Quality Assurance Project Plan for the

Chevron Richmond Refinery Fenceline Air Monitoring Program

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Revision 3

Approvals

Quality Assurance Project Plan
Fenceline Monitoring for the Chevron Refinery in Richmond, California

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1 Introduction

1.1 Background

On April 20, 2016, the Bay Area Air Quality Management District (BAAQMD) adopted Rule 12-15-403, which requires development of a Fenceline Air Monitoring Plan (Plan). The Plan must include procedures for implementing data quality assurance and quality control (QA/QC). The purpose of this QAPP is to fulfill the QA/QC requirements in Rule 12-15-403. In April 2016, the BAAQMD also published Air Monitoring Guidelines for Petroleum Refineries. Chevron's policy is to comply with all local and federal environmental regulations including the fenceline monitoring provisions of BAAQMD Rule 12-15.

This QAPP focuses on quality assurance of equipment that will become subject to Rule 12-15 that are not already subject to quality assurance measures by another regulatory program. Sorbent tube analysis for benzene and GLMs are mentioned for informational purposes, but QA/QC of this equipment is considered outside the scope of this QAPP. Sorbent tube analyses are subject to QA/QC requirements in 40 CFR 63 Appendix A Methods 325A and 325B. GLMs are subject to QA/QC requirements in BAAQMD Manual of Procedures Volume VI.

1.2 Fenceline Monitor Geographical Locations and Coverage Paths

The Chevron Richmond Refinery Fenceline Air Monitoring Program consists of six field equipment installation platforms as detailed in **Table 1.1** below.

Table 1-1. Fenceline Monitor Geographical Locations and Coverage Paths

Endpoint	Coordinate (Decimal Degrees)	UV-DOAS and open-path H_2S, once approved	FTIR
North end of North Richmond fenceline monitor	[redacted]	Path D, 694 m	Path D, 694 m
South end of North Richmond fenceline monitor	[redacted]		
North end of Atchison fenceline monitor	[redacted]	Path E, 793 m	Path E1, 420 m
Middle of Atchison Fenceline Monitor	[redacted]		
South end of Atchison fenceline monitor	[redacted]		Path E2, 380 m
North end of Point Richmond fenceline monitor	[redacted]	Path F, 897 m	Path F1, 497 m
Middle of Point Richmond fenceline Monitor	[redacted]		
South end of Point Richmond fenceline monitor	[redacted]		Path F2, 401 m

1.3 Fenceline Monitoring Key Personnel

The Chevron Richmond Refinery Fenceline Air Monitoring Program (Program) is operated by the following key personnel.

Program Manager – The Program Manager (PM) is responsible for maintaining and updating the Fenceline Air Monitoring Program and associated Quality Assurance Project Plan (QAPP). The Program Manager acts as the central point of contact with the BAAQMD. The PM provides an initial copy of the Plans and updates to key personnel. The Program Manager finds additional resources needed to support the fenceline air monitoring program when needed. Since the field work, the website, and the project quality assurance are operated by contractors, the Program Manager supports the contractors.

Data Manager – The Data Manager is responsible for data review, verification, and validation. The Data Manager is responsible for ensuring the quality of the data collected in this program. The Data Manager oversees data collection and review, provides QA oversight, and reports on QA activities to the Refinery PM. The Data Manager oversees daily data review and data management, works with the Field Technician Supervisor to ensure that any data issues are addressed promptly by the Field Technicians, and works with the Information Technology Manager to ensure that data provided to the public are credible and meet the requirements of Rule 12-15.

Daily data review and data validation are conducted by experienced air quality analysts. The Data Reviewers communicate with the Data Manager when there are issues and may also interact with the Field Technicians when they notice an issue that needs to be addressed.

Field Technician – The Field Technician is responsible for the day-to-day operation of the fenceline monitoring system, including following an equipment operation verification and maintenance schedule to assure data quality. Duties include performing work in a safe manner, completing training in a timely manner, and following all standard operating procedures associated with the Program.

Field Technician Supervisor – The Field Technician Supervisor is responsible for overseeing the day-to-day operation of the Program. The Supervisor ensures Standard Operating Procedures are updated, are maintained, and meet regulatory requirements. The Field Technician Supervisor coordinates staff coverage and serves as a technical resource for site measurements.

Information Technology Manager – The Information Technology Manager supports the website and information technology infrastructure that enables the fenceline monitoring data to be made available real time to the public. The Information Technology Manager also supports the system that sends alerts when monitor operating parameters are abnormal.

1.4 Personnel Qualification and Training

Field Technicians and the Field Technician Supervisor will be trained in the operation, maintenance, and operation verification of the equipment and will have resources to troubleshoot any technical issues. Training will be provided by an instructor who has undergone vendor-specific training for each analyzer. It is expected that once the Field Technicians and Field Technician Supervisor gain about three years of experience with the analyzers, they will have developed expertise so that they can become trainers of new Field Technicians.

1.5 Equipment Functionality

The following sections summarize equipment functionality.

1.5.1 Open-Path UV-DOAS

Benzene, toluene, o-xylene, m-xylene, p-xylene, and SO_2 are measured with a Cerex UV Sentry bistatic Ultra Violet-Differential Optical Absorption Spectrometer (UV-DOAS). The UV-DOAS operates in the bistatic configuration where the Xenon source is at one end of the path and the analyzer (detector) is at the other end. The analyzer records the intensity of light at discrete wavelengths. Any UV-absorbing gas that is present in the beam absorbs at a specific wavelength of light. Each species of gas has a unique absorbance fingerprint (i.e., the ratios between the absorbance at several different wavelengths are unique to that gas). The analyzer compares regions within the sample absorbance spectra to the same regions within the reference absorbance spectra. The analyzer uses a classical least squares regression analysis to compare the measured absorption spectrum to calibrated reference absorption spectra files. Beer's Law is used to report gas concentrations. The approach is analogous to that used in U.S. Environmental Protection Agency's (EPA) TO-16. Closeness of fit is indicated by the correlation coefficient (R^2) of agreement between the measured spectra and the reference spectra. The R^2 is provided with each concentration so that interference can be detected if it is present. Selection of regions of analysis that are free of absorbance due to other gases within the sample is the primary means of avoiding cross-interference. Spectral subtraction is used in cases with overlapping absorbance features; the subtraction technique is proprietary to the instrument manufacturer.

1.5.2 Open-Path Tunable Diode Laser

The Tunable Diode Laser (TDL) air monitoring system measures light in a region of the light spectra where a target analyte absorbs infrared light. The system then passes the light beam through an internal reference cell that contains a known concentration of the same analyte. Once the two measurements are complete, the two spectra are compared to each other using analytic software that determines the concentration of the analyte in the field data. In addition, the software reports a correlation coefficient (R^2) between the two measurements. Higher R^2 value reflects higher confidence that the field measurement was the correct analyte. TDL is one option for Hydrogen Sulfide (H_2S) measurement; however, a final measurement method has not been selected at this time.

1.5.3 FTIR

Straight chain alkanes 2 to 5 carbons long and methane are measured using a Cerex AirSentry Fourier Transform Infrared (FTIR) spectrometer. The FTIR operates by sending a beam of infrared light through the open air. The IR beam is reflected back to the analyzer by a retro-reflector array (monostatic configuration using gold thin film corner-cube retroreflectors), where the absorption due to target gases is measured and recorded. The analyzer uses a classical Least Squares Regression analysis to compare the measured absorption spectrum to calibrated reference absorption spectra files consistent with EPA's TO-16 Methodology. Beer's Law is used to report accurate gas concentrations. The FTIR operates on a similar premise as the UV-DOAS by using reference spectra. There are a variety of industry standard methods to minimize interference from both water vapor and interference gases, including spectral subtraction, path length adjustments, and selecting isolated absorbance peaks for the gases of interest. Proprietary methods include multi-peak analytics.

1.5.4 GC-PID

The North Richmond community monitor uses a gas chromatograph with a photoionization detector to measure BTEX compounds in ambient air. Sample gas flows through the gas chromatograph column and separates at different rates depending on the various chemical and physical properties. The photoionization detector causes ionization of the sample using ultraviolet light. The ionization chamber exposed to the light source contains a pair of electrodes. When a positive potential is applied to one electrode, an electro-magnetic field is created in the chamber. Ions formed by the adsorption of photons are driven to a collector electrode. The current produced correlates with concentration.

1.5.5 Pulsed Fluorescence

The Castro St. ground-level monitor uses two ultraviolet pulse analyzers to measure H_2S and SO_2 in ambient air. The H_2S analyzer draws sample gas through an H_2S-to-SO_2 converter coupled to a pulsed fluorescence SO_2 analyzer. Continuous H_2S monitoring is accomplished by conversion of the H_2S in the sample to SO_2 and its subsequent detection by the SO_2 analyzer. The SO_2 fluorescence analyzer has a similar principle of measurement as the H_2S analyzer: sample flows into the fluorescence chamber, where pulsating UV light excites the SO_2 molecules. The condensing lens focuses the pulsating UV light into the mirror assembly. The mirror assembly contains four selective mirrors that reflect only the wavelengths that excite SO_2 molecules. As the excited SO_2 molecules decay to lower energy states, they emit UV light that is proportional to the SO_2 concentration.

1.6 Instrument Performance

The entire fenceline monitoring system is continually monitored for system performance. This includes the instruments, workstations, internet communication hardware, and network operations. If at any time an element of the system fails to meet performance criteria, a message is generated to key personnel, who will begin activities to correct the problem. If an issue cannot be immediately corrected, the real-time website will be updated with a message explaining the problem. **Table 1.2** lists potential problems and responses; additional checks are listed in Section 1.7, Emergency Maintenance Procedures, and in Section 1.8, Routine Maintenance. If the Field Technician cannot correct an issue, the Field Technician Supervisor and/or specific instrument experts will be called.

Corrective action will be taken to ensure that data quality objectives are met. Table 1.2 lists the potential issues that require corrective actions. This table is not all-inclusive, and additional checks may be added as the project progresses. Additional tests and routine data are needed to confirm some of these performance indicators; these indicators will be evaluated during the first three months of 2020, with a particular focus on the performance indicators for the existing, older UV systems. The daily data reviewers will review data to identify issues and will work with the field technicians and instrument contractors to resolve issues that need to be addressed on site. Twice daily, analysts will examine both public-facing and internal websites to assess data quality and availability. If issues are noted, the analyst will further investigate and work with the Data Manager, Field Technician Supervisor, and Field Technicians to resolve the problem. Furthermore, 24/7 on-call field operations will be notified of any data availability issues. If necessary, maintenance tables will be modified and updated in the QAPP and submitted to BAAQMD for approval.

Table 1-2. Response to Potential Monitor Problems

Potential Problem	Response
Analyzer has low signal (integration time >250 ms for UV, less than 2% for IR)	Website updated with low signal message for specific analyzer. If the low signal is not due to weather conditions, a Field Technician corrects the issue.
Analyzer off-line	Website updated with analyzer off-line message. Field Technician corrects issue.
Workstation fails	Website updated with analyzer off-line message. Technician corrects the issue.
Internet communication failure	Backup Internet connection activated

1.7 Emergency Maintenance Procedures

When a problem is discovered with the fenceline monitoring system, corrective actions and maintenance procedures are required; specific problems are listed in **Tables 1.3 and 1.4** below. Because the fenceline monitoring system is composed of two major components—field hardware and the website software—two separate rotating teams will be on call 24/7 to respond to any issues that can be dealt with remotely. Any field work will occur the next business day. The two teams are (1) the STI on-call field operations team (field ops team, supported by Terra Applied Systems), and (2) the STI IT operations team (the IT ops team). The overall field ops team will consist of one field technician; the IT ops team will consist of one IS engineer and one IT specialist. STI will manually check the website daily, and automated checks will be enabled. If the automated checks identify a problem, the automated system will immediately send an alert to the field ops team and/or the IT ops team. This approach will help to guarantee that problems are identified and addressed in a timely manner. The on-call teams are required to investigate alerts within 30 minutes of their receipt. Refinery personnel will be notified if a solution for issues affecting data availability cannot be resolved within an hour. If the fenceline monitors are offline, a maintenance message will be put on the public website.

The rotating field ops team will remotely monitor the status of the field sites 7 days per week and use automated checks such as the following to determine actions:

1. Data not reporting to the website
2. Data out of expected range (for details, see Table 4.1 in Section 4 and the attached SOPs)
3. Metadata message indicates a problem with instrument operations

Problems with the analyzers or any associated hardware in the shelters will be addressed on the following business day. As soon as a problem is identified, the team will work with the IT ops team to ensure that the proper error message for the affected variables is displayed on the website by the following business day.

The IT ops team will remotely monitor that status of the website and associated equipment using automated system checks such as those listed in Table 1.3 to determine actions. Automated alerts are triggered when any of the parameters surpasses their limit or threshold.

Table 1-3. Parameters monitored by automated system checks, their monitoring frequency, and threshold for alerting.

Item	Parameter	Monitoring Frequency	Parameter Limit/Threshold for Alert
Website goes down	HTTP test on the: - public website - Administrator website DMS API	Every 300 seconds	Websites not reachable
DMS systems	- CPU utilization - Memory use - Disk space used	Every 300 seconds	- CPU utilization >60% - Memory used >75% - Disk used >75%
Other network-related issues	- Database replication - API load balancer - System services - Network connections	Every 300 seconds	Status either - OK - Insufficient-
Interruption in data flow	- Time since last data point received	Every 30 minutes	Most recent measurement is behind collection by more than 30 minutes
Errors in data processing pipeline	- Job scheduler	< 300 seconds	Status either - OK - Insufficient

The IT ops team is expected to respond within 30 minutes of any system alert and triage the problem as needed. If an issue needs to be escalated for project-specific reasons, the IT ops team will notify the project's primary and secondary point persons at STI. If deemed necessary, STI will notify the Refinery of any issues affecting data availability on the public website. Any instrument-level outages that occur during the weekend will be dealt with the following business day, and any issues that occur during weekday nights will be addressed the next business day. In the case of any long-term outage or scheduled maintenance at a specific site, a temporary message will be displayed on the public-facing website to alert the public. If there is an outage lasting more than 24 hours, BAAQMD personnel will be notified on the next business day (short-term outages less than 24 hours will be identified in the quarterly report). A spare analyzer may be installed if there is a long-term problem with a piece of operating equipment.

Corrective action will be taken to ensure that data quality objectives are met. Table 1.4 lists the types of issues that require corrective actions. This table is not all-inclusive, and additional checks may be added as the project progresses. Data Reviewers will review data daily to identify issues, and will work with the field technicians and instrument contractors to resolve issues that need to be addressed on site. Twice daily, Analysts will examine both public facing and internal websites to assess data quality and availability. If issues are noted, the Analyst will further investigate and work with the Data Manager, Project Manager, and Field Technicians to resolve the problem. Furthermore, 24/7 on-call field operations will be notified of any data availability issues. If necessary, maintenance tables will be modified and updated in the QAPP and submitted to BAAQMD for approval.

Table 1-4. Potential sampling and data reporting problems and corrective actions.

Item	Problem	Action	Notification	Person Responsible
Erratic data (highly variable or not physically possible)	Possible instrument malfunction	Contact Field Manager and Instrument Contractor	Document in logbook, notify Field Manager	Field Technician
Power	Power interruptions	Check line voltage, reset or restart instruments	Document in logbook, notify Field Manager	Field Technician
Data downloading	Data will not transfer to the DMS	Contact Field Manager and Instrument Contractor	Document in logbook, notify Field Manager and Website/Data System Manager	Field Technician
Supplies and consumables	Essential supplies run out	Contact Field Manager	Document in logbook, notify Field Manager	Field Technician
Access to sites	Technician cannot access the sites	Contact Project Manager	Document in logbook, notify Program Manager	Field Technician
Instrument light level	A low light level alert is observed	Contact Instrument Manufacturer; replace bulb	Document in logbook, notify Field Manager	Field Technician
Website	Website is down	Contact Website/Data System Manager	Notify Program Manager	IT Manager
Server	Not working properly	Contact Website/Data System Manager	Notify QA Manager	IT Manager
Network	Network is down	Contact Website/Data System Manager	Notify QA Manager	IT Manager
Data Flow	Data flow interruption	Contact Website/Data System Manager	Notify QA Manager	IT Manager
Data Flow	Errors in Processing	Contact Website/Data System Manager	Notify QA Manager	IT Manager

1.8 Required Routine Maintenance

Routine maintenance for the UV-DOAS, open-path H_2S, FTIR, and North Richmond GC is summarized in **Tables 1.5, 1.6, 1.7, and 1.8** below; additional details on the actions to be taken and when they will be taken are provided in the instrument SOPs (attached). Maintenance for the visibility sensors located at the analyzer sites for paths D (North Richmond) and E1 (Atchison) is included at the end of this section. The open-path H_2S equipment has not been selected and will not be installed until an instrument has been selected and approved by the BAAQMD; therefore, Table 1.6 will be updated (and the QAPP revised and submitted to the BAAQMD) with more details once the H_2S measurement method is selected. The Castro Street GLM is maintained in accordance with BAAQMD Manual of Procedures Volume VI. In addition, maintenance checks will be performed if Data Quality Checks fail or data availability targets are not met.

Chevron will keep a small supply of critical consumable parts on site for the UV-DOAS, FTIR and other instruments (TDL, etc.) as needed. The supply of critical consumables will be kept under the control of Chevron and made available to the maintenance contractor upon request. Critical consumables will be replaced as they are used such that a supply is always on hand. Beyond the supply of critical consumables, the maintenance contractor will be responsible for supplying any additional parts or materials needed to maintain the fenceline monitoring system

Table 1-5. Schedule of Maintenance Activities for Cerex UV Sentry UV-DOAS

Activity	Monthly	Quarterly	Annually
Visually inspect the system (an evolving checklist will be maintained)	✓		
Inspect optics on detector; clean if necessary	✓		
Inspect systems filters	✓		
Confirm the alignment to verify there has not been significant physical movement. Note: this is automatically monitored as well	✓		
Download data older than 6 months from detector hard drive, move to a permanent archive, and delete old files	✓		
Ensure there are no obstructions in the beam path (such as equipment, vegetation, vehicles)	✓		
Inspect all electrical cables for wear; replace as needed	✓		
Change out the UV source		✓	
Replace ventilation exit and intake filters		✓	
Realign system after service		✓	
Check system performance indicators		✓	
Perform bump test (simulates system-observed gas content at the required path average concentration) to verify the system can detect at or below a lower alarm limit. Take corrective action if % Accuracy exceeds 20%.		✓	
Review and test light and signal levels. Check average light intensity to establish baseline for bulb change frequency. Realign system if integration time exceeds 250 ms or signal intensity is less than 15% at 250 nm under high visibility conditions	✓		✓
Verify system settings			✓

Table 1-6. Schedule of Maintenance Activities for open-path H_2S analyzer (Checks may be modified and additional checks may be added pending instrument selection)

Activity	Monthly	Quarterly	Annually
Visually inspect the system	✓		
Inspect optics on detector, clean if necessary	✓		
Check the alignment to verify there has not been significant physical movement. Note: this is automatically monitored as well	✓		
Download data from detector hard drive and delete old files to free space, if needed	✓		
Ensure there are no obstructions in the beam path	✓		
Inspect all electrical and optical cables for wear; replace as needed.	✓		
Check system performance indicators		✓	
Perform bump test. Take corrective action if % accuracy exceeds 20%.		✓	
Review and test light and signal levels		✓	
Verify system settings			✓

Table 1-7. Schedule of Maintenance Activities for Cerex AirSentry FTIR

Activity	Monthly	Quarterly	Annually	Five Years
Visually inspect the system	✓			
Confirm the alignment to verify there has been no significant physical movement. Note: this is automatically monitored as well	✓			
Download data from detector hard drive and if needed delete old files to free space	✓			
Ensure there are no obstructions between the detector and the retro-reflector	✓			
Change out the IR source				✓
Realign system after service		✓		
Check system performance indicators		✓		
Check system response (bump test). Take corrective action if % Accuracy exceeds 20%.		✓		
Perform factory calibration check			✓	
Review and test light and signal levels. Check average light intensity to establish baseline for IR source change frequency and retro-reflector wear	✓			
Verify system settings		✓		
Perform Cryocooler Check. Replace Cooler or swap detector module assembly if necessary			✓	

Table 1-8. Schedule of Maintenance Activities for the North Richmond Community Monitor GC-PID

Activity	Quarterly	Annually	Two Years
Replace micro dust filter for sample	✓		
Remove dust from ventilator	✓	✓	
Clean the lamp		✓	
Clean the PID		✓	
Change the carrier gas filters		✓	
Clean the diaphragm		✓	
Renew external sample tubing		✓	
Replace preconcentration tenax tube		✓	
Replace cooled preconcentration trap		✓	
Optimize hard disk		✓	
Clean internal gas tubing			✓
Clean lamp housing			✓

Quarterly maintenance will be performed on the Campbell Scientific CS120A visibility sensors. Quarterly checks for the visibility sensors are as follows:

1. Inspect the sensor for dirt, spiderwebs, birds' nests, or other obstructions. Clean the glass windows.
2. Check that the cable connections are secure.
3. Inspect the hardware holding the sensors to the tower, and tighten the bolts if necessary.

The calibration of the visibility sensors will be checked annually.

2 Data and Measurement Quality Objectives

For all instrument/parameter combinations, data completeness requirements are provided in **Table 2.1**. Percent data recovery (or data capture) for 1-hr data is the percentage of valid 5-minute data values that were collected, divided by 12. An hour starts at the top of the hour and must contain 75% complete data for that 60-minute time period. Percent data recovery for the day (starting at midnight) is the number of valid 1-hr values collected divided by 24. Percent data recovery for the quarter (starting January 1, April 1, July 1, and October 1) is the number of days of valid data collected divided by the total number of days for that quarter. For communication purposes, the Percent Data Valid—the percentage of data values that are valid divided by the number of captured data values, corrected for weather related conditions—will also be computed. Rule 12-15 allows for the omission of time periods from the completeness calculation when atmospheric conditions prevented measurement, as indicated by three instruments at the same location (UV-DOAS, open-path H_2S, and FTIR) having drops in signal simultaneously, or as indicated by a measurement of visibility.

Table 2-1. Data Availability Requirements.

Completeness Requirement	Relevant to	Minimum No. of Values Needed
75% per hour	5-minute average data	9 per hour
75% per day	1-hr average data	18 per day
75% per quarter	Daily data	68 days per quarter [a]

[a] The exact number of days in the quarter will be used; this example is for illustration only.

2.1 Data Representativeness

Site locations for the fenceline monitoring system were selected to ensure data representativeness by strategically positioning monitors using the predominant and variable meteorological conditions as well as topographical terrain features within the refinery.

The fenceline monitoring sites were selected to be consistent with guidance from EPA and CARB. Environmental requirements were considered in the monitors' placement with respect to on-site and off-site sources. The existing fenceline monitors do not have any large-scale sources between the monitor and the fenceline. The monitors were placed with consideration given to the proximity of off-site emissions sources. Sampling requirements were also considered in the siting of monitors. Chevron's goal was for the horizontal distance from a point sampler to an obstacle, such as a building, to be at least twice the vertical distance that the obstacle protrudes above the sampler. Chevron's goal for horizontal distance was 90% of the open-path to obstacles at least twice the vertical distance that the obstacles protrude above the path. For open-path monitors, a direct line of sight between light source and receiver must be available for the monitors to function. As the open-path monitors are installed, if any one does not meet these criteria, we will develop mitigation efforts and discuss those with the BAAQMD.

Chevron met on multiple occasions between September 2011 and November 2012 with Shields-Reid, Point Richmond, and Atchison Village Neighborhood Councils, who provided input on the locations of the air monitors. These are all the neighborhoods that border the refinery. The compounds to be monitored were selected with input from the City of Richmond, Chevron's consultant, and community representatives. The compounds monitored by the fenceline system are considered representative of refinery operations. The specific chemicals that require monitoring were evaluated for each source from emissions estimates based on available TRI (Toxic Release Inventory) information. The compounds monitored by the community monitors represent a larger spectrum of compounds that can be attributed to many sources present in the Richmond community. The final siting locations and compounds to be monitored were approved by the City of Richmond in 2013.

