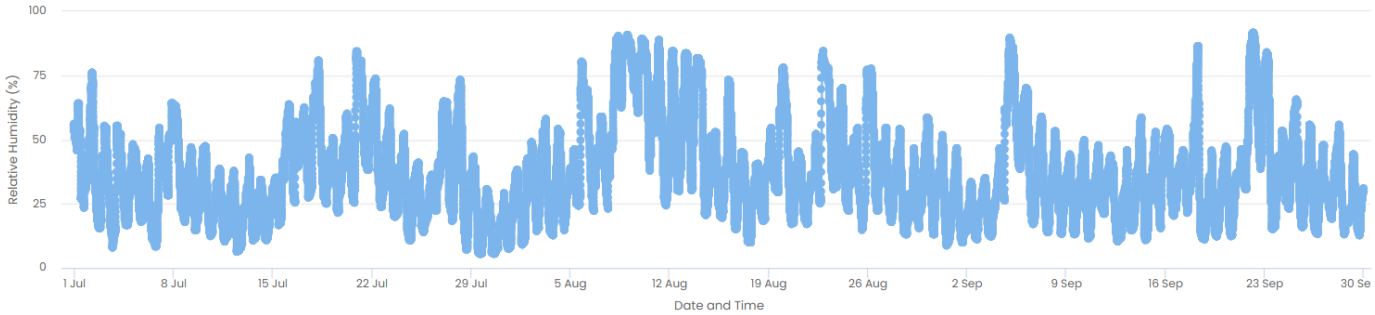

Figure 21. Relative Humidity Timeseries

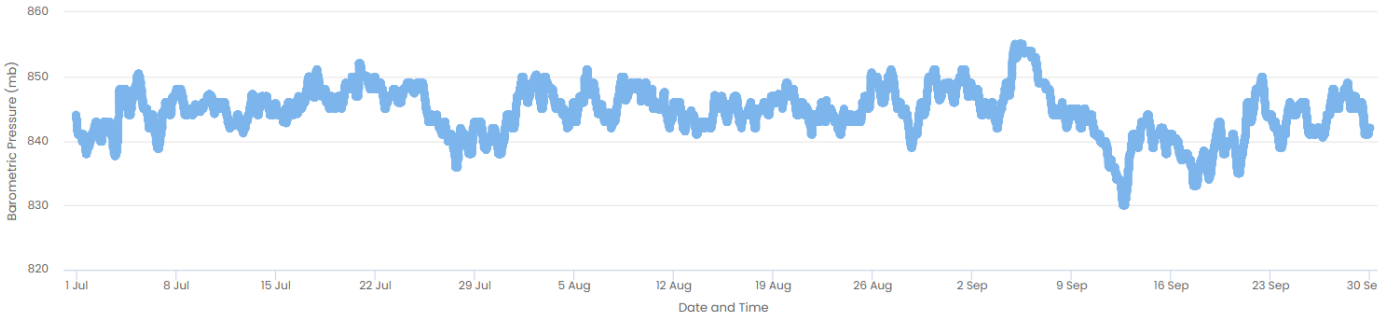

Figure 22. Barometric Pressure Timeseries

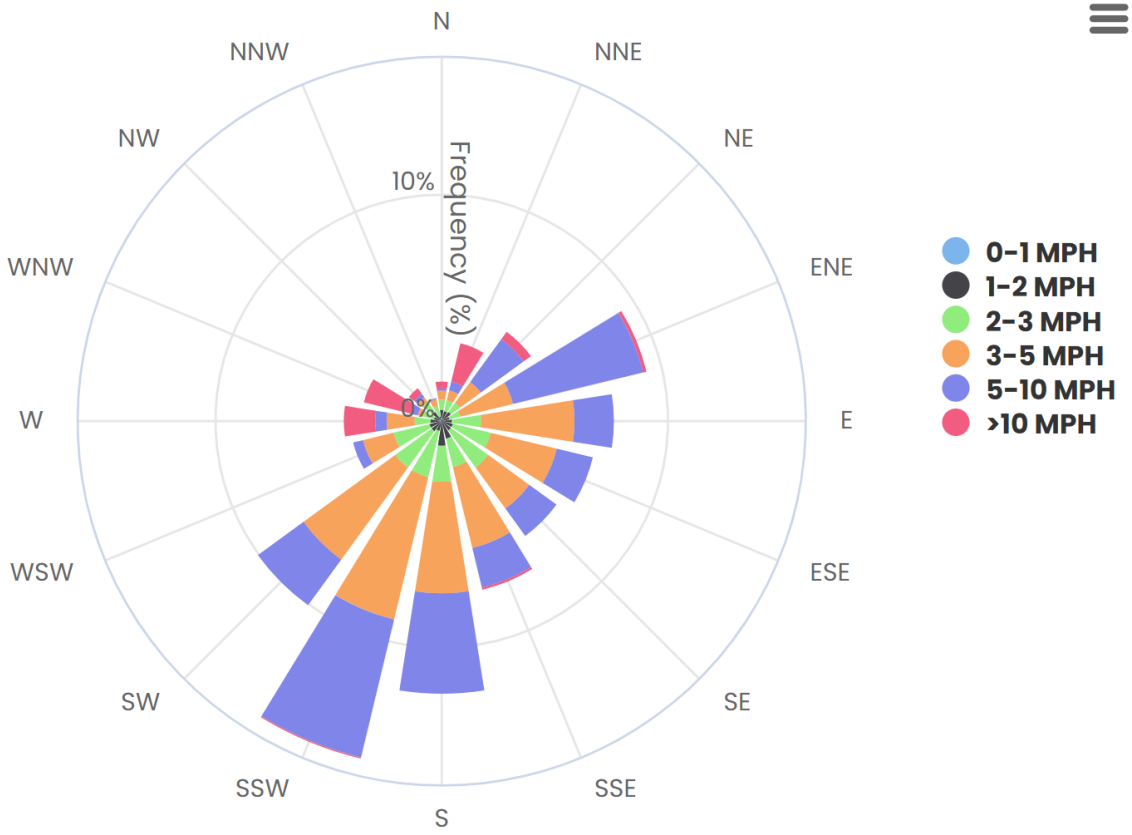

Figure 23. Wind Rose Plot

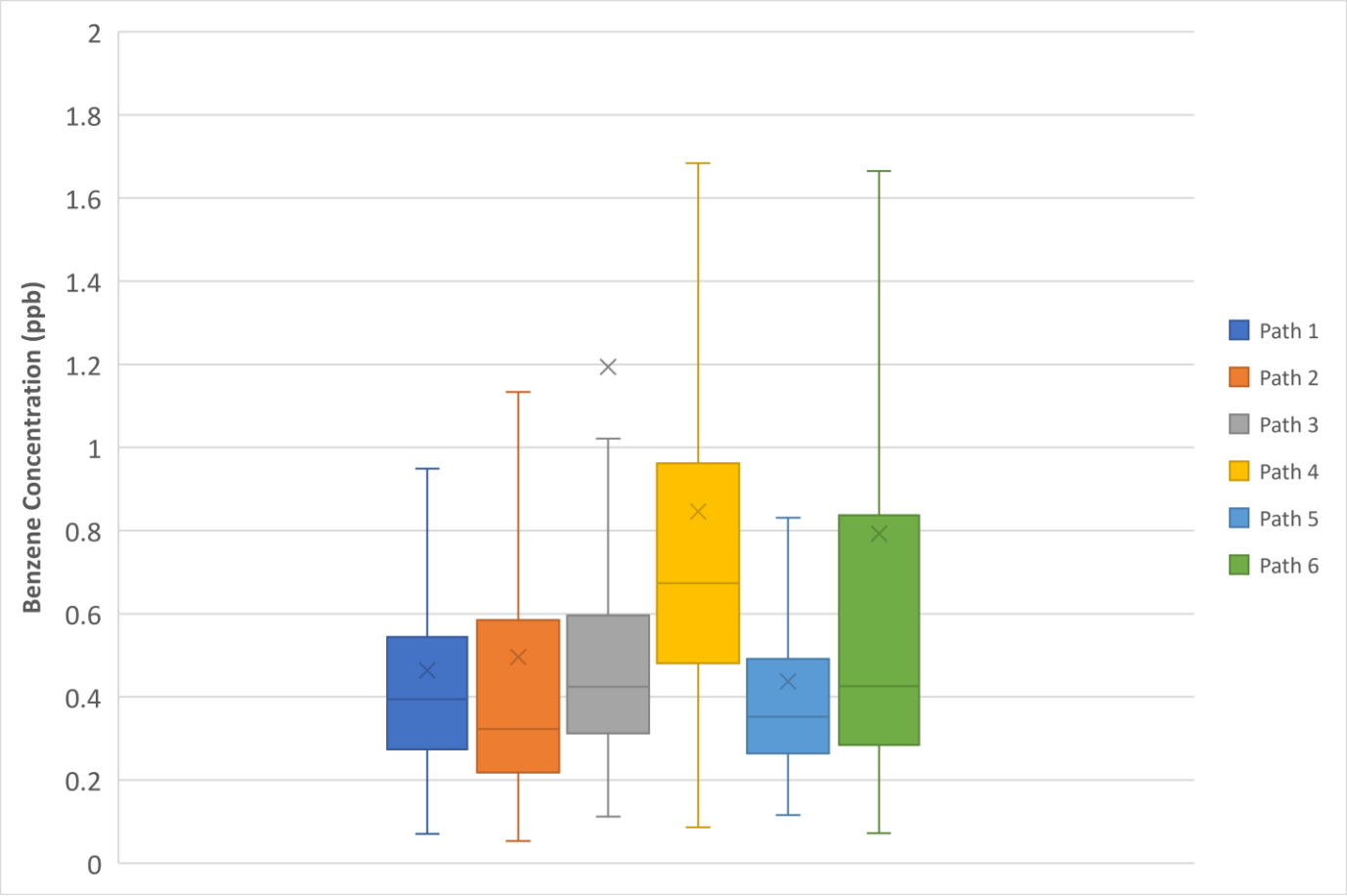

Figure 24. Benzene box plots for Paths 1 to 6.

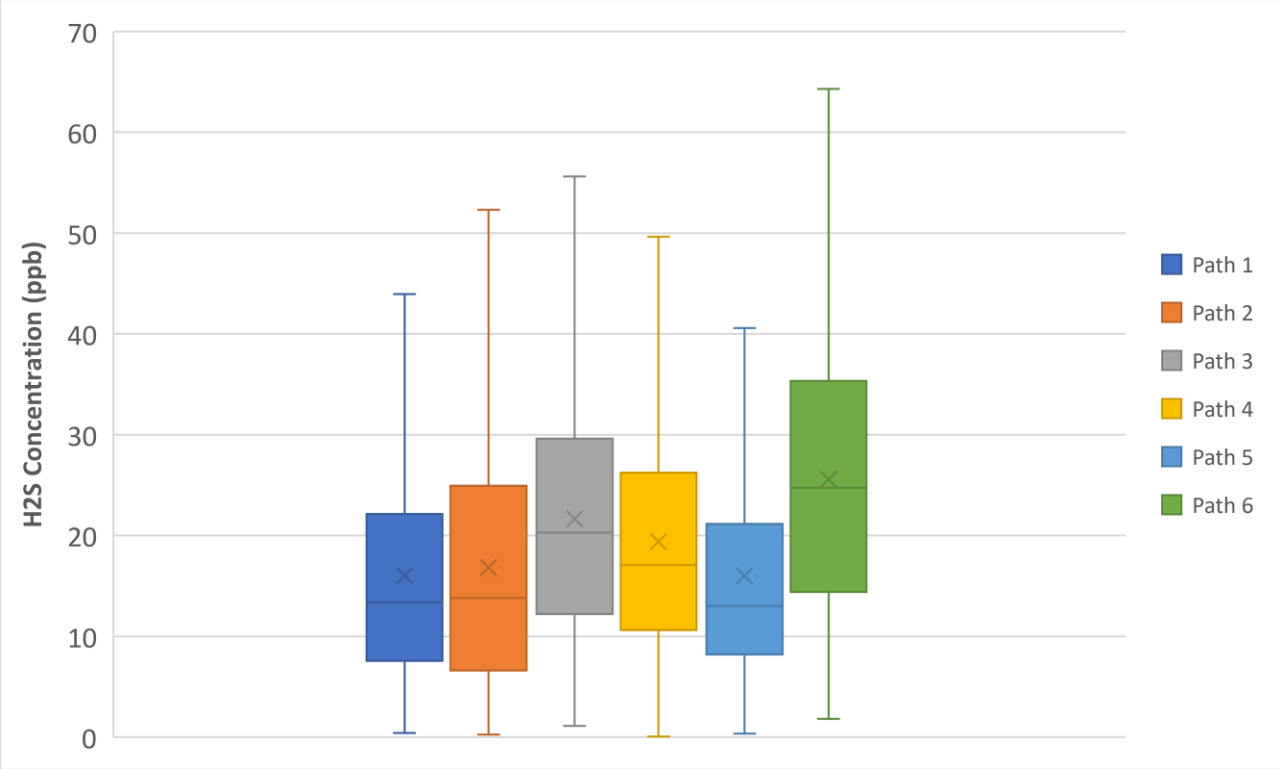

Figure 25. H_2S box plots for Paths 1 to 6.

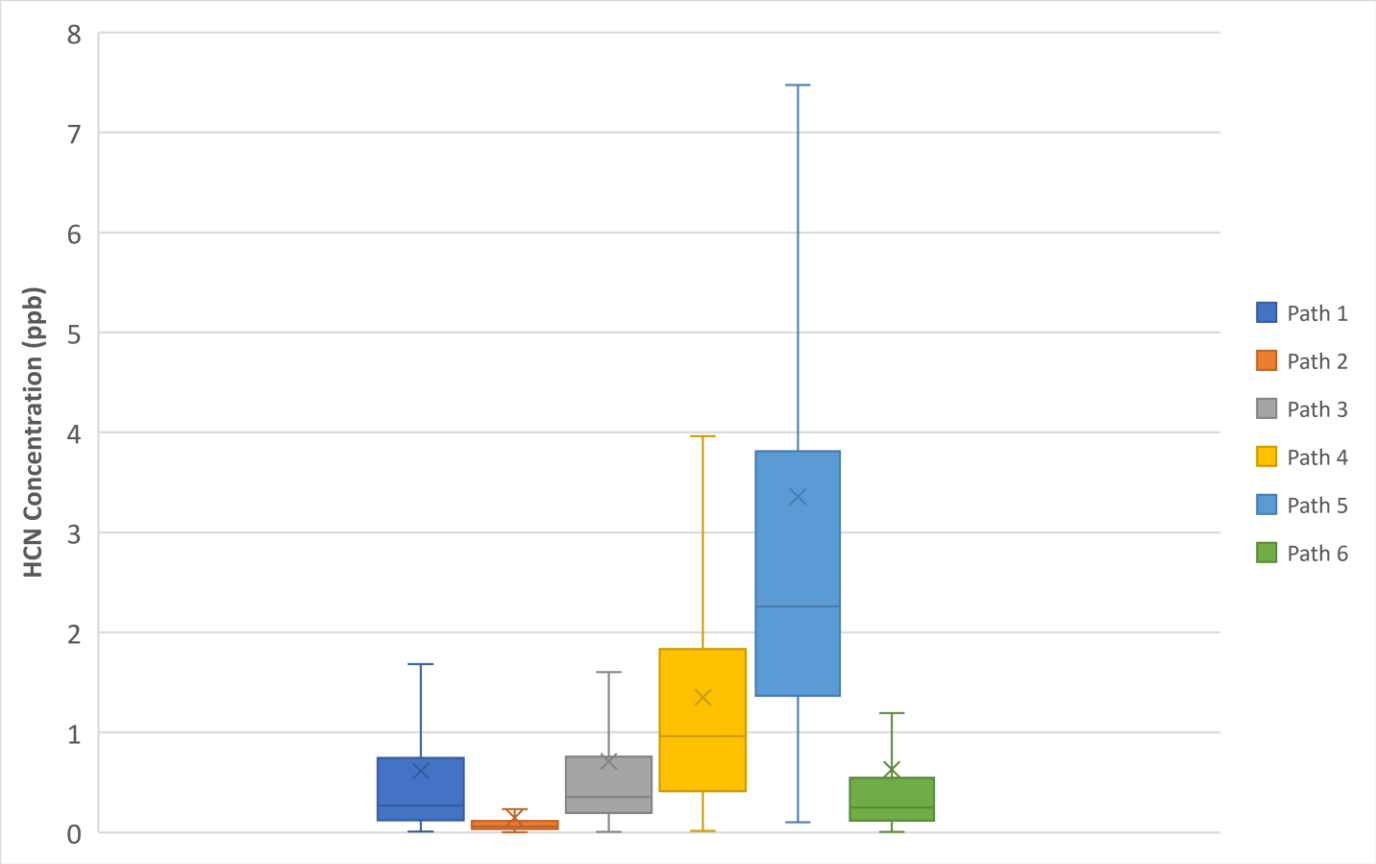

Figure 26. HCN box plots for Paths 1 to 6.

F. Discussion of Changes to Monitoring System, Operations and/or Procedures

Two main changes were performed to the fenceline monitoring plan procedures which are related with the automated QA/QC checks.

1. UV spectrometer temperature: the UV spectrometers were calibrated by the manufacturer at 35°C instead of the 39°C that the older models were used to be calibrated at. Thus, for the automated QA/QC checks, we changed the acceptance criteria to accommodate the updated spectrometer calibration conditions.
2. TDL signal intensity: the manufacturer recommended to monitor the absolute detector power instead of the signal intensity. The reason was related to the fact that the laser signal intensity is affected by multiple instrument parameters (I/O Gain, Signal Gain, signal collimation etc.). Due to these interferences, the signal intensity values that are reported by the analyzer could potentially not be representative of the actual signal power that is measured by the detector. To avoid these issues, we replaced the “signa intensity” parameter on the automated QA/QC checks with the parameter “absolute detector power”. The criteria for the data to be considered valid is the absolute detector power to be >0.1 mA.

VI. Appendices

A. Appendix A: Calibration and QA/QC Data

Table 7: Verification Activities

Date	Type of Verification	Path	Path Length[1]	Analyzer	Compound	Expected Concentration	Measured Concentration	Accuracy (%)	Precision (%)
9/19/2024	Bump test	1	452	UVDOAS	Benzene	100 ppm	99 ppm	3.8	4.2
9/19/2024	Bump test	1	452	UVDOAS	Benzene	200 ppm	190 ppm	4.9	1
9/19/2024	Bump test	2	1100	UVDOAS	Benzene	100 ppm	102 ppm	5.6	6
9/19/2024	Bump test	2	1100	UVDOAS	Benzene	200 ppm	179 ppm	15.4	11.1
9/19/2024	Bump test	3	330	UVDOAS	Benzene	100 ppm	99 ppm	4.4	4.5
9/19/2024	Bump test	3	330	UVDOAS	Benzene	200 ppm	189 ppm	5.4	1.6
9/19/2024	Bump test	4	630	UVDOAS	Benzene	100 ppm	98 ppm	5.6	7.1
9/19/2024	Bump test	4	630	UVDOAS	Benzene	200 ppm	167 ppm	16.6	12.1
9/19/2024	Bump test	5	444	UVDOAS	Benzene	100 ppm	104 ppm	4.4	4.4
9/19/2024	Bump test	5	444	UVDOAS	Benzene	200 ppm	208 ppm	4	2.3
9/19/2024	Bump test	6	276	UVDOAS	Benzene	100 ppm	96 ppm	5.6	4.8
9/19/2024	Bump test	6	276	UVDOAS	Benzene	200 ppm	198 ppm	3	3.6
9/30/2024	Audit Module	1	452	TDL	H2S	500 ppmm	470 ppmm	6.1	6.2
9/30/2024	Audit Module	1	452	TDL	H2S	625 ppmm	586 ppmm	6.3	2.5
9/30/2024	Audit Module	2	1100	TDL	H2S	500 ppmm	467 ppmm	6.6	1.3
9/30/2024	Audit Module	2	1100	TDL	H2S	625 ppmm	675 ppmm	8	2.1
9/30/2024	Audit Module	3	330	TDL	H2S	500 ppmm	439 ppmm	12.2	2.4
9/30/2024	Audit Module	3	330	TDL	H2S	625 ppmm	568 ppmm	9.1	1.6
9/30/2024	Audit Module	4	630	TDL	H2S	500 ppmm	440 ppmm	11.9	1.6
9/30/2024	Audit Module	4	630	TDL	H2S	625 ppmm	574 ppmm	8.1	3.1
9/30/2024	Audit Module	5	444	TDL	H2S	500 ppmm	444 ppmm	11.1	2.6
9/30/2024	Audit Module	5	444	TDL	H2S	625 ppmm	584 ppmm	6.5	2.2
9/19/2024	Audit Module	6	276	TDL	H2S	500 ppmm	437 ppmm	12.6	2.6
9/30/2024	Audit Module	6	276	TDL	H2S	625 ppmm	608 ppmm	2.8	2.4
9/19/2024	Audit Module	1	452	TDL	HCN	1010 ppmm	984 ppmm	2.6	0
9/19/2024	Audit Module	1	452	TDL	HCN	420ppmm	465 ppmm	10.8	0.7
9/19/2024	Audit Module	2	1100	TDL	HCN	1010 ppmm	958 ppmm	5.1	0.3
9/19/2024	Audit Module	2	1100	TDL	HCN	420ppmm	448 ppmm	6.6	0.2
9/19/2024	Audit Module	3	330	TDL	HCN	1010 ppmm	970 ppmm	3.9	0.1
9/19/2024	Audit Module	3	330	TDL	HCN	420 ppmm	457 ppmm	8.9	0.3
9/30/2024	Audit Module	4	630	TDL	HCN	1010 ppmm	951 ppmm	5.9	0.1
9/30/2024	Audit Module	4	630	TDL	HCN	420 ppmm	437 ppmm	4	0.3
9/30/2024	Audit Module	5	444	TDL	HCN	1010 ppmm	980 ppmm	3	2.2
9/30/2024	Audit Module	5	444	TDL	HCN	420 ppmm	457 ppmm	8.9	1.6
9/19/2024	Audit Module	6	276	TDL	HCN	1010 ppmm	971 ppmm	3.8	0.1
9/19/2024	Audit Module	6	276	TDL	HCN	420 ppmm	455 ppmm	8.4	0.3

[1]path length in meters

Table 8: Percent Recovery for Meteorological Parameters

Parameter	Percent Data Recovery
Wind Speed	100%
Wind Direction	100%
Temperature	100%
Humidity	100%
Pressure	100%