3 Quality Control

All monitoring equipment will be operated using quality assurance protocols outlined in this QAPP. This includes continuous monitoring of instrument parameters for data quality (error flags/messages from the analyzers, low signal measurements), quarterly validations, and annual servicing of the analyzers. Accuracy will be measured using the protocols outlined in the SOPs included in this QAPP. A Factory Acceptance Test (FAT) will be made at the manufacturer's location using these methods; a Site Acceptance Test (SAT) using the same methods will be made in the field during the startup phase, both tests will be done with the system in its standard operational configuration. Chevron will obtain a report of the FAT and SAT tests conducted. FAT and SAT tests determine precision and percent error using certified standard gas concentrations, with an expected precision of greater than 90% and an expected percent error of less than 25%, using the certified concentration and the procedures outlined in the SOPs. Adjustments and improvements will be made in the field until performance is acceptable (±25% of expected concentrations).

For the UV-DOAS system, a bump test will be performed quarterly, as recommended by the manufacturer. In the field, a bump test is used to verify that the system can detect at or below a set level of concern; performance should meet the same criteria as for the FAT tests. A bump test will also be performed if major changes are made to the instrument during troubleshooting or if there is a recently measured value that is still in question after investigations are performed (e.g., if there are multiple 5-minute measured values at a very high level [for example, a value over 20 times the MDL for that compound]; MDLs are given in Tables 4.2, 4.3, and 4.4 in Section 4).

For an open-path FTIR, a bump test will be performed quarterly, as recommended by the manufacturer. In the field, a bump test is used to verify that the system can detect at or below a set level of concern; performance should meet the same criteria as for the FAT tests. A bump test will also be performed if major changes are made to the instrument during troubleshooting or there is a recently measured value that is still in question after investigations are performed (e.g., if there are multiple 5-minute measured values at a very high level (for example, a value over 20 times the MDL for that compound); MDLs are given in Tables 4.2, 4.3, and 4.4).

For factory calibrations, a certification of the standard gases used will be requested from the manufacturer. In addition, the spectra background file version number used for signal processing will be documented.

For the North Richmond Community monitor GC-PID, zero and span checks are conducted monthly. The analyzer is calibrated if the target zero value reads greater than or equal to two ppb or if the span value is greater than equal to 15%. Calibrations are also scheduled quarterly. Instrument bias is checked annually to ensure the coefficient of variance is less than 10%.

For the Castro Street GLMs, a zero and span check is completed every two weeks.

Benzene sorbent tube will be used for EPA 40 CFR 63 compliance. Sorbent tubes and subsequent laboratory analyzers are calibrated in accordance with 40 CFR 63, Appendix A, Method 325B requirements.

For the open-path systems, precision can be measured by evaluating the variance of pollutant concentrations during a period of low variability, when atmospheric influence on variability is assumed to be minimal. For example, measurements should not be performed in the rain, fog, or when ambient concentrations of analytes/interfering species are changing rapidly (e.g., ozone). On a monthly basis, five-minute data will be selected during periods of low variability, but when concentrations are well above the MDL. The precision can then be evaluated by calculating the coefficient of variation (CV) during the period of low variability, as shown in the equations below. If there are no periods of low variability with concentrations above the MDL, bump test data will be used to calculate precision.

During these tests, a number (N) of replicated measurements (x_i) of a standard reference material of known magnitude (x_{std}) will be measured. Here, an acceptable number if trials will be defined as 7≤N≤15. The average value of these measurements is calculated as

$$\bar{x} = \frac{\sum_i x_i}{N} \qquad (1)$$

and the standard deviation (σ) as:

$$\sigma = \sqrt{\frac{\sum_i (x_i - \bar{x})^2}{N-1}}. \qquad (2)$$

From these definitions, %Accuracy is defined as:

$$\%Accuracy = \frac{\bar{x} - x_{std}}{x_{std}} \times 100\% \qquad (3)$$

and precision as the coefficient of variation (CV) expressed as a percentage:

$$Precision \equiv \%CV = \frac{\sigma}{\bar{x}} \times 100\% \qquad (4)$$

4 Data Management

Data quality criteria are evaluated through (1) automatic data checks conducted through a data management system and (2) data review by trained analysts.

4.1 Data Acquisition and Communications

Raw data management occurs on a real-time, monthly, quarterly, and annual basis. In near-real time, data are transferred from infield instruments through a data acquisition system (DAS) to a Data Management System (DMS). Data are also stored onsite on instrument computers. These raw data are not yet intended for the public website.

The DMS automatically quality-controls data, detects outliers and problems, generates reports, and creates alerts. The auto-screening and graphical capabilities will be used for continuous examination of data quality. The DMS will feed auto-screened data to the field operations website and notification system to inform/alert project and facility staff. The automatically QC'ed air quality data will be fed to the public website typically within 10 minutes of data measurement.

4.2 Automated Data Review

Automated data review is conducted within the DMS upon data ingest. Automated screening checks of data feeds are used to screen out invalid data for public display; the quality control (QC) codes and operational (OP) codes used in this process are summarized in **Table 4.1**. During later stages of data review, both QC and OP codes will be checked and confirmed. Initial quality review checks, along with actions to be taken, are summarized in **Table 4.2**. The review concentration criteria used to select the values in Table 4.2 are based on an analysis of expected instrument performance, concentration levels of concern by compound, and typical ambient concentrations by compound. All review criteria (flags and rates of change) are preliminary and will be refined during the project, based on actual observations. The DMS auto-review checks that will be used include

> **Range.** These checks will verify that the instrument is not reporting values outside of reasonable minimum and maximum concentrations; from minus a value equal to the MDL to single values higher than 20 times the MDL for that compound.
>
> **Sticking.** If values are repeated for a number of sampling intervals, data will be reviewed for validity. Typically, four or more intervals of sticking values are a reasonable time span to indicate that investigation is needed. Sticking checks will not be applied to data below the instrument detection limit.
>
> **Rate of Change.** Values that change rapidly without reasonable cause will be flagged and reviewed.
>
> **Missing.** If data are missing, data during those time periods will be coded as missing. Missing data may indicate a power issue, an instrumentation problem, or a data communication problem. Missing data alerting will be set for six missing 5-minute intervals (30 minutes).

Table 4-1. Overview of automated data quality control (QC) and operational (OP) codes.

Quality Control (QC) Codes	
0	Valid
5	Suspect/Questionable
8	Missing
9	Invalid
Operational (OP) Codes	
0	Valid
17	Below MDL
30	Instrument Maintenance
70	Instrument Malfunction
72	Marginal Operating Conditions – Elevated Integration Time
73	Poor Visibility (Weather)
74	Poor Spectral Match
76	Marginal Operating Conditions – Poor Spectral Match

Additional parameters that may be monitored as indicators of data quality include data quality values for each concentration as reported by the instrument (i.e., correlation between measured and reference spectra), and signal strength. For those data points that are collected with a signal strength percentage outside of an acceptable range, based on the criteria in Table 4.1, will either be flagged as invalid or undergo additional screening. For UV-DOAS, this can also be paired with the integration time (for example, data below 90% signal intensity and an integration time above 250 nm are flagged as invalid. Long integration times are indicators of difficulty achieving a sufficient signal level). For the TDL, data with signal strength less than 1000 are invalid. For the FTIR, data with relative intensity less than 3% are invalid. When the percent match is below 70%, interference and noise from the lack of signal are believed to have impacted measurements, so data are then flagged as below the detection limit of the analyzer. A visual review of peaks can be conducted using manufacturer-supplied data processing software. This visual inspection will be used to determine the validity of peaks with high concentrations. Data quality objectives for these parameters may continue to evolve as the project is in operation. The QAPP will be updated as needed to include addition or revision of any data quality indicators that are determined to improve data quality (for example, fewer false positives and false negatives).

Data flags identified through auto-review will be reviewed during data validation (i.e., not in real time), and QC flags will be updated with quarterly actions. Data quality analysts will review data daily in the beginning of operations. This may reduce to several times a week as the analysts become more familiar with the data and expected data trends are established. Analysts use the administrator website and the analyzer signal processing software to ensure that data flags are being applied correctly. If it is found that data was were incorrectly flagged during this process, the analyst will manually change the flag. Data changes will be tracked. Raw data are preserved as well as all changes.

Messages are provided for every compound and time period; these messages are listed in **Table 4.3**.

Table 4-2. The following checks are used for post-process data review. If visibility is less than 2.5 miles and data is missing, flag as missing due to environmental conditions.

	MDL	**Range**	**Checks**		
			Sticking	**Missing**	**Sensor OP Code or Alarm**
Benzene (ppb)	If below MDL, flag as below MDL	If above 5 ppb, flag for review	If value is above MDL and the same value is observed for four or more intervals, flag for review	If data are missing, flag as missing	If sensor indicates malfunction or calibration, flag as appropriate
Toluene (ppb)		If above 70 ppb, flag for review			
Ethylbenzene (ppb)		If above 320 ppb, flag for review			
Total Xylene (ppb)		If above 200 ppb, flag for review			
H_2S (ppb)		If above the MDL, flag for review			
SO_2 (ppb)		If above 40 ppb, flag for review			
Methane (ppm)		If below 1,820 ppm, flag for review			
Alkanes, C2-C5 (ppb)		If above 1 ppm, flag for review			

Table 4-3. Messages displayed on the website with each compound and data value (hover over the data point to view the message).

Condition	Message
Valid	X parts per billion of Compound Y were measured at this location
Below detection	The concentration of the compound is so low that the instrument cannot accurately detect it.
Questionable	No additional information available. Pending further review.
Missing	A problem (such as power failure, calibration, etc.) prevented the instrument from collecting or reporting the data.
Invalid	No additional information available. Pending further review.
Not Measured	There is no instrumentation at the given site to measure this chemical.

Tables 4.4, 4.5, and 4.6 show the expected detection ranges for the open-path monitors at North Richmond, Atchison, and Point Richmond. Chevron will install BAAQMD-approved open-path H_2S analyzers, once acceptance testing has been completed by the BAAQMD. H_2S detection limits will be provided at that time. Operation of these instruments will be conducted in accordance with the Fenceline Monitoring Plan pursuant to the timing requirements in Rule 12-15.

Table 4-4. Minimum detection limits (MDLs) and upper detection limits (UDLs) by compound and path.

				North Richmond (D)		Atchison (E)		Atchison (E1)		Atchison (E2)		Point Richmond (F)		Point Richmond (F1)		Point Richmond (F2)	
	Path Length	**N/A**	**N/A**	**692**		**793**		**420**		**380**		**897**		**497**		**401**	
		MDL (ppmm)	UDL (ppmm)	MDL (ppb)	UDL (ppb)	MDL (ppb)	UDL (ppb)	MDL (ppb)	UDL (ppb)	MDL (ppb)	UDL (ppb)	MDL (ppb)	UDL (ppb)	MDL (ppb)	UDL (ppb)	MDL (ppb)	UDL (ppb)
FTIR	**Methane**	7	4200	5.1	3000			8.4	5000	9.2	5500			7.1	4200	8.8	5200
	Ethane	3.2	1100	2.3	810			3.8	1300	4.2	1500			3.2	1100	4	1400
	Propane	3.8	1100	2.7	810			4.5	1300	5	1500			3.8	1100	4.7	1400
	Butane	4.2	1100	3	810			5	1300	5.5	1500			4.2	1100	5.2	1400
	Pentane	1.6	1100	1.2	810			1.9	1300	2.1	1500			1.6	1100	2	1400
TDLAS	**Hydrogen Sulfide**	TBD	TBD	TBD	TBD	TBD	TBD					TBD	TBD				
UV-DOAS	**Benzene**	0.27	16000	0.19	23000	0.17	20000					0.15	18000				
	Toluene	0.84	22000	0.61	32000	0.53	28000					0.47	25000				
	Ethylbenzene	0.3	11000	0.22	16000	0.19	14000					0.17	12000				
	o-xylene	3.8	2100	2.7	3100	2.4	2700					2.1	2400				
	m-xylene	0.35	920	0.25	1300	0.22	1200					0.2	1000				
	p-xylene	0.24	360	0.17	510	0.15	450					0.13	400				
	Sulfur Dioxide	0.68	21000	0.49	30000	0.43	26000					0.38	23000				

4.3 Data Verification

In addition to the automated system, which conducts initial data review checks, data analysts will examine both public-facing and internal websites twice daily to assess data quality and availability. If issues are noted, the analyst will further investigate and work with the QA Manager, the Project Manager, and Field Technicians to resolve the problem. Furthermore, 24/7 on-call field operations will be notified of any data availability issues. If it appears that an instrument is not operating, or the data are missing, the field operator will conduct further investigation and corrective action.

The automated alerting system will let technicians and managers know when data have been missing for a specified period of time. Missing data may indicate a power issue, an instrument problem, or a data communication problem. The time period allowed for missing data may be adjusted as the project proceeds to reduce false or excessive alerting. The alerting will be set initially for six missing 5-minute values (i.e., 30 minutes).

4.4 Data Validation

On a frequency of at least once every quarter, an experienced air quality analyst will validate data by building on the automated screening results. This process starts with an in-depth review of the data, a review that includes evaluation to ensure the data are valid for the intended end use. The QA Manager will evaluate QA/QC procedures and ensure adherence to the methods for meeting data quality objectives. Data validation activities will be reviewed and approved by the QA Manager.

Data validation activities include:

- Reviewing spectral features in flagged data to verify the measurement.
- Ensuring there are not several continuous 5-minute averages of the same number.
- Evaluating monthly summaries of the minimum, maximum, and average values.
- Ensuring data reasonableness by comparing to remote background concentrations and average urban concentrations.
- Ensuring the data or measurements are realistically achievable and not outside the limits of what can be measured.
- Inspecting several sampling intervals before and after data issues or instrument repairs to ensure all affected data have been properly flagged.
- Referring to site and operator logbooks to see if some values may be unusual or questionable based on observations by the site operator.
- Assessing instrument metadata to confirm reasonableness.
- Assessing weather-related downtime based on two or more analyzers in the same proximity experiencing a drop in signal simultaneously.

Additional QC checks for the instruments are summarized in Table 4.5 (entries for H_2S are tentative until the equipment is selected). Data that fail checks will be flagged in the DMS and brought to the attention of the reviewer by color coding in the graphic summaries. Common reasons for invalidation include instrument malfunction, power failure, and bump test data that were not identified as such. As the measurements progress, we will evaluate, refine, and update the screening to improve the data quality and minimize false positives and false negatives. If these analyses suggest that a reduction in frequency is prudent, then a request will be submitted to the BAAQMD for approval. Screening checks are typically specific to the site, instrument, time of day, and season and are adjusted over time as more data are collected.

Table 4-5. Instrument QA/QC Checks.

QA/QC Checks	Frequency	Acceptance Criteria
UV-DOAS		
Bump test (accuracy); benzene at about 4 ppb path average.	Quarterly and after major service	±25%
Single beam ratio test (strength of UV source)	Real-time	If peak to peak noise is less than 3 milli-absorbance units in the region for 251-254 nm
Integration time	Continuous	< 250 ms
Signal strength	Continuous	>75%
TDL		
Bump test; H_2S at about 50 ppb path average	Annually and after major service	±25%
Signal strength	Continuous	>5000 Signal intensity below 1000 results in a warning notification; data are invalid
FTIR		
Bump test; ammonia at about 15 ppb path average	Quarterly and after major service	±25%
Comparison with approximate ambient methane concentration	Continuous	Above 1.7 ppm
IR single beam ratio test (background vs. sample intensity)	Real-time	To be determined
Relative intensity	Continuous	>5% Signal intensity below 3 % results in a warning notification
GC-PID		
Zero and span	Monthly	Zero < 2 ppb Span < 15%
Precision	Quarterly	Linear regression correlation (R^2) > 0.96, zero +/- 0.5 ppb
Bias	Annually	Coefficient of Variance < 10%

Data are invalidated only if a reason can be found for the anomaly or automated screening check failure. If the data are anomalous or fail screening, but no reason can be found to invalidate the data, the data are flagged as suspect. Additional analysis may be needed to deem data valid or invalid. Voided data will be flagged as invalid in the database. A summary of issues leading to invalidated data will be documented in the data file.

On at least a quarterly basis, analysts will subject the data to final QC by filling in missing records with null values, and adding Null Codes:

- Invalid data will have a Null Code, or in other words, a reason for being invalid.
- If a record is not created for a particular site/date/time/parameter combination, a null record will be created for data completeness purposes.
- Data completeness for the quarter will be reviewed.

All actions will be documented so that raw data are retained and all actions that result in the final data are traceable.

On an annual basis, the refinery or its designated contractor will review the performance of the network by reviewing the data completeness by monitoring path, instrument, and species; by reviewing results of QA/QC tests; by analyzing the reported values in context of refinery operations; and by analyzing the data in context of the meteorology. The refinery or its designated contractor will also evaluate overall network performance to ensure it is meeting overall objectives, using analyses similar to those used to support the network design. The results will be summarized in a technical memorandum and provided to the BAAQMD upon request.

Chevron or its contractor will monitor and investigate any portion of the fenceline system that fails to meet data quality objectives, measurement quality objectives, or on-stream efficiency requirements under Rule 12-15. The investigation team will include members of the fenceline management team, contractors, and appropriate equipment vendors. They will assess the problem and initiate corrective action. Corrective actions will be undertaken in a timely manner with the understanding that all work will be done with safety as a primary focus. In addition, improvement opportunities identified will be considered to minimize the chance for similar problems in the future.

4.5 Data Uncertainty and Limitations of Use

Table 4.6 describes data uncertainty and limitations by instrument type in terms of monitoring technology capabilities, interferences, and measurement errors (entries for H_2S are tentative until the final equipment is selected).

It is important to note that monitoring data at the fenceline show higher concentrations than would be expected in the community due to dispersion. The Chevron fenceline monitoring website provides links to health standards for reference; however, when comparing fenceline monitor readings with health standards, it should be understood that concentrations in the community are expected to be less than the fenceline monitor readings. Additionally, due to higher minimum detection limits of some fenceline instruments, a comparison with health standards is not possible. In cases where a chemical is not detected, the fenceline monitoring website may show concentrations below the minimum detection limit, but accuracy is significantly poorer for these values. A notice will be posted on the monitoring website advising users about limitations on data use.

Table 4-6. Data Uncertainty and Limitations of Use

Equipment	Capabilities	Interferences	Limitations	Measurement Errors
Sorbent tubes	Absorbs benzene from ambient air, if present, at a point over approximately 14-day periods; Lower detection limit than open-path monitors	Sorbent artifacts, Water (rain)	Heavy rains with high winds; Continuous reporting not possible	Within 30% (Per 40 CFR 63 Appendix A Method 325B Section 9.7)
North Richmond Community Monitor Auto Gas Chromatograph	Measures BTEX continuously at a point with lower detection limit than open-path monitors		Measures at point vs. open-path	Within 25%
Open-path FTIR	Measures alkanes across an open-path continuously; Likely lower detection limit than extractive FTIR	Water (humidity), CO_2, and C2-C5 alkanes may interfere with each other	Heavy fog and rain	Within 25%
Open-path UV	Measures BTEX and SO_2 across an open-path continuously	Ozone and oxygen	Heavy fog and rain	Within 25%
Open-path TDL	Measures H_2S continuously across an open-path	Water (humidity) and CO_2	Heavy fog and rain	Within 25%;
Castro St. GLM H_2S and SO_2 Pulsed Fluorescence Analyzers	Measures H_2S and SO_2 at a point continuously; Lower detection limit than open-path monitors	High concentrations of hydrocarbons; Mercaptans interfere with H_2S measurement	Measures at a point vs. open-path	Within 10% for SO_2, within 15% for H_2S (BAAQMD MOP Volume VI)

5 Data Delivery

Final data sets will be compiled quarterly—60 days after each quarter—and provided to the BAAQMD by the Refinery PM. Outside of the normal quarterly delivery, data will be made available to the BAAQMD upon request; data will be delivered within 30 days of the request. Hourly concentrations of species will be provided in .csv format along with Site Code, Local Standard Time, Measurement Duration, Concentration Value, Concentration Unit, and QC and OP codes defined in Table 4.1.

In addition to chemical concentration data, meteorological data will be provided as a .csv file that includes Site Code, Local Standard Time, Duration, Wind Speed, Visibility, Wind Speed

Unit, Wind Direction, and Wind Direction Unit. Supporting documentation, such as SOPs and raw/spectral data, will be made available to BAAQMD upon request.

5.1 Fenceline Monitoring Plan and QAPP Distribution

The Program Manager will be responsible for providing initial copies and updates of the Plan including the QAPP to key personnel identified previously. The Plan and QAPP will be updated periodically and distributed to address a deficiency, improve procedural accuracy, or to make procedures more robust. The QAPP will be updated when changes are made to SOPs, testing criteria, etc.; new version numbers and dates will be assigned and distributed to the BAAQMD and project participants.

5.2 QA/QC Records

The Program Manager will retain QA/QC reports from equipment manufacturers. The Field Technician Supervisor will retain field QA/QC records.

5.3 Training Records

The Field Technician Supervisor is responsible for maintaining documentation of required training.

5.4 Document Control

Document No.	Document Title	Rev No.	Rev Date	Effective Date	Distribution
QAPP	Quality Assurance Project Plan	0	12/7/2018	12/7/2018	Air Team Lead, Data Manager, Field Technician Supervisor, Information Technology Manager, Program Manager
QAPP	Quality Assurance Project Plan	1	08/23/2019	08/23/2019	Air Team Lead, Data Manager, Field Technician Supervisor, Information Technology Manager, Program Manager BAAQMD
QAPP	Quality Assurance Project Plan	2	01/08/2020	01/08/2020	Air Team Lead, Data Manager, Field Technician Supervisor, Information Technology Manager, Program Manager BAAQMD
QAPP	Quality Assurance Project Plan	3	10/20/2020	10/20/2020	Air Team Lead, Data Manager, Field Technician Supervisor, Information Technology Manager, Program Manager BAAQMD

6 Standard Operating Procedures

Standard Operating Procedures for maintenance and quality assurance checks of the Cerex UV-DOAS instrument, the Cerex FTIR instrument, and the Synspec GC are provided in Appendices A through C of this QAPP.

Appendices
Standard Operating Procedures

A: CEREX UV Sentry UV-DOAS

B: CEREX AirSentry FTIR

C: Synspec GC955 Hydrocarbon Analyser

STi Sonoma Technology

Standard Operating Procedures for the CEREX UV Sentry UV-DOAS

July 6, 2020
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Sonoma Technology, Inc.
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Contents

1. Scope and Application

This SOP covers the use of the CEREX UV Sentry UV-DOAS analyzer in a fenceline monitoring application. This document addresses routine maintenance activities including visual inspections, instrument checks, data management, QA audit testing, and data validation.

2. Introduction and Overview

The CEREX UV Sentry ultraviolet differential absorption spectrometer (UV-DOAS, shown in **Figure A-1**) is an instrument that is used to detect BTEX, SO_2, NO_2, and a number of other gases in the ultraviolet (UV) region of the electromagnetic spectrum. The instrument consists of a Xenon light source, several optical elements, including a spectrometer. The light from the light source is collimated with the primary mirror and directed along a path length of about 500 m. At the other end of the path is an array of corner-cube reflectors called retroreflectors that direct the light directly back into the analyzer where the light is dispersed and measured using a spectrometer. The working range of the spectrometer is from about 200 to 300 nm. This document addresses the routine operations and maintenance procedures for the Cerex Monitoring Solutions UV Sentry units. The procedure is intended to guide the field technician in ensuring and verifying that the equipment is performing to expectations. Hard copies of this procedure and the associated test forms will be kept on site. Upon completion of the test procedure, a copy of the test form showing the results will be sent to the Refinery Project Manager.