B. Appendix B: Qualifier Codes

Table 9: List of Data Invalidation Codes

Qualifier Code	AQS Definition *(additional information added in parentheses)*	Type or Related Action
AB	Technician Unavailable. *(use if this affects scheduled QA/QC or necessary maintenance)*	Null Data Qualifier
AD	Shelter Storm Damage.	Null Data Qualifier
AG	Sample Time out of Limits. *(e.g., use if integration time is out of manufacturer recommended range and signal intensity and MDL cannot meet the critical criteria mentioned in the FLMP)*	Null Data Qualifier
AI	Insufficient Data. (cannot calculate)	Null Data Qualifier
AL	Voided by Operator. *(e.g., Datum rejected by data validators)*	Null Data Qualifier
AM	Miscellaneous Void.	Null Data Qualifier
AN	Machine Malfunction *(can be used for issues such as an instrument being out of alignment, or an analyzer being offline due to connection problems or instrument failure)*	Null Data Qualifier
AO	Bad Weather. *(Use if weather impacts open-path instrument operation/function)*	Null Data Qualifier
AP	Vandalism. *(Use if vandalism impacts open-path instrument operation/function)*	Null Data Qualifier
AQ	Collection Error. *(use specifically for low analyzer signal events, or when a low analyzer signal prevents the reported data from meeting the critical criteria, while the calculated MDL is lower than 25% of notification threshold)*	Null Data Qualifier
AT	Calibration.	Null Data Qualifier
AU	Monitoring Waived.	Null Data Qualifier
AV	Power Failure.	Null Data Qualifier
AW	Wildlife Damage. *(Use if damage impacts open-path instrument operation/function)*	Null Data Qualifier
AX	Precision Check.	Null Data Qualifier
AY	QC Control Points (zero/span).	Null Data Qualifier

AZ	QC Audit.	Null Data Qualifier
BA	Maintenance/Routine Repairs.	Null Data Qualifier
Qualifier Code	**AQS Definition *(additional information added in parentheses)***	**Type or Related Action**
BH	Interference/co-elution/misidentification.	Null Data Qualifier
BJ	Operator Error.	Null Data Qualifier
BK	Site computer/data logger down.	Null Data Qualifier
BL	QA Audit.	Null Data Qualifier
BM	Accuracy check.	Null Data Qualifier
DA	Aberrant Data (Corrupt Files, Spikes, Shifts).	Null Data Qualifier
DL	Detection Limit Analyses.	Null Data Qualifier
EC	Exceeds Critical Criteria. *(use when data exceeds critical criteria, such as for MDL)*	Null Data Qualifier
IA	African Dust. *(use for any dust event)*	Informational
IT	Wildfire-U.S. *(use for any wildfire event)*	Informational
J	Construction/Repairs in Area.	Informational
LJ	Identification of Analyte Is Acceptable; Reported Value Is An Estimate.	Quality Assurance Qualifier
MD	Value less than MDL.	Quality Assurance Qualifier
NS	Influenced by nearby sources. *(e.g., in the event of emissions influenced by nearby sources)*	Quality Assurance Qualifier
QP	Pressure Sensor Questionable. *(e.g., use if cell pressure is out of range, indicating malfunction)*	Quality Assurance Qualifier
QT	Temperature Sensor Questionable. *(e.g., use if cell temperature is out of range, indicating malfunction)*	Quality Assurance Qualifier
QV	Quality Control Multi-point Verification.	Null Data Qualifier
QX	Does not meet QC criteria. *(e.g., data exceeds automatic criteria for rejection)*	Quality Assurance Qualifier
SC	Sampler Contamination.	Null Data Qualifier
ST	Calibration Verification Standard.	Null Data Qualifier
TC	Component Check & Retention Time Standard. *(use this code for additional instrument checks, e.g., a robustness tests)*	Null Data Qualifier

C. Appendix C: Field Data Sheets

10:23 PM 7/2/2024 Montrose KL Remote
checked system

1:04 PM 7/10/2024 Montrose KL,CN,SD,FF Onsite
General TDL training
UVDOAS Paths 1 and 6 aligned, Path 1 UV retro hood was adjusted
H2S TDL Paths 1,5 and 6 aligned
H2S TDL Path 5 signal 0.49
HCN TDL no alignments
HCN TDL Path 5: Collimated (defocused) telescope and decreased maximum signal. Looks good now

8:44 PM 7/15/2024 Montrose KL Remote
Decreased integration time at paths 2,3

3:48 PM 7/16/2024 Montrose KL Onsite, TAS BG Onsite
Aligned path 6 H2S and HCN TDLs

4:52 PM 7/18/2024 Montrose KL Onsite, TAS BG Onsite
H2S analyzer: bypassed flow cell because there were evidence of contamination

7:07 PM 7/22/2024 Montrose KL Remote
checked UV Optimization

12:15 PM 7/23/24 Montrose FF Onsite
H2s TDL Path 1 aligned (signal = .745)

11:59 AM 8/5/2024 Montrose KL Remote
Analyzer TDL Shelter 1 was not scanning (it was stuck at Path 5). Probably a bug or software issue. It is now resolved.

12:16 8/6/2024 SD Montrose onsite
TDL path 1 HCN aligned .9, 37.8%
11:09 8/15/24 SD Montrose onsite
TDL path 6 H2S aligned 53%
11:22 8/30/2024 SD & CN Montrose onsite
Aligned path 5 H2S, OPM reading .16 and power is at 70%
path 1 H2S aligned power 1.2, 42%. path 6 H2S aligned .9 40%

12:45 9/25/24 FF MOntrose Onsite
aligned h2s and hcn path 5 both around .45 - .5
Aligned UV path 5

12:30 PM 9/30/2024 Montrose Onsite KL, SD
TDL H2S Calibration Paths 1,6 and 5
TDL HCN Calibration Paths 5

11:00 AM 10/9/2024 Montrose onsite SD
Replaced filter on retros and cleaned TDL mirrors with cloth, aligned UV path 1 and 6 and replaced their filters
Aligned H2S path 1 .6, HCN .6
Aligned path 6 HCN .6, H2S .6

11:15 AM 10/15/2024 Montrose SD onsite
Aligned path 1 H2S-.5 path 6 H2S-.5 HCN path 6-.5
Aligned path 5 h2s and hcn-.5

10:00 AM 10/17/2024 Montrose SD onsite
Aligned path 5 H2S .6 and HCN .5, still reading low

09:14 AM 10/20/2024 Montrose CF Onsite
aligned H2S and HCN Paths 1 and 5.
site was really hazy and made visibility hard

3:39 PM 10/21/2024 Montrose CF Onsite
aligned H2S and HCN Path 1

1:34 PM 10/22/2024 Montrose KL, EO Onsite
rebooted router and switch
changed switch port on router

2:27 PM 10/23/24 Montrose FF Onsite
aligned both path 6 HCN (.672) and H2S (.772)
aligned uv path 1 (pwr 49 %)

2:04 PM 10/29/2024 Montrose SD onsite
Aligned path 1H2S and HCN-.5, aligned HCN and H2S path 6 -.6, aligned UV path 1

2:11 PM 11/1/2024 Montrose SD Onsite
Aligned HCN path 6-->0.5
Aligned H2S path 5--> 0.47

1:10 PM 11/7/2024 Montrose KL Remote
heave snow since 11/5/2024 affects the signal

6:01 PM 11/13/2024 Montrose EO Onsite
aligned TDLs paths 1,5 and 6

6:02 PM 11/18/2024 Montrose CF Onsite
aligned TDLS paths 1,5 and 6
aligned UV Path 1

********** COMPUTER TIME**********

10:23 PM 7/2/2024 Montrose KL Remote
checked system

5:58 PM 7/8/2024 Montrose JG Onsite
Fan on UVDOAS head Path 4 was malfunctioning. UV Head was replaced.

1:31 PM 7/10/2024 Montrose KL,SD,CN,FF Onsite
UVDOAS 2, 3, 4 WERE ALIGNED
TDL H2S Path 3 was aligned
TDL HCN Path 3 was aligned

12:00 PM 7/12/2024 Montrose KL Onsite
replaced fan and UVHead path 4

8:44 PM 7/15/2024 Montrose KL Remote
Decreased integration time at paths 4 and 5

3:48 PM 7/16/2024 Montrose KL Onsite, TAS BG Onsite
TDL Retro glass window installation
aligned paths 2 and 3

7:07 PM 7/22/2024 Montrose KL Remote
checked UV Optimization

12:43 PM 7/23/24 Montrose FF Onsite
aligned H2s path 2 (signal:.488)
aligned HCN path 3 (signal:.716)

10:14 PM 7/23/2024 Montrose KL Remote
Reduced integration time UV Path 3

1:20 PM 7/30/2024 Montrose KL Remote
ALigned UV Paths 3 and 4
Aligned TDL H2S Paths 2 and 4

12:35 PM 8/6/2024 Montrose SD onsite
Aligned TDL paths 2 HCN and H2S
HCN-.7, 37%
H2S-.55

12:00 PM 8/15/2024 SD Montrose onsite
TDL path3 aligned: HCN-53% H2S-29.7%

9:37 8/20 SD Montrose onsite
TDL path 3 aligned; H2S 34% power .69

10:00 8/27 SD Montrose onsite
aligned H2s path 3" 27.5% .65

11:45 am 9/25 FF Montrose onsite
aligned h2s path2 .323 44%
aligned h2s path 3 .451 45%
aligneed UV path2
aligned all of the paths for 4 (UV &TDL) HCN = .509 H2s= .623

12:15 PM 10/9/2024 Montrose SD Onsite
Aligned all UV paths, replaced thier filters, and aligned H2S path 4-.6

12:10 pm 10/15/2024 Montrose SD Onsite
Aligned TDL path2 H2S-.45 and path 3 H2S-.45

3:41 PM 10/21/2024 Montrose CF Onsite
aligned TDL HCN Path 4- OPM at 0.45

2:11 PM 10/29/2024 Montrose SD Onsite
aligned path 2 H2S-.4, aligned path 4 H2S and HCN both around .4

1:11 PM 11/7/2024 Montrose KL Remote
heavy snow since 11/5 is affecting the signal

D. Appendix D: Non-Conformance/Corrective Action Data Sheets

Form Title: Non-Conformance Report
Document Number:
Revision Number: R0

Implementation Date: February 07, 2024
Form Owner (Department): MAQS
Form Approval: AHeitmann

Non-Conformance Report

Project: PROJ-043819	**Month: July 2024**

LOCATION/SITE: Phillips 66 Denver Terminal	**Parameter(s) Affected: Public Website**
Begin Date and Time (LST): July 18, 24 at 6PM	**End Date and Time (LST): July 18, 24 at 8:40pm**
Equipment: Public Website	**S/N#: N/A**

Description of Malfunction or Problem: Make specific reference to Assignable Cause(s). All tests results should be documented on appropriate form(s).

Data stopped being reporting on public website.

Investigative Actions: Describe Assignable Cause(s). Make specific reference to all dates, times and performance test results. All tests results should be documented on appropriate form(s).

Microsoft was experiencing a nationwide outage which was affecting Microsoft's Azure Services (public websites). This issue was substantial and impacted other web services. The Montrose team was diligently monitoring the situation and was fully committed to restoring full platform functionality as quickly as possible once the Azure issue is resolved.

Corrective Action Taken: Make specific reference to all dates, times and performance test results.

The Azure outage was resolved, and the public website went back online. The data were backfilled. No data were lost.

Is Problem Fully Resolved? **Yes** **x** **No** _____ If "NO", Describe Further Action Required: (File updated NC/CA Report when problem is fully resolved)

Additional Attachments or Information? **Yes** ____ **No** __x__ Client Notified? **Yes** _x_ **No**_____If so, **date_12/18/24**_____			
Field Operator's Assessment of Data Status: (Check One)	☒ **Valid**	☐ **Suspect**	☒ **Invalid**
Additional notes on Data Validity Status: No data were lost.			

Originator's Signature: **K.Liangou**

QA Review: Aricia Boyd

Non-Conformance Report

Project: PROJ-043819	**Month: September 2024**

LOCATION/SITE: Phillips 66 Denver	**Parameter(s) Affected: Benzene, H2S and HCN data Path 1**
Begin Date and Time (LST): 9/18/24 8am	**End Date and Time (LST):9/19/24 5pm**
Equipment: Retroreflectors' Structure Shelter 2	**S/N#: N/A**

Description of Malfunction or Problem: Make specific reference to Assignable Cause(s). All tests results should be documented on appropriate form(s).

H2S signal in Path 1 and had a lot of noise affecting the instrumentation DL.

Investigative Actions: Describe Assignable Cause(s). Make specific reference to all dates, times and performance test results. All tests results should be documented on appropriate form(s).

We investigated the stability of the retroreflector structures. The structures were vibrating with the wind and trucks passing nearby introducing noise to the systems.

Corrective Action Taken: Make specific reference to all dates, times and performance test results.

We coordinated with the engineering firm and the construction company in order to stabilize the retroreflector structures. The construction company installed additional bracing at Shelter 2 and stabilized the structures.

Is Problem Fully Resolved? **Yes** **x** **No** ____ If "NO", Describe Further Action Required: (File updated NC/CA Report when problem is fully resolved)

Additional Attachments or Information? **Yes** _____ **No** **x** Client Notified? **Yes** **x** **No**_____If so, **date_9/19/24**_____

Field Operator's Assessment of Data Status: (Check One)	☐ **Valid**	☐ **Suspect**	☒ **Invalid**

Additional notes on Data Validity Status: Instruments were covered because the construction workers did a lot of welding.

Originator's Signature: **Katia Liangou**

QA Review: Aricia Boyd

Form Title: Non-Conformance Report
Document Number: 331AA-QMS-FM-13
Revision Number: R0
Implementation Date: February 07, 2024
Form Owner (Department): MAQS
Form Approval: AHeitmann

Non-Conformance Report

Project: PROJ-029623	**Month: July 2024**

LOCATION/SITE: P66 Denver Terminal	**Parameter(s) Affected: Benzene Concentration**
Begin Date and Time (LST): 7/6/2024 5am	**End Date and Time (LST): 7/6/2024 7pm**
Equipment: UVDOAS OP4	**S/N#: MAYP116744**

Description of Malfunction or Problem: Make specific reference to Assignable Cause(s). All tests results should be documented on appropriate form(s).

On Saturday 7/6/2024, Montrose performed an onsite visit due to some issues that we noticed with the OP4 UVDOAS. More specifically, we got an alert that the system is offline, and we couldn't remotely resolve it so we had to go onsite.

Investigative Actions: Describe Assignable Cause(s). Make specific reference to all dates, times and performance test results. All tests results should be documented on appropriate form(s).

During the site visit, we identified that the optical head (part of the UV) was not working properly. More specifically, when the optical head was connected to the UV base the instrument was shutting down. We troubleshooted the instrument by checking all connections and concluded that some power issue caused the fan that is located inside the UVDOAS head to stop working (the power consumption when it was connected to the instrument was extremely high and was causing the instrument to shut down).

Corrective Action Taken: Make specific reference to all dates, times and performance test results.

The optical head was replaced with a spare one and the instrument is back online. We are in the process of replacing the fan on the original (P66) instrument and have it replaced back on site by 7/13.

Is Problem Fully Resolved? **Yes** _____ **No** __X__ If "NO", Describe Further Action Required: (File updated NC/CA Report when problem is fully resolved) The issue has been temporarily resolved, but we will have to replace the fan on the original optical head instrument and replace it back by 7/13.

Additional Attachments or Information? **Yes** _____ **No**__X__ Client Notified? **Yes** __X__ **No**_____If so, **date__7/9/2024_____**

Field Operator's Assessment of Data Status: (Check One)	☐ **Valid**	☐ **Suspect**	☒ **Invalid**

Additional notes on Data Validity Status: All date for the period 7/6/2024 5am to 7/6/2024 7pm are invalid.

Originator's Signature: A.Liangou

QA Review: Aricia Boyd

Form Title: Non-Conformance Report
Document Number: 331AA-QMS-FM-14
Revision Number: R0
Implementation Date: February 07, 2024
Form Owner (Department): MAQS
Form Approval: AHeitmann

Non-Conformance Report

Project: PROJ-029623	**Month: July 2024**

LOCATION/SITE: P66 Denver Terminal	**Parameter(s) Affected: HCN OP5 Concentration**
Begin Date and Time (LST): 7_1_2024 10:25 pm	**End Date and Time (LST): 7_2_2024 6am**
Equipment: TDL OP5 HCN	**S/N#: LAS23-066**

Description of Malfunction or Problem: Make specific reference to Assignable Cause(s). All tests results should be documented on appropriate form(s).

OP5 HCN Concentration started increasing above the 1300ppb threshold at 10:25pm. Montrose performed all data validation checks and concluded that the data were valid. Montrose contacted P66 at 11:25pm to take action and inform the state that they have a threshold exceedance event. Montrose continued validating data because it seemed that the TDL instrument was malfunctioning.

Investigative Actions: Describe Assignable Cause(s). Make specific reference to all dates, times and performance test results. All tests results should be documented on appropriate form(s).

Montrose checked the amplifier signal and concluded that it was malfunctioning. More specifically the signal was too high and the detector was misinterpreting it for high concentration.

Corrective Action Taken: Make specific reference to all dates, times and performance test results.

Montrose decreased the emitting frequency and aligned the instrument and informed P66 that the event was a false positive.

Is Problem Fully Resolved? **Yes _X_** **No _____** If "NO", Describe Further Action Required: (File updated NC/CA Report when problem is fully resolved)

Additional Attachments or Information? **Yes _____** **No____X** Client Notified? **Yes _X_** **No_____**If so, **date 7_2_2024_____**

Field Operator's Assessment of Data Status: (Check One)	☐ **Valid**	☐ **Suspect**	☒ **Invalid**

Additional notes on Data Validity Status: All data for the period mentioned above were invalid due to the amplifier malfunctioning.

Originator's Signature: **A.Liangou**

QA Review: Aricia Boyd

Form Title: Non-Conformance Report
Document Number: 331AA-QMS-FM-15
Revision Number: R0

Implementation Date: February 07, 2024
Form Owner (Department): MAQS
Form Approval: AHeitmann

Non-Conformance Report

Project: PROJ-029623	**Month: July 2024**

LOCATION/SITE: P66 Denver Terminal	**Parameter(s) Affected: None**
Begin Date and Time (LST): 7_1_2024 11:30PM	**End Date and Time (LST): 7_2_2024 11:30AM**
Equipment: CDPHE Emergency Hotline	**S/N#: N/A**

Description of Malfunction or Problem: Make specific reference to Assignable Cause(s). All tests results should be documented on appropriate form(s).

The issue was related to a threshold exceedance event at P66 Denver Terminal (OP5 HCN) that was later identified as a false positive. Montrose informed P66 that there is a threshold exceedance and that CDPHE will need to be notified. P66 called CDPHE at the emergency hotline mentioned in the FLMP, but the number was wrong. Then Montrose provided correct number to P66 (google search), and they called it in order to inform CDPHE but no one replied to the phone call. There was a voice mail suggesting that P66 should call another number. P66 called the third number but again no one replied to the phone call and P66 left a voice mail informing them about the exceedance event.

Investigative Actions: Describe Assignable Cause(s). Make specific reference to all dates, times and performance test results. All tests results should be documented on appropriate form(s).

Montrose and P66 requested a meeting with CDPHE in order to explain the procedure they followed and the issues that arose.

Corrective Action Taken: Make specific reference to all dates, times and performance test results.

Montrose and P66 had a meeting with CDPHE at 7_2_2024 9:30 am in which they described the processed they follow and the issues. CDPHE mentioned that they will resolve the issue internally and inform P66 when it is resolved.

Is Problem Fully Resolved? **Yes** _X_ **No** _____ If “NO”, Describe Further Action Required: (File updated NC/CA Report when problem is fully resolved)

Additional Attachments or Information? **Yes _____ No____X** Client Notified? **Yes _X___ No_____**If so, **date 7_2_2024_____**			
Field Operator's Assessment of Data Status: (Check One)	☐ **Valid**	☐ **Suspect**	☐ **Invalid**
Additional notes on Data Validity Status N/A This issue was related to procedure issues			

Originator's Signature: A Liangou

QA Review: Aricia Boyd

Form Title: Non-Conformance Report	**Implementation Date:** February 07, 2024
Document Number:	**Form Owner (Department):** MAQS
Revision Number: R0	**Form Approval:** AHeitmann

Non-Conformance Report

Project: PROJ-043819	**Month:July 2024**

LOCATION/SITE:Phillips 66 Denver Terminal	**Parameter(s) Affected:Data for UV Path 4**
Begin Date and Time (LST): July 6, 24 at 10am	**End Date and Time (LST): July 12, 24 at 12pm**
Equipment: UVDOAS Head Path 4	**S/N#:**

Description of Malfunction or Problem: Make specific reference to Assignable Cause(s). All tests results should be documented on appropriate form(s).

The fan inside the UVDOAS head path 4 was malfunctioning

Investigative Actions: Describe Assignable Cause(s). Make specific reference to all dates, times and performance test results. All tests results should be documented on appropriate form(s).

The fan inside the UVDOAS head Path 4 started malfunctioning (was burnt). The UVDOAS head was replaced with another head (spare head) and Montrose investigated the reason it happened. The cause seems to be related with a power issue.

Corrective Action Taken: Make specific reference to all dates, times and performance test results.

The fan was replaced with a new one on July 12th and the UVDOAS head installed back on the instrument.

Is Problem Fully Resolved? **Yes** _x_ **No** _____ If "NO", Describe Further Action Required: (File updated NC/CA Report when problem is fully resolved)

Additional Attachments or Information? **Yes** _____ **No** _x_ Client Notified? **Yes** _x_ **No**_____If so, **date_12/8/24**_____

Field Operator's Assessment of Data Status: (Check One)	☒ **Valid**	☐ **Suspect**	☐ **Invalid**

Additional notes on Data Validity Status: The data during the UVDOAS Path 4 fan malfunctioning were invalidated (July 6th). The data after the UVHead replacement are valid.

Originator's Signature: K.Liangou

QA Review: Aricia Boyd

Form Title: Non-Conformance Report	**Implementation Date:** February 07, 2024
Document Number:	**Form Owner (Department):** MAQS
Revision Number: R0	**Form Approval:** AHeitmann

Non-Conformance Report

Project: PROJ-043819	**Month: July 2024**

LOCATION/SITE:Phillips 66 Denver Terminal	**Parameter(s) Affected: Signal transmit for TDL Path 4**
Begin Date and Time (LST): July 17, 24 at 8am	**End Date and Time (LST): July 17, 24 at 2pm**
Equipment: H2S and HCN TDL Path 4	**S/N#: H2S and HCN TDL Path 4**

Description of Malfunction or Problem: Make specific reference to Assignable Cause(s). All tests results should be documented on appropriate form(s).