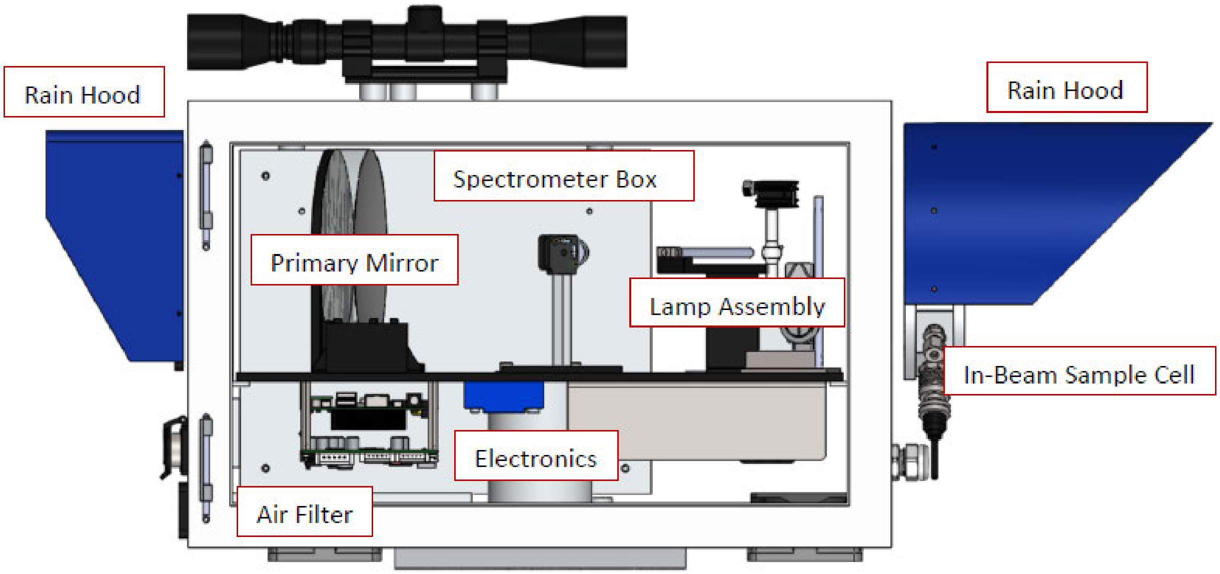


Figure A-1. Schematic of the UV Sentry UV-DOAS analyzer.

The purpose of field maintenance is to ensure that the instrument is operated within specification and for field verification of the factory calibration of the UV Sentry. The QA Test process challenges the instrument using known concentrations of select BTEX reference gases and/or Sulfur Dioxide to verify proper detection and quantification under field conditions.

3. Definitions

Term/Acronym	Definition
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes (Xylenes are composed of ortho, meta and para isomers)
Bump Test	Also known as QA Audit. A test where gas of a known concentration is introduced to the analyzer to check for response accuracy.
CMS	Continuous Monitoring Software
Integration Time	The amount of time the spectrometer detector collects light for (typically 20 to 300 ms)
Intensity	A measure of how much light was collected
PPE	Personal Protective Equipment
QA	Quality Assurance
STI	Sonoma Technology, Inc.
UV-DOAS	Ultra Violet Differential Absorption Spectroscopy

4. Safe Work, Hazard Identification, and Precautions

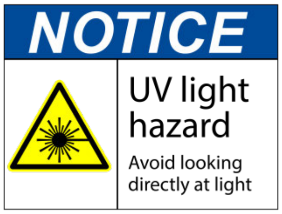
The following information is intended to provide guidance in ensuring a safe work environment.

Operator Qualifications

Installing, operating, and servicing Cerex UV Sentry analyzers should only be performed by personnel trained in the operation of the system components, familiar with the potential hazards associated with the deployment site, and familiar with the handling of gas delivery and testing equipment.

Work should conform to the manufacturer guidance and site health and safety practices.

The Cerex Monitoring Solutions UV Sentry Series Analyzers are not rated for safe operation in hazardous or explosive environments (not intrinsically safe). Any uses in an area that may contain flammable mixtures or highly corrosive vapors require special preparation to address safety and ensure safe operation of the equipment.



WARNING – Eye hazard. Risk of eye injury. CEREX UV-DOAS Analyzers contain an ultra-violet light source that may cause eye injury after prolonged exposure. Always wear UVA/B/C eye protection when working on or near the operating equipment.

Procedure Warnings

The procedure contained within this document requires the handling of toxic substances including but not limited to benzene, aromatic hydrocarbons, and sulfur dioxide gas, and it requires the operation of equipment designed for toxic gas containment and dispensation. Improper handling of materials or hardware may result in serious injury, destruction of property, or damage to the UV Sentry. Only qualified individuals should attempt or perform analyzer operation or testing activities.

Safe Operating Precautions

Ensure that a clear escape path is identified.

Standard site personal protective equipment (PPE) is appropriate. If gloves are required for work on optics, nitrile or latex should be used.

NOTICE

Please check off the following steps needed to minimize false notifications to our clients and the public.

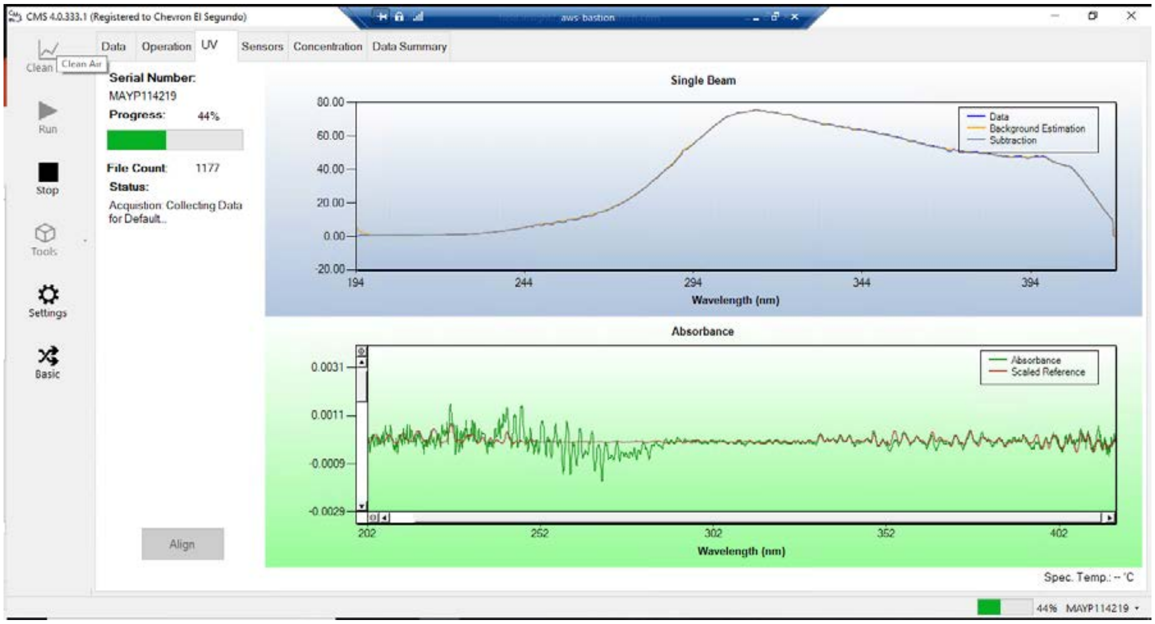
- Notify fieldopsalerts@sonomatech.com of ANY, no matter how minor, maintenance to be done on fenceline systems. Do not proceed with maintenance until you get confirmation that REL alerts are disabled.
- Disable data communications to the website during maintenance. Ensure you know how to do this correctly. If you have any doubts, check with the project manager.
- When maintenance is complete, re-establish data flow and check the public site for at least 1/2 hr to ensure proper reporting (no missing data, no high values, etc.).
- Notify fieldopsalerts when you are confident that the data shown to the public site are accurate.

Note that field measurements are frequently carried out on off hours (early morning), so please give the web team at STI enough “heads up” so they can disable the REL notifications.

5. Routine Operations

To set the UV-DOAS instrument to acquire data for normal operations, the instrument CMS must be operating and the instrument must be aligned. These actions are detailed in the steps below.

1. Start the CMS software (if not already initiated). You should see a window similar to the one shown below in Figure A-2.



CMS 4.0.333.1 (Registered to Chevron El Segundo)

Serial Number: MAYP114219

Progress: 44%

File Count: 1177

Status: Acqusition: Collecting Data for Default...

Spec. Temp.: -- °C

44% MAYP114219

Figure A-2. Screenshot showing the **UV** tab of the CMS software. Note that the **Align** button is grayed out because the instrument is in run mode (the **Run** button is also grayed out because the instrument is in run mode).

2. Under the **UV** tab, left-click on the **Align** button. This action brings up a new screen showing the instantaneous single beam plot (intensity vs wavelength). If the **Align** button is not active, you may need to press **Stop**. The **Align** mode is shown in Figure A-3.

Integration Time: 38

Path Length: 2.000

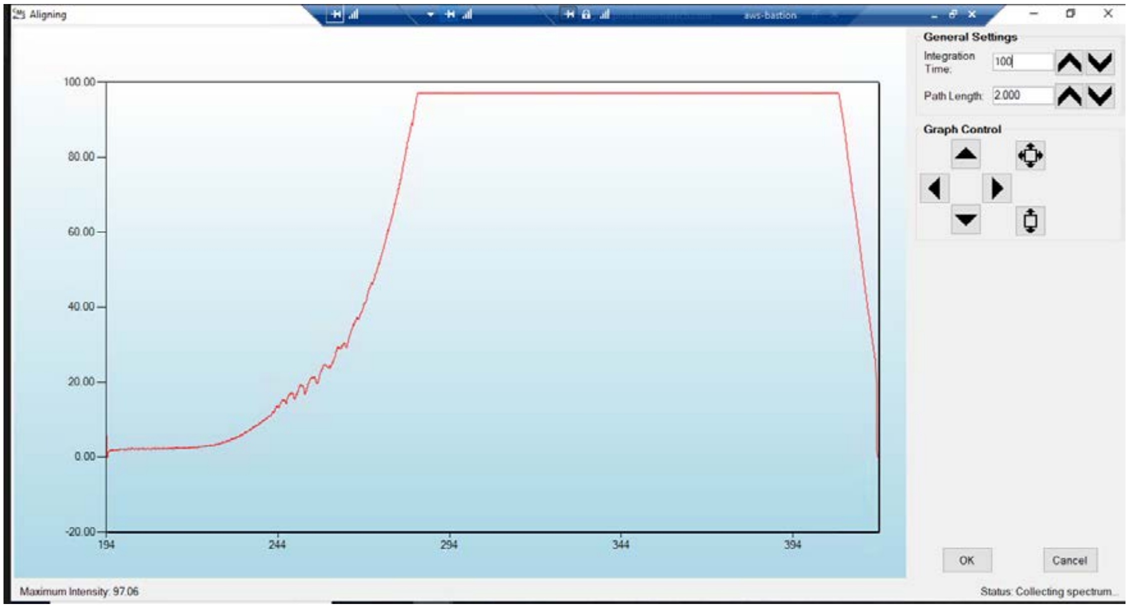
Maximum Intensity: 78.55

Status: Collecting spectrum...

Figure A-3. Screenshot for **Align** mode. The integration time can be entered in the upper right of the screen. In this particular screenshot, the integration time is 38 ms.

3. Enter an integration time of 25 ms and optimize the signal intensity by adjusting the pan-tilt head of the UV-DOAS unit to adjust the position of the UV beam on the retroreflector.

NOTE: Make sure not to saturate the peak of the spectrum when at 25 ms integration time. An example of a saturated spectrum is shown in Figure A-4; note that the spectrum is flattened out starting at about 290 nm. Also, ensure there is sufficient intensity at 250 nm compared to the stray light intensity. If there is more than 10% stray light, advanced optical adjustment or bulb change may be necessary. To measure stray light, block the beam from exiting the analyzer with an opaque object (such as a black cloth) and measure the intensity at the wavelength of interest.



Integration Time: 100

Path Length: 2.000

Maximum Intensity: 97.06

Status: Collecting spectrum...

Figure A-4. An example of a saturated spectrum when in **Align** mode. Note the "flat top" profile of the spectrum. The spectrum flattens out because the detector has saturated at those wavelengths and cannot quantitatively measure additional light.

4. Once sufficient alignment is obtained, exit the align mode by pressing **Cancel**.

5. Verify settings by left-clicking **Settings**.

Note: If you need to change any setting back to the original configuration, you must go to **File** and **Save** and **Save As Default.** You will be prompted for a password, which is **cerexconfig**

- <u>RunTime</u>
  - General
    - Operator Name: **Default** (these will change based on the path and site you are working on)
    - Sitename: **Cerex** (these will change based on the path and site you are working on)
    - Auto Run: **ON**
    - Auto Run Delay (s): **15**
  - File
    - File Type: **.CSV**
    - Primary Data Logging File: **ON**
      - C:\Users\CMS-USER\Documents\Cerex\Data
    - Secondary Data File Logging: **ON**
      - \\OPT1-PC1\VLOData\OPT1_Path1\UVSentry_POC1

            - Note this path will change based on the different computer and path you are working on. This is just a basic file writing path to show you what it should look like.
        - Single Data Folder: **OFF**
        - Primary Summary File Logging: **ON**
            - C:\Users\CMS-USER\Documents\Cerex\Data
        - Secondary Summary File Logging: **ON**
            - \\OPT1-PC1\VLOData\OPT1_Path1\UVSentry_POC1
                - Note this path will change based on the different computer and path you are working on. This is just a basic file writing path to show you what it should look like
        - Single Summary File: **OFF**
    - Library
        - Library File: C:\Users\CMS-USER\Documents\Cerex\Library\
    - UI
        - Sort Column: Compound Name
        - Data Summary Chart: **OFF**
        - Concentration Chart: **OFF**
        - Password Protection Settings: **ON**
        - Pump Control: **OFF**
        - Status Control: **OFF**
        - Testing Control: **OFF**
- Analysis
    - General
        - Moving Average Interval: **12**
        - Display Units: **PPM**
    - Concentration
        - Zero Readings on Non-Detect: **ON**
        - Zero Readings on Negative concentrations: **OFF**
        - Display BDL: **OFF**
        - Quick Analysis MDL Wave length Range: **276 -280 (Doesn't Matter the Range)**
        - Temperature/ Pressure Concentration: **OFF**
    - Filters
        - Absorbance Savitzhy-Golay: **ON**
        - Baseline Correction Savitzky-Golay: **OFF**

- Instruments
    - UV
        - Operation
            - UV: **ON**
            - Acquisition Time (s): **30**

            - Integration Time (ms): **Always will change if Auto integration is turned on**
            - Path Length (m): **2**
            - Trigger Mode: **Normal**
        - Auto Routine
            - Auto Integration: **ON**
            - Intervals (s): **300**
            - Wavenumber Range: **300-310 (This is different on all instruments due to Spectral Background and Intensity Range)**
            - Intensity Range **75-85 (This is based on intensity range)**
            - Maximum Integration: **300**
            - Auto Background: **ON**
            - Interval (Acquisitions): **5**
            - Wavenumber Range: **266-270**
        - Verification
            - Verification: **OFF (This inactivates all inputs)**
- <u>Controller</u>
    - General
        - Serial Port: **n/a**
        - Sensor Refresh Interval (s): **15**
    - Sensors
        - **Don't Touch Anything**
    - Alarms
        - **Don't Touch Anything**
- <u>Email</u>
    - General
        - Data Recipient: **Blank**
        - Email Sender: **Blank**
        - Email Periods (s) : **60 (doesn't matter the time we don't use this setting)**
        - Send Data: **OFF**
    - SMTP
        - Server: **smtp.gmail.com**
        - Port: **587**
        - Username: **Blank**
        - Password: **Blank**
        - Timeout (s): **100**
        - SSL Authentication: **ON**
- <u>Auxiliary Coms</u>
    - Modbus
        - Modbus: **ON**
        - System Type: **Ethernet**
        - TCP Port: **502**

  - Unit ID: **2**
  - 16-bit unsigned int to: **OFF**

6. After settings are verified and the instrument is aligned, you can place the instrument in run mode.

6. Equipment and Supplies

1. Field notebook
2. Tool kit, especially including: 7/64 hex driver, complete set of combination wrenches, adjustable wrenches, screwdrivers, etc.
3. Cleaning supplies designated to be safe for use on a Cerex UV-DOAS
4. All relevant PPE, hardware, and procedural guidance per SOP, Safety Plan, and Safe Work Permit
5. Local or remote network link device (as required).
6. External laptop computer with network interface device to the Sentry unit (as required)
7. Cerex UV Sentry Unit equipped with CMS software
8. Cerex UV-DOAS 8" x 8" x 1" pleated filter
9. Isopropyl Alcohol (≥80%)
10. Distilled water
11. Pressurized sprayers
12. Cerex UV-DOAS UV source bulb
13. Nitrile gloves
14. Cell bump test apparatus (including panels, regulators, valves, meters, etc.)
15. Tubing as required: 1/4" PTFE tubing for gas supply from the bottle to the QA cell
16. Tubing as required: 3/8" PTFE tubing with inline flow indicator from the QA cell to the scrubber
17. Flow regulation system capable of delivering gas 0.1 to 5 L/min at a total system pressure of 3 psig or less
18. Gas scrubber appropriate for gas used. Activated carbon may be used for benzene.
19. Reference standard traceable zero compressed air purge gas
20. Reference standard traceable gas blend in nitrogen for detection at about 5X instrument theoretical detection limit or higher
21. Cerex UV Sentry Unit equipped with CMS software

7. Maintenance Activities

The following sections outline the routine checks to be carried out for each analyzer and sensor, followed by maintenance forms (see Section 9) used to indicate when the checks are completed and document any corrective actions taken. These activities are also expected, based upon the project plan, to be logged in a site log book either in hard or electronic form and can reference this SOP and associated forms.

Perform the following visual inspections of the UV-DOAS system:

Activity	Monthly		Quarterly	Annually
Visually inspect the system.	✓			
Inspect optics on detector and retro-reflector; clean if necessary.	✓			
Inspect system filters.	✓			
Confirm the alignment to verify there has not been significant physical movement. Note: this is automatically monitored as well.	✓			
Download data from detector hard drive and delete old files to free space, if needed. Ensure data are backed up on external drive.	✓			
Ensure there are no obstructions between the detector and the retro-reflector (such as equipment, vegetation, vehicles).	✓			
Change out the UV source.			✓	
Replace ventilation exit and intake filters.			✓	
Clean optics on detector and retro-reflector.			✓	
Realign system after service.	✓			
Check system performance indicators.	✓			
Perform bump test (simulates system-observed gas content at the required path average concentration) to verify the system can detect at or below a lower alarm limit.	✓			
Review and test light and signal levels. Check average light intensity to establish baseline for bulb change frequency.			✓	
Verify system software settings.				✓

7.1 Monthly Visual Inspections

1. Ensure that the instrument is running and the data look reasonable.
2. Clean and correct any obvious problems with the system (cobwebs, rodent nests, broken optics, etc.).
3. Inspect all electrical cables for wear; replace as needed.
4. Indicate these visual checks are complete on the form included at the end of this document.
5. Document any changes to the system in the course of these checks in the site logbook.

7.2 Monthly Filter Inspection and Replacement

Remove and inspect instrument filters following the procedure described by here. Replace if necessary. Ensure fans are running (they should make an audible sound) when system is turned back on.

NOTICE

The UV Sentry should be powered down prior to changing the filter. When powering down, adhere to the recommended shut-down procedure, which includes properly shutting down all applications, and then shut down the instrument PC.

When the PC has been successfully shut down, remove the power cord from the unit.

The UV Sentry contains a single filter which must be changed on a periodic basis. Good airflow through the filter is directly related to the ability of the instrument to properly regulate internal temperature. If the filter is allowed to become clogged (through lack of maintenance), the system can overheat, and go into thermal shutdown. In extreme cases, damage may occur to the internal electronics.

The filter is a custom size 8″ x 8″ x 1″ pleated filter, which is stocked at the Cerex factory. If a large number of replacement filters are ordered, the lead time could be several weeks.

Installation Procedure

1. Power down the instrument—you cannot replace the filter with the instrument running. First, close the software and shut down the onboard PC. Next, disconnect the power.
2. The filter is accessible by removing the black plate located beneath the instrument touchscreen. The plate has the words “Filter Access” imprinted on it (**Figure A-5**).

3. Use a 7/64 hex driver to remove the six socket-head cap screws that retain the Filter Access Panel.

Figure A-5. Location of filter access plate.

4. Once the access plate is removed, the filter can be accessed for removal and replacement. Old filters should be discarded and not re-used. Insert the new filter with the “Airflow” arrow pointing in the “UP” direction (Figures A-6 and A-7).
5. When inserting the new filter, do not force the filter into the slot. If you encounter any unusual resistance, open the side door, and ensure no wires have fallen into the filter slot.
6. When fully inserted, the filter should be flush with the instrument case.

Figure A-6. Filter access plate removed and filter partially removed.

Figure A-7. Filter completely removed.

7. Re-attach the black filter access panel, using the same driver and six screws.
8. Power up the instrument, make sure CMS software has started, and realign the instrument.

7.3 Check Signal Strength and Integration Time

For good visibility conditions, signal strength is normally >90% and integration time is normally <50 ms. If it is determined that these values are out of range, re-alignment may be needed.

Check and record signal strength at 250 nm. With an integration time of less than 125 ms, minimum signal intensity at 250 nm should be 15%. If the value is less than 15% at 250 nm, the bulb should be changed.

7.4 Download and Archive Data

Raw instrument data are stored on both the analyzer computer, the site PC, and the hard drive attached to the site PC. Data consists of single beam spectral data containing two columns: one for the wavelength and the other for the intensity. The other file types stored are two types of "summary" files that contain data resulting from the classical least squares analysis of the spectral data as a function of time. These file formats are described in the CMS Software User Manual.[1] Data that are older than 6 months are automatically moved from the site PC to the external hard drive. Deliver the external hard drive to Chevron on an annual basis.

7.5 Monthly: Clean Optics on Detector and Retroreflector

Cleaning the retroreflector is an important part of the maintenance plan. Over time the retroreflector will collect debris that can alter the performance of the instrument. Caution should be taken, as there are electrical fan heaters that are used to keep moisture and particulates from collecting on the retroreflectors.

UV Sentry Retroreflector Cleaning

1. Power down any air drying equipment to prevent electrical shock or damage to the system.
2. Use a gentle stream of distilled water, usually from a weed sprayer or other type of gentle delivery method, to remove any salt or dust built up on the retroreflector.
3. Use a gentle stream of 80% isopropyl alcohol, usually from a weed sprayer or other type of gentle delivery method, to remove any salt or dust built up on the retroreflector.
4. Once the retroreflector has been cleaned and dry repower the any electrical equipment you have powered down and clean any spills you have created while cleaning.

---

[1] CMS Software User Manual Rev 4. CMS Version 4.0.298.1, CEREX Monitoring Solutions, December 5, 2017.

7.6 Inspect and Change Out UV Source If Intensity Spectrum Has Dropped Below Acceptable Range

NOTICE

Never power the UV Sentry without a properly installed Xenon UV Source obtained from Cerex.

Powering the system without a UV source may cause an electrical short, which will permanently damage the instrument.

Always remove the Xenon UV Source and secure the analyzer heat sink anode prior to transporting or shipping the UV Sentry.

Failure to remove the Xenon Source and secure the Heat Sink anode prior to transporting or shipping the UV Sentry may cause destruction of the source as well as the anode.

Always check the polarity of the Xenon UV Source for proper installation prior to powering the analyzer.

Installing the UV source with reverse polarity will permanently damage the UV Source and cause immediate failure. The Xenon UV Source is shipped from Cerex with Heat Shrink and labeling over the Anode (+) end of the Source. The UV Source must be installed so the Anode (+) end of the bulb mounts to the Anode Heat Sink. The UV Source will be oriented with the (+) end at the top.

Xenon UV Source Handling

The UV Sentry Xenon Source is shipped from Cerex in a protective plastic enclosure. The (+) Anode end of the UV Source is labeled “UP”. The UV Source must be installed with the (+) side UP. Always wear clean nitrile gloves when handling the UV Source. Oils from hands deposited on the UV Source glass bulb will cause damage in operation. Remove the “UP +” label from the UV Source prior to installation. If the glass bulb is touched with bare hands, clean the glass bulb with isopropyl alcohol or acetone prior to installation.

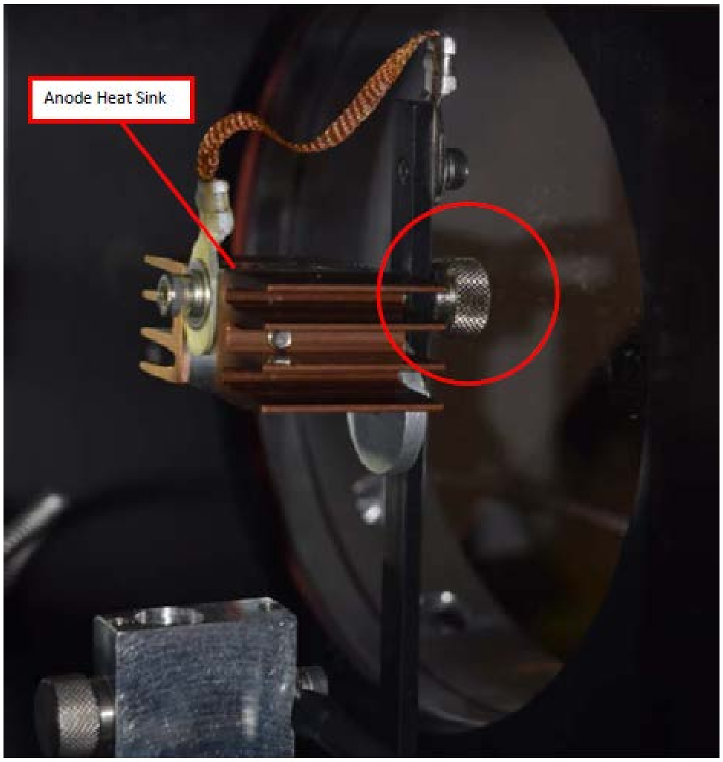
The ANODE end of the UV Source is marked (+). The CATHODE end of the UV Source is marked (-).

UV Sentry Xenon Source Removal

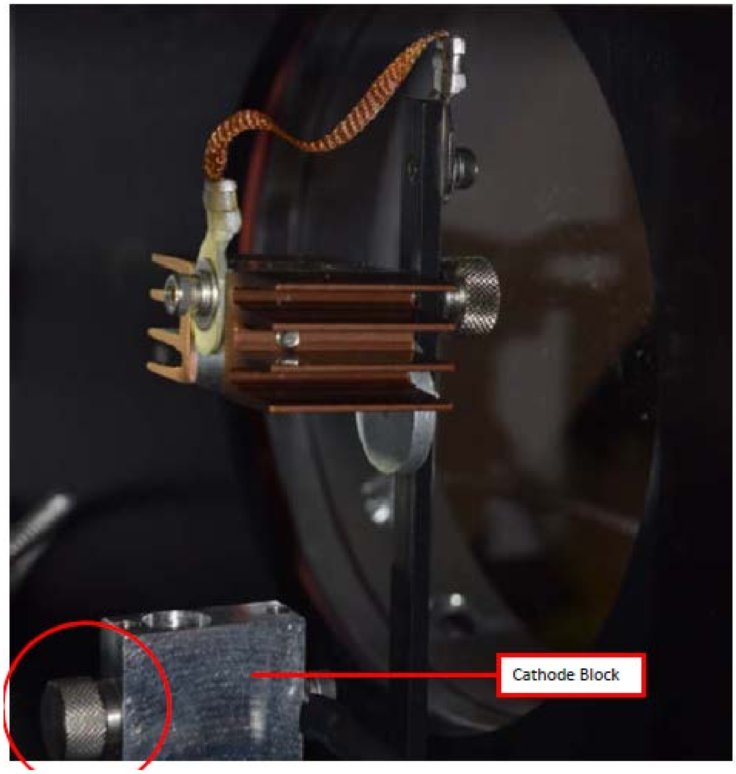
Prior to shipping or transporting the UV Sentry, remove the Xenon UV Source and secure the anode heat sink assembly.

1. Power off the analyzer and disconnect from power. Allow the analyzer to cool completely.
2. Use the provided key to remove the Source Access Panel.

3. Wearing clean nitrile gloves, loosen the retaining thumbscrew on the Anode Heatsink at the top of the UV Source.



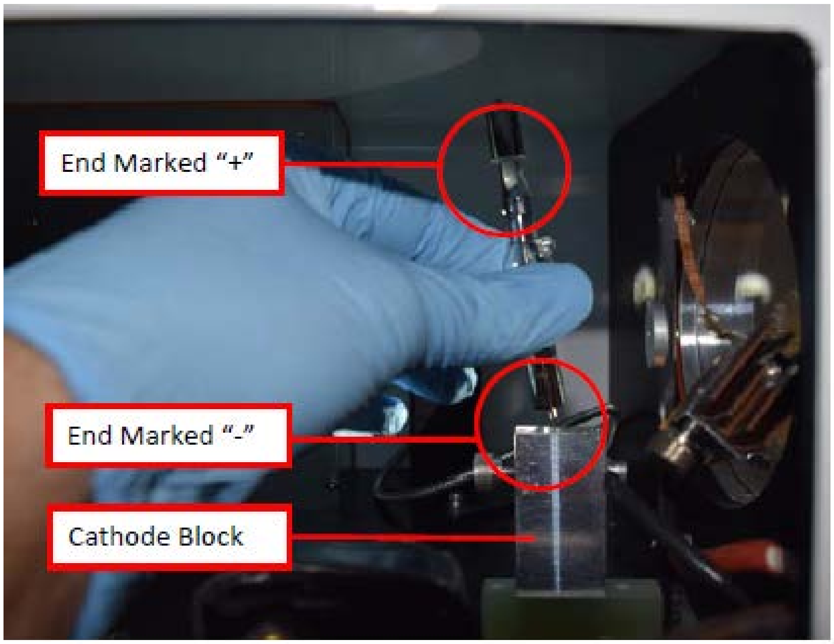
4. Lift the Anode Heat Sink off the top of the UV Source. It is connected to the post by a cable. Gently let the heat sink dangle.
5. Loosen the retaining thumbscrew on the Cathode block at the bottom of the source.



6. Lift the source lamp straight up and out of the mount.

UV Sentry Xenon UV Source Installation

1. Insert the Cathode (-) end of the Xenon UV Source into the Cathode Block. The Cathode end of the UV Source is marked with (-).



2. Rotate the UV Source so the nipple on the glass envelope faces the aluminum disc on the mounting post.
3. Tighten the Cathode block thumbscrew gently. Gently pull up on the Xenon UV Source to verify the thumbscrew has made contact with the nipple on the UV Source cathode.
4. Slide the Anode Heat Sink (+) over the top of the UV Source Anode. The Anode end of the UV Source is marked (+). Gently tighten the Anode Heat Sink thumbscrew to secure. Gently pull up on the heat sink to ensure the thumbscrew has made contact with the nipple on the UV Source anode.
5. Reinstall the Source Access Panel prior to powering on the analyzer.
6. Confirm signal strength through remote desktop connection before leaving path.

7.7 Perform Bump Test and Attach Bump Check Form to This Document

7.7.1 Apparatus Setup

Audits of open-path analyzers require high concentration (~100 ppm) calibration gases. Standard refinery personal protective equipment (PPE) should be worn at all times, including safety glasses. This procedure requires the use of pressurized gas cylinders; training on proper handling of pressurized systems is required. The operator-supplied Standard Operating Procedure (SOP), approved by the End User and in compliance with End User's Health and Safety Plan, is also required.

7.7.2 Calibration Procedure for Benzene

Verify system is set up (minus the instrument connections) as depicted in **Figure A-8**.

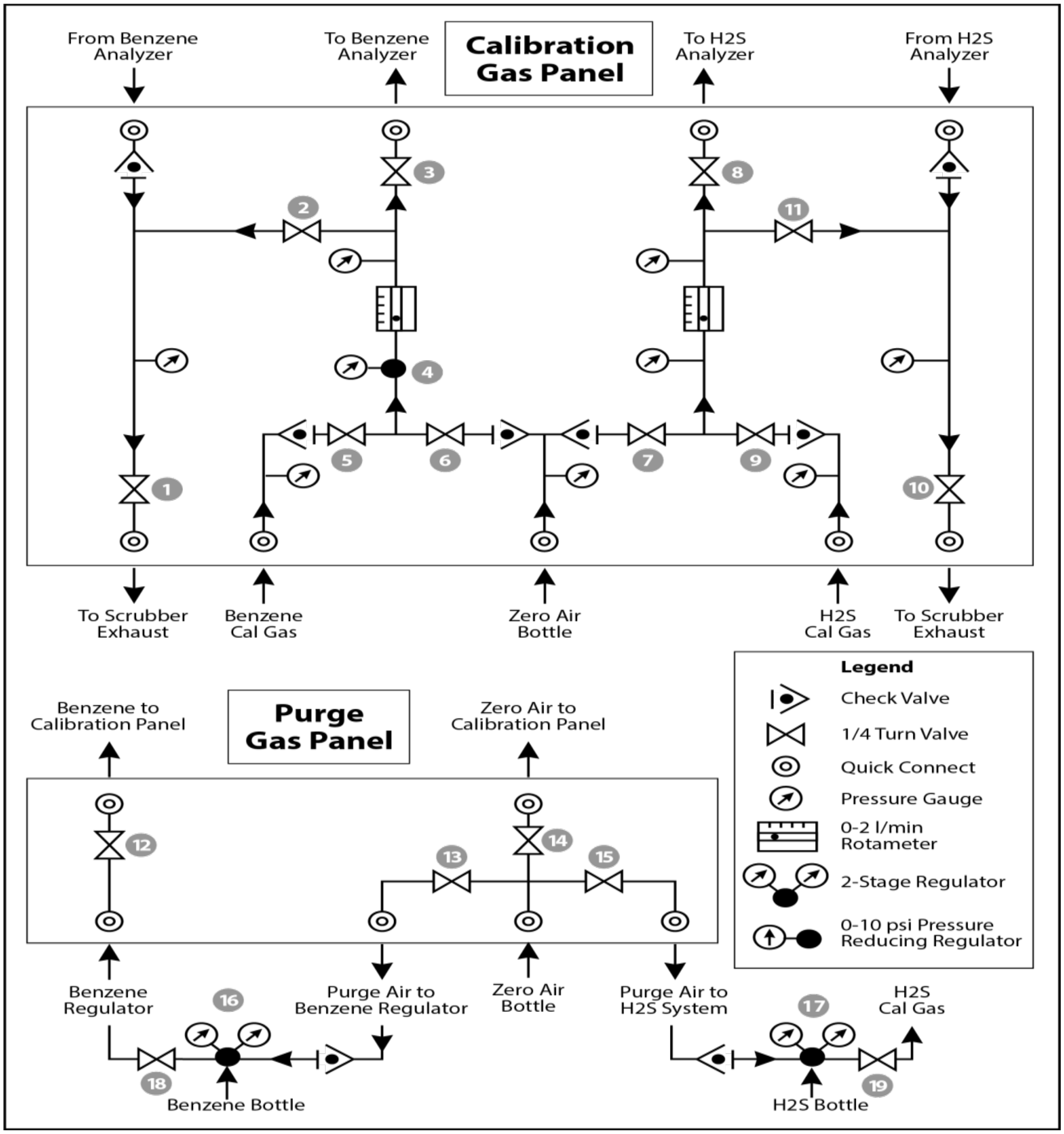


Figure A-8. Diagram of the calibration gas panel (top) and purge gas panel (bottom) used for gas delivery.

7.7.3 Prepare CMS for Gas Testing

Note: There is a summary of system settings in Section 5 that can help you when you are changing any setting in the Cerex UV-DOAS instrument.

7.7.4 Configure CMS for Test (This may be concurrent with Gas Purge System setup)

1. The analyzer should be powered and running for **at least 30 minutes**.
2. Stop CMS data collection by pressing the **STOP** button.

7.7.5 Configure Test Files

1. Click **Advanced** on the left side of the CMS software window; password is *advanced*.
2. Under **Advanced** -> **Settings** -> **Runtime -> File**, turn off **Secondary Logging**. Change the primary file logging paths (both of them) to: C:\Users\CMS-USER\Documents\Cerex\Data\bumptest. Then select **File** and select **Save**.

7.7.6 Leak Check

1. Ensure all the tubing from the purging panel is connected to the calibration panel in the mobile van. Ensure gas cylinders are connected to the purge panel as depicted in Figure A-8. Then attach the calibration panel to the analyzer connection in the analyzer shelter.
2. Connect the PTFE tubing containing the activated carbon scrubber to the analyzer exhaust.
3. Close all valves on the calibration and purging panel.
4. Verify that the regulators on the zero air and benzene cylinders are completely closed (all the way to the LEFT!!) to prevent any pressure buildup at the regulator.
5. Open high pressure valves on both the benzene and zero air bottles.
6. Open valve (14) and slowly open the regulator on the zero air cylinder to a pressure of 5-10 psi, observed on the calibration panel zero gas pressure gauge. Do this by making small adjustments at the cylinder regulator and watching the pressure on the calibration panel.
7. Open valve (12) and slowly open the regulator on the benzene cylinder to a pressure of 5-10 psi on the pressure gauge on the benzene calibration gas channel of the panel. Do this by making small adjustments at the cylinder regulator and watching the pressure on the calibration panel.
8. Open the bypass valve (2).
9. Open zero air valve (6) and slowly open the regulator to a final pressure of about 2 psi (as read on cell and exhaust pressure gauges). **DO NOT pressurize above 3 psi**.
10. Now pressurize cell: slowly open the valve going to the cell (valve 3) and close the bypass valve (2) while carefully watching the cell pressure gauge after the regulator (4). If you note any sudden pressure increase, just open the bypass valve (2) to relieve the pressure on the cell. Wait until the same pressure is reached on the pressure gauge of the exhaust side of the calibration panel.
11. Close the zero air valve (6) going to the benzene regulator on the panel so the system is now fully closed off to external pressure.
12. Watch the system for a minimum of 5 minutes to ensure there is no pressure drop and the system is leak free.
13. Open the leak check valve (1) to release the pressure from the system, and then close all the valves on both panels.

14. Record leak check.
15. Click the **ALIGN** button at the bottom left of the plot display.
16. Adjust the alignment until the signal intensity is optimized.
    a. **Target intensity is 70 – 90%.**
    b. **Target integration time is between 20 ms and 25 ms.**
17. **Record** the intensity and integration time.

7.7.7 Bump Test

This procedure was written assuming that the benzene and zero (purge) air side of the calibration panel has been pressurized according to the procedure above. At this point it is prudent to set up the instrument to start taking test measurements according to the UV-DOAS test procedure.

Background Measurement Using Zero (Purge) Gas

1. Close the secondary pressure regulator (4) on the panel by turning all the way to the left.
2. Open the leak check (1) and bypass valve (2)
3. Open Zero Air Valve (6)
4. Adjust the flow of purge air going through the bypass until the desired flow rate (1 lpm) and pressure are achieved by slowly increasing the pressure on the secondary pressure regulator (4). The backpressure on the scrubber (measured between valves (1) and (2)) is typically less than 1 psi.
5. Open the valve going to the cell (3) and close the valve on the bypass (2) while carefully watching the cell pressure gauge after the regulator (4). If you note any sudden pressure increase, just open the bypass valve (2) to relieve the pressure on the cell. Wait until the desired flow rate has stayed the same and the pressure on the entire system has not increased.
6. Press **RUN** to start background acquisitions
7. Flow compressed zero air purge gas at total flow of 1 L/min for 10 30-second acquisitions.
8. Monitor until a stable zero reading is reached and then allow the analyzer to run until an acceptable background is reached.
9. Close the zero gas valve (6).
10. Close all valves.
11. Close the secondary pressure regulator (4) on the panel.

Span Test

1. Open the leak check (1) and bypass valve (2).

2. Open the benzene valve (5).
3. Adjust the flow of benzene going through the bypass and scrubber until the desired flow rate (1 lpm) and pressure are achieved by slowly increasing the pressure on the secondary pressure regulator (4). The backpressure on the scrubber (measured between valves (1) and (2)) is typically less than 1 psi.
4. Open the valve going to the cell (3) and close the valve on the bypass (2) while carefully watching the cell pressure gauge after the regulator (4). If you note any sudden pressure increase, just open the bypass valve (2) to relieve the pressure on the cell. Ensure the desired flow rate has stayed the same and adjust as needed.
5. Wait 5 minutes to fill and condition lines and cell.
6. After 5 minutes of Check Gas flow, press **Start** in CMS.
7. Collect Check Gas data.
   a. Observe the concentration reported on the **DATA** tab.
   b. After the concentration becomes stable, allow the analyzer **to run until 15 stable measurements are made.**
   c. **Verify that the value is near the expected concentration.** If the measurements do not meet the data quality objectives listed in the QAPP, repeat the procedure. If repeated measurements appear nonconforming, initiate corrective action investigation.

Completion of Test and Purge of Benzene Regulator

1. Close the benzene cylinder. You will see benzene pressure increase and/or fluctuate as the pressure on the bottle regulator drops. This is normal - be patient and wait for the benzene pressure to zero out.
2. When pressure on cylinder and panel read zero, open the benzene purge valve (13)
3. **Verify that the target gas(es) concentration has returned to 0 ppm** with non-detect R2.

NOTE If not, ambient background target gas concentration has changed during the procedure; testing may need to be repeated to verify results.

4. Once zero reading is indicated on the UV-DOAS, close all valves.
5. Close the zero air cylinder and allow for all the pressure to be released from the system.
6. Close all valves and ensure there is zero pressure on the system.
7. Disconnect tubing to the analyzer and activated carbon scrubber.

Restore Normal Operation

1. **Restore** Normal Operation.

   Note: When restoring normal operation, you will change the file writing path in the settings menu back to the normal file writing path (this is slightly different for each unit, so make a note when first setting up the instrument for the QA test). Once you restart CMS, you will see the file number located on the UV main menu of CMS. If the file count restarts and starts at file 1, you have the incorrect file writing path because it is starting a new folder for the entire day. Also, once you restart CMS, take a look at the single beam graph also located on the CMS UV main menu to ensure a good alignment and intensity in the lower UV wavelengths.

2. **STOP** CMS.
3. On the CMS **OPERATION** tab, enter the site name "UV# YearMoDy" and click **APPLY.** Click the **RUN** button and allow the analyzer to complete at least one acquisition.
4. Press **STOP.**
5. **Check the system alignment** as previously described.
6. Press **RUN** to begin monitoring.

Test Suspension

In the event of a leak or plant alarm requiring suspension of work, the process should be safely suspended.

1. If a plant or site alarm sounds during the validation, stop the test immediately as follows.
2. Close the reference gas bottle valve completely.
3. Allow the system to flow purge gas to the scrubber/vent.

Data Evaluation and Reporting

1. Concentration
    a. Average the concentration of 15 consecutive stable measurements.
    b. Report the percent difference between the average and the certified value. The acceptable percent difference is greater than 20% of the calculated certified value.

       Note: To calculate the certified value that will be seen on the Cerex UV-DOAS from the actual certified instrument calibration gas concentration, you multiply the certified gas concentration by the calibration cell length (0.047 meters) and divide that answer by the path length set in the instrument software. For most Cerex instruments in operation by Sonoma Technology, the path length is set to 2 meters.
2. Calculate the Limits of Detection and Quantitation.
    a. Calculate the sample standard deviation of the 15 selected results.
    b. Report the Detection Limit as three times the standard deviation.
    c. Report the Quantitation Limit as five times the standard deviation.

3. Compile all configuration files, spectra files, and log files into a single folder.
    a. The folder should be named "CUS LOC QATest UV# YearMonDy" where CUS is a three-letter designator for the customer and LOC is a three-letter designator for the facility location.

8. Data Validation and Quality Control

Data for the fenceline monitoring network appears on both public and internal sites. The internal website allows for detailed quality control and flagging of the data. Data are checked daily and finalized quarterly as outlined in the QAPP. This section outlines how to perform daily and quarterly data validation.

8.1 Daily Checks

Both public website and admin website need to be checked twice daily (for example, before 10 AM and 10 PM).

1. Ensure that the site is operating properly by pointing your browser to elsegundo1180.com.
2. View the data display at https://elsegundo1180.com/data. Take note of any outages by selecting **All Compounds**" from the pollutant dropdown menu.
3. View the timeseries graphs for each species by selecting them in the pollutant dropdown menu. Verify that pollutant concentrations are reasonable by using the guidance in Table A-1. Notify the field operations team if anything seems erroneous.

Table A-1. List of parameters measured with the UV-DOAS with notes on the typical characteristics of the data.

Parameter	Observational Notes
Visibility	~30 miles is the maximum measured by the sensor. Values are typically less than 30 miles due to smog and fog.
Integration Time	Should generally be <250 ms. Report values stuck at 300 ms to PM and fieldopsalerts. Should be anticorrelated with visibility for fog events.
Winds	Typically there is a sea breeze during the day, land breeze at night. Winds are stronger near the coast at met west.
HCN	Typically below MDL (~1 ppb) – note any high values above REL

Parameter	Observational Notes
Benzene	Typically below MDL (~1 ppb) – note any high values above REL or immediately visible on the public website (this is a toxic compound)
Toluene	Typically below MDL (~1 ppb) – note any high values above REL
Ethylbenzene	Typically below MDL (~1 ppb) – note any high values above REL
o-xylene	Typically below MDL (~1 ppb)– note any high values above REL
m-xylene	Typically below MDL (~1 ppb) – note any high values above REL
p-xylene	Typically below MDL (~1 ppb) – note any high values above REL
VOCs	Sum of C2 through C5 alkanes. Typically show zero, although this is suspect and subject to change.
SO2	0 to 100 ppb, usually zero. Refineries are a local source – note any high values above REL
NO2	Typically 0 to 200 ppb. values typically peak at night; sunlight destroys it, traffic and combustion produce it. Some instruments may not detect NO_2 if they are saturated.

8.2 Quarterly Validation

Quarterly validation activities involve looking at the data over a longer time period (3 months) than the daily checks (typically a time range of a few days).

1. Plot time series and look for statistical anomalies. If problems are found they may be flagged using the DMS.
2. Review any instrument bump test results.
3. Verify that daily instrument checks were acceptable.
4. Review manual changes to operations/data, and verify that the changes were logged and appropriately flagged; ensure that logged information is complete and understandable.
5. Ensure that instrument checks have the appropriate QC codes applied.
6. Assign invalid data a Null Code, providing a reason for data being invalid.

7. If a record is not created for a particular site/date/time/parameter combination, create a null record for data completeness.
8. Inspect data consistency.
9. Review collected data ranges for consistency – ranges should remain within expected values over months of monitoring.
10. Check bump test values for completeness; ensure they meet acceptance criteria.
11. Review quarterly data completeness.

9. Monthly Maintenance Forms

Path:______________________________

Technician:________________________

Date:______________________________

Instructions: complete checks described below and enter data or initial next to each one once complete. Make note of any corrective action.

Please check off the following steps needed to minimize false notifications to our clients and the public.