The fuses on the ffts were burnt.

Investigative Actions: Describe Assignable Cause(s). Make specific reference to all dates, times and performance test results. All tests results should be documented on appropriate form(s).

The fused at the ffts that are used for TDL signal transmit from Path 4 to Shelter 3 were burnt due to some power issue.

Corrective Action Taken: Make specific reference to all dates, times and performance test results.

The fuses were replaced and the ffts are now working. Both H2S and HCN data for Path 4 are reported.

Is Problem Fully Resolved? **Yes** _x_ **No** _____ If "NO", Describe Further Action Required: (File updated NC/CA Report when problem is fully resolved)

Additional Attachments or Information? **Yes** _____ **No** _x_ Client Notified? **Yes** _x_ **No**_____If so, **date_12/17/24**_____

Field Operator's Assessment of Data Status: (Check One)	☒ **Valid**	☐ **Suspect**	☒ **Invalid**

Additional notes on Data Validity Status: After the fuses replacement the data are valid.

Originator's Signature: **K.Liangou**

QA Review: Aricia Boyd

Non-Conformance Report

Project: PROJ-043819	**Month: July 2024**

LOCATION/SITE: Phillips 66 Denver	**Parameter(s) Affected: H2S data Paths 1, 5 and 6**
Begin Date and Time (LST): 7/18/24 8am	**End Date and Time (LST):7/18/24 3pm**
Equipment: TDL H2S Shelter 1 analyzer	**S/N#: N/A**

Description of Malfunction or Problem: Make specific reference to Assignable Cause(s). All tests results should be documented on appropriate form(s).

H2S analyzer in Shelter 1 had a lot of noise affecting the instrumentation DL.

Investigative Actions: Describe Assignable Cause(s). Make specific reference to all dates, times and performance test results. All tests results should be documented on appropriate form(s).

Checked inside analyzer to determine where the noise was coming from.

Corrective Action Taken: Make specific reference to all dates, times and performance test results.

We bypassed the H2S calibration cell at Shelter 1 analyzer.

Is Problem Fully Resolved? **Yes** _____ **No** **x** If "NO", Describe Further Action Required: (File updated NC/CA Report when problem is fully resolved)

Additional Attachments or Information? **Yes** _____ **No** **x** Client Notified? **Yes** **x** **No**_____If so, **date_7/18/24**_____

Field Operator's Assessment of Data Status: (Check One)	☐ **Valid**	☐ **Suspect**	☒ **Invalid**

Additional notes on Data Validity Status: Instrument in maintenance mode

Originator's Signature: **Katia Liangou**

QA Review: Aricia Boyd

Form Title: Non-Conformance Report	**Implementation Date:** February 07, 2024
Document Number: 331AA-QMS-FM-5	**Form Owner (Department):** MAQS
Revision Number: R0	**Form Approval:** AHeitmann

Non-Conformance Report

Project: PROJ-043819	**Month: August 2024**

LOCATION/SITE: Phillips 66 Denver	**Parameter(s) Affected: Benzene, H2S and HCN data Paths 5 and 6**
Begin Date and Time (LST): 8/29/24 8am	**End Date and Time (LST):8/30/24 3pm**
Equipment: Retroreflector structures Sh 6 and 7A	**S/N#: N/A**

Description of Malfunction or Problem: Make specific reference to Assignable Cause(s). All tests results should be documented on appropriate form(s).

H2S signal in Path 6 and Path 5 and had a lot of noise affecting the instrumentation DL.

Investigative Actions: Describe Assignable Cause(s). Make specific reference to all dates, times and performance test results. All tests results should be documented on appropriate form(s).

We investigated the stability of the retroreflector structures. The structures were vibrating with the wind and trucks passing nearby introducing noise to the systems.

Corrective Action Taken: Make specific reference to all dates, times and performance test results.

We coordinated with the engineering firm and the construction company in order to stabilize the retroreflector structures. The construction company installed additional bracing at Shelters 6 and 7A and stabilized the structures.

Is Problem Fully Resolved? **Yes** **x** **No** ____ If "NO", Describe Further Action Required: (File updated NC/CA Report when problem is fully resolved)

Additional Attachments or Information? **Yes** ____ **No** **x** Client Notified? **Yes** **x** **No** ____ If so, **date_8/29/24**_____

Field Operator's Assessment of Data Status: (Check One)	☐ **Valid**	☐ **Suspect**	☒ **Invalid**

Additional notes on Data Validity Status: Instruments were covered because the construction workers did a lot of welding.

Originator's Signature: **Katia Liangou**

QA Review: Aricia Boyd

Form Title: Non-Conformance Report	**Implementation Date:** February 07, 2024
Document Number: 331AA-QMS-FM-5	**Form Owner (Department):** MAQS
Revision Number: R0	**Form Approval:** AHeitmann

Non-Conformance Report

Project: PROJ-043819	**Month: October 2024**

LOCATION/SITE: Phillips 66 Denver	**Parameter(s) Affected: HCN data Path 5 and Path 6**
Begin Date and Time (LST): 10/15/24 2:15pm	**End Date and Time (LST):10/15/24 7:05pm**
Equipment: HCN data Path 6 and Path 5	**S/N#: N/A**

Description of Malfunction or Problem: Make specific reference to Assignable Cause(s). All tests results should be documented on appropriate form(s).

The HCN laser at Shelter 1 HCN analyzer was stopped at Path 1 and was not cycling between the three paths.

Investigative Actions: Describe Assignable Cause(s). Make specific reference to all dates, times and performance test results. All tests results should be documented on appropriate form(s).

The technician that performed the weekly site visit and the system alignments, did not set the laser to cycle between the three paths.

Corrective Action Taken: Make specific reference to all dates, times and performance test results.

Logged in remotely and set the laser to cycle between the three paths.

Is Problem Fully Resolved? **Yes** **x** **No** ____ If "NO", Describe Further Action Required: (File updated NC/CA Report when problem is fully resolved)

Additional Attachments or Information? **Yes** _____ **No** **x** Client Notified? **Yes** _____ **No** **x** If so, **date**_____

Field Operator's Assessment of Data Status: (Check One)	☐ **Valid**	☐ **Suspect**	☒ **Invalid**

Additional notes on Data Validity Status: Data for HCN Paths 5 and 6 for the period mentioned was lost.

Originator's Signature: **Katia Liangou**

QA Review: Aricia Boyd

Form Title: Non-Conformance Report	**Implementation Date:** February 07, 2024
Document Number: 331AA-QMS-FM-5	**Form Owner (Department):** MAQS
Revision Number: R0	**Form Approval:** AHeitmann

Non-Conformance Report

Project: PROJ-043819	**Month: October 2024**

LOCATION/SITE: Phillips 66 Denver	**Parameter(s) Affected: NaN**
Begin Date and Time (LST): 10/14/24 2pm	**End Date and Time (LST):10/15/24 2:05pm**
Equipment: Systems in Shelter 3	**S/N#: N/A**

Description of Malfunction or Problem: Make specific reference to Assignable Cause(s). All tests results should be documented on appropriate form(s).

All equipment located in Shelter 3 were offline.

Investigative Actions: Describe Assignable Cause(s). Make specific reference to all dates, times and performance test results. All tests results should be documented on appropriate form(s).

The Shelter 3 router stopped being connected to the internet.

Corrective Action Taken: Make specific reference to all dates, times and performance test results.

Rebooted the router and everything went back online.

Is Problem Fully Resolved? **Yes** **x** **No** ____ If "NO", Describe Further Action Required: (File updated NC/CA Report when problem is fully resolved)

Additional Attachments or Information? **Yes** _____ **No** **x** Client Notified? **Yes** _____ **No** **x** If so, **date**_____

Field Operator's Assessment of Data Status: (Check One)	☒ **Valid**	☐ **Suspect**	☒ **Invalid**

Additional notes on Data Validity Status: Once the instruments were back online all data were backfilled. No data loss.

Originator's Signature: **Katia Liangou**

QA Review: Aricia Boyd

E. Appendix E: Calibration verification forms

UVDOAS Calibration Form

Form Title: UVDOAS Calibration Form	**Implementation Date:** July 10, 2024
Document Number: 331AA-OPS-FM-13	**Form Owner (Department):** MAQS
Revision Number: Rev. 0	**Form Approval:** Katia Liangou

Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/19/2024

Instrument Model: UV Mono Path 1 Instrument Serial Number: _____

Instrument Parameters	
Optical Path Length (meters)	452 m/ 0.047m
Maximum Intensity (%)	93
Integration Time (ms)	89

Standard Information	
Benzene Standard Concentration (PPM)	100

File #	**Benzene Concentration (PPM)**	**Measured Concentration (PPM)**	**Error (%)**
1	100	97	9.7
2	100	98	9.8
3	100	106	6
4	100	96	4
5	100	96	4
Averages	100	99	3.8

Montrose Air Quality Services
5120 Northshore Dr. North Little Rock, AR 72218
T: (501-)900-6400
www.montrose-env.com

Form Title: UVDOAS Calibration Form	**Implementation Date:** July 10, 2024
Document Number: 331AA-OPS-FM-13	**Form Owner (Department):** MAQS
Revision Number: Rev. 0	**Form Approval:** Katia Liangou

	Calculated Values	**Expected Values**
Overall Percent Precision	95.8	**≥ 75%**
Overall Percent Error	3.8	**≤ 30%**

Notes:
Calibration verification passed.

Operator's Signature Katia Liangou

Witness's Signature James Garrett

Montrose Air Quality Services
5120 Northshore Dr. North Little Rock, AR 72218
T: (501-)900-6400
www.montrose-env.com

UVDOAS Calibration Form

Form Title: UVDOAS Calibration Form	**Implementation Date:** July 10, 2024
Document Number: 331AA-OPS-FM-13	**Form Owner (Department):** MAQS
Revision Number: Rev. 0	**Form Approval:** Katia Liangou

Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/19/2024

Instrument Model: UV Mono Path 1 Instrument Serial Number: _____

Instrument Parameters	
Optical Path Length (meters)	452 m/ 0.047m
Maximum Intensity (%)	95
Integration Time (ms)	54

Standard Information	
Benzene Standard Concentration (PPM)	200

File #	**Benzene Concentration (PPM)**	**Measured Concentration (PPM)**	**Error (%)**
1	200	187	6.5
2	200	190	5
3	200	192	4
4	200	192	4
5	200	190	5
Averages	200	190	4.9

Montrose Air Quality Services
5120 Northshore Dr. North Little Rock, AR 72218
T: (501-)900-6400
www.montrose-env.com

Form Title: UVDOAS Calibration Form	**Implementation Date:** July 10, 2024
Document Number: 331AA-OPS-FM-13	**Form Owner (Department):** MAQS
Revision Number: Rev. 0	**Form Approval:** Katia Liangou

	Calculated Values	**Expected Values**
Overall Percent Precision	99	**≥ 75%**
Overall Percent Error	4.9	**≤ 30%**

Notes:
Calibration verification passed.