- ☐ Notify fieldopsalerts@sonomatech.com of ANY, no matter how minor, maintenance to be done fenceline systems. Do not proceed with maintenance until you get confirmation that REL alerts are disabled.
- ☐ Disable data communications to the website during maintenance. Ensure you know how to do this correctly. If you have any doubts, check with the project manager.
- ☐ When maintenance is complete, re-establish data flow and check the public site for at least 1/2 hr to ensure proper reporting (no missing data, no high values, etc.).
- ☐ Notify fieldopsalerts when you are confident that the data shown to the public site are accurate.

Note that field measurements are frequently carried out on off hours (early morning), so please give the web team at STI enough “heads up” so they can disable the REL notifications.

Upon completion sign and date:_______________________________

Checklist of maintenance activities for the UV-DOAS.

Activity	Monthly
Visually inspect the system (an evolving checklist will be maintained).	
Current bulb service hours.	
Signal Intensity at 250 nm (% at 40 ms integration time)	
Inspect system filters (clean if necessary)	
Confirm the alignment to verify there has not been significant physical movement. This is also automatically monitored.	
Ensure there are no obstructions between the detector and the retro-reflector (such as equipment, vegetation, or vehicles).	
Move data older than 1 week old into an archive folder & note location.	
Remove archive data that is older than 6 months old and store on an offsite location (note location in corrective actions below). Deliver a copy to Chevron	
Realign instrument.	
Activity	**Quarterly**
Perform bump test.	
Replace UV source.	
Inspect and replace system filters.	
Clean and inspect optics on detector and retro-reflector.	
Activity	**Annually**
Verify system settings.	

Corrective Actions for UV-DOAS:

UV Sentry Fenceline Detection System

DATE: ________________ Location: ______________________________

Test Technician 1:___________________________ 2:___________________________

Sentry Alignment

Integration time	________________________	Target 20-24ms
300 nm Intensity	________________________	Target 80-120%
254 nm Intensity	________________________	Target >5%

Gas Purge System

Flow purge gas Start Time ____________________

Prepare CMS

Path length in the CMS Configuration ____________________ m

Configure Test Files

Site File (i.e. QA Audit UV# YearMoDy) ______________________________________

Baseline Check ____________________ init

Reference Gas

Concentration ____________________ ppm

Source ____

Date ____________________

Cylinder Pressure ____________________

NOTES:

QA Audit Record - UV Sentry Detection System - Page 2

Purge Flow Conditions

Start Time ________________________

Purge Gas flow ________________________ L/min

NOTES: Around 1 LPM

Check Gas Test

Initial Gas flow ________________________ L/min

Around 1 LPM

Start Time ________________________

Reduced Gas flow ________________________ L/min

Start Time ________________________

Collect Check Gas Data Start Time ________________________

Data Record:

TIME	PPM	R2

Verify Client ________________________ Init

Stop Time ________________________ Init

Open the **PURGE** gas Time ________________________

Reference Concentration __________ ppm

Average Concentration __________ ppm

% difference (+/- 20% Acceptable) __________ %

Std Deviation __________ ppm

Estimated MDL (3X Std Dev) __________ ppm

Restore Normal Operation

Restore running data file ________________________ Init

Press **RUN** to begin monitoring. ________________________ Init

Appendix B

CEREX AirSentry FTIR QA Audit Procedure

May 19, 2019 STI-918045-7036-SOP

Contact: Ryan Moffet
Sonoma Technology, Inc.
rmoffet@sonomatech.com
707-665-9900

Contents

QA Audit Procedure Summary

This document addresses the commissioning and performance audit procedure for Cerex Monitoring Solutions AirSentry units. The procedure is intended to verify that the equipment is performing to expectations and that the detection and communication links are functioning correctly.

***NOTE ***
THIS IS A WORKING DRAFT FOR INITIAL SYSTEM VALIDATION.
IT SHOULD BE REVIEWED FOR COMPLIANCE WITH LOCAL SAFETY AND QUALITY ASSURANCE PRACTICES.
This procedure should only be used by personnel with experience in the safe use of the analyzer and test equipment.

The purpose of the QA Audit procedure is field verification of the factory calibration of the AirSentry. The QA Audit process challenges the instrument using known concentrations of Ammonia, Hexane, and/or 1,3-butadiene to verify proper detection and quantification under field conditions.

QA audits (bump tests) are to be performed on a quarterly basis.

Safe Work and Hazard Identification

The following information should be noted when preparing work plans and permits for safe work practices.

Operator Qualifications

Installing, operating, and servicing Cerex AirSentry FTIR analyzers should only be performed by personnel trained in the operation of the system components and familiar with the handling of gas delivery and testing equipment. This includes troubleshooting, cleaning, replacement of parts, IR light source installation, etc.

Safe Work and Hazardous Environment Operation

Work should conform with manufacturer guidance and site health and safety practices.

The Cerex Monitoring Solutions AirSentry Series Analyzers are not rated for safe operation in hazardous or explosive environments. Any uses in an area that may contain flammable mixtures or highly corrosive vapors require special preparation to address safety and ensure safe operation of the equipment.

CAUTION – Laser Radiation. Risk of eye injury with prolonged direct exposure. CEREX FTIR Analyzers contain a Class 3B invisible laser radiation when the interferometer cover is removed. Do not remove the interferometer cover. Eye protection is recommended when working near the IR source.

Procedure Warnings

This QA Audit procedure requires the handling of hazardous Ammonia, Hexane and/or 1,3-butadiene, and it requires the operation of equipment designed for toxic gas containment and dispensation. Improper handling of materials or hardware may result in serious injury, destruction of property, or damage to the AirSentry FTIR. Only qualified individuals should attempt or perform analyzer quality assurance audit activities. Cerex assumes no liability for the use or misuse of this guidance document, or for operator-performed QA Audits, Calibration, or Gas Handling activities. No claims are made by Cerex as to the compliance of this procedure with any regulations or engineering best practices. The operator is solely responsible for safety of personnel and property.

Preliminary Preparation

Safe Operating Precautions

1. Locate the closest safety showers and eyewash stations and ensure they are operational.
2. Field at least 2 people for the validations.
3. Ensure that a clear escape path is identified.
4. Standard site PPE is appropriate. If gloves are required, nitrile or latex should be used.
5. Operator should be fully trained and experienced in the use of compressed gas cylinders, 1 and 2 stage regulators used in conjunction with the cylinders, flow controllers, tubing connections (Swagelok, for example). Operator should be experienced with the parameters of flow and pressure, and how these relate to compressed gas and its use with calibrating gas analysis equipment.

Test Apparatus Setup

Materials Required

1. Operator supplied Standard Operating Procedure approved by the End-User and in compliance with End-User’s Health and Safety Plan.
2. This procedure is for the Internal AirSentry FTIR QA Cell

3. Cell bump test purge apparatus including:
    a. Tubing as required: 1/4” PTFE tubing for gas supply from the bottle to the QA cell
    b. Tubing as required: 1/4” PTFE tubing with inline flow indicator from the QA cell to the vent
    c. Flow regulation system capable of delivering gas 0.1 to 5 L/min at a total system pressure of 3 psig or less.
4. Purge gas
5. Reference standard traceable gas blend in nitrogen for detection at about 10X instrument theoretical detection limit or higher.
6. All relevant PPE, hardware and procedural guidance per SOP, Safety Plan, and Safe Work Permit.
7. Local or remote network link device (as required).
8. External laptop computer with network interface device to the AirSentry FTIR unit (as required).

Verify Proper AirSentry Alignment

1. Open the CMS window.
2. Click on the **FTIR** tab.
3. If Run is active, press **STOP**.
4. Click the **ALIGN** button at the bottom left of the plot display.
5. Select 32 cm^{-1} and wait for resolution change.
6. Aim the AirSentry FTIR at the retroreflector and adjust the alignment until the signal intensity is optimized.
    a. **Target intensity should be between 20% and 80%. Once stable signal is obtained, select desired operating resolution – 1 cm^{-1} is required unless otherwise directed by Cerex.**
7. **Record** the signal intensity.
8. **Optional – at this point you may wish to record the current field pathlength, and create a backup of the existing configuration file, in the event that you need a restore-point**
9. **Set** the QA Cell’s path length – 0.15 m is the required value.
10. Press **OK and SAVE** or **ACCEPT** (when prompted) settings to exit the CMS Alignment window.
11. Press **RUN** to resume operation. If the FTIR analyzer is accidentally bumped or moved in any way, then stop the procedure, and return to the Align to verify and correct if necessary.

Gas Purge System Setup and Purge

1. Connect the reference cell vent line to the reference cell and route it through an appropriate vapor scrubber (as required) and outside the structure.
2. A precision 2 stage regulator is attached to the cylinder (both target gas, and N_2 purge gas) at all times. Before connecting verify that the output pressure is set to less than 1 psi. Verify the flow rate is preset to 1 liter per minute prior to connecting to the FTIR. **Failure to follow this step will result in permanent and costly damage to the QA cell.**
3. Connect the purge gas cylinder tubing to the AirSentry FTIR Gas Inlet and tighten.
4. Slowly open the valve (flow previously adjusted to 1 L/min). Ensure the cell vent is open and unobstructed to atmosphere by monitoring vent flow. **Cell pressure must remain below 1 psi**.
5. Flow purge gas at vent flow of 1 L/min for 1 minute to purge the system.
6. Take a clean air background after a minimum of three volume exchanges have completed. Ensure the background is “saved” in the software, and that the software is using this updated, new background. Further instructions can be found in the CMS manual if required.
7. Reduce flow to 0.3 L/min

Prepare CMS for Gas Testing

Configure CMS for Audit - (This may be concurrent with Gas Purge System setup)

1. The analyzer should be powered and running for **at least 30 minutes**.
2. Stop CMS data collection by pressing the **STOP** button.

Configure Test Files

1. On the CMS **OPERATION** tab enter the site file name, “QA Audit FTIR# YearMoDy” where # is the FTIR identification number and YearMnDy indicates the date of the test (i.e., 1969Aug09). Click the **APPLY** button.
2. Click the **RUN** button and allow the analyzer to complete 3 or more acquisitions.
    a. If after 2 acquisitions the absorbance graph shows negative features greater than 3X the peak-to-peak baseline noise level, take another clean air background.
3. Repeat this process until sequential absorbance acquisitions (as seen in the absorbance graph) remain near zero (a straight baseline with only normal noise peaks).
4. Click the **FTIR** Tab and inspect the absorbance plot for background target gas detection. If none is present, proceed to the next step.
5. Click the **RUN** button and allow the analyzer to continue operation.

Gas Check and QA Audit

Span Gas Test

1. Start Span Gas flow.
   a. Close the purge gas to stop flow and remove purge gas tubing from the Gas Inlet.
   b. Allow residual pressure to vent (approximately 10 seconds).
   c. Prior to connecting to the analyzer, ensure the span gas regulator is set to flow 1 L/min, and is at a pressure of less than 1 psi.
   d. Connect Span gas's tubing to Gas Inlet and open the Span gas flow control slowly.

NOTE **Cell pressure must remain below 1 psi, or optical windows may break.**

   e. Set vent flow to 1 L/min.
   f. After 1 min, reduce flow to 0.3 L/min.
2. Collect Span Gas data.
   a. Observe the concentration reported on the **DATA** tab.
   b. After the concentration becomes stable, allow the analyzer **to run until at least 15 stable measurements are made.**
   c. **Verify that the value is near the expected concentration (±25% of reference standard).** If the measurements do not meet specifications, repeat the procedure. If repeated measurements appear nonconforming, initiate corrective action investigation.
   d. **Verify client system** is receiving and displaying instrument information correctly.
   e. After 15 stable measurements are observed, **close the Reference bottle valve**. Allow the pressure to fall to zero and flow to stop.
3. Purge the Reference gas
   a. **Open the purge gas** valve to flow nitrogen through the system.
   b. **Set the flow** rate to 3 L/min.
   c. **Purge the QA cell** with nitrogen for at least 2 minutes.
   d. **Verify that the target gas(es) concentration has returned to 0 ppm** with non-detect R2.

*****NOTE*****If not, ambient background target gas concentration has changed during the procedure; testing may need to be repeated to verify results.

   e. Once the target gas value returns to non-detect, stop flow.
   f. Remove the hoses and cap the connectors.

Restore Normal Operation

1. **Restore** Normal Operation.
2. **STOP** CMS.
3. On the CMS **OPERATION** tab enter the site name "FTIR# YearMoDy" and click **APPLY.** Click the **RUN** button and allow the analyzer to complete at least one acquisition.
4. Press **STOP.**
5. **Check the system alignment** as previously described.
6. Be sure to set the pathlength back to the field value (i.e., not 0.15). Restore the field background file, or let auto-background perform this function (if enabled).
7. Press **RUN** to begin monitoring.

Test Suspension

In the event of a leak or plant alarm requiring suspension of work, the process should be safely suspended.

1. If a plant or site alarm sounds during the validation, stop the test immediately as follows.
2. Close the reference gas bottle valve completely.
3. Allow the system to flow purge gas to the scrubber/vent.

Data Evaluation and Reporting

1. Concentration
    a. Average the concentration of 15 consecutive stable measurements.
    b. Report the percent difference between the average and the certified value.
2. Calculate the Limits of Detection and Quantitation
    a. Calculate the sample standard deviation of the 15 selected results.
    b. Report the Detection Limit as three times the standard deviation.
    c. Report the Quantitation Limit as five times the standard deviation.
3. Compile all configuration files, spectra files, and log files into a single folder.
    a. The folder should be named "CUS LOC QATest FTIR# YearMonDy" where CUS is a three letter designator for the customer and LOC is a three letter designator for the facility location.

AirSentry FTIR Fenceline Detection System

DATE: ________________ Location: ______________________________

Test Technician 1 :___________________________

Test Technician 2 :___________________________

AirSentry Alignment

Intensity ________________________ Target 20% to 80%

Gas Purge System

Flow purge gas

Start Time ___________________

Stop Time ___________________

Prepare CMS

Saved "**Run Configuration**" in ____

Path length in the CMS Configuration ___________________ m

Save "**Audit Configuration**" in the default directory. ___________________ initials

Configure Test Files

Site File (QA Audit FTIR# YearMoDy) ______________________________________

Optical Ringing Check ___________________ initials

NOTES:

QA Audit Record - AirSentry FTIR Vapor Detection System - Page 2

Purge Flow Conditions

Initial Gas flow ____________________ L/min
Start Time____________________
Reduced Gas flow____________________ L/min

Check Gas Test

Initial Gas flow ____________________ L/min
Start Time____________________
Reduced Gas flow time ____________________
Start Time____________________
Collect Check Gas data
Start Time ____________________
Concentration ____________________ ppm
Verify Client ____________________ Initial
Stop Time ____________________ Initial
Close Reference Gas Start Time ____________________

Open the **PURGE** gas ____________________
End Test Gas Concentration
________ppm_______ R2
________ppm_______ R2
________ppm_______ R2
________ppm_______ R2
________ppm_______ R2
________ppm_______ R2
________ppm_______ R2

Restore Normal Operation

Settings > **Configuration** > **File** > **Load** > **C:\User\Documents\Cerex\CMS** > **'Run Configuration'**
Operation > Ammonia FTIR# > **Apply**.
RUN > complete one acquisition > **STOP**
Verify Ammonia Background Ammonia________ppm_______ R2
Press **RUN** to begin monitoring. ____________________ Init

Data Files (CUS LOC QATest FTIR# YearMonDy) ____________________________________

NOTES:

SOP for: Synspec GC955 Hydrocarbon Analyser

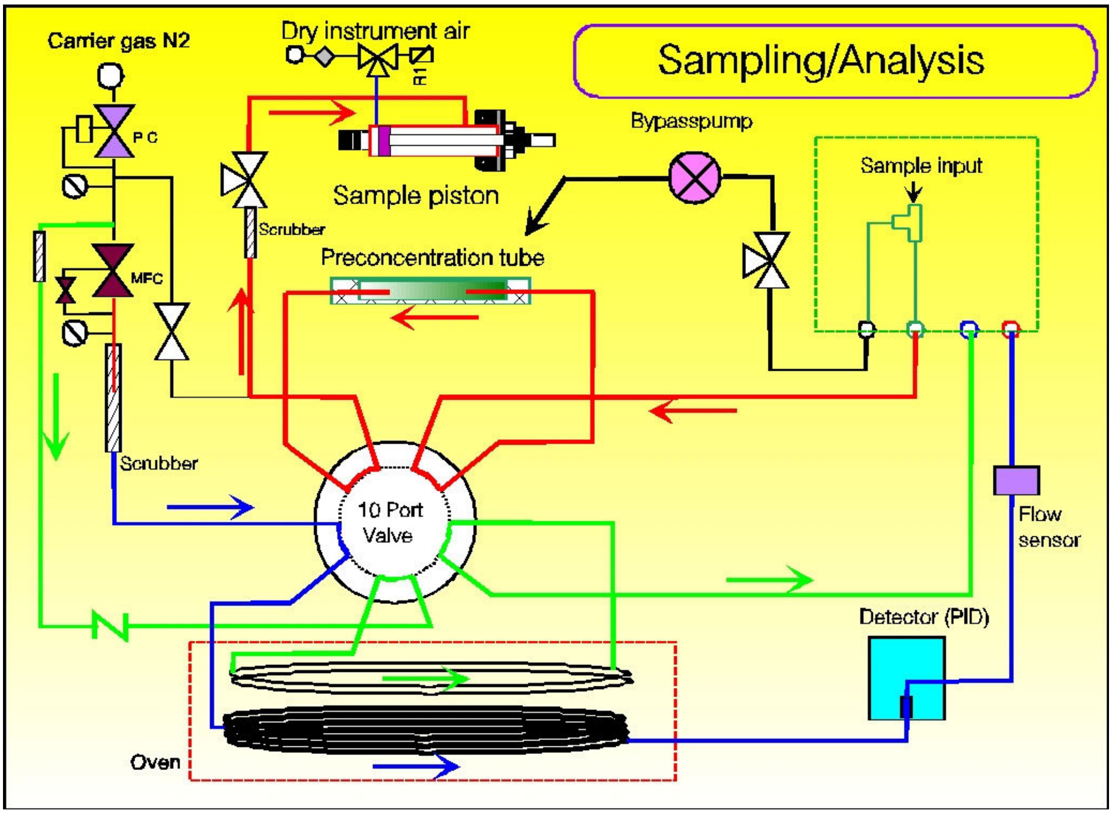
1 Scope and Application

This document refers to the use of the Synspec GC 955 analyser for the continuous measurement of volatile organic compounds at community air monitoring stations. The document includes procedures on the operation, quality checking and calibration of the unit.

2 Summary of Method

A gas chromatograph for the automatic measurement of air samples and other gases has a special method to take a sample: not by injection, but by leading the sample through a loop. Either the sample is pumped, or the sample flows in under a slight overpressure. By switching a valve the sample is introduced into a gas chromatographic column where it is separated. Then the separated compounds are measured in the detector. The figure below from the GC 955 manual shows the unit configuration:

Figure 2.1: Instrument Configuration in analyzing/sampling mode (from GC955 Manual)



The major processes in getting from a sample to a concentration value are described in Section 3 of the GC955 manual. These basic processes are:

- Sampling: taking a sample of fresh air
- Preconcentration: getting enough sample for analysis
- Desorption and stripping: getting the sample from the preconcentrator to the column

- Separation: passing the gas through a column
- Detection: The gases from the column are passed through a photionisation detector

3 Definitions

Abbreviation	**Meaning**
AC	Alternating current
BAM	Beta attenuation monitor
BC	Black carbon
C14	Carbon 14
CFR	Code of Federal Regulations
CO2	Carbon dioxide
CPU	Central processing unit
CV	Coefficient of variance
DAS	Data acquisition system
DOT	Department of Transport
DQO	Data quality objective
DRV	Documented Reference value
EC	Elemental Carbon
FEM	Federal equivalent method
GC	Gas chromatograph
H2O	Water
H2S	Hydrogen sulfide
IO	Input/output
IR	Infra-red
IZS	Internal zero /span device
kV	kilo volts
LPM	liters per minute
MFC	Mass flow control/controller
MSDS	Material safety datasheet
N/A	Not applicable
NH3	Ammonia
NH$_3$_CE_FACTOR1	The ammonia converter efficiency factor
NO	Nitrogen oxide
NO2	Nitrogen dioxide
NO$_2$ CE FACTOR1	Nitrogen oxide efficiency factor
NOx	Oxides of nitrogen
O2	Oxygen
PC	Personal computer
PID	Photo-ionisation detector
PM	Particulate matter
PM10	Particulate matter with aerodynamic diameter less than 10um
PM2.5	Particulate matter with aerodynamic diameter less than 2.5um
ppb	part per billion

Abbreviation	**Meaning**
ppm	parts per million
psi	Pounds per square inch
QA	Quality assurance
QC	Quality control
QS	Quality standard
RH	Relative humidity
RS-232	Analyzer digital communication port
SO2	Sulfur dioxide
SOP	Standard operating procedure
TM	Trade mark
TNX	The sum of the ammonia and the oxides of nitrogen concentrations
UPS	Uninterrupted Power Supply
US EPA	United States Environmental protection agency
UV	Ultra violet
VAC	Volts alternating current
VSCC	Very sharp cut cyclone
Z/S	Zero/Span

4 Health and Safety Warnings

Please note that the following risks have to be considered when working with the instrument:

- A relevant selection of the gases nitrogen, helium, hydrogen and air at a pressure from 0.5 to 5 bar will be connected to the instrument. Personnel must be schooled in working safely with these gases.
- The instrument works with a 220VAC power supply. Inside the instrument there is a high voltage supply of 2 kV in a protective housing.
- The preconcentration unit will be at a temperature of 100 to 260 °C during desorption.

5 Cautions

See section above and GC955 operations manual.

6 Interferences

Individual analyses can be affected by the peaks from other organic compounds in the gas mixture. These are mitigated by:

- Making sure that the peaks chosen are not too broad with the assistance of the manufacturer
- Perform monthly checks with a traceable gas mixture

7 Personnel Requirements

The person’s chosen to operate the unit need to have a basic understanding of chemistry and electronics

8 Equipment and Supplies

Monitoring Apparatus: GC 955 with PID detector see figure 2.1 for schematic

Other apparatus and equipment includes the following.
Instrument Shelter: A shelter is required to protect the analyzer from precipitation and adverse weather conditions, maintain operating temperature within the analyzer's temperature range requirements, and provide security and electrical power. The recommended shelter temperature range is 20-30^{o}C.
Spare Parts and Incidental Supplies: See the GC955 manual, Section 6, for a list of recommended spare parts.
Calibration System: A system that creates concentrations of organic target gases of known quality is necessary for establishing traceability..
DAS: A data acquisition system is necessary for storage of ambient and ancillary data collected by the GC955. This is detailed in the SOP_CHEV_BO_19: SOP for data acquisition and storage.

9 Sampling Procedures

9.1 Sample Collection

Sample collection for hydrocarbons is performed by drawing ambient air through a sample manifold into the analyzer using a vacuum pump. At 1.5 l/min The inlet is constructed of Teflon^{TM} and borosilicate glass. The siting of the community monitoring station, of which the GC955 is a part, is carried out according to the USEPA Quality Assurance Handbook Volume II.

9.2 Sample Handling and Preservation

The sample is preconcentrated in the analyzer before being desorbed and transported through the column to the detector using Nitrogen N 5.0.

9.3 Sample Preparation and Analysis

N/A

9.4 Instrument Operation, Startup and Maintenance

This section describes the operation and maintenance of the GC955. The operator of the instrument should be familiar with the GC955 Operation manual before attempting to operate the unit

9.4.1 Startup

See Section 2 and 4 of the GC955 manual for how to connect and startup the instrument. (see excerpts form the manual below).

1. The instrument can be switched on once the gases are connected and the filter is in place. The GC must be connected to a mouse and a keyboard. The oven cover must be closed. The L-shaped cover must be put on.
2. After starting the GC the Windows 98 program starts and the 955 screen appears. A self-test is performed on electronics and PID lamp and the oven is heated to the base temperature of your default application program. Then the PID lamp is started
3. The carrier gas flow through the capillary column should be between 1.0 and 5.0 ml/min., through the packed column between 12 and 25 ml/min. This will be set by the mass flow controller. Checking for leaks or obstructions is advised after long transports, or after working without adequate filters. The flow is set for the application.
4. A pressure sensor is used to check if the pressure to switch the diaphragm valve is correct.

5. The program contains seven different functions: actual run, data file, program edit, calibration, graphs, autoliniarisation and IO-state diaphragm. See also the overview of the program structure in Chapter 3.
6. The default mode is actual run. After an automatic check of the settings, the program is standby for run. The oven must reach the desired starting temperature before the first cycle is started by clicking start run with the mouse. Now the background zero adjust signal is set, then the program starts. The detectors need some time to stabilize, so the first reset may take a minute. (In automatic mode it will start either immediately or as soon as synchronization is reached.) The measured values can be seen on the chromatogram. In the status lines below the chromatogram information is given : clock time, cycle time, the actual measured value for the detectors, ambient temperature, oven temperature. Further extra sensor signals, from left to right: pressure of valve switching air, flow of carrier gas. The ambient temperature is measured on the underside of the instrument. The base line is normally set at about 10 mm above the edge of the chromatogram window. This can be changed under actual run\options\adjust detector Y-offset. With two detectors it is most practical to keep one on offset zero and the other one at 30. With unstable baselines you may want to put it even higher.

Stopping the Program(Section 4.2.5 of the manual)

1. There are three ways to stop the program:
   The correct way is to click the button: stop run, then the program stops at the end of the present run and this run is still saved normally. After this you can either start again after making changes or you can stop the instrument: do this by clicking in the upper left corner of the window and then clicking on close
2. If you must break off in between for some reason, click abort run: now the program stops immediately and you can switch off the power. After this, go back to Windows and close the program. The next run of the GC may be contaminated by rests of the aborted run.
3. The last way is for emergencies: just switch off the power. The last run is not saved and this way of stopping the GC is only advised in emergencies, as the computer has no way to save open files correctly. Independently of the way used to stop the program the machine makes a reset of all set parameters to the position needed for a restart. This also happens in case of any power failure.

9.4.2 Operation and Range Setting

N/A

9.4.3 Diagnostic Checks/Manual Checks

To determine whether the GC955 is working properly, the field operators should perform the Diagnostic Checks every time they visit the monitoring station as per the SOP for station checks (Section 10.1 item 10). It is good practice for the operator to check these Diagnostic Checks either on the computer or manually. Below are instructions on how to perform this manually. The table below from the GC955 manual

no.	Action	dialog to use	optional
1	Switch on power	-	-
2	do first run by click start run	view mode \ actual run	check temperatures, PID lampfunctioning, attenuation
3	check peak windows	view mode \ data file \ edit screen elements and edit peak windows	wait for second run after start to get actual chromatogram
4	stop program	view mode \ actual run - stop run	click abort run in emergencies, close the program GC955 by clicking the left top pull down menu.

9.4.4 Preventative maintenance

The table below from section 6.03 of the manual summarizes the maintenance tasks for the unit:

C	1	Optimise hard disk	1 x every year	4	
D	2	Clean internal Gastubing	1x every 2 Years	6.3.3	
C	1	Clean lamphouse	1x every 2 Years	6.1.2	

9.4.5 Troubleshooting

See Section 6.02 of the GC 955 manual for the troubleshooting scheme.

9.5 Calibration and Standardisation

Two levels of calibration are undertaken in order to maintain the quality of data from the analysers at the stations. The following DQO’s are currently used to assess data quality.

- Monthly quality assurance check for zero and span using an internal permeation device (IZS)
  - Action to be taken if zero is >2ppb (immediate adjustment) and span > 15% (recalibration as soon as practicably possible) different to the documented reference value during dynamic calibration (DRV).
- Quarterly calibration consists of a zero and 80% full scale set-point calibration, followed by four evenly spaced additional checks (E.g. For 500ppb full-scale, 80%=400ppb and additional point of concentration 300ppb, 200ppb, 100ppb and zero). This five (5) point dynamic multipoint calibration must be linear (correlation >

0.96 passing within 2ppb of zero). For the 80% set-point, no adjustment is made if value “as found” is within 2%. If > 2%, analyser is adjusted. Subsequent values generated require action (repeat 80% and zero) if > 2% and ≥ 5ppb in error. (this seldom occurs) For the zero value, no adjustment is required if zero ≤ 2ppb.

- Data outside the required DQO’s is flagged for correction or removal subsequent to any corrective action taken. Removal of data is considered a last resort and would only typically occur due to analyser or component failure and then only data subsequent to the last acceptable IZS calibration check.

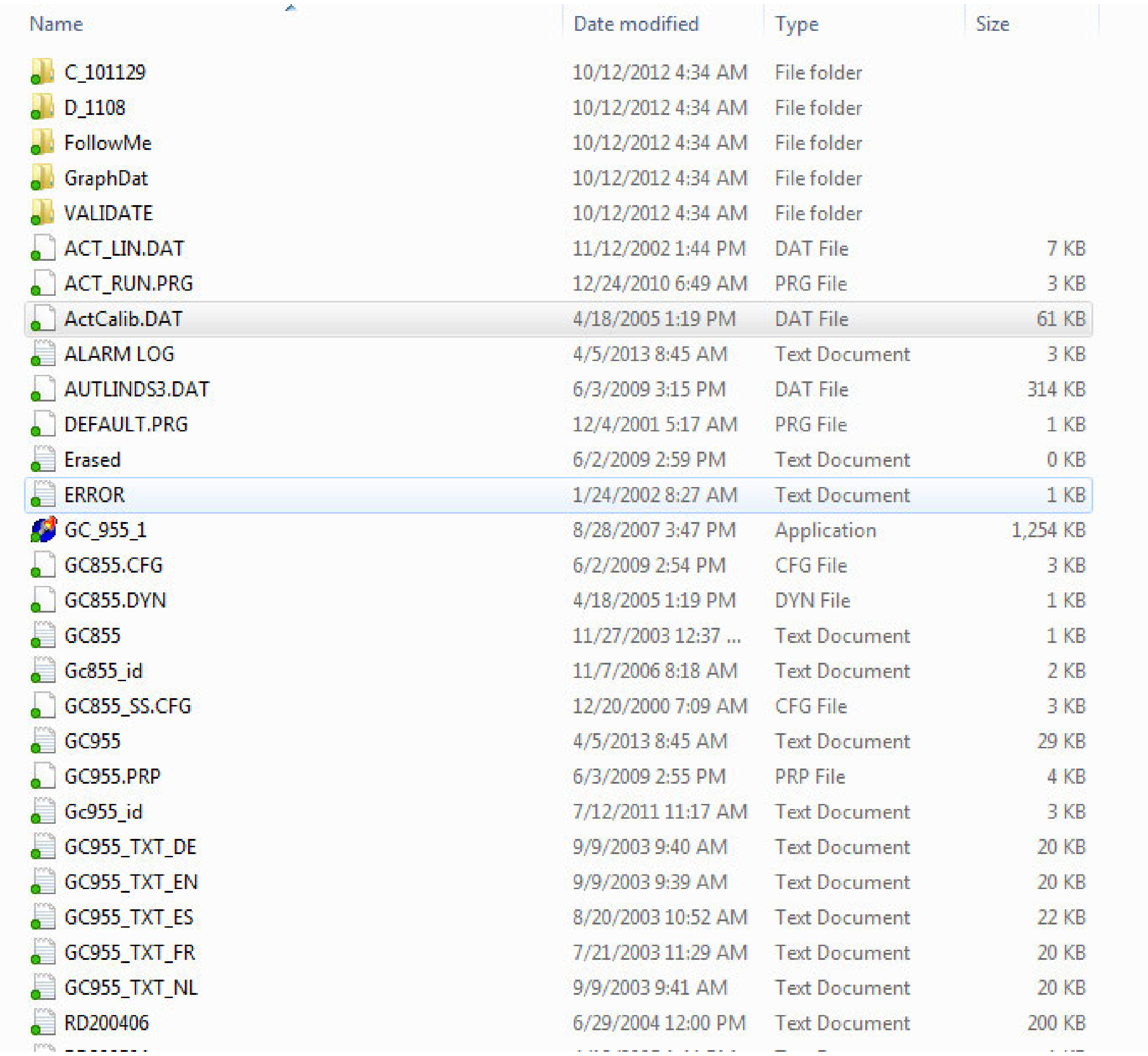
A documented reference value (DRV) for the IZS is always determined just after the dynamic calibration and forms an important part of the ongoing quality assurance of the analysers.

9.5.1 Adjustment to Zero Air

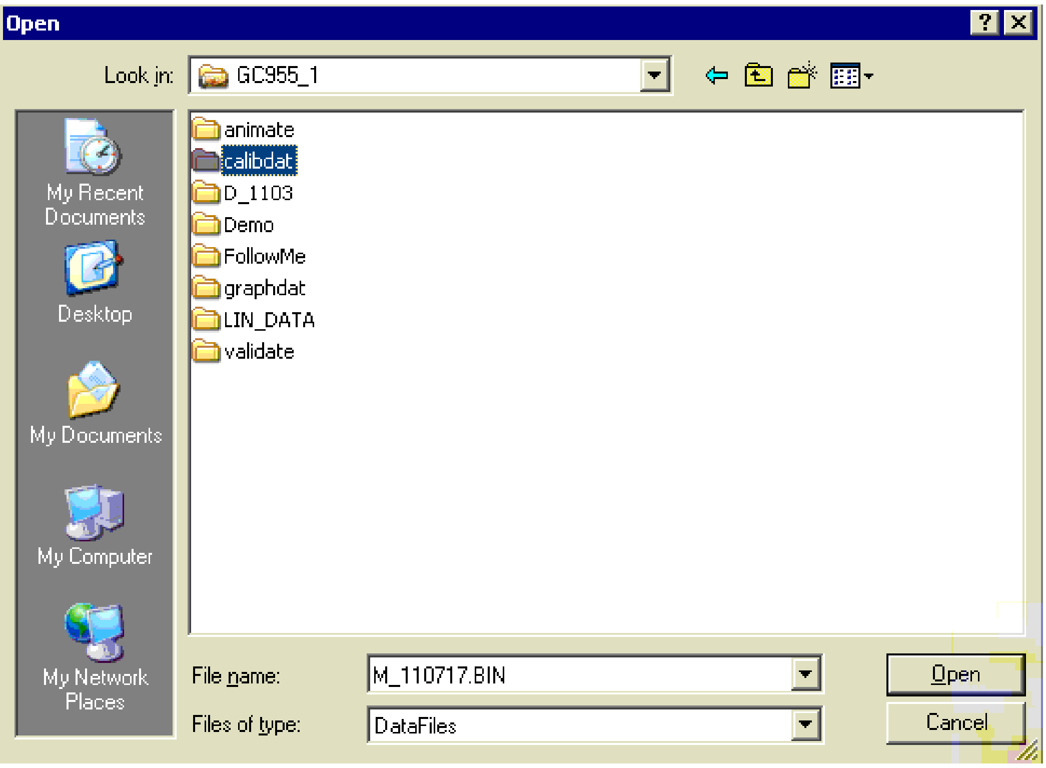
9.5.2 Adjustment to Calibration Gas

The calibration process for the analyzer is shown below (also consult section 4.3 of the GC955 manual):

1. Go to DAS and put into Cal mode from View screen
2. Use explorer and copy actcalib.dat from GC955 root directory into last valid calibration file folder – newest data in calibdat folder as shown below



Name	Date modified	Type	Size
C_101129	10/12/2012 4:34 AM	File folder	
D_1108	10/12/2012 4:34 AM	File folder	
FollowMe	10/12/2012 4:34 AM	File folder	
GraphDat	10/12/2012 4:34 AM	File folder	
VALIDATE	10/12/2012 4:34 AM	File folder	
ACT_LIN.DAT	11/12/2002 1:44 PM	DAT File	7 KB
ACT_RUN.PRG	12/24/2010 6:49 AM	PRG File	3 KB
ActCalib.DAT	4/18/2005 1:19 PM	DAT File	61 KB
ALARM LOG	4/5/2013 8:45 AM	Text Document	3 KB
AUTLINDS3.DAT	6/3/2009 3:15 PM	DAT File	314 KB
DEFAULT.PRG	12/4/2001 5:17 AM	PRG File	1 KB
Erased	6/2/2009 2:59 PM	Text Document	0 KB
ERROR	1/24/2002 8:27 AM	Text Document	1 KB
GC_955_1	8/28/2007 3:47 PM	Application	1,254 KB
GC855.CFG	6/2/2009 2:54 PM	CFG File	3 KB
GC855.DYN	4/18/2005 1:19 PM	DYN File	1 KB
GC855	11/27/2003 12:37 ...	Text Document	1 KB
Gc855_id	11/7/2006 8:18 AM	Text Document	2 KB
GC855_SS.CFG	12/20/2000 7:09 AM	CFG File	3 KB
GC955	4/5/2013 8:45 AM	Text Document	29 KB
GC955.PRP	6/3/2009 2:55 PM	PRP File	4 KB
Gc955_id	7/12/2011 11:17 AM	Text Document	3 KB
GC955_TXT_DE	9/9/2003 9:40 AM	Text Document	20 KB
GC955_TXT_EN	9/9/2003 9:39 AM	Text Document	20 KB
GC955_TXT_ES	8/20/2003 10:52 AM	Text Document	22 KB
GC955_TXT_FR	7/21/2003 11:29 AM	Text Document	20 KB
GC955_TXT_NL	9/9/2003 9:41 AM	Text Document	20 KB
RD200406	6/29/2004 12:00 PM	Text Document	200 KB



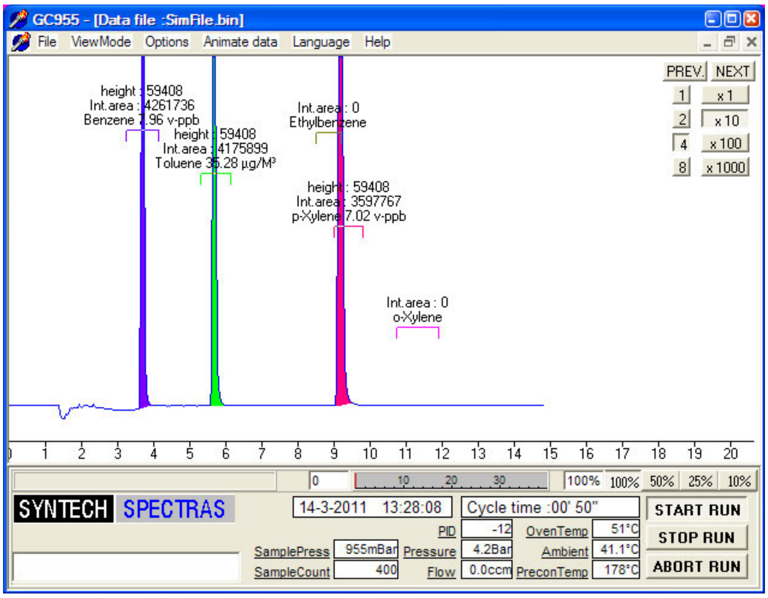
Look in: GC955_1

animate
calibdat
D_1103
Demo
FollowMe
graphdat
LIN_DATA
validate

File name: M_110717.BIN

Files of type: DataFiles

3. On GC 955 go to viewmode : act run PID



GC955 - [Data file :SimFile.bin]

height : 59408
Int.area : 4261736
Benzene 7.96 v-ppb

height : 59408
Int.area : 4175899
Toluene 35.28 µg/M³

Int.area : 0
Ethylbenzene

height : 59408
Int.area : 3597767
p-Xylene 7.02 v-ppb

Int.area : 0
o-Xylene

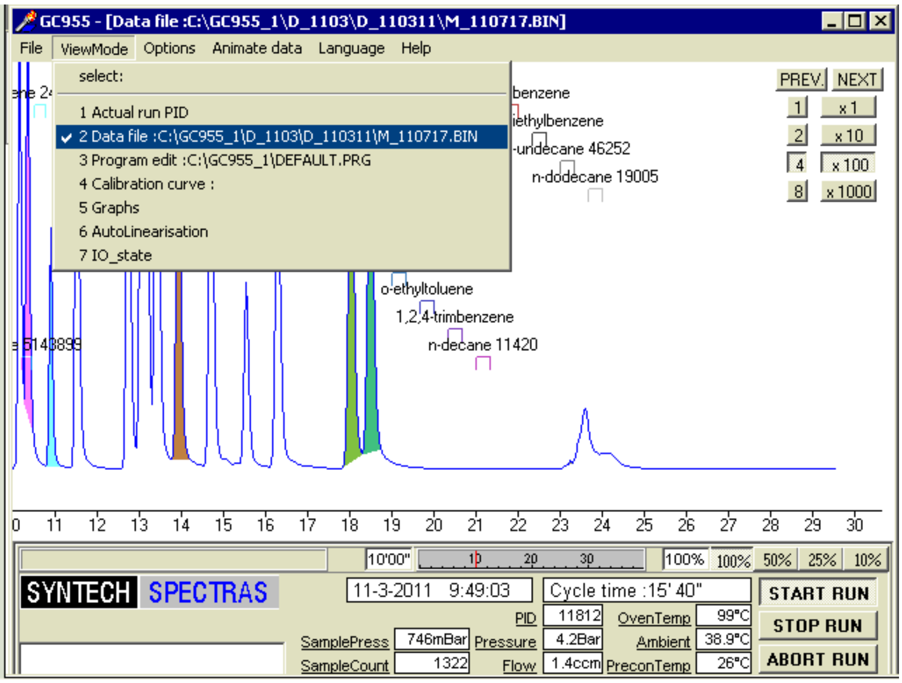
0
100%

14-3-2011 13:28:08

Cycle time :00' 50"

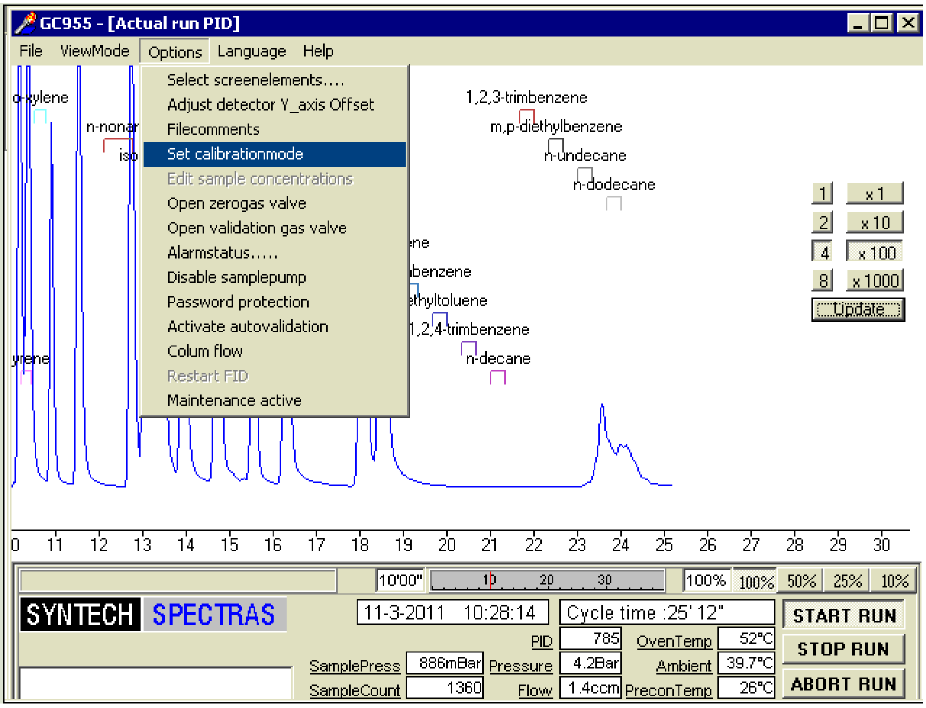
PID -12
OvenTemp 51°C
SamplePress 955mBar
Pressure 4.2Bar
Ambient 41.1°C
SampleCount 400
Flow 0.0ccm
PreconTemp 178°C

4. Connect span gas to span port on switchbox – purge gas at inlet so cal gas is at inlet to valve
5. Go to options and click on open validation gas valve
6. Let run for a couple of runs (4 to 5) – observe peaks (insert screenshot)
7. Go to view mode data file and open recent files – adjust peak windows if necessary



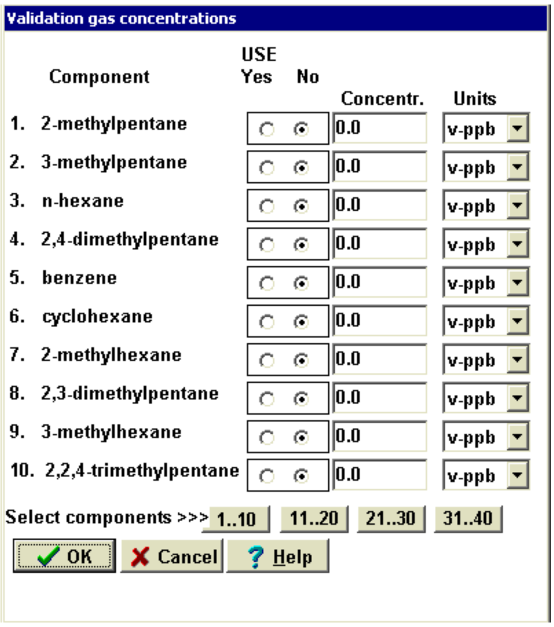
11-3-2011 9:49:03
Cycle time :15' 40"
PID 11812
OvenTemp 99°C
SamplePress 746mBar
Pressure 4.2Bar
Ambient 38.9°C
SampleCount 1322
Flow 1.4ccm
PreconTemp 26°C

8. Go to view mode act run PID and put unit into calibration mode – have gas flowing to span valve inlet on switch box
9. Select start new calibration



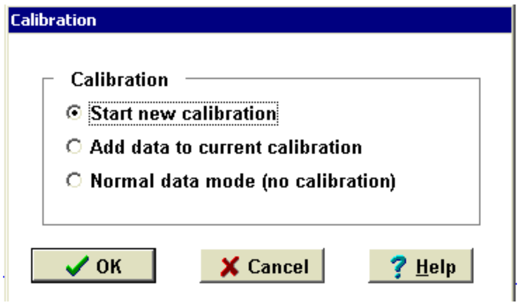
11-3-2011 10:28:14
Cycle time :25' 12"
PID 785
OvenTemp 52°C
SamplePress 886mBar
Pressure 4.2Bar
Ambient 39.7°C
SampleCount 1360
Flow 1.4ccm
PreconTemp 26°C

10. Enter in bottle values – remember para and meta-xylene co-elute so add those 2 values together as the value- click USE yes



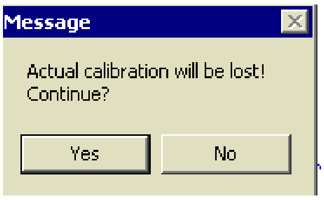
Validation gas concentrations

Component	USE Yes	USE No	Concentr.	Units
1. 2-methylpentane	○	●	0.0	v-ppb
2. 3-methylpentane	○	●	0.0	v-ppb
3. n-hexane	○	●	0.0	v-ppb
4. 2,4-dimethylpentane	○	●	0.0	v-ppb
5. benzene	○	●	0.0	v-ppb
6. cyclohexane	○	●	0.0	v-ppb
7. 2-methylhexane	○	●	0.0	v-ppb
8. 2,3-dimethylpentane	○	●	0.0	v-ppb
9. 3-methylhexane	○	●	0.0	v-ppb
10. 2,2,4-trimethylpentane	○	●	0.0	v-ppb



Calibration

Calibration
● Start new calibration
○ Add data to current calibration
○ Normal data mode (no calibration)

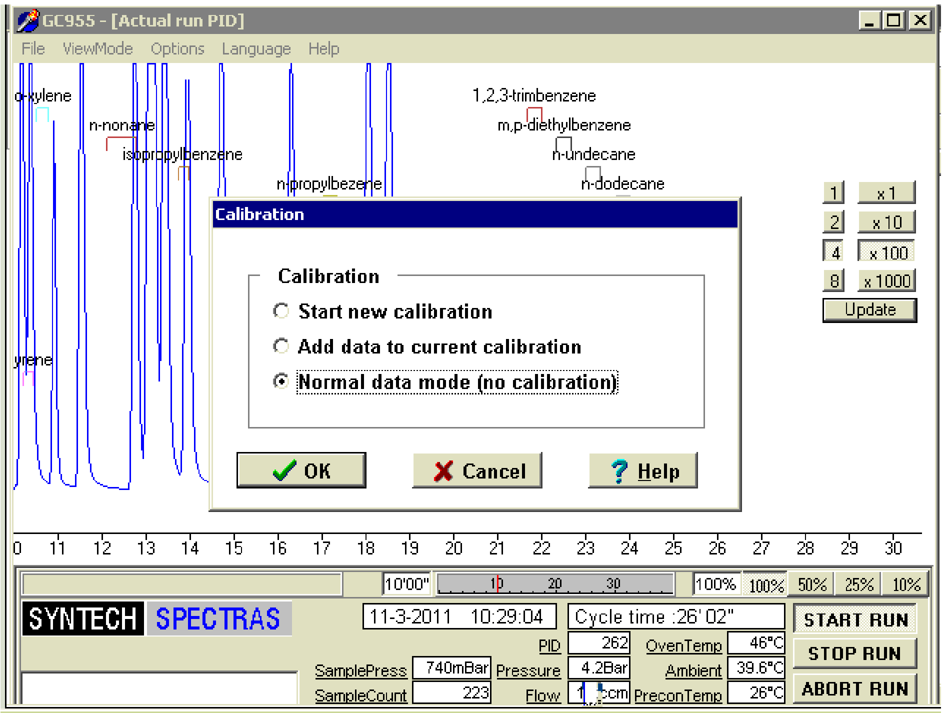


Message

Actual calibration will be lost!
Continue?