Operator's Signature Katia Liangou

Witness's Signature James Garrett

UVDOAS Calibration Form

Form Title: UVDOAS Calibration Form	**Implementation Date:** July 10, 2024
Document Number: 331AA-OPS-FM-13	**Form Owner (Department):** MAQS
Revision Number: Rev. 0	**Form Approval:** Katia Liangou

Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/19/2024

Instrument Model: UV Mono Path 2 Instrument Serial Number: _____

Instrument Parameters	
Optical Path Length (meters)	1100 m/ 0.047m
Maximum Intensity (%)	82
Integration Time (ms)	34

Standard Information	
Benzene Standard Concentration (PPM)	100

File #	**Benzene Concentration (PPM)**	**Measured Concentration (PPM)**	**Error (%)**
1	100	95	5
2	100	108	8
3	100	107	7
4	100	105	5
5	100	97	3
Averages	100	102	5.6

Form Title: UVDOAS Calibration Form	**Implementation Date:** July 10, 2024
Document Number: 331AA-OPS-FM-13	**Form Owner (Department):** MAQS
Revision Number: Rev. 0	**Form Approval:** Katia Liangou

	Calculated Values	**Expected Values**
Overall Percent Precision	94.0	**≥ 75%**
Overall Percent Error	5.6	**≤ 30%**

Notes:
Calibration verification passed.

Operator's Signature Katia Liangou

Witness's Signature James Garrett

UVDOAS Calibration Form

Form Title: UVDOAS Calibration Form	**Implementation Date:** July 10, 2024
Document Number: 331AA-OPS-FM-13	**Form Owner (Department):** MAQS
Revision Number: Rev. 0	**Form Approval:** Katia Liangou

Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/19/2024

Instrument Model: UV Mono Path 2 Instrument Serial Number: _____

Instrument Parameters	
Optical Path Length (meters)	1100 m/ 0.047m
Maximum Intensity (%)	82
Integration Time (ms)	34

Standard Information	
Benzene Standard Concentration (PPM)	200

File #	Benzene Concentration (PPM)	Measured Concentration (PPM)	Error (%)
1	200	158	21
2	200	213	6.5
3	200	172	14
4	200	162	19
5	200	167	16.5
Averages	200	179	15.4

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UVDOAS Calibration Form

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Document Number: 331AA-OPS-FM-13	**Form Owner (Department):** MAQS
Revision Number: Rev. 0	**Form Approval:** Katia Liangou

	Calculated Values	**Expected Values**
Overall Percent Precision	88.9	**≥ 75%**
Overall Percent Error	15.4	**≤ 30%**

Notes:
Calibration verification passed.

Operator's Signature Katia Liangou

Witness's Signature James Garrett

Montrose Air Quality Services
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UVDOAS Calibration Form

Form Title: UVDOAS Calibration Form	**Implementation Date:** July 10, 2024
Document Number: 331AA-OPS-FM-13	**Form Owner (Department):** MAQS
Revision Number: Rev. 0	**Form Approval:** Katia Liangou

Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/19/2024

Instrument Model: UV Mono Path 3 Instrument Serial Number: _____

Instrument Parameters	
Optical Path Length (meters)	330 m/ 0.047m
Maximum Intensity (%)	80
Integration Time (ms)	69

Standard Information	
Benzene Standard Concentration (PPM)	100

File #	**Benzene Concentration (PPM)**	**Measured Concentration (PPM)**	**Error (%)**
1	100	103	3
2	100	95	5
3	100	106	6
4	100	102	2
5	100	106	6
Averages	100	99	4.4

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Document Number: 331AA-OPS-FM-13	**Form Owner (Department):** MAQS
Revision Number: Rev. 0	**Form Approval:** Katia Liangou

	Calculated Values	**Expected Values**
Overall Percent Precision	95.5	**≥ 75%**
Overall Percent Error	4.4	**≤ 30%**

Notes:
Calibration verification passed.

Operator's Signature Katia Liangou

Witness's Signature James Garrett

UVDOAS Calibration Form

Form Title: UVDOAS Calibration Form	**Implementation Date:** July 10, 2024
Document Number: 331AA-OPS-FM-13	**Form Owner (Department):** MAQS
Revision Number: Rev. 0	**Form Approval:** Katia Liangou

Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/19/2024

Instrument Model: UV Mono Path 3 Instrument Serial Number: _____

Instrument Parameters	
Optical Path Length (meters)	330 m/ 0.047m
Maximum Intensity (%)	80
Integration Time (ms)	69

Standard Information	
Benzene Standard Concentration (PPM)	200

File #	**Benzene Concentration (PPM)**	**Measured Concentration (PPM)**	**Error (%)**
1	200	184	8
2	200	191	4.5
3	200	190	5
4	200	192	4
5	200	189	5.5
Averages	200	189	5.4

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UVDOAS Calibration Form

Form Title: UVDOAS Calibration Form	**Implementation Date:** July 10, 2024
Document Number: 331AA-OPS-FM-13	**Form Owner (Department):** MAQS
Revision Number: Rev. 0	**Form Approval:** Katia Liangou

	Calculated Values	**Expected Values**
Overall Percent Precision	98.4	**≥ 75%**
Overall Percent Error	5.4	**≤ 30%**

Notes:
Calibration verification passed.

Operator's Signature Katia Liangou

Witness's Signature James Garrett

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UVDOAS Calibration Form

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Document Number: 331AA-OPS-FM-13	**Form Owner (Department):** MAQS
Revision Number: Rev. 0	**Form Approval:** Katia Liangou

Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/19/2024

Instrument Model: UV Mono Path 4 Instrument Serial Number: _____

Instrument Parameters	
Optical Path Length (meters)	630 m/ 0.047m
Maximum Intensity (%)	85
Integration Time (ms)	71

Standard Information	
Benzene Standard Concentration (PPM)	100

File #	**Benzene Concentration (PPM)**	**Measured Concentration (PPM)**	**Error (%)**
1	100	102	2
2	100	103	3
3	100	92	8
4	100	103	3
5	100	88	12
Averages	100	98	5.6

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Document Number: 331AA-OPS-FM-13	**Form Owner (Department):** MAQS
Revision Number: Rev. 0	**Form Approval:** Katia Liangou

	Calculated Values	**Expected Values**
Overall Percent Precision	92.9	**≥ 75%**
Overall Percent Error	5.6	**≤ 30%**

Notes:
Calibration verification passed.

Operator's Signature Katia Liangou

Witness's Signature James Garrett

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Revision Number: Rev. 0	**Form Approval:** Katia Liangou

Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/19/2024

Instrument Model: UV Mono Path 4 Instrument Serial Number: _____

Instrument Parameters	
Optical Path Length (meters)	630 m/ 0.047m
Maximum Intensity (%)	85
Integration Time (ms)	71

Standard Information	
Benzene Standard Concentration (PPM)	200

File #	**Benzene Concentration (PPM)**	**Measured Concentration (PPM)**	**Error (%)**
1	200	184	8
2	200	200	0
3	200	149	25.5
4	200	144	28
5	200	157	21.5
Averages	200	167	16.6

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UVDOAS Calibration Form

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Document Number: 331AA-OPS-FM-13	**Form Owner (Department):** MAQS
Revision Number: Rev. 0	**Form Approval:** Katia Liangou

	Calculated Values	**Expected Values**
Overall Percent Precision	87.9	**≥ 75%**
Overall Percent Error	16.6	**≤ 30%**

Notes:
Calibration verification passed.

Operator's Signature Katia Liangou

Witness's Signature James Garrett

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Revision Number: Rev. 0	**Form Approval:** Katia Liangou

Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/19/2024

Instrument Model: UV Mono Path 5 Instrument Serial Number: _____

Instrument Parameters	
Optical Path Length (meters)	444 m/ 0.047m
Maximum Intensity (%)	96
Integration Time (ms)	51

Standard Information	
Benzene Standard Concentration (PPM)	100

File #	**Benzene Concentration (PPM)**	**Measured Concentration (PPM)**	**Error (%)**
1	100	99	1
2	100	101	1
3	100	103	3
4	100	109	9
5	100	108	8
Averages	100	104	4.4

UVDOAS Calibration Form

Form Title: UVDOAS Calibration Form	**Implementation Date:** July 10, 2024
Document Number: 331AA-OPS-FM-13	**Form Owner (Department):** MAQS
Revision Number: Rev. 0	**Form Approval:** Katia Liangou

	Calculated Values	**Expected Values**
Overall Percent Precision	95.6	**≥ 75%**
Overall Percent Error	4.4	**≤ 30%**

Notes:
Calibration verification passed.

Operator's Signature Katia Liangou

Witness's Signature James Garrett

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UVDOAS Calibration Form

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Revision Number: Rev. 0	**Form Approval:** Katia Liangou

Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/19/2024

Instrument Model: UV Mono Path 5 Instrument Serial Number: _____

Instrument Parameters	
Optical Path Length (meters)	444 m/ 0.047m
Maximum Intensity (%)	96
Integration Time (ms)	51

Standard Information	
Benzene Standard Concentration (PPM)	200

File #	**Benzene Concentration (PPM)**	**Measured Concentration (PPM)**	**Error (%)**
1	200	203	1.5
2	200	209	4.5
3	200	208	4
4	200	215	7.5
5	200	205	2.5
Averages	200	208	4

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Revision Number: Rev. 0	**Form Approval:** Katia Liangou

	Calculated Values	**Expected Values**
Overall Percent Precision	97.7	**≥ 75%**
Overall Percent Error	4	**≤ 30%**

Notes:
Calibration verification passed.

Operator's Signature Katia Liangou

Witness's Signature James Garrett

UVDOAS Calibration Form

Form Title: UVDOAS Calibration Form	**Implementation Date:** July 10, 2024
Document Number: 331AA-OPS-FM-13	**Form Owner (Department):** MAQS
Revision Number: Rev. 0	**Form Approval:** Katia Liangou

Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/19/2024

Instrument Model: UV Mono Path 6 Instrument Serial Number: _____

Instrument Parameters	
Optical Path Length (meters)	276 m/ 0.047m
Maximum Intensity (%)	78
Integration Time (ms)	64

Standard Information	
Benzene Standard Concentration (PPM)	100

File #	**Benzene Concentration (PPM)**	**Measured Concentration (PPM)**	**Error (%)**
1	100	91	9
2	100	95	5
3	100	92	8
4	100	103	3
5	100	97	3
Averages	100	96	5.6

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Form Title: UVDOAS Calibration Form	**Implementation Date:** July 10, 2024
Document Number: 331AA-OPS-FM-13	**Form Owner (Department):** MAQS
Revision Number: Rev. 0	**Form Approval:** Katia Liangou

	Calculated Values	**Expected Values**
Overall Percent Precision	95.2	**≥ 75%**
Overall Percent Error	5.6	**≤ 30%**

Notes:
Calibration verification passed.

Operator's Signature Katia Liangou

Witness's Signature James Garrett

UVDOAS Calibration Form

Form Title: UVDOAS Calibration Form	**Implementation Date:** July 10, 2024
Document Number: 331AA-OPS-FM-13	**Form Owner (Department):** MAQS
Revision Number: Rev. 0	**Form Approval:** Katia Liangou

Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/19/2024

Instrument Model: UV Mono Path 6 Instrument Serial Number: _____

Instrument Parameters	
Optical Path Length (meters)	276 m/ 0.047m
Maximum Intensity (%)	78
Integration Time (ms)	64

Standard Information	
Benzene Standard Concentration (PPM)	200

File #	**Benzene Concentration (PPM)**	**Measured Concentration (PPM)**	**Error (%)**
1	200	197	1.5
2	200	209	4.5
3	200	199	0.5
4	200	192	4
5	200	191	4.5
Averages	200	198	3

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Form Title: UVDOAS Calibration Form	**Implementation Date:** July 10, 2024
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Revision Number: Rev. 0	**Form Approval:** Katia Liangou

	Calculated Values	**Expected Values**
Overall Percent Precision	96.4	**≥ 75%**
Overall Percent Error	3	**≤ 30%**

Notes:
Calibration verification passed.