MAKE SURE YOU HAVE THE ACTCALIB.DAT BACKED UP PER INSTRUCTIONS ABOVE

11. Let system run for 2 files or until data stable
12. Go to view mode calibration mode
13. Go to Data selection calibration files
14. Choose component to calibrate
15. Select data files from the calibdat folder (YR/month/day) of data files collected – add to the display
16. Select Calculate calibration line – select linear regression with fixed basepoint
17. Calculate calibration line
18. Repeat for all parameters
19. Let DAS stay in calibration flag mode for ½ hour after finish collecting cal data so it is flagged in DAS



Calibration

Calibration

○ Start new calibration

○ Add data to current calibration

● Normal data mode (no calibration)

11-3-2011 10:29:04

Cycle time :26' 02"

PID 262

OvenTemp 46°C

SamplePress 740mBar

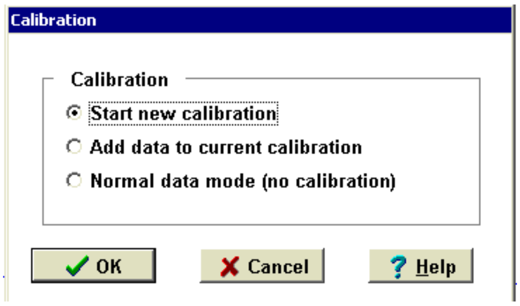
Pressure 4.2Bar

Ambient 39.6°C

SampleCount 223

Flow 1 ccm

PreconTemp 26°C



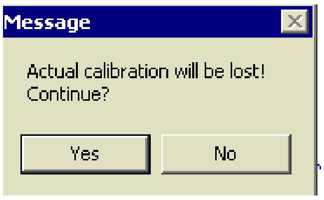
Calibration

Calibration

● Start new calibration

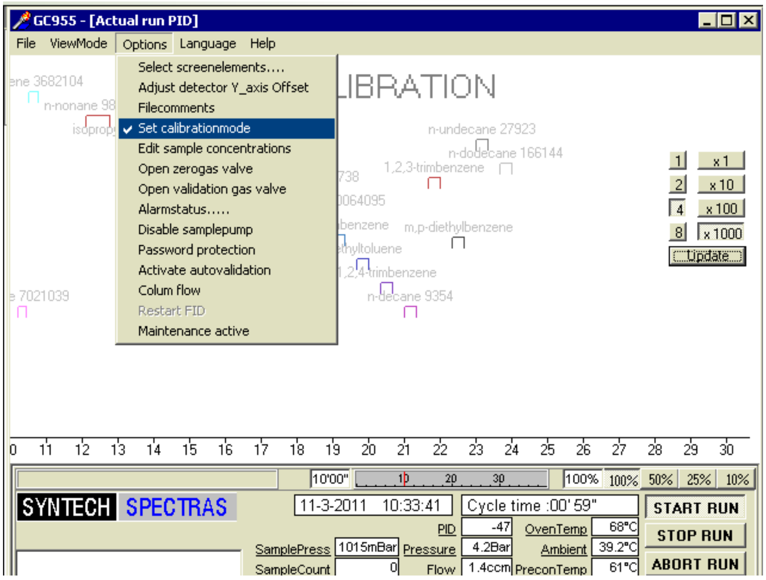
○ Add data to current calibration

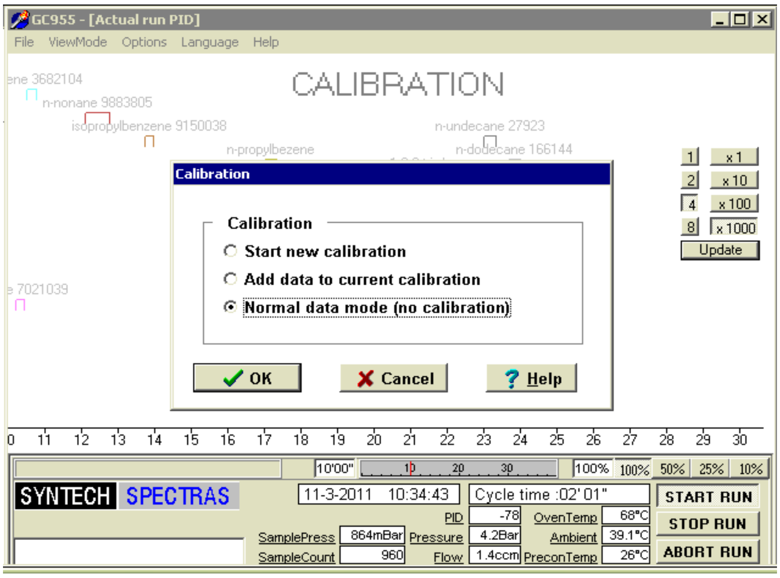
○ Normal data mode (no calibration)



Message

Actual calibration will be lost!
Continue?





Calibration

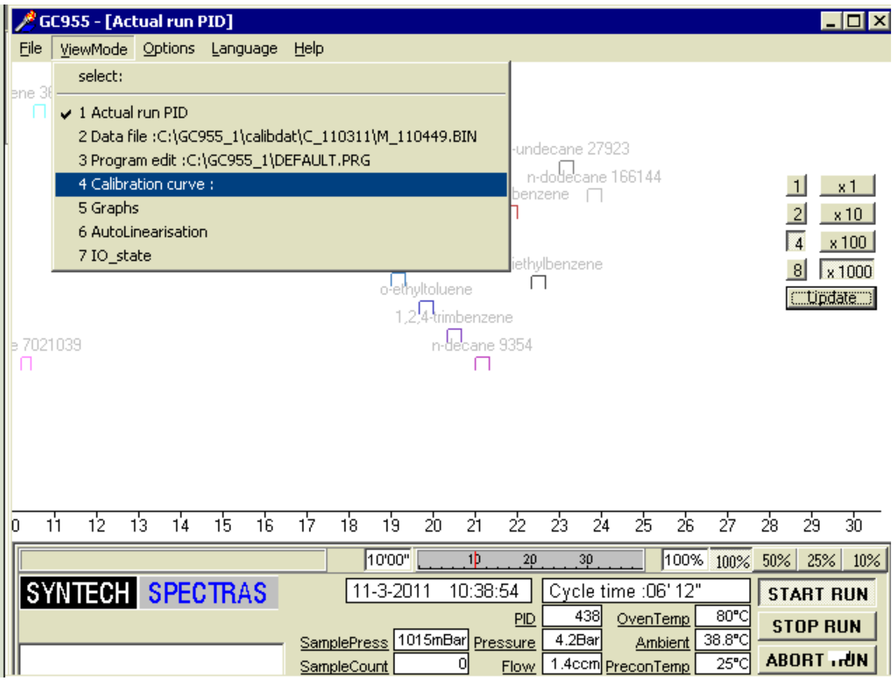
○ Start new calibration

○ Add data to current calibration

● Normal data mode (no calibration)

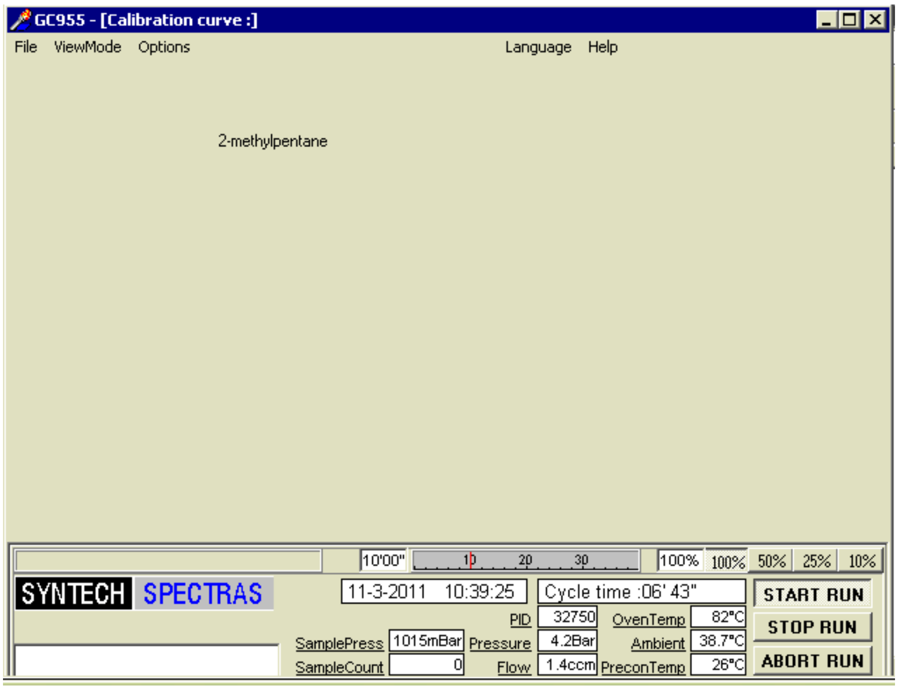
Constructing a calibration Curve

1) Click in the “ViewMode” on “Calibration curve” :



11-3-2011 10:38:54
Cycle time :06' 12"
PID 438
OvenTemp 80°C
SamplePress 1015mBar
Pressure 4.2Bar
Ambient 38.8°C
SampleCount 0
Flow 1.4ccm
PreconTemp 25°C

2) You see:

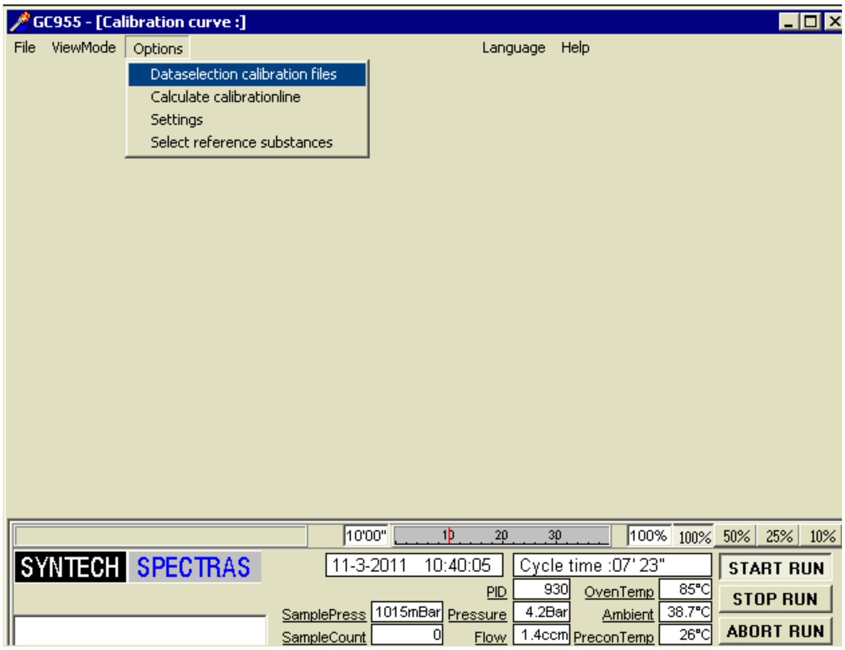


11-3-2011 10:39:25
Cycle time :06' 43"
PID 32750
OvenTemp 82°C
SamplePress 1015mBar
Pressure 4.2Bar
Ambient 38.7°C
SampleCount 0
Flow 1.4ccm
PreconTemp 26°C

Click on :

- Options
- Data selection calibration files

3) You see



10'00"

11-3-2011 10:40:05

Cycle time :07' 23"

PID 930

OvenTemp 85°C

SamplePress 1015mBar

Pressure 4.2Bar

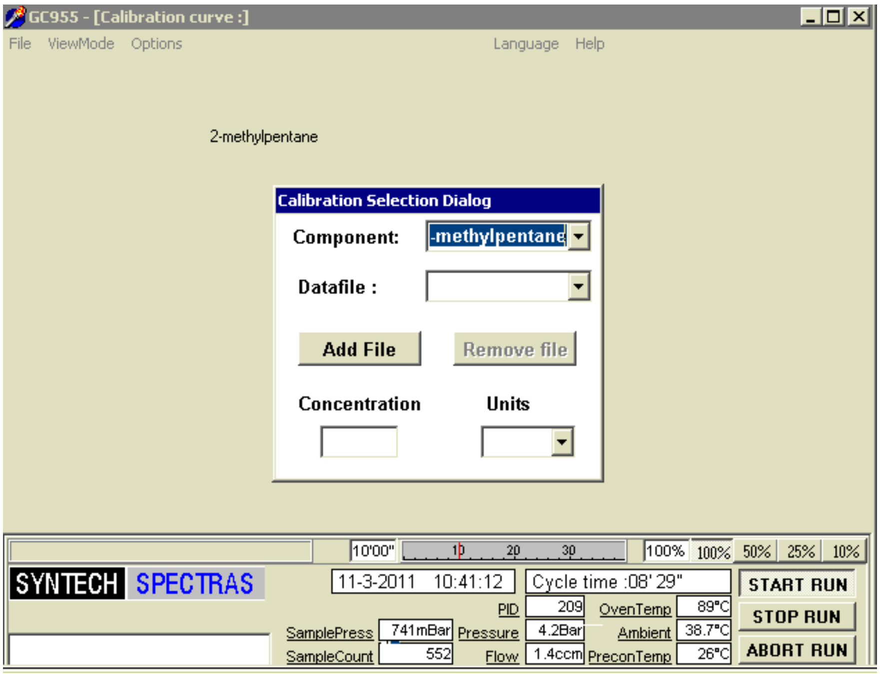
Ambient 38.7°C

SampleCount 0

Flow 1.4ccm

PreconTemp 26°C

4) You see:



Component: -methylpentane

Datafile :

Concentration

Units

10'00"

11-3-2011 10:41:12

Cycle time :08' 29"

PID 209

OvenTemp 89°C

SamplePress 741mBar

Pressure 4.2Bar

Ambient 38.7°C

SampleCount 552

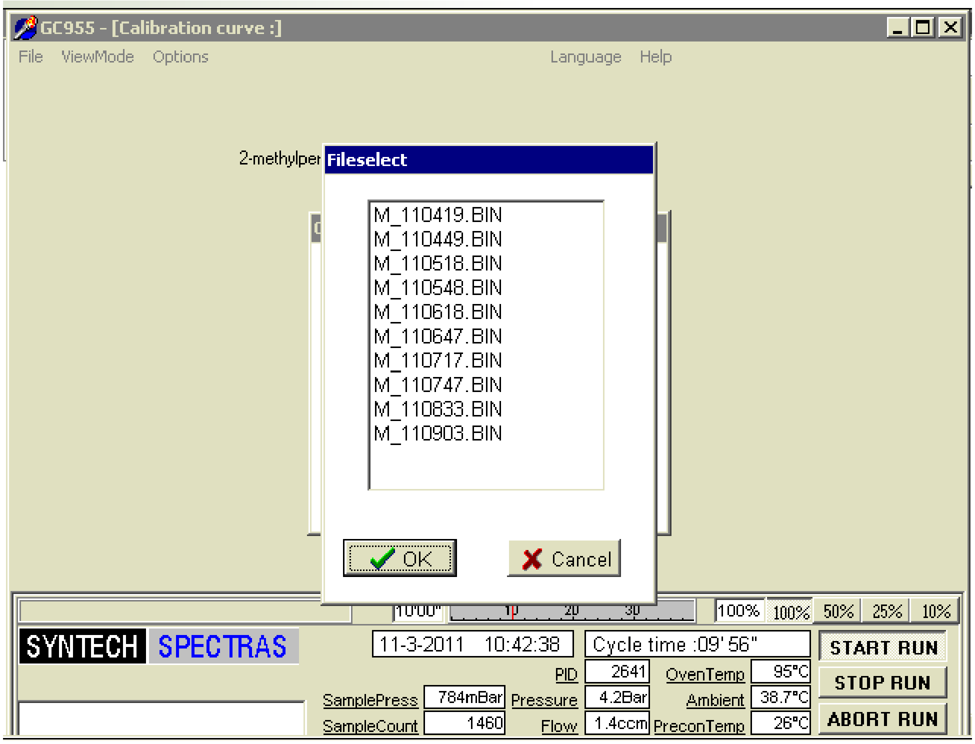
Flow 1.4ccm

PreconTemp 26°C

Click on :

- Add File:

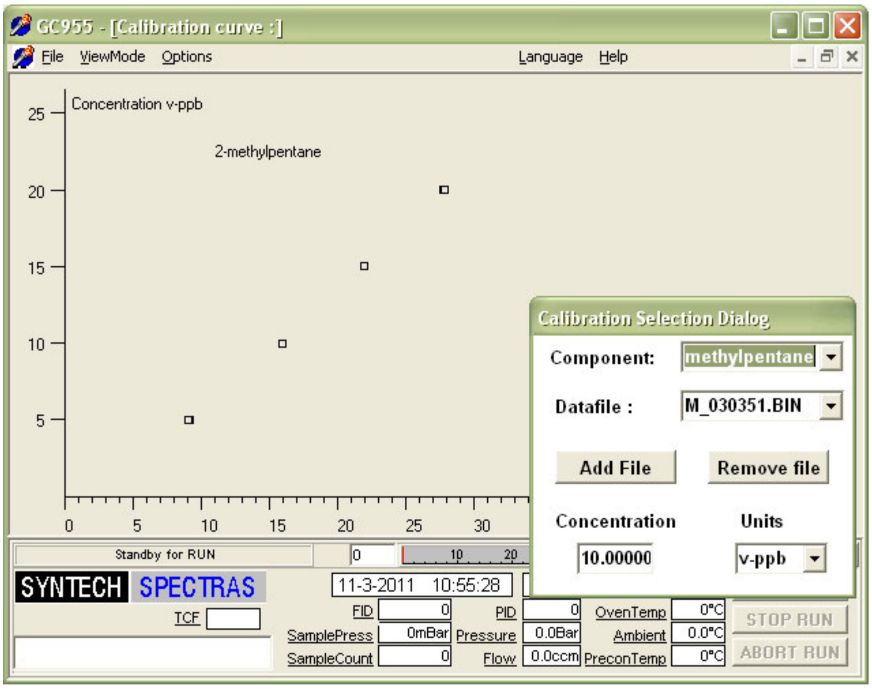
5) You see:



M_110419.BIN
M_110449.BIN
M_110518.BIN
M_110548.BIN
M_110618.BIN
M_110647.BIN
M_110717.BIN
M_110747.BIN
M_110833.BIN
M_110903.BIN

11-3-2011 10:42:38
Cycle time :09' 56"
PID 2641
OvenTemp 95°C
SamplePress 784mBar
Pressure 4.2Bar
Ambient 38.7°C
SampleCount 1460
Flow 1.4ccm
PreconTemp 26°C

6) You select
- All files, in this case : M_110419 to M_110903
- OK



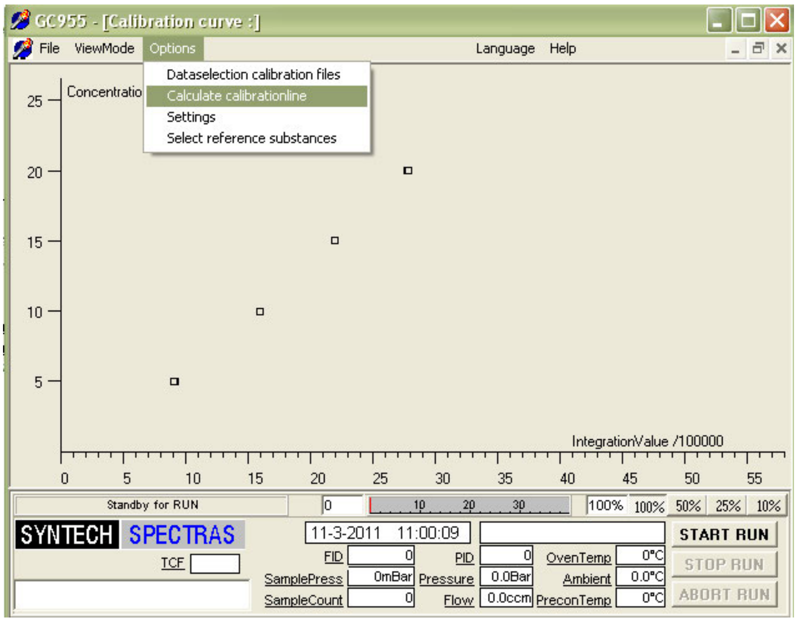
Component: methylpentane
Datafile : M_030351.BIN
Concentration 10.00000
Units v-ppb

11-3-2011 10:55:28
FID 0
PID 0
OvenTemp 0°C
TCF
SamplePress 0mBar
Pressure 0.0Bar
Ambient 0.0°C
SampleCount 0
Flow 0.0ccm
PreconTemp 0°C

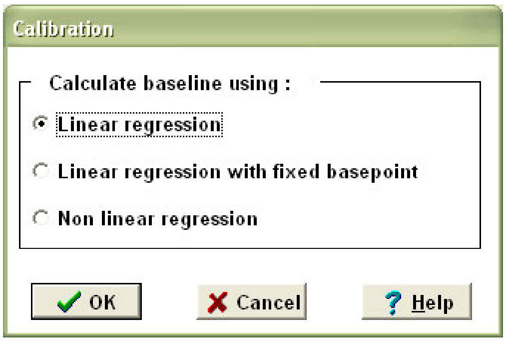
You see that there is no calibration curve but only points.

So you have to make a calibration curve.

1) Click on :
- Options
- Calculate calibration line



2) You see:


Calibration

Calculate baseline using :

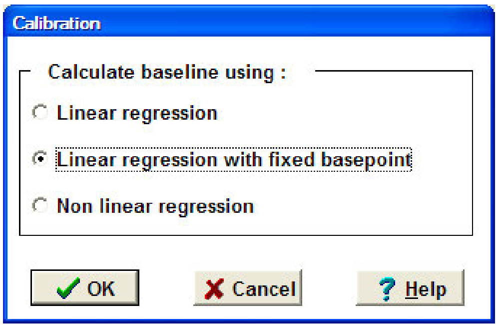
● Linear regression

○ Linear regression with fixed basepoint

○ Non linear regression

3) Then you click on :

- Linear regression with fixed basepoint.


Calibration

Calculate baseline using :

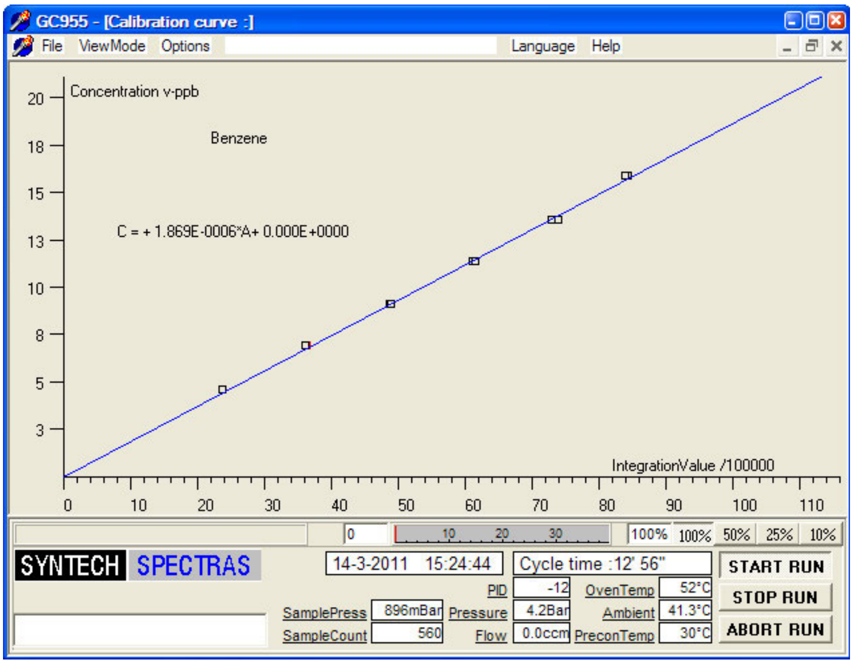
○ Linear regression

● Linear regression with fixed basepoint

○ Non linear regression

- Ok

So then you have a calibration line like example below.



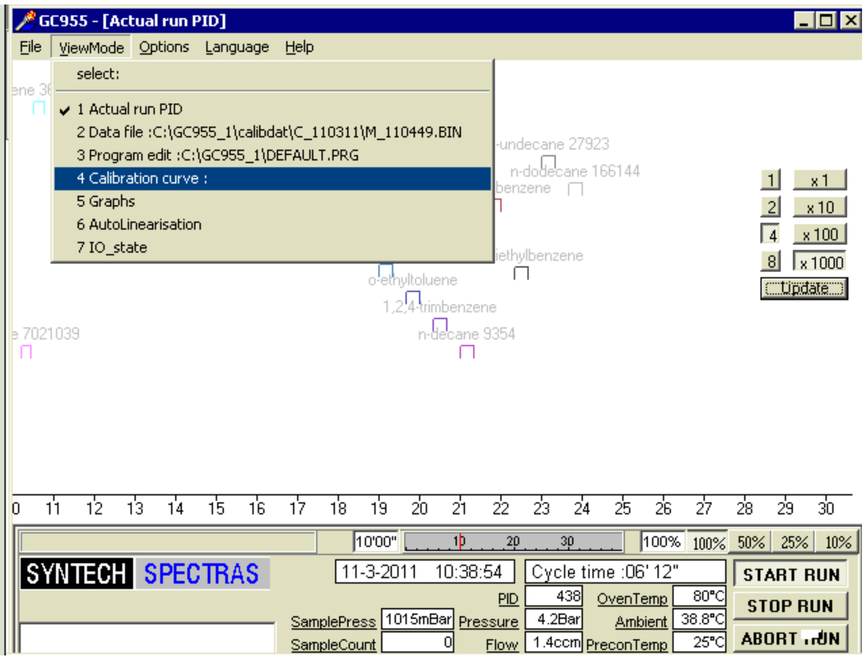
C = + 1.869E-0006*A+ 0.000E+0000

14-3-2011 15:24:44
Cycle time :12' 56"
PID -12
OvenTemp 52°C
SamplePress 896mBar
Pressure 4.2Bar
Ambient 41.3°C
SampleCount 560
Flow 0.0ccm
PreconTemp 30°C

You have to do this for each and every compound.
You have more compounds.
So the next is:

Selecting Next Compounds

- Click on the View Mode on Calibration curve:

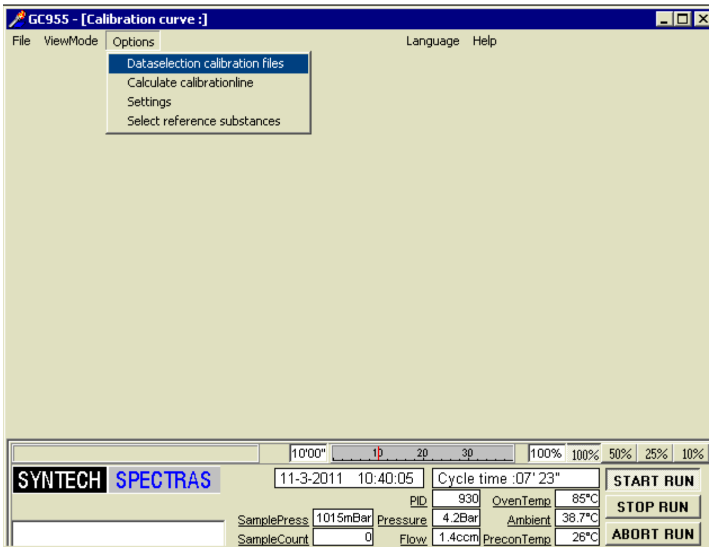


11-3-2011 10:38:54
Cycle time :06' 12"
PID 438
OvenTemp 80°C
SamplePress 1015mBar
Pressure 4.2Bar
Ambient 38.8°C
SampleCount 0
Flow 1.4ccm
PreconTemp 25°C

Click then on :

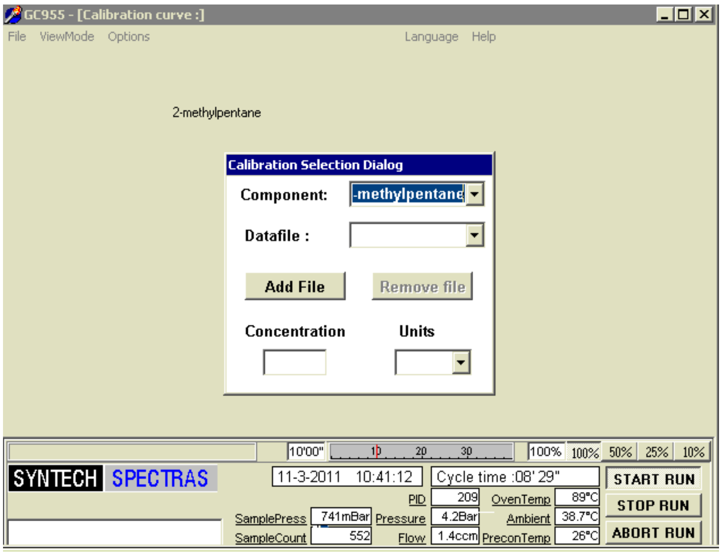
- Options
- Data selection calibration files

1) You see



10'00"
100%
11-3-2011 10:40:05
Cycle time :07' 23"
PID 930
OvenTemp 85°C
SamplePress 1015mBar
Pressure 4.2Bar
Ambient 38.7°C
SampleCount 0
Flow 1.4ccm
PreconTemp 26°C

2) You see:



2-methylpentane

Component: -methylpentane

Datafile :

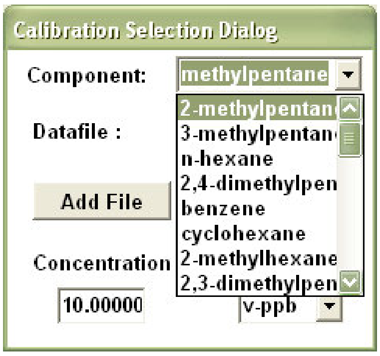
Concentration

Units

10'00"
100%
11-3-2011 10:41:12
Cycle time :08' 29"
PID 209
OvenTemp 89°C
SamplePress 741mBar
Pressure 4.2Bar
Ambient 38.7°C
SampleCount 552
Flow 1.4ccm
PreconTemp 26°C

Click at ARROW down by component:

You see :



Component: methylpentane

2-methylpentan
3-methylpentan
n-hexane
2,4-dimethylpen
benzene
cyclohexane
2-methylhexane
2,3-dimethylpen

Datafile :

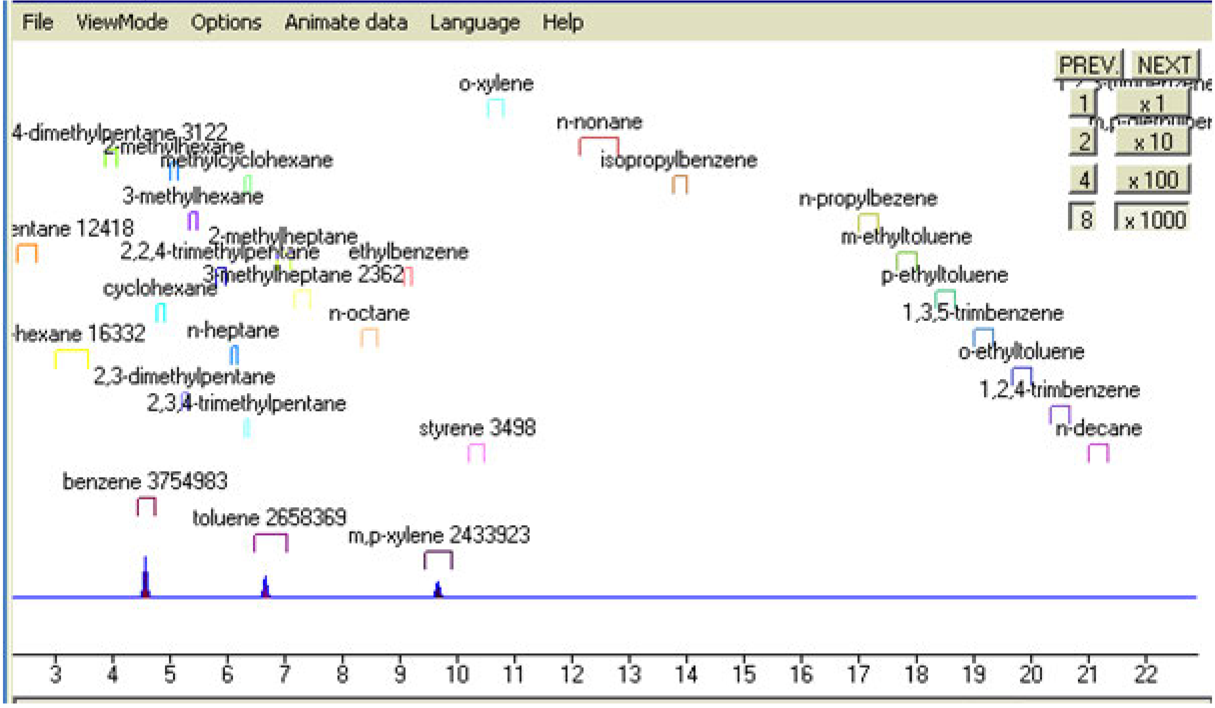
Concentration 10.00000 v-ppb

You click on next compound and you start again with add file and so on. (See page 20)
Now you are ready with calibration curve.

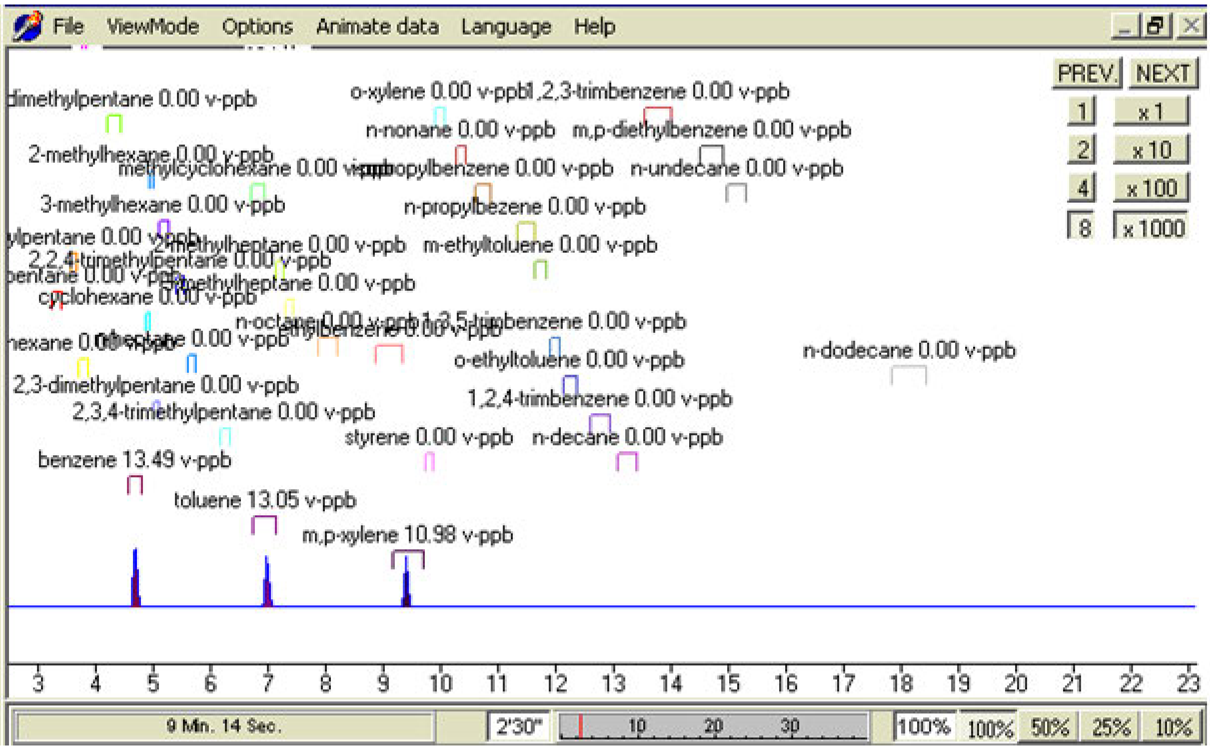
You can see in calibdat the chromatograms with the concentrations and not areas.

Next page you see for example: Before and after Calibration.

You see here BEFORE calibration :
You see only areas.

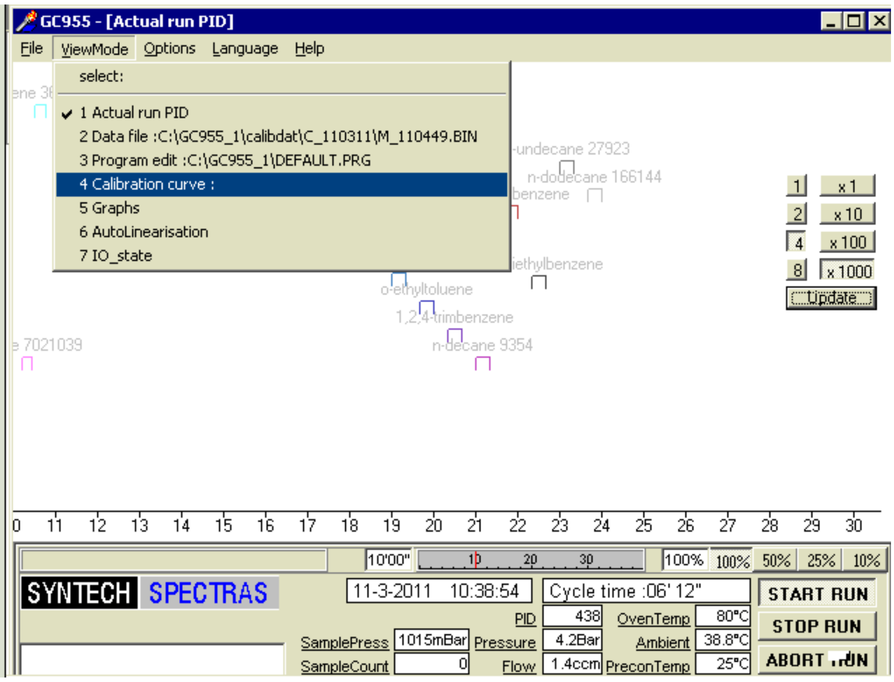


Then AFTER calibration you see the concentrations in ppb’s:



Using the Calibration setting

1) Click in the ViewMode on Calibration curve:



11-3-2011 10:38:54

Cycle time :06' 12"

PID 438

OvenTemp 80°C

SamplePress 1015mBar

Pressure 4.2Bar

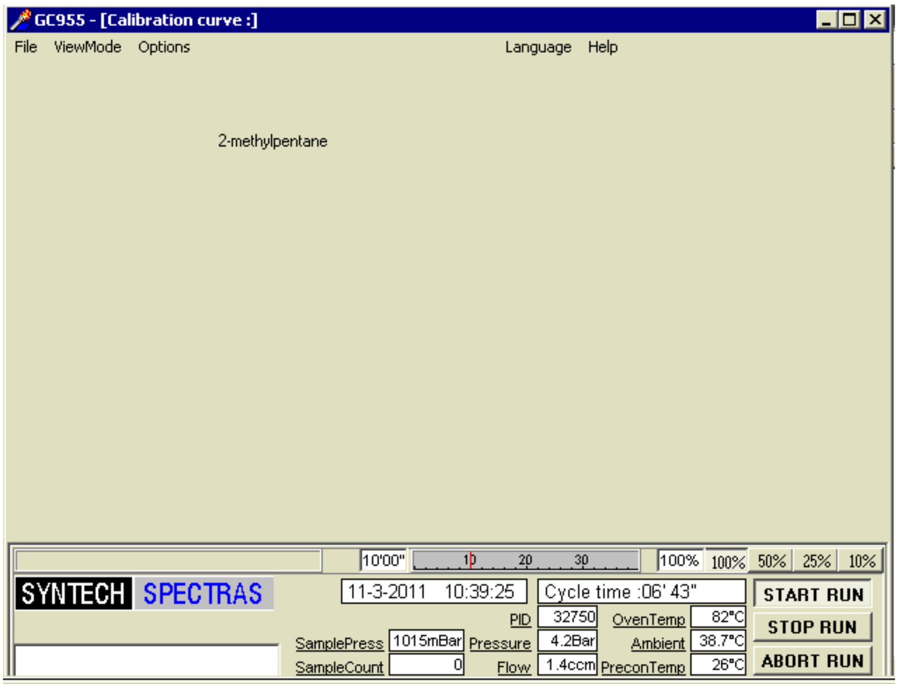
Ambient 38.8°C

SampleCount 0

Flow 1.4ccm

PreconTemp 25°C

2) You see:



11-3-2011 10:39:25

Cycle time :06' 43"

PID 32750

OvenTemp 82°C

SamplePress 1015mBar

Pressure 4.2Bar

Ambient 38.7°C

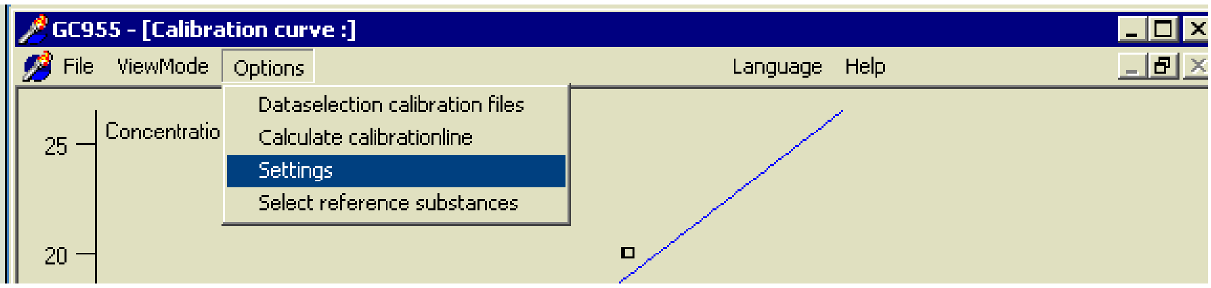
SampleCount 0

Flow 1.4ccm

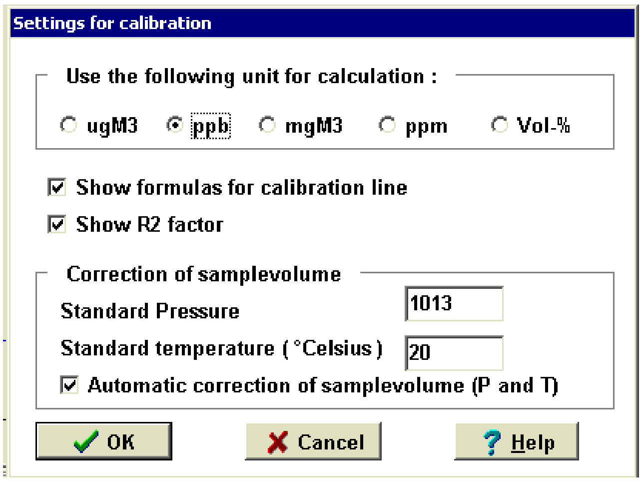
PreconTemp 26°C

Click on :

- Options
- Settings



3) You see


Settings for calibration

Use the following unit for calculation :

○ ugM3 ● ppb ○ mgM3 ○ ppm ○ Vol-%

☑ Show formulas for calibration line

☑ Show R2 factor

Correction of samplevolume

Standard Pressure 1013

Standard temperature (°Celsius) 20

☑ Automatic correction of samplevolume (P and T)

You can choose the unit for calculation.

9.6 Data Acquisition, Calculations and Data Reduction

Data analysis for this analyzer is detailed in the SOP_CHEV_BO_19 SOP for data acquisition and storage.

9.7 Computer Hardware and Software

(Used to manipulate analytical results and report data)

10 Quality Control and Quality Assurance

Requirement	**Frequency**	**Acceptance Criteria**	**Action**
Bias	Annually	Coefficient of Variance (CV) $\leq$ 10%	Calculate according to 40 CFR Part 58 App A sec 2.1.
Precision	Quarterly as per SOP_CHEV_CO_1	Linear regression correlation > 96 %, zero +- 2 ppb	Adjust analyser if not within acceptance criteria
	Monthly Zero/Span	zero < 2ppb, span < 15 %	Recalibrate if analyser not within acceptance criteria

Completeness	N/A	80%	If below 80 % institute quality control measures
Representativeness	N/A	Neighborhood as per 40 CFR 58	N/A
Comparability	N/A	Ambient air	N/A
Method Detection Limit		0.5 ppb	Recalibrate if analyser not within acceptance criteria

10.1 Corrective Action

Corrective actions to be carried out according to SOP_CHEV_BO_20: SOP for Corrective Action.

11 References

Manual for the Syntech Spectras GC955-series Version 4, Synspec b.v, March 2009

Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II, US EPA Ambient Air Quality Monitoring Programme, December 2008

BIOS SOP

T702 SOP

Instrument checksheet

SOP_CHEV_BO_19: SOP for data acquisition and storage

SOP_CHEV_BO_20: SOP for Corrective Action

12 Appendix A: Analyzer Checklist

GC-955 Checkout		Notes
SN		
Power on functional		
Column flow		
Pressure		
Ambient Temp		
Oven start Temp		
Precon Start Temp		
Syringe Sample Strokes		
Peak Windows		
Std Response		