Operator's Signature Katia Liangou

Witness's Signature James Garrett

TDL Calibration Form

Form Title: TDL Calibration Form	**Implementation Date:** August 8, 2024
Document Number: 331AA-OPS-FM-15	**Form Owner (Department):** MAQS
Revision Number: Rev. 1	**Form Approval:** Katia Liangou

Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/30/24

Instrument Model: H2S Path 1 Instrument Serial Number: _____

Instrument Parameters	
Optical Path separation(meters-one-way)	226 m
Compound (H2S/HCN)	H2S

Standard Information	
Compound External Audit Cell Concentration (PPMM)	500 PPMM

File #	**Compound Concentration (PPMM)**	**Measured Concentration (PPMM)**	**Error (% Reading)**
1	500	492	1.6
2	500	472	5.6
3	500	464	7.2
4	500	422	15.6
5	500	502	0.4
Averages	500	470	6.1

	Calculated Values	**Expected Values**
Overall Percent Precision	93.8%	**≥ 80%**
Overall Percent Error	6.1 %	**≤ 30%**

TDL Calibration Form

Form Title: TDL Calibration Form	**Implementation Date:** August 8, 2024
Document Number: 331AA-OPS-FM-15	**Form Owner (Department):** MAQS
Revision Number: Rev. 1	**Form Approval:** Katia Liangou

Notes:
Calibration verification passed.

Operator Signature(s):  Witness Signature(s): James Garrett

TDL Calibration Form

Form Title: TDL Calibration Form	**Implementation Date:** August 8, 2024
Document Number: 331AA-OPS-FM-15	**Form Owner (Department):** MAQS
Revision Number: Rev. 1	**Form Approval:** Katia Liangou

Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/30/24

Instrument Model: H2S Path 1 Instrument Serial Number: _____

Instrument Parameters	
Optical Path separation(meters-one-way)	226 m
Compound (H2S/HCN)	H2S

Standard Information	
Compound External Audit Cell Concentration (PPMM)	625 PPMM

File #	Compound Concentration (PPMM)	Measured Concentration (PPMM)	Error (% Reading)
1	625	584	6.5
2	625	598	4.3
3	625	598	4.3
4	625	560	10.4
5	625	588	5.9
Averages	625	586	6.3

	Calculated Values	Expected Values
Overall Percent Precision	97.5%	**≥ 80%**
Overall Percent Error	6.3 %	**≤ 30%**

TDL Calibration Form

Form Title: TDL Calibration Form	**Implementation Date:** August 8, 2024
Document Number: 331AA-OPS-FM-15	**Form Owner (Department):** MAQS
Revision Number: Rev. 1	**Form Approval:** Katia Liangou

Notes:
Calibration verification passed.

Operator Signature(s):  Witness Signature(s): James Garrett

TDL Calibration Form

Form Title: TDL Calibration Form	**Implementation Date:** August 8, 2024
Document Number: 331AA-OPS-FM-15	**Form Owner (Department):** MAQS
Revision Number: Rev. 1	**Form Approval:** Katia Liangou

Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/30/24

Instrument Model: H2S Path 2 Instrument Serial Number: _____

Instrument Parameters	
Optical Path separation(meters-one-way)	550 m
Compound (H2S/HCN)	H2S

Standard Information	
Compound External Audit Cell Concentration (PPMM)	500 PPMM

File #	Compound Concentration (PPMM)	Measured Concentration (PPMM)	Error (% Reading)
1	500	472	5.6
2	500	470	6
3	500	462	7.6
4	500	472	5.6
5	500	458	8.4
Averages	500	467	6.6

	Calculated Values	Expected Values
Overall Percent Precision	98.7%	**≥ 80%**
Overall Percent Error	6.6 %	**≤ 30%**

TDL Calibration Form

Form Title: TDL Calibration Form	**Implementation Date:** August 8, 2024
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Revision Number: Rev. 1	**Form Approval:** Katia Liangou

Notes:
Calibration verification passed.

Operator Signature(s):  Witness Signature(s): James Garrett

TDL Calibration Form

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Revision Number: Rev. 1	**Form Approval:** Katia Liangou

Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/30/24

Instrument Model: H2S Path 2 Instrument Serial Number: _____

Instrument Parameters	
Optical Path separation(meters-one-way)	550 m
Compound (H2S/HCN)	H2S

Standard Information	
Compound External Audit Cell Concentration (PPMM)	625 PPMM

File #	Compound Concentration (PPMM)	Measured Concentration (PPMM)	Error (% Reading)
1	625	696	11.3
2	625	666	6.5
3	625	678	8.5
4	625	666	6.6
5	625	670	7.2
Averages	625	675	8.0

	Calculated Values	Expected Values
Overall Percent Precision	97.9%	**≥ 80%**
Overall Percent Error	8.0 %	**≤ 30%**

TDL Calibration Form

Form Title: TDL Calibration Form	**Implementation Date:** August 8, 2024
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Notes:
Calibration verification passed.

Operator Signature(s):  Witness Signature(s): James Garrett

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Revision Number: Rev. 1	**Form Approval:** Katia Liangou

Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/30/24

Instrument Model: H2S Path 3 Instrument Serial Number: _____

Instrument Parameters	
Optical Path separation(meters-one-way)	165 m
Compound (H2S/HCN)	H2S

Standard Information	
Compound External Audit Cell Concentration (PPMM)	500 PPMM

File #	**Compound Concentration (PPMM)**	**Measured Concentration (PPMM)**	**Error (% Reading)**
1	500	448	10.4
2	500	440	12
3	500	422	15.6
4	500	432	13.6
5	500	452	9.6
Averages	500	439	12.2

	Calculated Values	**Expected Values**
Overall Percent Precision	97.6%	**≥ 80%**
Overall Percent Error	12.2 %	**≤ 30%**

TDL Calibration Form

Form Title: TDL Calibration Form	**Implementation Date:** August 8, 2024
Document Number: 331AA-OPS-FM-15	**Form Owner (Department):** MAQS
Revision Number: Rev. 1	**Form Approval:** Katia Liangou

Notes:
Calibration verification passed.

Operator Signature(s): 

Witness Signature(s): James Garrett

TDL Calibration Form

Form Title: TDL Calibration Form	**Implementation Date:** August 8, 2024
Document Number: 331AA-OPS-FM-15	**Form Owner (Department):** MAQS
Revision Number: Rev. 1	**Form Approval:** Katia Liangou

Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/30/24

Instrument Model: H2S Path 3 Instrument Serial Number: _____

Instrument Parameters	
Optical Path separation(meters-one-way)	165 m
Compound (H2S/HCN)	H2S

Standard Information	
Compound External Audit Cell Concentration (PPMM)	625 PPMM

File #	Compound Concentration (PPMM)	Measured Concentration (PPMM)	Error (% Reading)
1	625	552	11.7
2	625	576	7.8
3	625	566	9.4
4	625	568	9.1
5	625	578	7.5
Averages	625	568	9.1

	Calculated Values	Expected Values
Overall Percent Precision	98.4%	**≥ 80%**
Overall Percent Error	9.1%	**≤ 30%**

TDL Calibration Form

Form Title: TDL Calibration Form	**Implementation Date:** August 8, 2024
Document Number: 331AA-OPS-FM-15	**Form Owner (Department):** MAQS
Revision Number: Rev. 1	**Form Approval:** Katia Liangou

Notes:
Calibration verification passed.

Operator Signature(s):  Witness Signature(s): James Garrett

TDL Calibration Form

Form Title: TDL Calibration Form	**Implementation Date:** August 8, 2024
Document Number: 331AA-OPS-FM-15	**Form Owner (Department):** MAQS
Revision Number: Rev. 1	**Form Approval:** Katia Liangou

Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/30/24

Instrument Model: H2S Path 4 Instrument Serial Number: _____

Instrument Parameters	
Optical Path separation(meters-one-way)	315 m
Compound (H2S/HCN)	H2S

Standard Information	
Compound External Audit Cell Concentration (PPMM)	500 PPMM

File #	**Compound Concentration (PPMM)**	**Measured Concentration (PPMM)**	**Error (% Reading)**
1	500	440	12
2	500	430	12.8
3	500	450	10
4	500	444	11.2
5	500	432	13.6
Averages	500	440	11.9

	Calculated Values	**Expected Values**
Overall Percent Precision	98.4%	**≥ 80%**
Overall Percent Error	11.9%	**≤ 30%**

TDL Calibration Form

Form Title: TDL Calibration Form	**Implementation Date:** August 8, 2024
Document Number: 331AA-OPS-FM-15	**Form Owner (Department):** MAQS
Revision Number: Rev. 1	**Form Approval:** Katia Liangou

Notes:
Calibration verification passed.

Operator Signature(s):  Witness Signature(s): James Garrett

TDL Calibration Form

Form Title: TDL Calibration Form	**Implementation Date:** August 8, 2024
Document Number: 331AA-OPS-FM-15	**Form Owner (Department):** MAQS
Revision Number: Rev. 1	**Form Approval:** Katia Liangou

Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/30/24

Instrument Model: H2S Path 4 Instrument Serial Number: _____

Instrument Parameters	
Optical Path separation(meters-one-way)	315 m
Compound (H2S/HCN)	H2S

Standard Information	
Compound External Audit Cell Concentration (PPMM)	625 PPMM

File #	**Compound Concentration (PPMM)**	**Measured Concentration (PPMM)**	**Error (% Reading)**
1	625	592	5.3
2	625	542	13.3
3	625	576	7.8
4	625	584	6.6
5	625	578	7.5
Averages	625	574	8.1

	Calculated Values	**Expected Values**
Overall Percent Precision	96.9%	**≥ 80%**
Overall Percent Error	8.1%	**≤ 30%**

TDL Calibration Form

Form Title: TDL Calibration Form	**Implementation Date:** August 8, 2024
Document Number: 331AA-OPS-FM-15	**Form Owner (Department):** MAQS
Revision Number: Rev. 1	**Form Approval:** Katia Liangou

Notes:
Calibration verification passed.

Operator Signature(s):  Witness Signature(s): James Garrett

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TDL Calibration Form

Form Title: TDL Calibration Form	**Implementation Date:** August 8, 2024
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Revision Number: Rev. 1	**Form Approval:** Katia Liangou

Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/30/24

Instrument Model: H2S Path 5 Instrument Serial Number: _____

Instrument Parameters	
Optical Path separation(meters-one-way)	222 m
Compound (H2S/HCN)	H2S

Standard Information	
Compound External Audit Cell Concentration (PPMM)	500 PPMM

File #	Compound Concentration (PPMM)	Measured Concentration (PPMM)	Error (% Reading)
1	500	438	12.4
2	500	426	14.8
3	500	450	10
4	500	448	10.4
5	500	460	8
Averages	500	444	11.1

	Calculated Values	Expected Values
Overall Percent Precision	97.4%	**≥ 80%**
Overall Percent Error	11.1%	**≤ 30%**

TDL Calibration Form

Form Title: TDL Calibration Form	**Implementation Date:** August 8, 2024
Document Number: 331AA-OPS-FM-15	**Form Owner (Department):** MAQS
Revision Number: Rev. 1	**Form Approval:** Katia Liangou

Notes:
Calibration verification passed.

Operator Signature(s): 

Witness Signature(s): James Garrett

TDL Calibration Form

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Document Number: 331AA-OPS-FM-15	**Form Owner (Department):** MAQS
Revision Number: Rev. 1	**Form Approval:** Katia Liangou

Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/30/24

Instrument Model: H2S Path 5 Instrument Serial Number: _____

Instrument Parameters	
Optical Path separation(meters-one-way)	222 m
Compound (H2S/HCN)	H2S

Standard Information	
Compound External Audit Cell Concentration (PPMM)	625 PPMM

File #	**Compound Concentration (PPMM)**	**Measured Concentration (PPMM)**	**Error (% Reading)**
1	625	580	7.2
2	625	574	8.2
3	625	600	4
4	625	570	8.8
5	625	598	4.3
Averages	625	584	6.5

	Calculated Values	**Expected Values**
Overall Percent Precision	97.8%	**≥ 80%**
Overall Percent Error	6.5%	**≤ 30%**

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Notes:
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Operator Signature(s):  Witness Signature(s): James Garrett

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Revision Number: Rev. 1	**Form Approval:** Katia Liangou

Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/19/24

Instrument Model: H2S Path 6 Instrument Serial Number: _____

Instrument Parameters	
Optical Path separation(meters-one-way)	138 m
Compound (H2S/HCN)	H2S

Standard Information	
Compound External Audit Cell Concentration (PPMM)	500 PPMM

File #	Compound Concentration (PPMM)	Measured Concentration (PPMM)	Error (% Reading)
1	500	450	10
2	500	444	11.2
3	500	430	14
4	500	442	11.6
5	500	418	16.4
Averages	500	437	12.6

	Calculated Values	Expected Values
Overall Percent Precision	97.4%	**≥ 80%**
Overall Percent Error	12.6%	**≤ 30%**

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Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/30/24

Instrument Model: H2S Path 6 Instrument Serial Number: _____

Instrument Parameters	
Optical Path separation(meters-one-way)	138 m
Compound (H2S/HCN)	H2S

Standard Information	
Compound External Audit Cell Concentration (PPMM)	625 PPMM

File #	Compound Concentration (PPMM)	Measured Concentration (PPMM)	Error (% Reading)
1	625	590	5.6
2	625	626	0.2
3	625	598	4.3
4	625	620	0.8
5	625	604	3.4
Averages	625	608	2.8

	Calculated Values	Expected Values
Overall Percent Precision	97.6%	**≥ 80%**
Overall Percent Error	2.8%	**≤ 30%**

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Witness Signature(s): James Garrett

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Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/19/24

Instrument Model: HCN Path 1 Instrument Serial Number: _____

Instrument Parameters	
Optical Path separation(meters-one-way)	226 m
Compound (H2S/HCN)	HCN

Standard Information	
Compound External Audit Cell Concentration (PPMM)	420 PPMM

File #	Compound Concentration (PPMM)	Measured Concentration (PPMM)	Error (% Reading)
1	420	470	11.9
2	420	462	10
3	420	464	10.5
4	420	466	11
5	420	464	10.5
Averages	420	465	10.8

	Calculated Values	Expected Values
Overall Percent Precision	99.3%	**≥ 80%**
Overall Percent Error	10.8 %	**≤ 30%**

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Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/19/24

Instrument Model: HCN Path 1 Instrument Serial Number: _____

Instrument Parameters	
Optical Path separation(meters-one-way)	226 m
Compound (H2S/HCN)	HCN

Standard Information	
Compound External Audit Cell Concentration (PPMM)	1010 PPMM

File #	**Compound Concentration (PPMM)**	**Measured Concentration (PPMM)**	**Error (% Reading)**
1	1010	984	2.6
2	1010	984	2.6
3	1010	984	2.6
4	1010	984	2.6
5	1010	984	2.6
Averages	1010	984	2.6

	Calculated Values	**Expected Values**
Overall Percent Precision	100%	**≥ 80%**
Overall Percent Error	2.6 %	**≤ 30%**

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Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/19/24

Instrument Model: HCN Path 2 Instrument Serial Number: _____

Instrument Parameters	
Optical Path separation(meters-one-way)	550 m
Compound (H2S/HCN)	HCN

Standard Information	
Compound External Audit Cell Concentration (PPMM)	420 PPMM

File #	**Compound Concentration (PPMM)**	**Measured Concentration (PPMM)**	**Error (% Reading)**
1	420	448	6.7
2	420	448	6.7
3	420	446	6.2
4	420	448	6.7
5	420	448	6.7
Averages	420	448	6.6

	Calculated Values	**Expected Values**
Overall Percent Precision	99.8%	**≥ 80%**
Overall Percent Error	6.6%	**≤ 30%**

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Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/19/24

Instrument Model: HCN Path 2 Instrument Serial Number: _____

Instrument Parameters	
Optical Path separation(meters-one-way)	550 m
Compound (H2S/HCN)	HCN

Standard Information	
Compound External Audit Cell Concentration (PPMM)	1010 PPMM

File #	**Compound Concentration (PPMM)**	**Measured Concentration (PPMM)**	**Error (% Reading)**
1	1010	956	5.3
2	1010	954	5.5
3	1010	960	5
4	1010	960	5
5	1010	960	5
Averages	1010	958	5.1

	Calculated Values	**Expected Values**
Overall Percent Precision	99.7%	**≥ 80%**
Overall Percent Error	5.1%	**≤ 30%**

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Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/19/24

Instrument Model: HCN Path 3 Instrument Serial Number: _____

Instrument Parameters	
Optical Path separation(meters-one-way)	165 m
Compound (H2S/HCN)	HCN

Standard Information	
Compound External Audit Cell Concentration (PPMM)	420 PPMM

File #	**Compound Concentration (PPMM)**	**Measured Concentration (PPMM)**	**Error (% Reading)**
1	420	456	8.6
2	420	458	9
3	420	458	9
4	420	456	8.6
5	420	458	9
Averages	420	457	8.9

	Calculated Values	**Expected Values**
Overall Percent Precision	99.7%	**≥ 80%**
Overall Percent Error	8.9%	**≤ 30%**

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Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/19/24

Instrument Model: HCN Path 3 Instrument Serial Number: _____

Instrument Parameters	
Optical Path separation(meters-one-way)	165 m
Compound (H2S/HCN)	HCN

Standard Information	
Compound External Audit Cell Concentration (PPMM)	1010 PPMM

File #	Compound Concentration (PPMM)	Measured Concentration (PPMM)	Error (% Reading)
1	1010	972	3.8
2	1010	970	4
3	1010	970	4
4	1010	970	4
5	1010	970	4
Averages	1010	970	3.9

	Calculated Values	Expected Values
Overall Percent Precision	99.9%	**≥ 80%**
Overall Percent Error	3.9%	**≤ 30%**

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Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/30/24

Instrument Model: HCN Path 4 Instrument Serial Number: _____

Instrument Parameters	
Optical Path separation(meters-one-way)	315 m
Compound (H2S/HCN)	HCN

Standard Information	
Compound External Audit Cell Concentration (PPMM)	420 PPMM

File #	**Compound Concentration (PPMM)**	**Measured Concentration (PPMM)**	**Error (% Reading)**
1	420	438	4.3
2	420	430	3.8
3	420	436	3.8
4	420	438	4.3
5	420	436	3.8
Averages	420	437	4

	Calculated Values	**Expected Values**
Overall Percent Precision	99.7%	**≥ 80%**
Overall Percent Error	4%	**≤ 30%**

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Operator Signature(s):  Witness Signature(s): James Garrett

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Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/30/24

Instrument Model: HCN Path 4 Instrument Serial Number: _____

Instrument Parameters	
Optical Path separation(meters-one-way)	315 m
Compound (H2S/HCN)	HCN

Standard Information	
Compound External Audit Cell Concentration (PPMM)	1010 PPMM

File #	**Compound Concentration (PPMM)**	**Measured Concentration (PPMM)**	**Error (% Reading)**
1	1010	950	5.9
2	1010	952	5.7
3	1010	952	5.7
4	1010	950	5.9
5	1010	950	5.9
Averages	1010	951	5.9

	Calculated Values	**Expected Values**
Overall Percent Precision	99.9%	**≥ 80%**
Overall Percent Error	5.9%	**≤ 30%**

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Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/30/24

Instrument Model: HCN Path 5 Instrument Serial Number: _____

Instrument Parameters	
Optical Path separation(meters-one-way)	222 m
Compound (H2S/HCN)	HCN

Standard Information	
Compound External Audit Cell Concentration (PPMM)	420 PPMM

File #	**Compound Concentration (PPMM)**	**Measured Concentration (PPMM)**	**Error (% Reading)**
1	420	448	6.7
2	420	460	9.5
3	420	456	8.6
4	420	456	8.6
5	420	466	11
Averages	420	457	8.9

	Calculated Values	**Expected Values**
Overall Percent Precision	98.4%	**≥ 80%**
Overall Percent Error	8.9%	**≤ 30%**

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Operator Signature(s): 

Witness Signature(s): James Garrett

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Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/30/24

Instrument Model: HCN Path 5 Instrument Serial Number: _____

Instrument Parameters	
Optical Path separation(meters-one-way)	222 m
Compound (H2S/HCN)	HCN

Standard Information	
Compound External Audit Cell Concentration (PPMM)	1010 PPMM

File #	Compound Concentration (PPMM)	Measured Concentration (PPMM)	Error (% Reading)
1	1010	940	6.9
2	1010	990	2
3	1010	990	2
4	1010	990	2
5	1010	990	2
Averages	1010	980	3

	Calculated Values	Expected Values
Overall Percent Precision	97.8%	**≥ 80%**
Overall Percent Error	3%	**≤ 30%**

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Operator Signature(s):  Witness Signature(s): 

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Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/19/24

Instrument Model: HCN Path 6 Instrument Serial Number: _____

Instrument Parameters	
Optical Path separation(meters-one-way)	138 m
Compound (H2S/HCN)	HCN

Standard Information	
Compound External Audit Cell Concentration (PPMM)	420 PPMM

File #	**Compound Concentration (PPMM)**	**Measured Concentration (PPMM)**	**Error (% Reading)**
1	420	456	8.6
2	420	456	8.6
3	420	454	8.1
4	420	456	8.6
5	420	454	8.1
Averages	420	455	8.4

	Calculated Values	**Expected Values**
Overall Percent Precision	99.7%	**≥ 80%**
Overall Percent Error	8.4%	**≤ 30%**

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Operator Name(s): Katia Liangou Test Date (YYYY/MM/DD): 9/19/24

Instrument Model: HCN Path 6 Instrument Serial Number: _____

Instrument Parameters	
Optical Path separation(meters-one-way)	138 m
Compound (H2S/HCN)	HCN

Standard Information	
Compound External Audit Cell Concentration (PPMM)	1010 PPMM

File #	Compound Concentration (PPMM)	Measured Concentration (PPMM)	Error (% Reading)
1	1010	972	3.8
2	1010	972	3.8
3	1010	970	4
4	1010	972	3.8
5	1010	970	4
Averages	1010	971	3.8

	Calculated Values	Expected Values
Overall Percent Precision	99.9%	**≥ 80%**
Overall Percent Error	3.8%	**≤ 30%**

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